REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

REPUBLIC OF THE PHILIPPINES

SPECIAL ASSISTANCE FOR PROJECT SUSTAINABILITY (SAPS) FOR KAMANAVA AREA FLOOD CONTROL AND DRAINAGE SYSTEM IMPROVEMENT PROJECT

FINAL REPORT

FEBRUARY 2014

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ORIENTAL CONSULTANTS CO., LTD. (OC)
PACIFIC CONSULTANTS CO., LTD.

PP
CR(10)
14-002

REPUBLIC OF THE PHILIPPINES
DEPARTMENT OF PUBLIC WORKS AND HIGHWAYS

REPUBLIC OF THE PHILIPPINES

SPECIAL ASSISTANCE FOR PROJECT SUSTAINABILITY (SAPS) FOR KAMANAVA AREA FLOOD CONTROL AND DRAINAGE SYSTEM IMPROVEMENT PROJECT

FINAL REPORT

FEBRUARY 2014

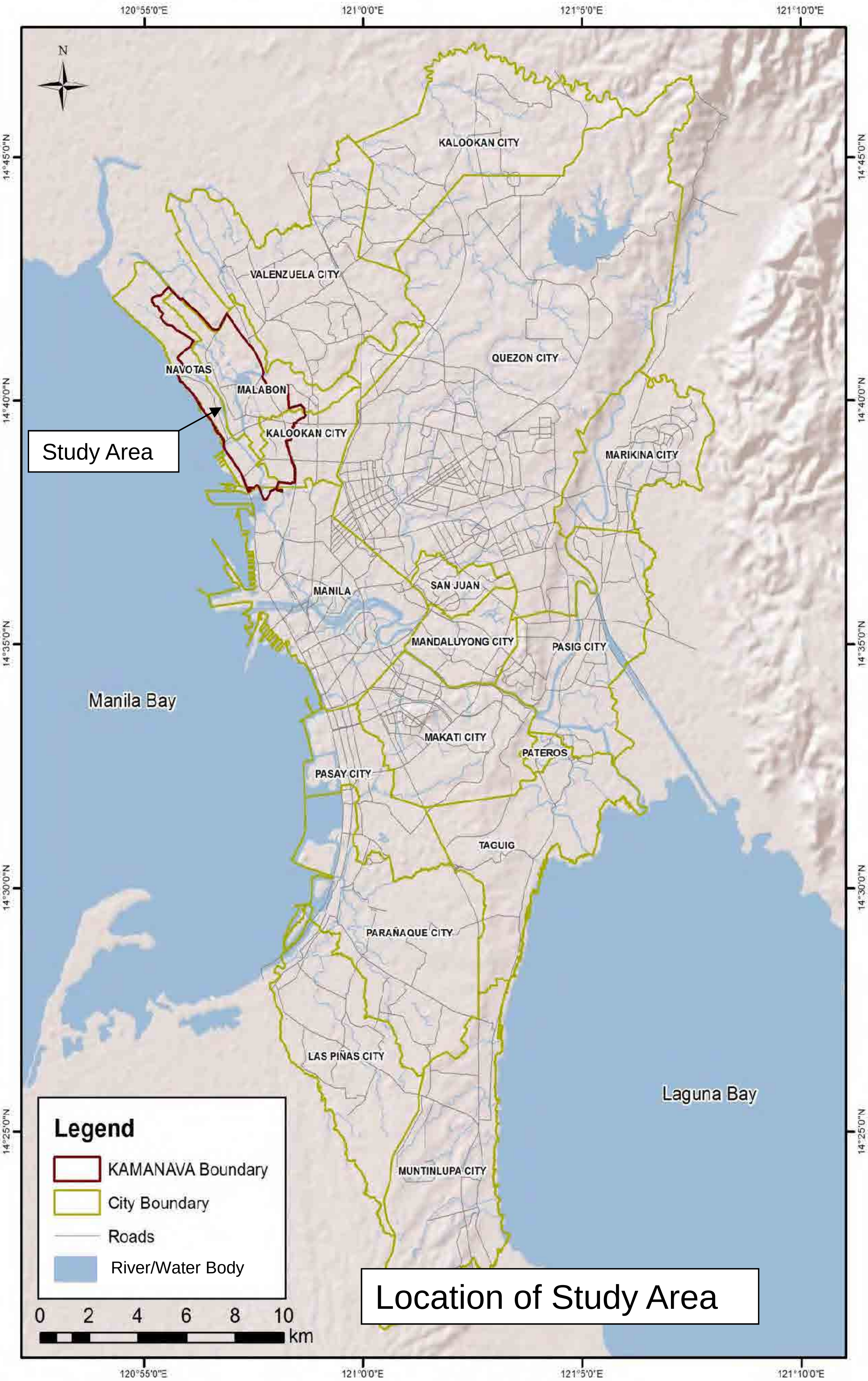
JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

ORIENTAL CONSULTANTS CO., LTD. (OC)
PACIFIC CONSULTANTS CO., LTD.

Foreign Currency Exchange Rates

Currency	Exchange Rate/USD
Philippine Peso (PHP)	45.26
Japanese Yen (JPY)	102.46

(February, 2014)



120°55'0"E
121°0'0"E
121°5'0"E
121°10'0"E
14°45'0"N
14°40'0"N
14°35'0"N
14°30'0"N
14°25'0"N
N
KALOOKAN CITY
VALENZUELA CITY
QUEZON CITY
NAVOTAS
MALABON
KALOOKAN CITY
Study Area
MARIKINA CITY
SAN JUAN
MANILA
MANDALUYONG CITY
PASIG CITY
Manila Bay
MAKATI CITY
PATEROS
PASAY CITY
TAGUIG
PARAÑAQUE CITY
LAS PIÑAS CITY
Laguna Bay
MUNTINLUPA CITY
Legend
KAMANAVA Boundary
City Boundary
Roads
River/Water Body
0 2 4 6 8 10
km
Location of Study Area

Summary

1. Introduction

1.1 Background of the Study

The KAMANAVA area is the area comprised of the whole or parts of two cities and two municipalities, namely; Kalookan, Malabon, Navotas and Valenzuela in Metro Manila and is generally a flat and low lying terrain with two thirds of it below high tide level and therefore, prone to frequent flooding.

The government of Philippines (GOP) with technical assistance from Japan International Cooperation Agency (JICA), carried out a feasibility study for flood control and drainage improvement of Metro Manila in 1990 and identified KAMANAVA as one of the high priority projects to be implemented.

In 1999, following the Project Appraisal by JBIC (JICA), the implementation of KAMANAVA Area Flood Control and Drainage System Improvement Project (hereinafter referred to as "KAMANAVA Project") was initiated and went through the following stages:

- Detailed Design (completed in 2001)

- Construction (2003-2013)

In general, it has been observed/reported that the frequent flooding in the area is reduced drastically with the progressive completion of the facilities under KAMANAVA Project. For example, only five (5) Barangays in Malabon were reportedly flooded during typhoon "Ondoy" in 2009 although construction works were not fully completed by then. However, the onset of monsoon (Habagat) and the incessant heavy rains, caused unprecedented flooding in the area in August 2012, and this has triggered the local community as well as the concerned Local Government Units (LGUs), to raising the questions about the effectiveness of the KAMANAVA Project.

Whilst progressing with this augmentation works, DPWH intends to implement further measures to ensure the long term sustainability of KAMANAVA Project, following a study to:

a) understand/confirm the effectiveness/impact of the Project during floods in August 2012;

b) technically review the completed works and confirm the necessary measures to be taken, if any; and

c) establish a cooperative relationship among the stakeholders in KAMANAVA area.

In July 2013, JICA agreed to provide special assistance to DPWH for the above purpose referred to as the "Special Assistance for Project Sustainability (SAPS) for KAMANAVA Area Flood Control & Drainage System Improvement Project".

1.2 Study Area

The Study area shall be KAMANAVA Project Area with a drainage area of 18.48 km^2, in Metro Manila

1.3 Outcomes of the Study

a) Philippine Government's (Local/National) understanding on the plan and objectives of the Project is enhanced.

b) The effects of the Project are examined.

c) The causes of the flood in August 2012 are explained.

d) Measures to achieve, promote, and enhance the effects of the Project and its sustainability, based on the current situation are proposed.

e) Survey results are efficiently utilized by DPWH to properly and effectively share and explain the information regarding the Project to the stakeholders

2. KAMANAVA Project

2.1 Planning Objectives

The planning objectives of the KAMANAVA Project were to:

- Protect the area from high tide and riverbank overflows in extreme weather events where tide level is the highest observed and river flow is the estimated flood flow with a 30 year return period (450 m^3/s)
- Decrease the affected area of the inland flood (inundation) from 90% of the area to less than 15% during a 10 year rainfall/flood event with water depths not exceeding 20 cm; and

The 'target year' for the above planning was year 2020.

2.2 Completed components

There have been modifications/revisions to KAMANAVA Project since the time of appraisal by JBIC in 1999 at various stages of its implementation to completion in 2013.

Modifications/revisions that may impact the functionality, (and therefore the project objectives), include:

- Lowering of the top level of Polder Dike (Road Dike) to elevation +12.10 m (DPWH Datum) in the initial stretch (compared to +12.60 m (DPWH Datum) in the rest of the Polder Dike)
- Deferring the construction of Pumping Stations at two locations in Malabon River northern area (Dampalit and South Pinagkabalian areas) due to present land use conditions; and
- Downgrading of the Navigation Lock to a Navigation Gate;

2.3 Preconditions of the Project

As per the discussion between JICA and DPWH as well as the detailed design, the following components of Project were not included in the JICA funding portion, but implementation of them by GOP was confirmed and agreed as necessary to achieve and sustain project objectives effectively.

- Dredging of Malabon river bed (by DPWH)
- Raising Malabon (Tonsuya) Bridge, Lambingan Bridge and Tinajeros Bridge at the completion of the project (by DPWH);
- Improvement of secondary and tertiary drainage systems in the project area (by LGUs); and
- Solid waste management in the area (by LGUs).

2.4 Conditions during 2009 Typhoon "Ondoy" and 2012 Monsoon (Habagat)

The evolvement of KAMANAVA Project from planning through to completion can be summarized as shown in Table S.1. The statuses of the related projects outside of KAMANAVA Project are mentioned in Table S.2.

To examine the flooding phenomena in the protected area, it is necessary to understand the level of flood protection facilities that were accomplished under KAMANAVA Plan at the onset of 2009 typhoon "Ondoy" and 2012 monsoon (Habagat). The levels of accomplishment at the onset of the above floods were as follows.

(1) At the onset of 2009 Typhoon "Ondoy"

As per the details provided in the Completion Report, a local contractor completed a portion of the work under Local Contract Package 1, prior to the onset of typhoon "Ondoy" in September 2009, and the accomplishments in Polder Dike and River wall Raising are as follows;

- Completion of 3.4 km of Polder Dike
- Completion of approx. 1.1 km of River Wall Raising.

(2) At the onset of the 2012 Monsoon (Habagat)

As per the Completion Report, all works under KAMANAVA Project were fully accomplished by January 2012. However, the related projects such as dredging of the Malabon river bed, bridge raising, some improvement in existing drainage channels, and solid waste management were not fully completed.

Table S.1 Summary of Evolvement of KAMANAVA Project

Project Feature	Description	Planning (2000)	Design (2001)	Completion (2012)
Objective/Planning Criteria	High Tide	Highest observed (1.38 m above MSL, 11.86m DPWH Datum)	1.625 m above MSL (12.1m above DPWH Datum)	Same as in design
	River Flow	30 year return period	Same as in planning with dredging of Malabon river	Same as in design
	Inundation	Rainfall of 10 year return period	-do-	-do-
	Flooding	Maximum depth of inundation 20 cm for less than 24 hours	-do-	-do-
	Target Year	2020	-do-	-do-
Funding	Main Flood Protection Facilities	JICA	JICA	88% Using JICA funds; 12% Using GOP funds
	Supporting Flood Protection Facilities	LGUs, DPWH	LGUs, DPWH	LGUs, DPWH. Partially implemented
Structural Measures (Using JICA Funds originally, however, later GOP fund was used to complete.)	Polder Dike	8.0 km	8.6 km	Same as in design. Partly accomplished using JICA funds. Balance completed using GOP funds
	Raising of River walls	12.4 km (two types only)	Malabon River 6.6 km (9 types) Marala River 3.9 km (3 types)	-do-
	Navigation Lock/Gate	One Navigation Lock (facilitate navigation during high tide also)	One Navigation Gate (navigation limited to low tide period only)	Same as in design. Fully completed using JICA funds
	Independent Flood Gates	6 Units	5 Units	-do-
	Control Gates	2 Units	Nil	-do-
	Pumping Stations with Flood Gates	6 Units	4 Units (Pumping Stations at Dampalit & South Pinagkabalian deferred)	-do-
	Pumping Stations without Flood Gates	1 Unit (adjacent to Navigation Lock)	1 Unit (adjacent to Navigation Gate)	-do-
	Improvement of Existing Drainage Channels	6.4 km	5.6 km	-do-
	New Drainage Channels	1.8 km	2.1 km	Same as in design. Fully completed using JICA funds

Source: JICA Study Team

Table S.2 Summary of Evolvement of Related Projects by DPWH and LGUs

Project Feature	Description	Planning (2000)	Design (2001)	Completion (2012)
Structural Measures (Using GOP Funds)	Raising of Bridges by DPWH	Bangkulasi	Bangkulasi	Not raised yet
		Tonsuya	Tonsuya	-do-
		Lambingan	Lambingan	Being raised
		Tinajeros	Tinajeros	Not raised yet
	Secondary & Tertiary Drainage by LGUs	Scope not quantified	Scope not quantified	Not yet
	Solid Waste Management by LGUs	Scope not quantified	Scope not quantified	On-going
	Dredging of Malabon River by DPWH	Scope not quantified	Scope not quantified	Not yet

Source: JICA Study Team

3. Effectiveness of the KAMANAVA Project

3.1 Findings regarding 2009 typhoon "Ondoy"

(a) At the end of September 2009, the KAMANAVA area as well as the upstream Tullahan river basin was affected by the rainfall associated with the landfall of Typhoon “Ondoy”. The two days rainfall of 371.9mm in the area is assessed to correspond to about a 10-year return period.

(b) Peak discharge in the Tullahan river before it enters the KAMANAVA Project Boundary, was estimated as 600 m^3/s for 2009 typhoon “Ondoy” based on the flood marks. The Tullahan river was already flooded and also because of the channel capacity in the upper section of the Malabon river was about 100 m^3/s (less than the design discharge 450 m^3/s for a 30 year return period), therefore, during typhoon “Ondoy”, over flow from the Malabon river took place in the Project area. One of the reasons for such small channel capacity was the river bed dredging as a precondition of the Project was not conducted in the Project.

(c) The highest tide elevation observed during typhoon “Ondoy” at North Navotas Navigation Gate was +12.20 m (DPWH Datum) against the design tide level of +12.1 m (DPWH Datum)

(d) At the onset of typhoon “Ondoy” in 2009, the northern part of the Malabon River and areas adjacent to the Malabon River were not as fully protected as the Polder Dike and the raising of River Walls were only partly accomplished. So there were some stretches where existing or partly constructed Polder Dike’s embankment level was below +12.20 m (DPWH Datum). Therefore, during typhoon “Ondoy”, sea water escaped over the low stretches of the partly completed Polder Dike and contributed to flooding in the protected area north of Malabon River, and the flood water overflowed from the upper section of the Malabon River to contribute to flooding north and south of the Malabon River.

(e) The return period of the rainfall (the hourly rainfall was 60.0 mm) in the protected area during typhoon “Ondoy” was found to be 5 years and less than the 10 year return period adopted in the design.

(f) During typhoon “Ondoy”, the incomplete Polder Dike and rainfall exceeding the design scale have compounded the flooding north of Malabon River.

3.2 Effectiveness of the KAMANAVA Project during 2009 typhoon "Ondoy"

For a high tide of +12.20 m (DPWH Datum) under the without condition, about 13 km^2 of the Project area could be submerged completely, however, the area along the downstream of the Malabon river and the Marala river were protected by the completed raising of the river wall to +12.60 m (DPWH Datum).

For the said high tide, the polder dike protected the sub-drainage areas such as North Navotas, Dampalit and South Pinagkabalian, while in the northern edge of the Project area overflow occurred because some portion was not completed up to a top elevation of +12.60 m (DPWH Datum) at the time of “Ondoy”.

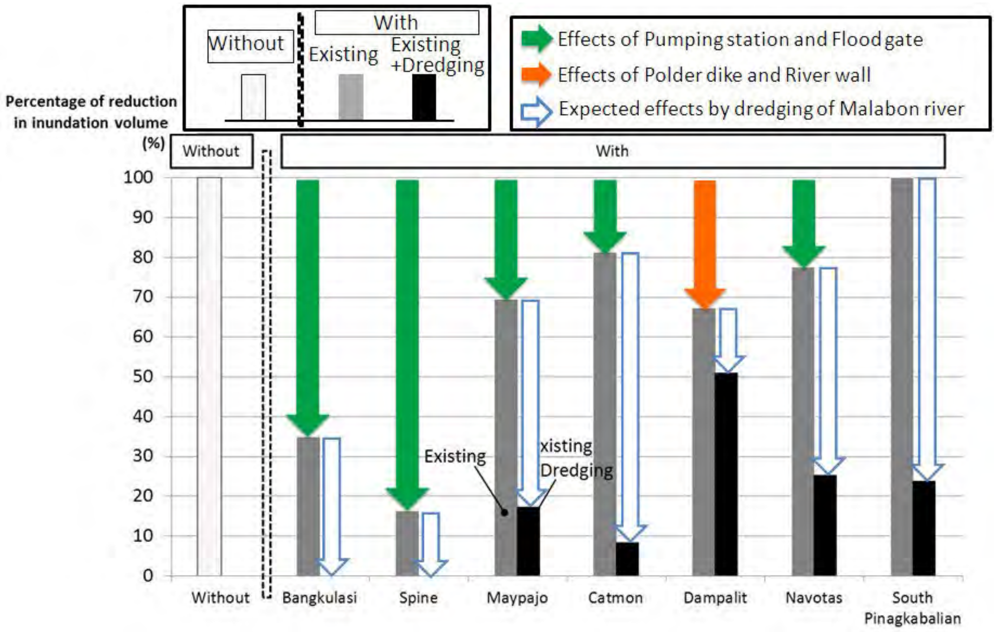
For the flood water discharge of 600 m^3/s from the Tullahan river basin (the upstream of Tinajeros Bridge), which came overflowing in the area due to shortage of flow capacity in the Tullahan river, the upstream end of the Malabon river also could not accommodate the said discharge, resulting in the overflow toward the inland area (sub-drainage areas such as Catmon sub-drainage area and South Pinagkabalian sub-drainage area). This phenomenon cannot be regarded as positive effectiveness of the Project, however, it is a very important point because it affected the effectiveness of the facilities for inland flood.

The above phenomena and the effectiveness of the Project are illustrated in Figure S.1. This figure is a schematic one, but it can show the general picture, as explained in the above, about what happened in 2009 typhoon “Ondoy”.

This figure shows by each sub-drainage area, the ratio (%) of inundation volume for the "with" condition to that for the "without" condition. Also in the figure, the extent of such reduction rate is shown by arrow marks.

For Bangkulasi and Spine sub-drainage areas, the pumps can reduce the inundation volume by 60-80 % compared with "without" conditions. For Maypajo, Catmon, Dampalit, Navotas and South Pinagkabalian sub-drainage areas, the reduction by the pumps is only 30 % or less. Especially in South Pinagkabalian and Dampalit, there is no effect from the pumps. While in Catmon there is a pumping station, but the reduction rate is small because of the overflow volume from the Malabon River. In Dampalit, the polder dike is effective to reduce the flood water volume.

This figure also shows the effectiveness of dredging of the Malabon River. By improvement of the Malabon River, the overflow from the river can be eliminated, so that Bangkulasi and Spine sub-drainage areas could become free from flooding. For Maypajo, Catmon, Navotas and South Pinagkabalian sub-drainage areas, the reduction by the dredging is large as 50 % or so.



Source: JICA Study Team

Figure S.1 Effectiveness of the KAMANAVA Project in 2009 Typhoon "Ondoy"

3.3 Findings regarding 2012 monsoon (Habagat)

(a) At the beginning of August 2012, the KAMANAVA area as well as the upstream Tullahan river basin was affected by the rainfall associated with the monsoon (Habagat). The two day rainfall of 737.5 mm in the area is assessed to correspond to about a 100-year return period.

(b) At the onset of monsoon (Habagat) in 2012, all flood protection facilities under KAMANAVA project were accomplished except for some balance works in Catmon Creek drainage channel improvements.

(c) Peak discharge in the Tullahan river before it enters the KAMANAVA Project Boundary, was estimated as 600 m^3/s for the 2012 monsoon (Habagat) based on the flood marks survey. The Tullahan river was already flooded and the channel capacity in the upper section of the Malabon river was 350 m^3/s (less than the design discharge 450 m^3/s for a 30 year return period), therefore, during the monsoon in 2012, over flow from the Malabon river took place in the Project area. One of the reasons for such small channel capacity was the river bed dredging as a precondition of the Project was not conducted in the Project.

(d) The highest tide elevation observed during monsoon (Habagat) in 2012 was more than +12.60 m (DPWH Datum) whereas the design tide level assumed is only +12.1 m (DPWH Datum).

(e) The return period of the rainfall (80 mm/h) in the protected area during monsoon (Habagat) in 2012 was found to be 10 years and is almost the same as the 10 year return period assumed in the design.

(f) Deferring the construction of Two Pumping Stations and continuous rainfall events have compounded the flooding north of Malabon River during monsoon (Habagat) in 2012.

3.4 Effectiveness of the KAMANAVA Project during 2012 monsoon (Habagat)

For the high tide of +12.65 m (DPWH Datum), the area along the downstream of the Malabon River and the Marala River were not protected by the completed river wall up to +12.60m (DPWH Datum).

For the said high tide, the polder dike protected the sub-drainage areas such as North Navotas, Dampalit and South Pinagkabalian, while there were 3 sections that allowed overflow because some portion was lower compared with the top elevation of +12.60m (DPWH Datum).

For the flood water discharge of 600 m^3/s from the Tullahan river basin (the upstream reach of Tinajeros Bridge), which came overflowing in the area due to shortage of flow capacity in the Tullahan river, the upstream end of the Malabon river could not accommodate the said discharge, resulting in the overflow toward the inland area (sub-drainage areas such as Catmon sub-drainage area and South Pinagkabalian sub-drainage area). This phenomenon cannot be regarded as positive effectiveness of the Project, however, it is a very important point because it affected the effectiveness of the facilities for inland flood.

Compared with "Ondoy", the right bank of Malabon river (From Tonsuya bridge to Lambingan bridge) were protected because of the progress of the river wall raising.

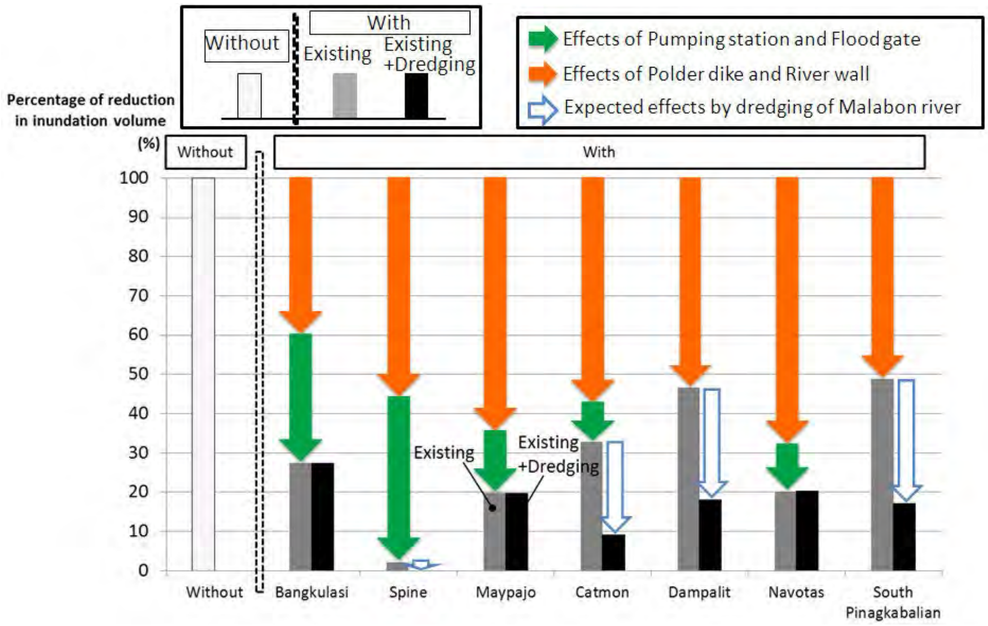
The above phenomena and the effectiveness of the Project are illustrated in Figure S.2. This figure is a schematic one, but it can show the general picture, as explained in the above about what happened in the 2012 monsoon (Habagat).

This figure shows each sub-drainage area, the ratio (%) of inundation volume for the "with" condition to that for the "without" condition. Also in the figure, the extent of such reduction rate is shown by arrow marks.

Different from the effectiveness for 2009 typhoon "Ondoy", the polder dike and raising of the river wall were effective in all sub-drainage areas especially because the raising of the river wall of Malabon river was completed before the 2012 monsoon (Habagat) so that the channel capacity increased from 100 m^3/s to 350m^3/s. Because of this, the overflow volume from the Malabon River was reduced.

For Bangkulasi, Spine and Maypajo sub-drainage areas, the pumps can reduce the inundation volume by 20-30 % compared with "without" conditions. For Catmon, Dampalit, Navotas and South Pinagkabalian sub-drainage areas, the reduction by the pumps is only 10 % or less. Especially in South Pinagkabalian and Dampalit, there is no effect from the pumps. While in Catmon there is a pumping station, the reduction rate is small because of the overflow volume from the Malabon River. In Dampalit, the polder dike is effective to reduce the flood water volume.

This figure also shows the effectiveness of dredging of the Malabon River. By improvement of the Malabon River, the overflow from the river can be eliminated, so that Spine sub-drainage areas could become free from flooding. For Catmon, Dampalit and South Pinagkabalian sub-drainage areas, the reduction by the dredging is as large as 20 to 30 % or so.



Source: JICA Study Team

Figure S.2 Effectiveness of the KAMANAVA Project in the 2012 monsoon (Habagat)

3.5 Important Issues based on Analysis of Effectiveness of the KAMANAVA Project

During the 2012 monsoon (Habagat), at which the Project was almost completed, 68% of the flood volume was reduced by the Project (river wall, polder dike, pumping station and drainage channel) compared with the condition without the project. As for the remaining 32 %, which is supposed to be reflecting the actual flooding, if the dredging of the Malabon river bed were conducted before those flood events, most of the flood volume could have been eliminated in the Project area.

In this line, it was presented that the Project would be very effective if the dredging was conducted before the 2012 monsoon properly. However, at the event of 2012, the tide level was extremely high (up to +12.65m in DPWH Datum) so that the flood water overflowed the completed river wall top and entered the inland flood area, in which the inundation condition was beyond the design condition.

Also, before the 2012 monsoon, the bridge raising, improvement of secondary/tertiary channels and solid waste management had not been implemented despite the fact that these were prescribed as the preconditions of the KAMANAVA Project.

Indeed, just before the 2012 monsoon (Habagat), the number of pumps which could be operated at Spine and Bangkulasi pumping stations were 50 % of the full capacity because of the cleaning of impeller that had been fouled with garbage. Also during the monsoon, Lambingan bridge which had little clearance, was clogged by floating garbage from upstream and this resulted in flooding more seriously along the Malabon river.

The necessity and urgency of proper implementation of these preconditions in collaboration with DPWH and LGUs were confirmed to contribute to achieving the full effectiveness of the intended impact of the Project.

It goes without saying that the construction of the deferred pumping stations (Dampalit and South Pinagkabalian) would contribute to the full effectiveness of the Project in terms of the inland flood mitigation. In order to implement the construction of these structures, the future land use plan in the Project areas shall be confirmed by LGUs to convert the present fish pond to residential and industrial area.

4. Information Dissemination (Workshops)

In order to enhance the understanding of the Project and explain the effectiveness of the Project, workshops were planned and held by DPWH.

The objectives of the planned workshops were:

- The presentation of the results of the study by DPWH
- City / Residents grouping for the preparation of their roles and responsibilities in the sustainable implementation of the project.
- Discussions among all stakeholders regarding the sustainable implementation of the project.

The workshops were held 3 times in the middle of January, 2014. The workshops were conducted after the results of the specific technical and social/institutional studies were undertaken by DPWH to make use of the SAPS Study results. The matrix below shows the schedules of the conducted study and the participants who actually attended the said workshops.

Table S.3 Participants of Workshops

Date and Venue	Type of Workshop	Participants who Attended the Workshops
21 January 2014 UPMO-FCMC DPWH Conference Room	Joint Workshop of DPWH-LGU (city level)	• DPWH officials including KAMANAVA Project • Malabon City Mayor, Planning Officers and Engineers • Officials and representatives from MMDA, PAGASA, NAMRIA • JICA Philippines
24 January 2014 Navotas Mayor Conference Room	Continuation of the 21 January Workshop to Resolve the Transboundary Issue on the North Navotas Navigation Gate Operation	• DPWH officials including KAMANAVA Project • Navotas City Mayor and the City Engineer • JICA Philippines representative • Malabon City Engineers
23 January 2014 Penthouse, Malabon City Hall	Community Workshop for Malabon City	• DPWH officials including KAMANAVA Project • Malabon City LGU including representatives from local agencies • JICA Philippines representative • Barangay LGUs and respective Sector representatives (e.g. youth. women. senior citizens and homeowners association) from eight (8) barangays in Malabon City
24 January 2014 Palaisdaan Hall, Navotas City Hall	Community Workshop for Navotas City	• DPWH officials including KAMANAVA Project • Malabon City LGU including representatives from local agencies • JICA Philippines representative • Barangay LGUs and respective Sector representatives (e.g. youth. women. senior citizens and homeowners association) from SEVEN (7) barangays in Malabon City

Source: JICA Study Team

In general, both the DPWH and the LGU stakeholders (city and barangay levels) were satisfied with the outputs of the workshops.

The barangays/communities, in particular, appreciated the information on the status of the KAMANAVA Project in their respective barangays, the effectiveness of the KAMANAVA Flood during the 2009 typhoon “Ondoy” and 2012 monsoon (Habagat) occurrences and the agreed structural and non-structural measures to sustain the KAMANAVA Project initiatives; The barangays further appreciated that they were given the chance to air out their concerns on the flood structures and they are positive that their visions would be achieved if there will be constant collaboration and coordination between the DPWH and the Project stakeholders.

On the side of the city local governments of Malabon and Navotas, the transboundary issues on the navigation floodgate operation and land use development and it was accordingly agreed to take necessary steps to address said issues.

In both workshop levels (city and community), the DPWH emphasized the need for constant and regular collaboration between the DPWH and the project stakeholders to sustain the initiatives of the KAMANAVA Project. In particular, the structural and non-structural recommendations as shown in Tables S.4 and S.5 were presented and were confirmed by the project stakeholders.

5. Recommendations

Based on the findings and analysis described in previous chapters, the following recommendations for DPWH are made by the SAPS Team. It is expected that DPWH shall continue to discuss and coordinate with all the Project- related stakeholders such as LGUs.

The recommendations were placed into two categories, the "the Recommendations to achieve intended benefits/impact of the Project" and "the Recommendations to further enhance benefits/impact of the Project".

5.1 Recommendations to achieve intended benefits/impact of the Project

SAPS Team recommends (a) Coordination among stakeholders, (b) Replacing of Bridges, (c) Dredging of Rivers, (d) Construction of Deferred Works, (e) Solid Waste Management, (f) Drainage Channel Improvement and (g) Monitoring.

Table S.4 Recommendations to achieve intended benefits/impact of the Project

Item	Evaluation	Recommendations
(a) Coordination among stakeholders	Establishment of cooperative relationship with stakeholders was a challenge before the SAPS Study since LGUs/barangays deemed that coordination/information sharing should have been more active before/during the project implementation for their better understanding and proper actions. However, the LGUs and barangays expressed their appreciation to DPWH for the coordination/consultation and information sharing regarding the Project during the workshops of the SAPS Study, and committed further cooperation with flood control efforts of DPWH. In the course of the SAPS Study, it was made clear that the communication among DPWH, LGUs, communities and MMDA could be activated more if some organized meetings are provided. Also if such opportunities become periodical, the information exchange among stakeholders is expected to be promoted.	DPWH shall hold periodical meetings, once every 6 months, with all the concerned stakeholders (LGUs, MMDA and communities) for exchange of information regarding the Project. DPWH should organize a working group on the KAMANAVA Project and specify members from each stakeholder. The most important stakeholders are LGUs, such as Malabon and Navotas cities in the Project area including MMDA. Also DPWH should invite other stakeholders such as NAMRIA, PAGASA depending on the agenda of the periodical meeting. The level of invited personnel is the city engineer and officer in charge of the environmental section and city planning and representative from project-affected barangay.
(b) Replacing of Bridges	As of the beginning of 2014, the bridges of Bangkulasi, Tonsuya and Tinajeros are not yet replaced / strengthened according to the KAMANAVA Project Design.	DPWH (NCR) has already planned the replacement/strengthening of the said bridges. DPWH should implement them in 2014 as planned.
	Replacing of Lambingan Bridge over the Malabon river is on-going	DPWH should establish a common bench mark network within DPWH

Item	Evaluation	Recommendations
	work. Design drawing of the Lambingan Bridge by DPWH (NCR) use different elevation datum from KAMANAVA Project. The DFL at the bridge in the drawing cannot be confirmed as to whether it is following the Malabon river flood control profile or not.	(UPMO and NCR) to avoid confusion in terms of elevations among stakeholders.
	The design parameters for bridge replacement of Bangkulasi, Tonsuya and Tinajeros were specified in the Design Report 2001. However in the Report it is not clear if the bridge parameters were considered in the calculated design waterlevel in Malabon river. Also the hydraulic effect on the flood waterlevel by bridges has been one of the serious concerns in LGUs.	DPWH should confirm the bridge clearance of the design for the Bangkulasi, Tonsuya and Tinajeros bridges and study their compatibility with the completed river wall elevation in upstream and downstream of those bridges using the latest and detailed cross section data of the Malabon river.
(c) Dredging of Rivers	SAPS Study confirmed by the river cross section survey (Nov. 2013) the present river bed of the Malabon river is higher than the design because of the sedimentation from upstream area. The channel capacity of the Malabon river under DFL is evaluated to be less than the design discharge of the Project. This is because the river bed dredging as a precondition for the design discharge was not conducted in the Project period.	DPWH should conduct the river bed dredging of the Malabon river. In the present Malabon river, especially, stations 2+200 and 3+500 are comparatively shallow. DPWH should prioritize these shallow sections in the implementation schedule.
	The water depth in the Navotas river near North Navotas Navigation Gate is very shallow and therefore to prevent interference with the dock operation a high gate closure level is needed for the ship users in Navotas city, however such high level causes frequent inundation in Malabon city as well as reverse flow of the drainage channel in Navotas city.	DPWH in collaboration with LGUs should conduct the river wall raising along the Navotas river and provide pumps in addition to the river bed dredging of the Navotas river in order to allow the gate closure level high to be as high as needed.
(d) Construction of Deferred Works	Due to the deferred works in the Project, Dampalit and South Pinagkabalian sub-drainage areas do not have major pumping stations for drainage. Especially in barangay Dampalit there is no major facility to control waterlevel of fishpond at present. Malabon city desires the early implementation of the deferred construction as planned.	DPWH should confirm the latest land use plan in Malabon city if the fishponds or swampy areas are developed. If the latest land use plan is confirmed to be urban area, DPWH should start the following actions. 1. Review and update of the drainage improvement plan / design in the Project based on the latest land use plan. 2. Some measures which were not

Item	Evaluation	Recommendations
		included in the Project shall be studied. For example, retarding ponds and upgrading of the polder dike are to be studied comprehensively.
	It was recognized that there is an idea that upgrading of the Polder Dike to a Road Dike to accelerate the development work in the subject area by improving the access for developers to convert the fish ponds for residential, industrial and commercial properties. According to the community workshop held on Jan.23, 2014. Barangay Dampalit desires the upgrading of the polder dike as a cycling road.	DPWH should decide the use of the polder dike as the project plan. In the plan DPWH should consider the followings. 1. Since such area is on soft ground basically, countermeasures for land subsidence as well as erosion control are to be included. 2. A comprehensive feasibility study is needed for the upgrading of the polder dike in Malabon city.
(e) Solid Waste Management	In Malabon river, at Lambingan bridge it was reported by Malabon city that during 2009 “Ondoy” the garbage clogged and caused flooding around the bridge. Also it was said due to the clogging in drainage channels, the water flow into the pumping stations was reduced. Most of the garbage is those coming from upstream area . In this sense the solid waste management issue cannot be regarded as a separate one for each LGU.	DPWH should collaborate with LGUs of Navotas and Malabon cities and the upper areas’ LGUs such as Kalookan, Valenzuela and Quezon cities as well as MMDA to promote solid waste management in the Project area from viewpoint of the wider areas.
	Local people’s awareness for solid waste management is well rooted in the Project area according to a series of discussions with LGUs. However, for the more effective solid waste management, local people’s activity is needed to be organized and continuous in community basis.	DPWH should promote LGUs to frequently disseminate information on the importance of solid waste management as DPWH conducted in the Workshop on Jan.23-24, 2014 and collaborate with the LGUs to educate the people on solid waste management to use simple material such as comic (Refer to Annex 4 of this Report) .
(f) Drainage Channel Improvement	The improvement of secondary / tertiary drainage channel is a precondition of the Project in order to achieve the full effectiveness of the constructed pumping stations in the Project.. It is regarded as an obligation of LGUs, however the full implementation of the work is too great a burden for LGUs because of lack of funds.	DPWH should collaborate with LGUs to support the technical aspect on local drainage for LGUs. DPWH should provide LGUs with all the information on the completed drainage facilities in the Project. Regarding the necessary funds for the improvement of secondary / tertiary drainage channel in LGUs, DPWH should collect information on other area’s example such as subsidiary system and involvement of the private sector for urban drainage improvement and study the applicability in the Project area .

Item	Evaluation	Recommendations
	Local people's awareness for dredging of local channel is well rooted in the Project area.	DPWH should promote the LGUs to disseminate information and DPWH should collaborate with the LGUs to educate the people on how effective the periodical maintenance such as dredging of local channel and garbage disposal is in the course of IEC.
(g) Monitoring	The past flood situation at the local level is not recorded in DPWH. Also operation records of small, local pumps and gates are not shared with DPWH. This is important information for monitoring the effectiveness of the Project continuously. Also this information can contribute to more effective operation and maintenance of the Project facilities.	DPWH should collaborate with the LGUs to commonly share and effectively utilize information regarding local conditions. DPWH should materialize such information sharing with LGUs in the course of the periodical meetings as proposed in the above (a) .
	The tide elevations are measured hourly at Bangkulasi Pumping station/Floodgate and North Navotas Navigation Gate as outside water level. These locations are north and south of the Project area, so their locations are well balanced. However, while the measured tide data is quite valuable, the data is not utilized for comparison with NAMRIA's Manila Bay tide and is not shared with stakeholders in electric form.	DPWH should continue the tide level measurement at Bangkulasi PS and North Navotas Navigation Gate in order to check and compared with the NAMRIA tide data. DPWH should convert the measured tide data at those pumping stations based on NAMRIA bench mark, by which the relation between the Project area and the Manila Bay in terms of the tide level can be studied. DPWH should store the measured tide level data in electric form and share with the stakeholders (especially LGUs) for the purpose of effective operation of the Project facilities and further review of the design of the Project in the future.

5.2 Recommendations to further enhance benefits/impact of the Project

The SAPS Team recommends (a) Additional Works for upgrading of the Project: Raising of River wall, (b) River Improvement Works, (c) Construction of Navotas Coastal Dike, (d) Study/Design for upgrading of the Project and (e) Monitoring, Land use Regulations, and Education / Sensitization.

Table S.5 Recommendations to further enhance benefits/impact of the Project

Item	Evaluation	Recommendations
(a) Additional Works for upgrading of the Project: Raising of River wall	The additional raising / strengthening of the river wall constructed by DPWH can be assessed as a quite practical and realistic measure because during the 2012 monsoon (Habagat), the tide and flood water level exceed the existing top elevation. Some portion of the floodwall has been constructed on the old wall structure, in which the stability should be assured.	DPWH should extend the additional river wall raising to the Marala river and the Navotas river up to 13.5m (DPWH Datum) as top elevation. DPWH should undertake checking and rehabilitation / strengthening of the sections which were constructed on the old wall structure.

Item	Evaluation	Recommendations
	According to the leveling results of bench marks in the SAPS Study based on newly established benchmarks by NAMRIA and PMRCIP III, some discrepancies in elevation among the KAMANAVA Project elevations and the leveling results were observed.	DPWH should carefully check the elevation of bench marks of the ongoing additional works (raising of river wall) to utilize some recent bench marks of NAMRIA as reference.
	The Top elevation of 13.5m (DPWH Datum) is uniformly applied regardless of the sections of the river based only on the situation of downstream section although it should be designed based on the actual condition of each river section.	DPWH should review the relation between design high water level and proposed 13.5 m (DPWH Datum) as river wall top elevation for the whole reach of planned sections in order to formalize the design top elevation of the said additional works.
(b) Additional Works for upgrading of the Project: River Improvement Works	In 2009 and 2012, the Tullahan river was flooded and the flooded water entered the KAMANAVA Project boundary, which resulted in inland inundation. This section of the Tullahan river is outside the scope of the Project, however, the work is necessary for the sustainability of the Project. The current channel capacity of the Malabon river is 350 m^3/s at the lowest section because the riverbed dredging was not conducted during the Project. The river wall raising along the Tullahan river is planned and implemented. An increase in peak discharge because of this work is anticipated, so it should be planned in accordance with the progress of the Malabon river improvement in terms of flood discharge continuity.	DPWH should conduct the Tullahan river improvement work in close coordination with the Malabon river improvement in the Project area. DPWH should review the flood control plan for Tullahan- Malabon river. DPWH should prioritize the Malabon river improvement (dredging for downstream of Tinajeros bridge) in order to accommodate the design discharge (450 m^3/s).
(c) Additional Works for upgrading of the Project: Construction of Navotas Coastal Dike	Navotas area was seriously flooded in September 1999 and July 2000 as well as partially affected in 2009 typhoon "Ondoy" and 2012 monsoon (Habagat) as a result of high tide. Considering the recent high tide events like 12.65 m (DPWH Datum) at 2012 monsoon (habagat), the Navotas Coastal dike is regarded as an urgently necessary measure. The proposed top elevation 13.5 m (DPWH Datum) is appropriate as urgent measure.	DPWH should complete the ongoing Navotas coastal dike construction and formalize the planning, design, implementation and funding to integrate with the local drainage system .
(d) Study/Design for upgrading of the Project	In order to satisfy the flood control need of Malabon and Navotas cities and the ship passage needs, the siltation of the Navotas river and its	As to the siltation along the navigation route in the Navotas river, DPWH should conduct the maintenance dredging periodically.

Item	Evaluation	Recommendations
	river mouth is to be mitigated.	As to the siltation at the river mouth (Manila Bay side), DPWH should conduct a study to investigate the origin of the sedimentation materials as well as topographical survey for appropriate structural measures. Applicability of breakwater should be carefully examined based on the results of the said study.
	In Catmon sub-drainage area, the area of the retarding pond was reduced in the construction stage to less than design due to the difficulty of land acquisition. Also the improvement of secondary and tertiary drainage channel will take a long time, therefore, the reduction of rainwater runoff from the urban area is necessary in the short term.	Also in order to mitigate the inundation condition, DPWH should plan the development of retarding ponds in accordance with the latest land use plan by the LGUs. DPWH should conduct a study and design the rainwater retention measure for the urban area.
	It is observed that in addition to the Project facilities, some pumping stations (e.g. 2 RPS at Longos FG, etc.) were constructed by DPWH. These structures are regarded in DPWH and LGUs as alternate measures to make up for the reduced size of the retarding ponds near Catmon pumping station.	DPWH should formalize and upgrade of selected RPS (e.g. 2 RPS at Longos FG, etc.). In order to enhance and upgrade the Project facility based on the formal planning, DPWH should conduct a review study for Catmon drainage area.
(e) Monitoring, Land use Regulation and Education / Sensitization	It was observed that some operators were recording the water levels as displayed in the control room while others were recording the water levels on the staff gauge outside. Also some operators are not paying attention to the datum of the NAMRIA tide table.	In order to institute a standard level of operation data monitored for the pumping station and flood gates under the KAMANAVA Project, DPWH (the KAMANAVA PMO) shall hold periodical workshops for operators and laborers for capacity building. For example, training on how to read the water level and how to compare it with NAMRIA tide table. DPWH has already conducted a workshop once and it is expected to be programmed continuously within DPWH and MMDA in the future.
	There is no rainfall measurement station in the Project area and no discharge measurement has been conducted in Malabon-Tullahan river even though such hydrological data is the base for the flood control and drainage improvement projects, planning and design. In terms of the security issue for equipment (automatic rainfall recording gauge), the Project area already has secure areas such as the floodgates and pumping stations for the	DPWH should start rainfall and river water level / discharge measurement / monitoring in the KAMANAVA Project area in order to use the information for the planning, design and implementation of the flood control and drainage structure. DPWH should install automatic rain gauges at Floodgate/Pumping stations such as North Navotas Navigation Gate, Kailungan, Pinagkabalian, South Pinagkabalian, Muzon, Catmon, Longos, Spine, Maypajo, Navotas and Bangkulasi.

Item	Evaluation	Recommendations
	installation of equipment.	Those locations are already protected, and the operators can be the ones in charge of the rainfall measurement. DPWH should understand that the hydrological monitoring activities (tide, waterlevel, discharge and rainfall) are emphasized by the SAPS Team because the hydrological measurement and its accumulation are the basis of flood control and drainage improvement projects for evaluation of the effectiveness and proper operation and maintenance in general. DPWH, as an implementation agency for flood control and drainage improvement in KAMANAVA area, shall have its own data using its own funds.
	The reduction of rainfall runoff volume is necessary to cope with the future urbanization and mitigate the load for pumps during storm events.	In relation to the development of retarding ponds in the Project area, it is necessary to control and monitor the land use development activities by LGUs as well as communities. DPWH shall disseminate information on the planning of retarding ponds to the LGUs and coordinate with the LGUs land use plan.
	Suring the 2012 monsoon (Habagat), the overflow along the Polder dike started in a local eroded section and spread to wider sections. For such cases, the initial protection with sand bags would be effective to stop erosion. Also such sandbagging activity can be done at the community level in coordination with DPWH and LGUs.	As has already been conducted in the Project area along the polder dike section, DPWH should promote and provide support to LGUs and communities for flood fighting activities. One of the prioritized actions is to store sand bags along the polder dike.

5.3 Other Recommendations

In order to make the structures completed in the KAMANAVA Project fully function, the contributions of Navotas city and Malabon city are indispensable. SAPS Team's recommendations are as follows,

- Regarding the North Navotas Navigation Gate, there is a conflict of interest in terms of the gate closure level among Navotas ship associations (the ship users) and Malabon city. The ship users prefer a higher elevation for gate closing such as 11.5 m (DPWH Datum) for dock operation while the Malabon city prefers the lower elevation for gate closing such as 10.5 m (DPWH Datum) as per the KAMANAVA original plan because there are low elevation areas that could be inundated. At present, as a compromising solution, the elevation of 11.0 m (DPWH Datum) is selected for gate closure by DPWH; however, continuous discussion are needed among stakeholders. The actions toward the solutions were already discussed during the SAPS Study among LGUs and DPWH. Since one of the issues to be solved is the shallow draft in the Navotas river. Basically the passable water depth at the gate is decided by the sill elevation (3.6 m) and the tide level. Therefore, the dredging of the navigation route below the sill level in Navotas river is not a substantial solution. Of course the dredging of the sedimentation above the sill level should be conducted by relevant stakeholders. The countermeasure (breakwater) for siltation on the Manila Bay side is also to be studied to check the origin of the present sedimentation.

- In relation to the North Navotas Navigation Gate's closure level issue, in Navotas City, in order to mitigate the impact of high water in Navotas River, the Navotas City has been implementing the construction of a river wall with a small pumping station (Bombastik) along the Navotas river bank by its own funds. This measure would lead to make the Navotas Sub-drainage area more sub-drainage areas. Under this situation, the Malabon city side along the Navotas River shall be protected by a similar river wall to confine the lowland area. Therefore, in Navotas Sub-drainage area, the protection of the left and right banks along the Navotas River is a common interest of Navotas City and Malabon City. For intervention by structural measures such as river wall construction, floodgates, and pumping stations, both the Cities as well as DPWH should organize a working group to coordinate the planning, design and implementation. It should be pointed out that these river walls along the Navotas River would mitigate the conflicts on the gate closure level among the 2 cities because they can allow higher water levels in the river.
- In Malabon City, especially in the Barangay Dampalit area, the future land use plan shall be confirmed in accordance with the KAMANAVA Project Plan immediately. For the land use issue, Malabon city should take initiative to make the future plan clearer.
- More coordination and sharing of information on the KAMANAVA Project are required among stakeholders under the coordination of DPWH. The Project facilities such as river walls, polder dike, pumping station, floodgates, and drainage channels shall be maintained and operated and also upgraded by DPWH, MMDA, LGUs and the communities. In general, flood control and drainage improvement projects need a long project period from the feasibility study, detailed design, construction and operation / maintenance stages. The KAMANAVA Project is not an exception. In fact, during such long time, the Project area has been facing unavoidable changes in terms of climate change and socio-economic conditions. To cope with such changes, the accumulation of hydrological data and topographic data, land use control and communities' involvement in the Project with collaboration among stakeholders under the coordination of DPWH.

TABLE OF CONTENTS

Annex

LIST OF TABLES

LIST OF FIGURES

4. Effectiveness of the Project

5. Detailed Analysis for 2012 Monsoon (Habagat)

7. Information Dissemination on Effectiveness of the Project

ABBREVIATIONS

AGENCIES/ORGANIZATIONS

ADB	:	Asian Development Bank
CENRO	:	Community Environment and Natural Resources Office
COA	:	Commission of Audit
DENR	:	Department of Environmental and Natural Resources
DOH	:	Department of Health
DOST	:	Department of Science and Technology
DPWH	:	Department of Public Works and Highways
GOP	:	Government of the Philippines
GOJ	:	Government of Japan
IEC	:	Information, Education and Communication
JBIC	:	Japan Bank for International Cooperation
JICA	:	Japan International Cooperation Agency
KAMANAVA	:	Kaloocan - Malabon - Navotas - Valenzuela
LGU(s)	:	Local Government Unit(s)
MMDA	:	Metro Manila Development Authority
MNDEO	:	Malabon Navotas District Engineering Office
NAMRIA	:	National Mapping and Resources Information Authority
NCR	:	National Capital Region
NEDA	:	National Economic and Development Authority
NHA	:	National Housing Authority
NGO(s)	:	Non-Governmental Organization(s)
NSCB	:	National Statistical Coordination Board
NSO	:	National Statistical Office
OCD	:	Office of Civil Defense, Department of National Defense
PAGASA	:	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PMO	:	Project Management Office, DPWH
PMRCIP	:	Pasig-Marikina River Channel Improvement Project
PNR	:	Philippine National Railway
SAPS	:	Special Assistance for Project Sustainability
SWMA	:	Solid Waste Management Agency
SWMP-PMO	:	Solid Waste Management Project, Project Management Office
UPMO-FCMC	:	Unified Project Management Office - Flood Control Management Cluster
VOM	:	Valenzuela - Obando - Meycauayan (Area)
WB	:	World Bank

ACRONYMS

BM	:	Bench Mark
DFL	:	Design Flood Level
DHWL	:	Design High Water Level
DTL	:	Design Top Level
FG	:	Flood Gate
GDP	:	Gross Domestic Product
GRDP	:	Gross Regional Domestic Product
HWL	:	High Water Level
IEE	:	Initial Environmental Examination
MLLW	:	Mean Lower Low Water
MOD	:	Minutes Of Discussion
MSL	:	Mean Sea Level
MSHHWL	:	Mean Spring Higher High Water Level
O&M	:	Operation and Maintenance
PS	:	Pumping Station
RPS	:	Relief Pumping Station
SWEEP	:	Solid Waste Ecological Enhancement Project
UDHA	:	Urban Development Housing Act

1. Introduction

1.1 Background

The study area or the project area, comprised of the whole or parts of two cities and two municipalities, namely; Kalookan, Malabon, Navotas and Valenzuela (referred to as “KAMANAVA” in the flood control studies and related implementation works for the last 25 years), is generally a flat and low lying terrain with two third of it below high tide level and therefore, prone to frequent flooding. The government of Philippines (GOP) with technical assistance from Japan International Cooperation Agency (JICA), carried out a feasibility study for flood control and drainage improvement of Metro Manila, in 1990 (JICA 1990 F/S) and identified KAMANAVA as one of the high priority projects to be implemented.

In 1998, following a review of JICA 1990 F/S and the Project Appraisal by Japan Bank for International Cooperation in 1999 (JBIC 1999 Appraisal), implementation of the KAMANAVA Area Flood Control and Drainage System Improvement Project (hereinafter referred to as “KAMANAVA Project”) was initiated through a Loan Agreement between JBIC (now merged into JICA) and GOP and since, then the Project implementation has gone through the following stages:

- Detail Design (completed in 2001)
- Construction:
  - In September 2008, 88% of the scope of work was completed when the international contractor stopped the works upon the exhaustion of the JBIC’s component of the funds provided in the above Loan Agreement;
  - In 2009, construction of the remaining and/or incomplete scope of works of KAMANAVA Project was commenced employing three local contractors at various stages and completed in 2013, using local funds.

The above is within the scope of works as appraised in the JBIC 1999 Appraisal. In addition to this, flood control facilities have been provided and maintained with the funding from various organizations. Also, it is worth mentioning here, that the augmentation of the facilities provided under KAMANAVA Project is being undertaken using various funds (other than JICA), in response to catastrophic floods and public concerns in the area, particularly in 2012.

In general, it has been observed/reported that the frequent flooding in the area is reduced drastically with the progressive completion of the facilities under KAMANAVA Project Plan. For example, only five (5) out of twenty one (21) Barangays in Malabon were reportedly flooded during typhoon “Ondoy” in 2009 although construction works was not fully completed by then. However, the onset of monsoon (Habagat) and the incessant heavy rains, caused unprecedented flooding in the area in August 2012, and this has triggered the local community as well as the concerned Local Government Units (LGUs), raising the questions about the effectiveness of the KAMANAVA project. Further, in light of social acceptability, the Project was now subject to a Citizen Participatory Audit by the Commission on Audit (COA).

The above situation culminated in the Department of Public Works & Highways (DPWH), the implementation agency of KAMANAVA Project, to take urgent measures to assess and improve the current situation. In this regard, as one of the immediate measures, DPWH has secured an ad hoc fund from GOP and already commenced the additional construction works in KAMANAVA area which includes the heightening of River Walls (beyond the wall top levels set in the KAMANAVA plan/design) and construction of the Coastal Dike. Whilst progressing with this augmentation works, DPWH intends to implement further measures to ensure the long term sustainability of KAMANAVA Project, following a study to:

a) understand/confirm the effectiveness/impact of the Project during floods in August 2012;
b) technically review the completed works and confirm the necessary measures to be taken, if any; and
c) establish a cooperative relationship among the stakeholders in KAMANAVA area.

As a result of series of discussions, JICA has agreed to provide special assistance to DPWH for the above purpose referred to as “Special Assistance for Project Sustainability (SAPS) for KAMANAVA Area Flood Control & Drainage System Improvement Project” (hereinafter referred to as “SAPS Study”). In October 2013, JICA dispatched the Study Team composed of Oriental Consultants Co. Ltd and Pacific Consultants Co. Ltd to undertake this study in compliance with the requirements of this agreement.

The JICA Study Team carried out the SAPS Study from October 2013 to January 2014 and prepared this report describing the process of activities during the study with the objective of understanding the level of flood protection facilities planned and accomplished under the KAMANAVA Project, and the overall effectiveness of the project under the scales or the magnitudes of extreme floods and the project facilities exposed during the 2009 typhoon “Ondoy” and 2012 monsoon (Habagat). Further, this report also provides the conclusions of the SAPS Study and recommendations to ensure long term sustainability of KAMANAVA Project, following the consultation with all stakeholders.

1.2 Purpose of the Study

1. To examine the effects of the Project based on the data of a recent large-scale flood that happened in the Project area

   (As for the flood in August 2012, the technical background of the flood event is also analyzed.)

2. To propose necessary measures to be taken by the Philippine government to achieve, promote, and enhance the effects of the Project and its sustainability.
3. To provide support so that DPWH properly and effectively shares information about the effects of the Project with the stakeholders, such as the relevant local government, promotes understanding among the stakeholders, and builds a cooperative relationship with each stakeholder.

1.3 Expected Outputs

1. Philippine Government's (Local/National) understanding on the plan and objectives of the Project is enhanced.
2. The effects of the Project are examined.
3. The causes of the flood in August 2012 are explained.
4. Measures to achieve, promote, and enhance the effects of the Project and its sustainability, based on the current situation are proposed.
5. Survey results are efficiently utilized by DPWH to properly and effectively share and explain the information regarding the Project to the stakeholders

1.4 Study Area

The Study area shall be KAMANAVA Project Area with a drainage area of 18.48 km^2, Metro Manila (Figure 1.4.1)

1.5 Outline of SAPS Study

At the commencement of the study, the JICA Study Team has prepared the Inception Report (ICR) which outlines the methodology or the process of activities to be undertaken in compliance with:

- study objectives;
- the scope of works;
- resourcing;
- time frame; and
- other obligations,

as specified in Minutes of Discussion (MOD) for SAPS between JICA and DPWH on July 10, 2013. The JICA Study Team has adopted the stepwise methodology for the SAPS study as outlined in the approved ICR.

In summary, the stepwise methodology or the processes adopted in this study, mainly includes the following:

a) Review of the scope of the JBIC 1999 Appraisal of KAMANAVA Project Plan in light of project planning objectives and criteria, project components to be funded by JBIC (JICA) and the project components to be funded by LGUs, MMDA and DPWH
(scope of the appraised project is used as a benchmark to compare the level of flood control facilities implemented at various stages to-date, as described in item (b) below) ;

b) Collection of information to assess the level of flood control facilities planned, designed, constructed and maintained under KAMANAVA Project, using JICA funds and funds from other organizations (DPWH, LGUs, MMDA etc.) at various stages and particularly those at the onset of typhoon “Ondoy” in 2009 and monsoon (Habagat) in 2012;

c) Assessment of the effectiveness of flood control facilities implemented under KAMANAVA Project, based on the with/without analysis.

d) Carrying out flood mark and inundation mark surveys by interviewing the residents;

e) Estimation of magnitude and scale of floods in Malabon river, based on the outcome of hydrologic/hydraulic analysis for tides, river flows and rainfalls:
   - at or below design scales;
   - during 2009 typhoon ‘Ondoy’; and
   - during 2012 monsoon (Habagat)

f) Limited topographical survey to:
   i. understand/confirm the land subsidence and verification of DPWH datum in relation to NAMRIA observed sea water levels since the implementation of the Project;
   ii. obtain the flood and inundation levels at locations identified during the interviews described in item c) above;
   iii. obtain cross sections of Malabon - Tullahan river for hydraulic analysis; and
   iv. obtain levels at some selected locations in drainage catchments to confirm topographical features.

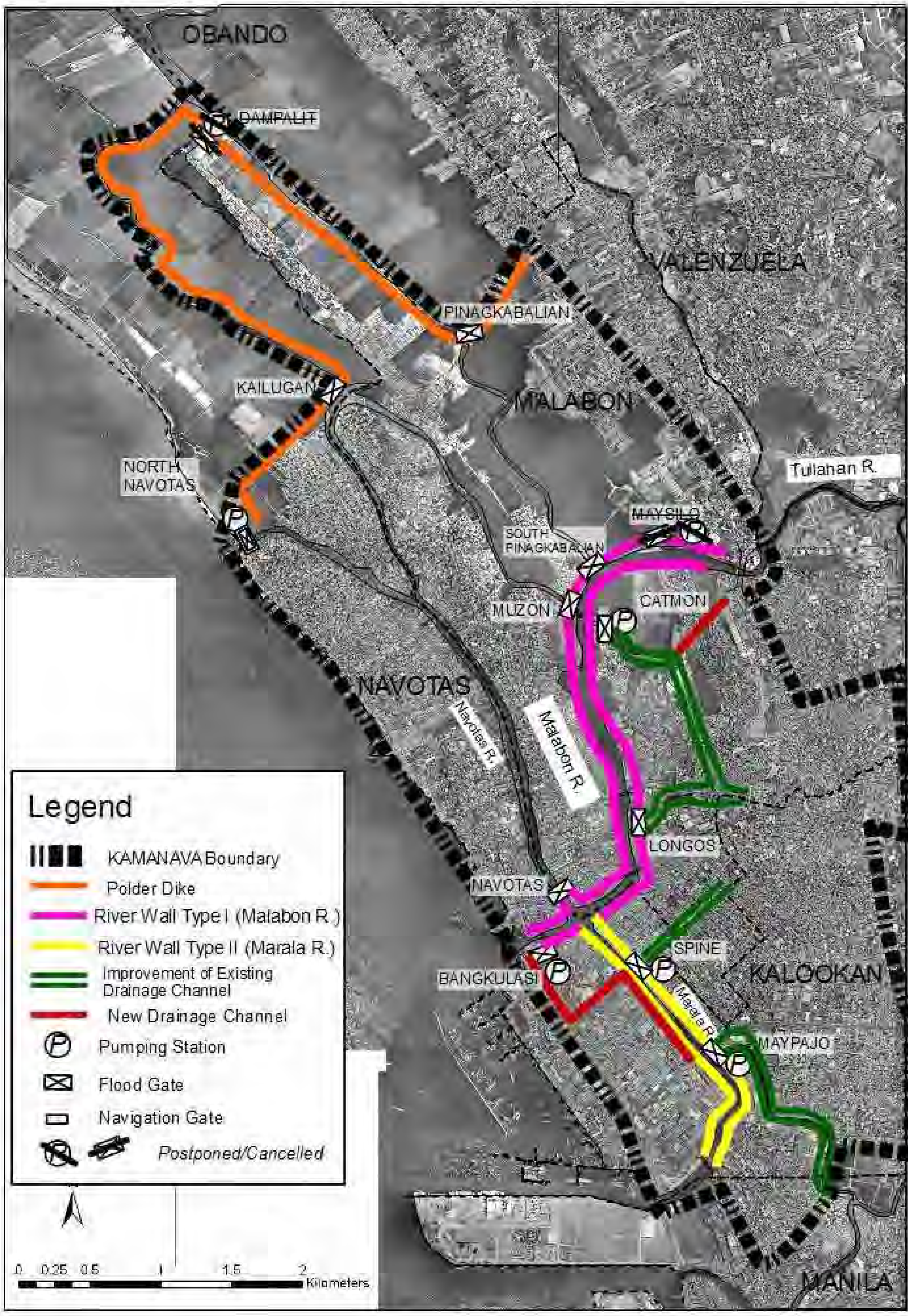
g) Carrying out a social survey with the objective of assessing the general opinion on KAMANAVA Project and its effectiveness and also to identify localized topographical conditions and operational and maintenance issues causing inundations locally ;

h) Review of opinions/thoughts/comments of interested parties and the public on the effectiveness of KAMANAVA Project and its sustainability

i) Consultation through formal and informal discussions/meetings with the objective of setting up the basis to establish a cooperative relationship among the stakeholders (Various offices of DPWH, LGUs, MMDA etc.);

j) Preparation of a Draft Final Report of the study and presentation of the findings of the study based on the above process/activities at stakeholder workshops; and

k) Submission of the Final Report of the study with recommendations.



Source: JICA Study Team. Only the flood control and drainage improvement structures provided under KAMANAVA Project are shown for clarity and their locations and sizes are indicative/conceptual only

Figure 1.4.1 Study Area

2. Planned & Implemented Flood Control Facilities in Project Area

The majority of flood control facilities have been planned and implemented with JICA funding in the KAMANAVA Project area whilst the rest, generally in smaller scales, have been planned and implemented using funds from LGUs, MMDA, DPWH (using GOP funds) etc. In the context of overall planning and implementation of flood control facilities under the KAMANAVA Project, and in compliance with the subject Loan Agreement referred to above, there were obligations for LGUs and DPWH to implement certain works to realize the full effect of the KAMANAVA Project that are not funded by JICA, at various stages as described below.

2.1 KAMANAVA Project at Appraisal Stage in 1999

JICA (then by JBIC) appraised KAMANAVA Project, and as per the Minutes of Discussions between JICA and DPWH on 20 October, 1999, the salient features of KAMANAVA Project included the following.

(1) Planning Objectives/Criteria

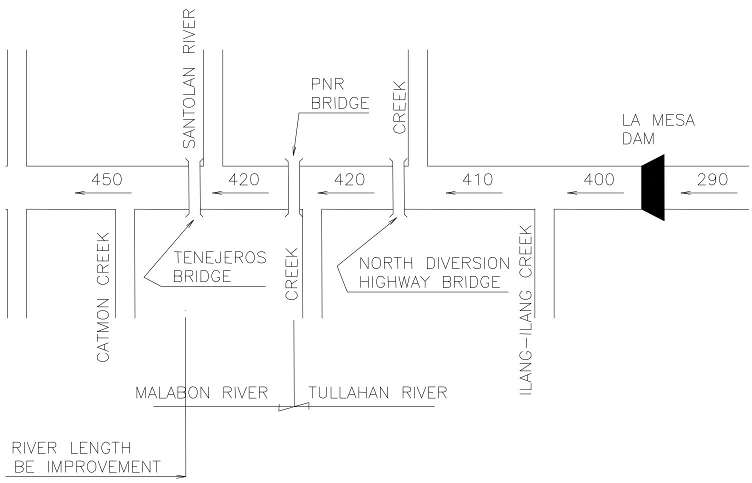
The planning objectives were to:

(a) Protect the area from high tide and riverbank overflows in extreme weather events where tide level is at or below the highest observed as at the planning stage and river flows are at or below the estimated flood flow with a 30 year return period (Figure 2.1.1);

(b) Decrease the affected area of the inland flooding (inundation) from 90% of the area to less than 15% during a 10 year rainfall/flood event with water depths exceeding 20 cm; and

(c) Reduce the flood damages by 500 million Pesos in every year.

The ‘target year’ for the above planning was year 2020.



Unit: m^3/s

Source: Main Design Report, 2001

Figure 2.1.1 Design Discharge Distribution for Flood Control (Scale 30 Year Return Period)

(2) Flood Control Facilities (JICA Funded Portion)

The KAMANAVA Project included the following flood control facilities to be implemented using JICA funds:

(a) North of Malabon River:

i.	Polder Dike	(8.0 km)
ii.	Raising of River Walls (Type I)	(4.4 km)
iii.	Navigation Lock	(1 unit)
iv.	Independent Flood Gates	(5 units)
v.	Control gates	(2 units)
vi.	Pumping Station with Flood Gates	(2 units)
vii.	Pumping Stations without Flood Gates	(1 unit)

(b) South of Malabon River:

i.	Raising of River Walls (Type I)	(3.9 km)
ii.	Raising of River Walls (Type II)	(4.1 km)
iii.	Independent Flood Gates	(1 unit)
iv.	Pumping Station with Flood Gates	(4 units)
v.	Drainage Channels (Improve Existing)	(6.4 km)
vi.	Drainage Channels (New)	(1.8 km)

(3) Other Works to be Implemented (GOP Portion)

As per the MOD between JICA and DPWH, the following components of the overall Project were not included in the Project funded by JICA, but implementation of them by GOP was confirmed and agreed as necessary to achieve and sustain project objectives effectively.

(a) Raising Malabon Bridge, Lambingan Bridge and Tinajeros Bridge at the completion of the project (by DPWH);

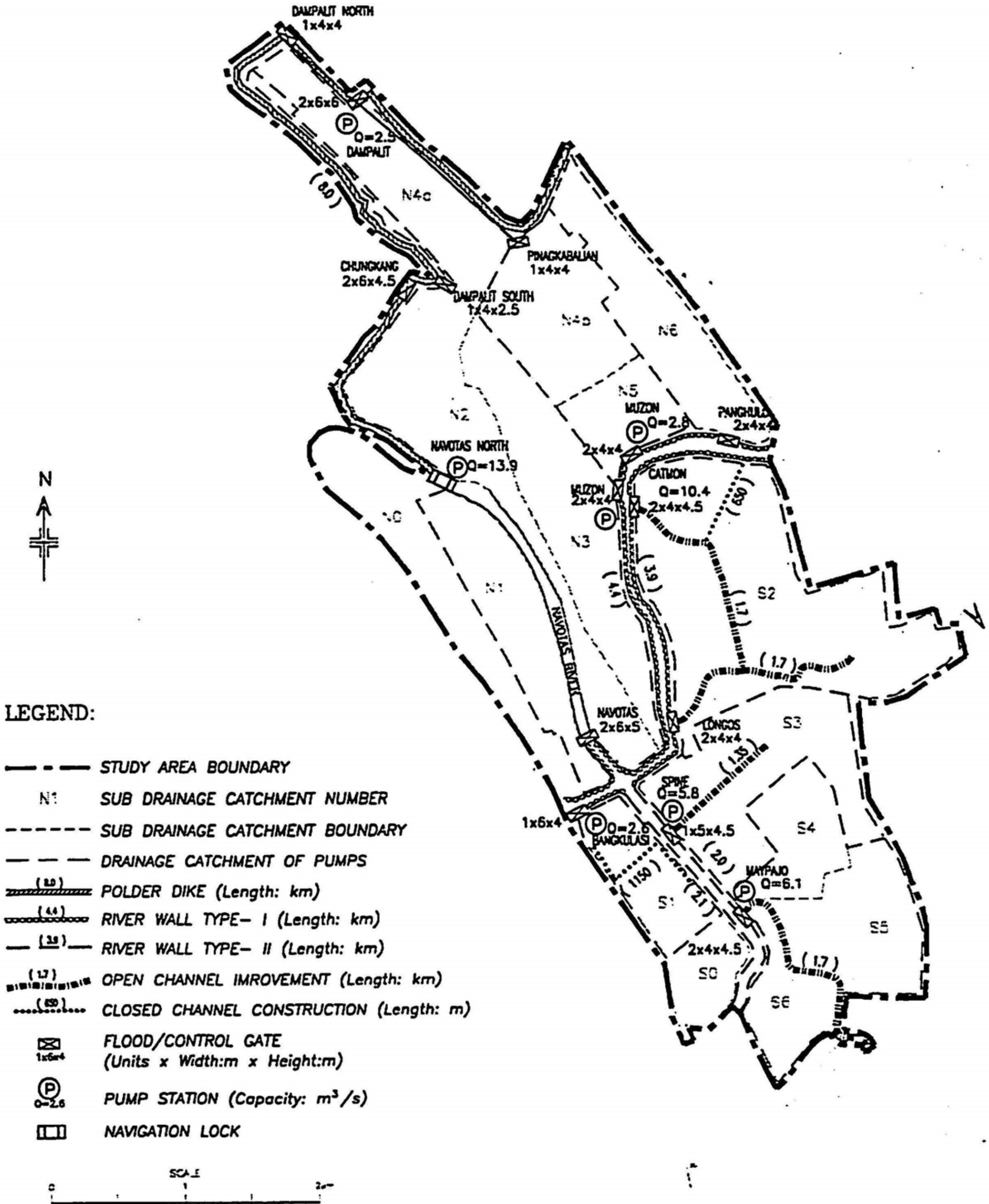
(b) Improvement of secondary and tertiary drainage systems in the project area (by LGUs); and

(c) Solid waste management in the area (by LGUs).

Notes:

1. *The necessity of the dredging of Malabon River in the KAMANAVA project area was recognized in the 1990 JICA Study and also in the 1998 F/S Review to achieve the planning objective. However, due to the fact that the Project had been proposed as a drainage improvement project since the JICA Study, and the dredging as flood control was considered as 'not urgent', the dredging of Malabon River was not included in JBIC's appraised Project.*
2. *A Coastal Dike was considered in the 1990 F/S. Considering the protection that would be provided by the proposed reclaimed area for North Bay Business Park (NBBP), comparatively higher ground elevations and potential issues in large scale resettlement of squatters in the area by then, the Coastal Dike was not included in JBIC's Appraised Project in 1999. The NBBP proposal is yet to be implemented. However, a portion of the Coastal Dike is under construction at the time of preparation of this report using GOP funds.*

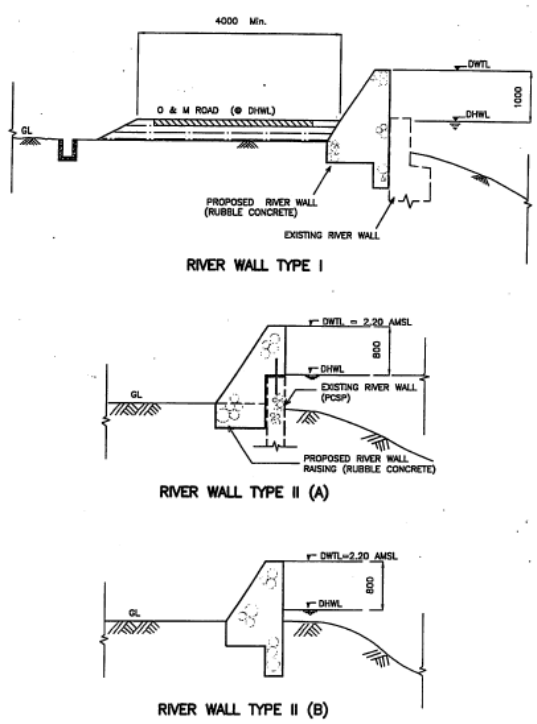
The locations of facilities proposed in 1998 Study are shown in Figure 2.1.2. The river walls Type I and II are shown in Figure 2.1.3.



Source: 1998 FS Main Report[1]

Figure 2.1.2 Proposed Facilities in 1998 FS Study

[1] DPWH, The Study on Flood Control and Drainage System Improvement for Kalookan-Malabon-Navotas-Valenzuela (KAMANAVA Area), Final Report,1998



Source: 1998 FS Main Report

Figure 2.1.3 Proposed River Walls for KAMANAVA Project

2.2 KAMANAVA Project as at Design Stage in 2001

In 2001, during the detail design stage, the planning objectives (or the design criteria), the scope of works and funding arrangements including the obligations of LGUs and DPWH, were adjusted based on the discussions among stakeholders to result in some modifications to the flood control facilities as detailed below.

(1) Modifications to the Facilities North of Malabon River

i. At the north-west end of the protected area, alignment of the Polder Dike was modified to include an additional area (mainly comprised of fish ponds) between Chungkang river and Kailugan river and therefore, the total length of the Polder Dike was increased from 8.0 km to 8.6 km

ii. The Independent Flood Gate proposed at Maysilo was deleted as the drainage channel leading to this Flood Gate was reclaimed and non-existent.

iii. It was decided to defer the construction of the Pumping Stations and Flood Gate at Dampalit, and the Pumping Station at South Pinakabalian, as the protected area is predominantly comprised of fish ponds and no appreciable land development has taken place in the area and the area was supposed to be adequately protected by the Polder Dike and the rehabilitation of the existing Control Gate at Chungkang.

iv. A Navigation Lock was modified to a Navigation Gate based on agreement between the Ship Builders and DPWH.

v. For River Walls Raising, eight (8) different types, namely; P1, P2, P3, P4, R1, R2, R4, & R5, were introduced to replace Type I in JBIC's appraised plan in 1999.

vi. Total length of river walls was reduced to 3.3 km from 4.4 km in JBIC's appraised plan in 1999. (Detail design information on river wall raisings was extracted from the Main Design Report. Reduction is mainly due to existing high walls/ground)

(2) Modifications to the Facilities South of Malabon River

vii. For River Walls Raising, nine (9) different types, namely; P3, R1, R2, R3, R4, & R5 (in Malabon River) and MR1, MR2 & MR3 (in Marala River), were introduced to replace Type I and II in JBIC's appraised plan in 1999.

Total length of river walls was reduced to 7.3 km from 8.0 km in JBIC's appraised plan in 1999.
(*Detail design information on river wall raisings was extracted from the Main Design Report. Reduction is mainly due to existing high walls/ground)*

viii. Retarding/Regulation Ponds covering 12.5 ha were provided at four (4) locations in Catmon Creek. Note: Retarding/Regulation Ponds were not included in JBIC's appraised plan in 1999.

2.3 KAMANAVA Project Contract Document in 2003

The Contract Documents in 2003 are composed of 2 volumes, namely Part 1: Polder Dike and River / Drainage Channel Improvement and Part 2: Flood Gate and Pumping Station. The contents of Part 1 are shown in Table 2.3.1.

Originally, there were the 26 main construction activities in the contract, however, 18 of the 26 were completed as of September 4, 2008. Of the 8 unfinished work components, one is Dampalit Flood Gate which was deferred and recommended for implementation under Stage 2 of KAMANAVA Project (VOM) and the other is Maysilo Floodgate which was cancelled as decided by the LGU engineering Office of Malabon City. The Dampalit Floodgate (deferred) and Maysilo Floodgate (cancelled) were confirmed in the Memorandum on Variation Order No.2 of DPWH dated on April 24, 2006.

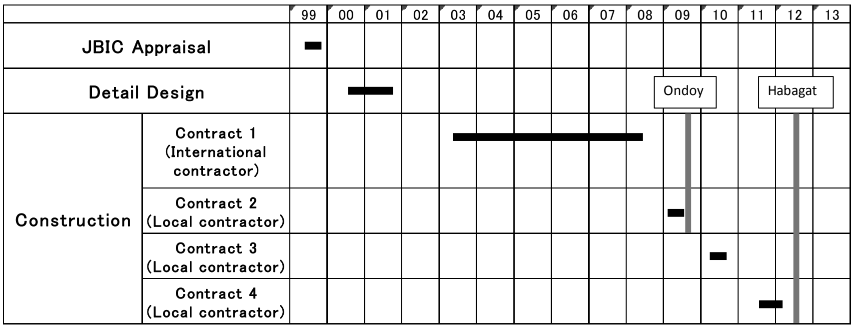
Table 2.3.1 Components specified in the Contract Document in May 2003 (Except for Flood Gate and Pumping Station)

Bill No.	Title
G1	Preliminary and General
C1	Polder Dike
C2	Malabon River Channel Improvement
C3	Marala River Channel Improvement
C4	Estero de Maypajo Drainage Channel Improvement
C5	Longos Creek Drainage Channel Improvement
C6	Catmon Drainage Channel Improvement
C7	Spine Drainage Channel Improvement
C8	Drainage Facilities in Northern Catmon
C9	Drainage Facilities in Bangkulasi

Source: JICA Study Team

2.4 Progressively Implemented Physical Works under KAMANAVA Project

The majority of physical works for the original plan were executed under 4 contracts. Those 4 contracts were engaged by an international contractor using JICA funds, and 3 local contractors using GOP funds at various stages, as described below. After the majority of the original plan was completed, a 5th contract was started to upgrade some facilities using GOP funds. The timeframe of accomplishments (contract completions) is as shown in Figure 2.4.1.



Source: JICA Study Team

Figure 2.4.1 Time Frame of Accomplishment

2.4.1 Works Completed at the Exhaustion of JICA Funds (by Contract 1 as at September 2008)

In June 2003, the international contractor commenced the construction works on the flood protection facilities that were included in Detail Designs in 2001 (Refer section 2.2 above). However, due to various reasons and with the exhaustion of JICA funds in September 2008, the contractor of Contract 1 managed to complete 88% of the above works and eventually, the Contract 1 was formally terminated in September 2009.

As at September 2008, the contractor of Contract 1 had completed the works on all Flood Gates, Pumping Stations and Navigation Gate. The works of all other features remained partially completed. Table 2.4.1 shows the status of accomplished works as at September 2008.

Table 2.4.1 Summary of Accomplished Works (as at September 2008)

Item	Feature	Completion by Contract 1		Remarks
		100%	Partly	
North of Malabon River				
1	Pinagkabalian (North) Flood gate	√		
2	Pinagkabalian (South) Flood gate	√		
3	Muzon Flood gate	√		
4	Kailugan Flood Gate	√		
5	Navotas (South) Flood Gate	√		
6	Navigation Gate (North Navotas)	√		
7	Navotas (North) Pumping Station (adjacent to Navigation Gate)	√		
8	Polder Dike		√	Ref. Section 2.4.2
9	River Walls Raisings		√	Ref. Section 2.4.2
South of Malabon River				
1	Catmon Flood Gate & Pumping Station	√		
2	Spine Flood Gate & Pumping Station	√		
3	Maypajo Flood Gate & Pumping Station	√		
4	Bangkulasi Flood Gate & Pumping Station	√		
5	Longos Flood Gate	√		
6	River Walls Raisings		√	Ref. Section 2.4.2
7	Drainage Channel Improvement including Retarding Ponds		√	Ref. Section 2.4.2
8	New Drainage Channels		√	Ref. Section 2.4.2

Source: JICA Study Team

2.4.2 Details of Unfinished Works at the Exhaustion of JICA Funds and Accomplishments of the Balance of Work using GOP Funds

With full exhaustion of JICA funds, although the contract 1 accomplishment is estimated at 88%, from a hydraulic view point, the constructed facilities were not adequate to prevent the flood entering the protected areas. (*For an example, if the construction of dike embankment is fully completed up to 95 % of its whole length and 5% is kept opened, it is said to be almost 0% complete in a hydraulic view point as it lets the flood into the protected area through the 5% opening*). Therefore, considering the urgency and importance of accomplishment of the balance of the works (of KAMANAVA Project), DPWH engaged local contractors, to complete the works using GOP funds. The local contractors commenced the balance of the work in February 2009 and completed by January 2012 before the onset of monsoon (Habagat).

Details of works commenced and accomplished by the international contractor that were subsequently completed by local contractors are as described below.

1) Polder Dike

The 8.6 km long Polder Dike (from Navigation Gate to Panghulo Road branching off from H. Del Pillar Street which runs along the highly elevated north-east boundary of the Project area) which is mainly to protect the northern section of project area from high tides, was partially completed by the international contractor.

The following segments of the Polder Dike are used for easy referencing and reporting.

i. Tanza River segment
(from Navigation Gate to Kailugan Flood Gate near Tanza River, approx. 1.3 km);

ii. Kailugan River segment
(from Kailugan Flood Gate to the confluence of Pinagkabalian River along Kailugan River, approx. 3.7 km);

iii. Pinagkabalian River segment
(from Kailugan/Pinagkablian River confluence to Pinagkablian Flood Gate along Pinagkabalian River, approx. 2.6 km); and

iv. Pinagkabalian (Naverette) Road segment
(from Pinagkabalian Flood Gate to Punghulo Road along Pinagkabalian Road, approx. 0.8 km).

The international contractor was able to accomplish 3.4 km out of the 8.6 km long Polder Dike at the time of the stoppage/termination of their contractual works in September 2008. Details of works accomplished by the international contractor are as shown in Table 2.4.2 below.

Table 2.4.2 Accomplishment on Polder Dike by Contract 1 as at September 2008

Polder Dike Segment	Original Scope (km)	Status of Accomplishment	Dike Elevation (DPWH Datum, m)
Tanza River Segment	1.3	Complete	Top of dike embankment reached EL.12.60 m and above
Kailugan River Segment	3.7	Work limited to a 300 m long segment and the dike was partially completed	DTL reached +11.40 m to +12.00 m
Pinagkabalian River Segment	2.6	Work limited to a 980 m long segment and the dike was partially completed	DTL reached +12.00 m
Pinagkabalian Road Segment	0.8	Complete	Road/Dike Top Level reached EL.+12.10 m and above

Source: JICA Study Team

All works on the Polder Dike were reported to be completed to the design levels, by local contractors, before the onset of monsoon Habagat in 2012.

2) River Wall Raising

The international contractor was able to partially complete the river wall raising at the time of the stoppage/termination of their contractual works in September 2008. Details of works completed by the international contractor are as shown in Table 2.4.3 below.

Table 2.4.3 Accomplishment on River Wall by Contract 1 as at September 2008

Wall Raising Location	Scope (km)	Accomplishment	Status
Malabon River (North)			
Malabon River (Right Bank)	3.3	Raised to design wall top level of 12.60-12.90 m	Partially complete
Malabon River (South)			
Malabon River (Left Bank)	3.4	Raised to design wall top level of 12.60-12.90 m	Partially complete
Marala River (Right bank)	1.9	Raised to design wall top level 12.60 m	Complete
Marala River (Left bank)	2.0	Raised to design wall top level 12.60 m	Complete

Source: JICA Study Team

All River Walls Raising works were reported to be completed to the design levels, by local contractors, before the onset of monsoon Habagat in 2012.

2.4.3 Implementation of Unfinished Works under KAMANAVA Project

After the International Contractor left the KAMANAVA area, DPWH engaged with local contractors to complete the KAMANAVA original plan as follows,

Table 2.4.4 Components of Unfinished Works Implemented by Local Contractors

Component		Contract 2	Contract 3	Contract 4
Polder Dike	Kailugan Section	●	●	
	Pinagkabalian River	●	●	
	others			●
Malabon River Channel Improvement		●	●	●
Catmon Creek Channel Improvement		●	●	●
Longos Creek Channel Improvement		●	●	●
Northern Catmon Drainage Facilities		●	●	●
Estero de Maypajo Channel Improvement		●	●	●

Source: JICA Study Team

It is understood that as per Project Completion Report - January 2013, construction works of all flood protection facilities were fully accomplished (except Dampalit Floodgate) and they were fully operational before the onset of monsoon Habagat in August 2012. However, at the onset of typhoon Ondoy in September 2009, construction works for the Polder Dike, River Walls and Drainage Improvements were partially complete. To understand the level of flood protection facilities at the onset of typhoon Ondoy and monsoon Habagat, it is necessary to examine the progressive accomplishment of physical works under KAMANAVA Project.

2.4.4 Works Accomplished by LGUs and DPWH in addition to KAMANAVA Project

(1) Works as Preconditions of the KAMANAVA Project

1) Dredging of the Malabon River by DPWH

The necessity of the dredging of the Malabon riverbed to accommodate the flood discharge for a 30 year return period has been recognized since the JICA Study in 1990. Therefore dredging of the Malabon riverbed has not been included in the scope of work of the KAMANAVA Project. It was already agreed that it is an important precondition for the KAMANAVA Project to achieve the full effects of the Project.

In the detailed design stage, flow capacity of the Malabon river was reported as only 210 m^3/s in average with the range from 30 to 710 m^3/s comparing with design discharge of 450m^3/s, therefore, it was strongly recommended that the river improvement including dredging/excavation shall be carried out covering problematic reaches from the river mouth to the North Diversion Highway 12km upstream from the river mouth through the Malabon river reach.

In addition to the dredging of the Malabon river, the MOD in October 20, 1999[2] indicates as the obligation of DPWH and LGUs to complement the Project in the KAMANAVA Project area as follows;

2) Raising the Bridges by DPWH

At the time of MOD it was confirmed that some of the bridges on Malabon River should be raised associated with the construction of river walls under the Project. The bridges are

- Malabon Bridge (Tonsuya Bridge)
- Lambingan Bridge
- Tinajeros Bridge (Tenejeros Bridge)

[2] Attachment in the Memorandum between JICA and DPWH on 7 April, 2001

As of November 2013, the Lambingan Bridge is under construction by DPWH funds. According to Malabon Navotas District Engineering Office, DPWH (MNDEO), other bridges are also planned to be strengthened in accordance with the river wall construction progress from 2014.

3) Tributary Drainage System in the Project Area by LGUs

At the time of MOD in 1999, DPWH and LGUs agreed that the appropriate development of such tributary drainage system as secondary and tertiary channels is a fundamental requirement of the sustainability of the Project. At that time it was also confirmed that the planning, implementation and operation of the tributary drainage systems are under the LGUs' responsibility since maintaining the compatibility between the Project and the tributary drainage systems is a prerequisite of the successful implementation of the Project.

Malabon City Engineers pointed out that the City Government is only maintaining the existing channels and does not have enough funding for large scale drainage channel improvements such as secondary and tertiary channels. The City Engineer says the City Government has been requesting that DPWH implement the necessary projects.

In terms of drainage channel improvement, the situation of Navotas City is the same, while Navotas City has been implementing a local pumping station project and local river wall construction by its own funds.

4) Solid Waste Management in the Project Area by LGUs

The solid waste management in the Project Area is indispensable to the sustainability of the Project. At the time of MOD in 1999, DPWH assured that LGUs shall take the necessary measures to pursue appropriate solid waste management.

In the consulting service of the KAMANAVA Project, enhancement of solid waste disposal as a part of environmental management was discussed among DPWH and LGUs. The solid waste disposal covered not only the construction stage but also the operation stage in order to ensure safe and proper disposal of waste generated by automatic trash removal facilities. According to the Project Completion Report in 2013, the solid waste during the operation stage shall be stored and disposed of properly and LGUs shall coordinate with the MMDA.

Malabon City Engineers pointed out during the SAPS Study that most of the garbage in the Project area is coming from the upper parts of the Project area such as Valenzuela city, Kalookan city as well as Quezon city. In order to assure the sustainability of the Project in terms of the solid waste management, it is necessary to coordinate the regional areas of LGUs, because only a single LGU has limited capacity to deal with the solid waste management.

(2) Recommendations in the Project Completion Report on the KAMANAVA Project

The Project Completion Report in January 2013 recommends the necessary follow-up actions to attain sustained benefits from the Project as follows;

(a) Successive implementation of Project components that were deferred due to budgetary constraints, namely: Dampalit Pumping Station with ancillary Floodgate and South Pinagkabalian Pumping Station.

(b) Early implementation of the related works identified, namely:

- Dredging/excavation of Malabon-Tullahan and Navotas-Marala Rivers,
- Raising of bridge girders of the existing Tonsuya, Lambingan and Tenejeros (Tinajeros) Bridges to Design High Water Level set by the Project, and
- Improvement/development of secondary and tertiary drainage channels in each of the seven (7) drainage areas.

(c) Raising public awareness and coordinated efforts at the community level to guard against encroachment by informal settlers into rivers/drainage channel water ways, indiscriminate garbage dumping and improper disposal of solid waste that adversely affect the operational efficiency of the Project.

(d) Early implementation of VOM Area Drainage System Improvement and Related Works Project, which is contiguous to the KAMANAVA Project and also suffered from chronic flooding.

2.5 Summary of Evolvement of KAMANAVA Project from Planning through to Current Status

Summing up what has been discussed hereto, the evolvement of KAMANAVA Project from planning through to completion can be summarized as shown in Table 2.5.1. The status of the related project outside of KAMANAVA Project is mentioned in Table 2.5.2.

Table 2.5.1 Summary of Evolvement of KAMANAVA Project

Project Feature	Description	Planning(2000)	Design(2001)	Completion(2012)
Objective/Planning Criteria	High Tide	Highest observed (1.38m above MSL) (11.89m (DPWH Datum))	1.625 m above MSL (12.10m (DPWH Datum))	Same as in design
	River Flow	30 year return period	Same as in planning with dredging of Malabon river	Same as in design
	Inundation	Rainfall of 10 year return period	-do-	-do-
	Flooding	Maximum depth of inundation 20 cm for less than 24 hours	-do-	-do-
	Target Year	2020	-do-	-do-
Funding	Main Flood Protection Facilities	JICA	JICA	88% Using JICA funds; 12% Using GOP funds
	Supporting Flood Protection Facilities	LGUs, DPWH	LGUs, DPWH	LGUs, DPWH. Partially implemented
Structural Measures (Using JICA Funds originally, however, later GOP funds were used to complete.)	Polder Dike	8.0 km	8.6 km	Same as in design. Partly accomplished using JICA funds. Balance completed using GOP funds
	Raising of River walls	12.4 km (two types only)	Malabon River 6.6 km (9 types) Marala River 3.9 km(3 types)	-do-
	Navigation Lock/Gate	One Navigation Lock (facilitate navigation during high tide also)	One Navigation Gate (navigation limited to low tide period only)	Same as in design. Fully completed using JICA funds
	Independent Flood Gates	6 Units	5 Units	-do-
	Control Gates	2 Units	Nil	-do-
	Pumping Stations with Flood Gates	6 Units	4 Units (Pumping Stations at Dampalit & South Pinagkabalian deferred)	-do-
	Pumping Stations without Flood Gates	1 Unit (adjacent to Navigation Lock)	1 Unit (adjacent to Navigation Gate)	-do-
	Improvement of Existing Drainage Channels	6.4 km	5.6 km	-do-
	New Drainage Channels	1.8 km	2.1 km	Same as in design. Fully completed using JICA funds

Source: JICA Study Team

Table 2.5.2 Summary of Evolvement of Related Projects by DPWH and LGUs

Project Feature	Description	Planning (2000)	Design (2001)	Completion (2012)
Structural Measures (Using GOP Funds)	Raising of Bridges by DPWH	Bangkulasi	Bangkulasi	Not raised yet
		Tonsuya	Tonsuya	-do-
		Lambingan	Lambingan	Being raised
		Tenejeros	Tenejeros	Not raised yet
	Secondary & Tertiary Drainage by LGUs	Scope not quantified	Scope not quantified	Partially
	Solid Waste Management by LGUs	Scope not quantified	Scope not quantified	On-going
	Dredging of Malabon River	Scope not quantified	Scope not quantified	Not yet

Source: JICA Study Team

2.6 Levels of Flood Protection Facilities Accomplished at the Onset of Typhoon "Ondoy" & 2012 Monsoon (Habagat)

To examine the flooding phenomena in the protected area, it is necessary to understand the level of flood protection facilities that were accomplished under the KAMANAVA Project at the onset of 2009 typhoon "Ondoy" and 2012 monsoon (Habagat). Based on the progressive accomplishment of works as described in the preceding sections of this report, the levels of accomplishment at the onset of the above typhoons are as follows.

(1) At the onset of 2009 Typhoon "Ondoy"

The levels of flood protection facilities that were accomplished by the international contractor and the balance works as at September 2008 are as shown in Table 2.4.1 above. As per the details provided in the Completion Report, a local contractor completed a portion of the balance of the work under Local Contract Package 1 (Contract 2), prior to the onset of typhoon "Ondoy" in September 2009 and the additional accomplishment during the period from September 2008 to September 2009 and the details of accomplishments on the Polder Dike and River wall Raisings are as follows;

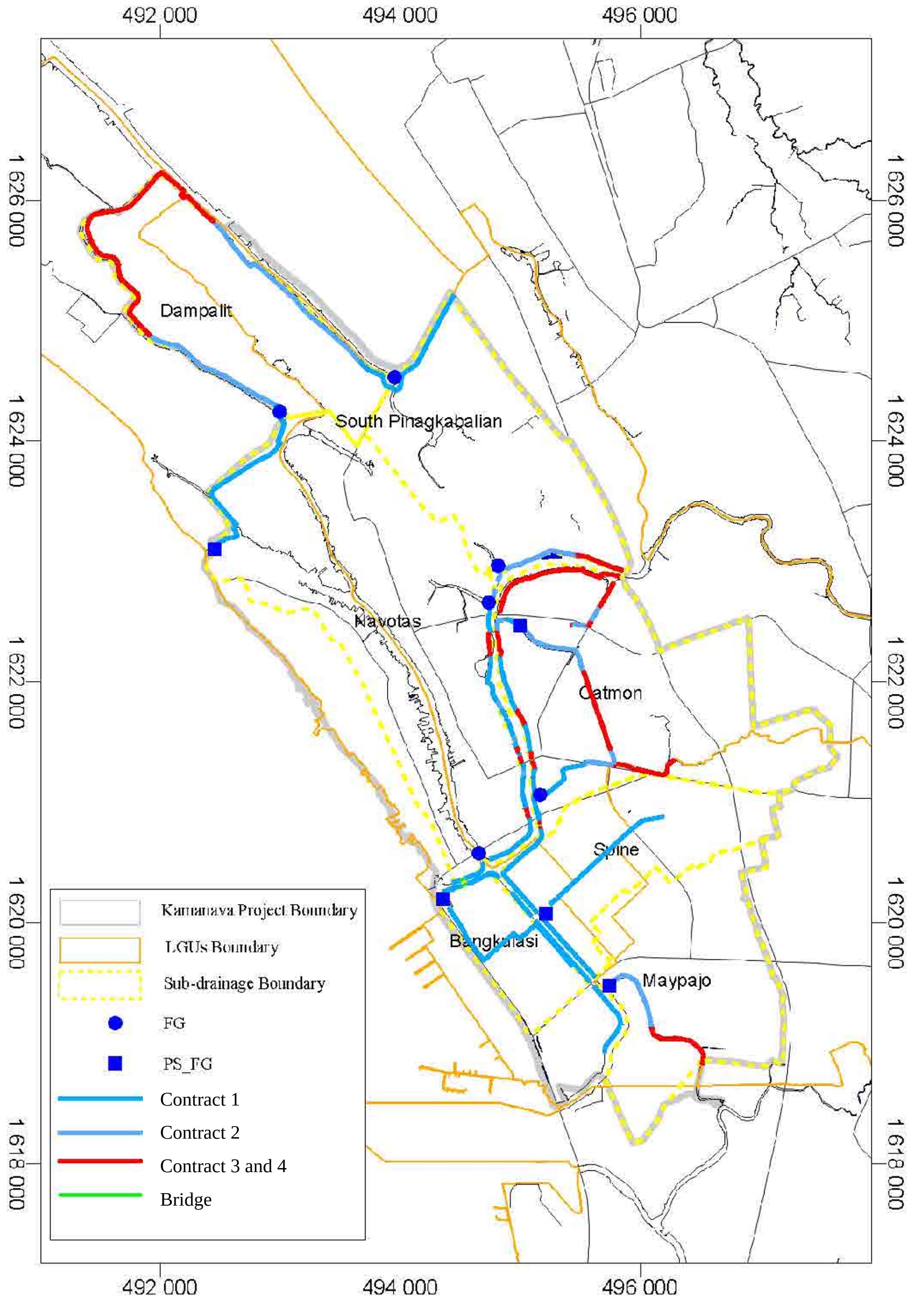
- Completion of 3.4 km of the Polder Dike where international contractor accomplishment was not commenced and partial (see Table 2.4.2); and
- Completion of approx. 1.1 km of River Walls Raising.

(2) At the onset of 2012 Monsoon (Habagat)

As per the Completion Report, all works under the KAMANAVA Project were fully accomplished by January 2012.

The details of the levels of flood protection facilities accomplished at the onset of typhoon "Ondoy" and monsoon (Habagat) are as shown in the following figures.

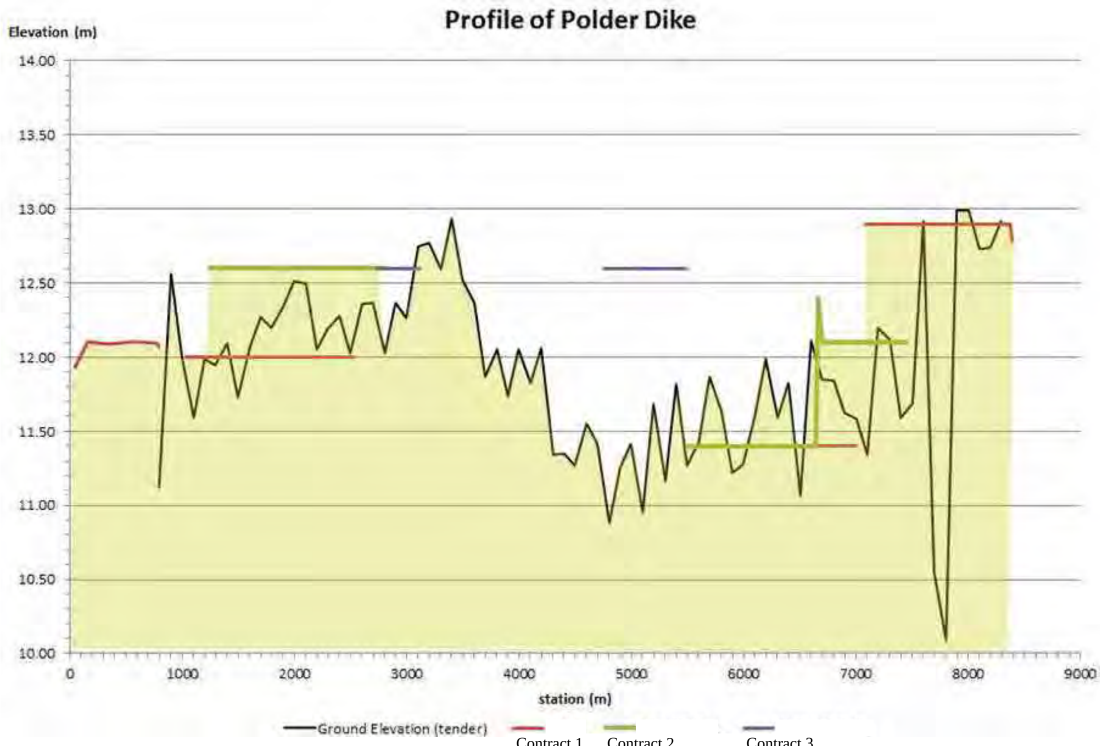
The related projects such as bridge raising, some improvement in the existing drainage channels, and solid waste management were not fully completed.



Source: JICA Study Team

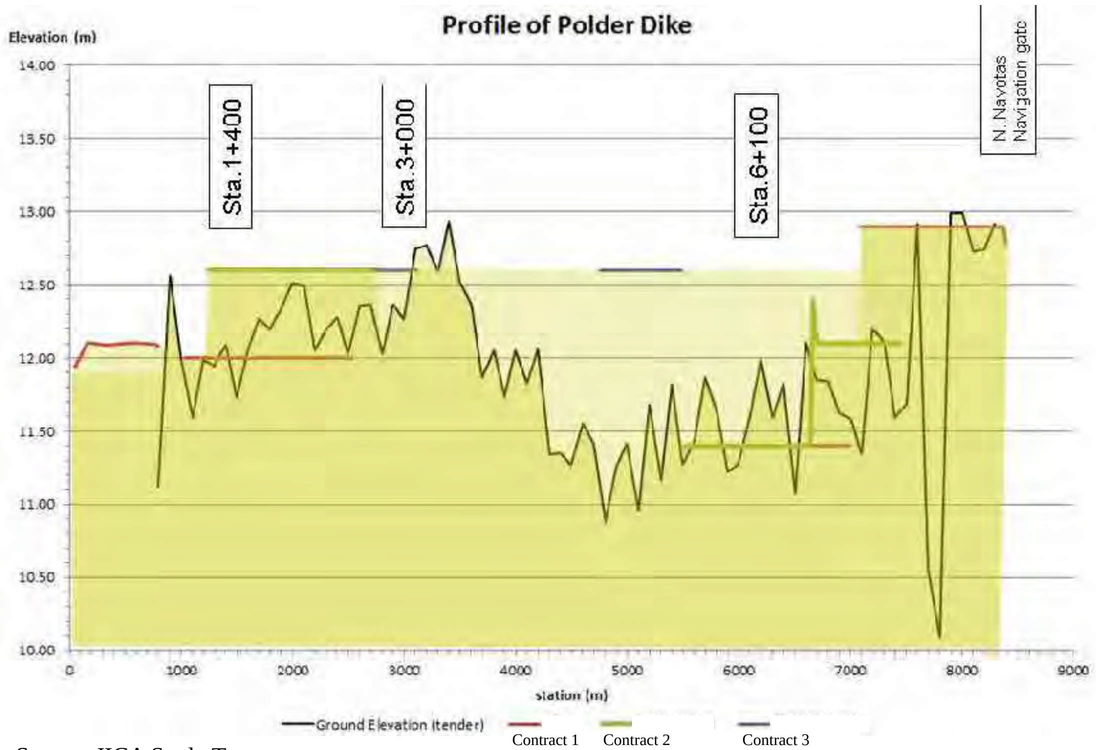
Figure 2.6.1 Layout of Accomplishment as at the onset of 2012 Monsoon (Habagat)

Remarks: As of the onset of 2009 typhoon "Ondoy", all the Flood Gates, Pumping Stations by Contract 1 and some of the river walls and drainage channels were completed by Contract 1 and Contract 2 which are illustrated by the blue color. As of the onset of 2012 monsoon (Habagat), the remaining works were completed by Contract 3 and 4. In the figure, the bridges to be improved, while they are out of the project component, are shown for reference because they are related to Malabon river improvement from the technical viewpoint, for further discussion.



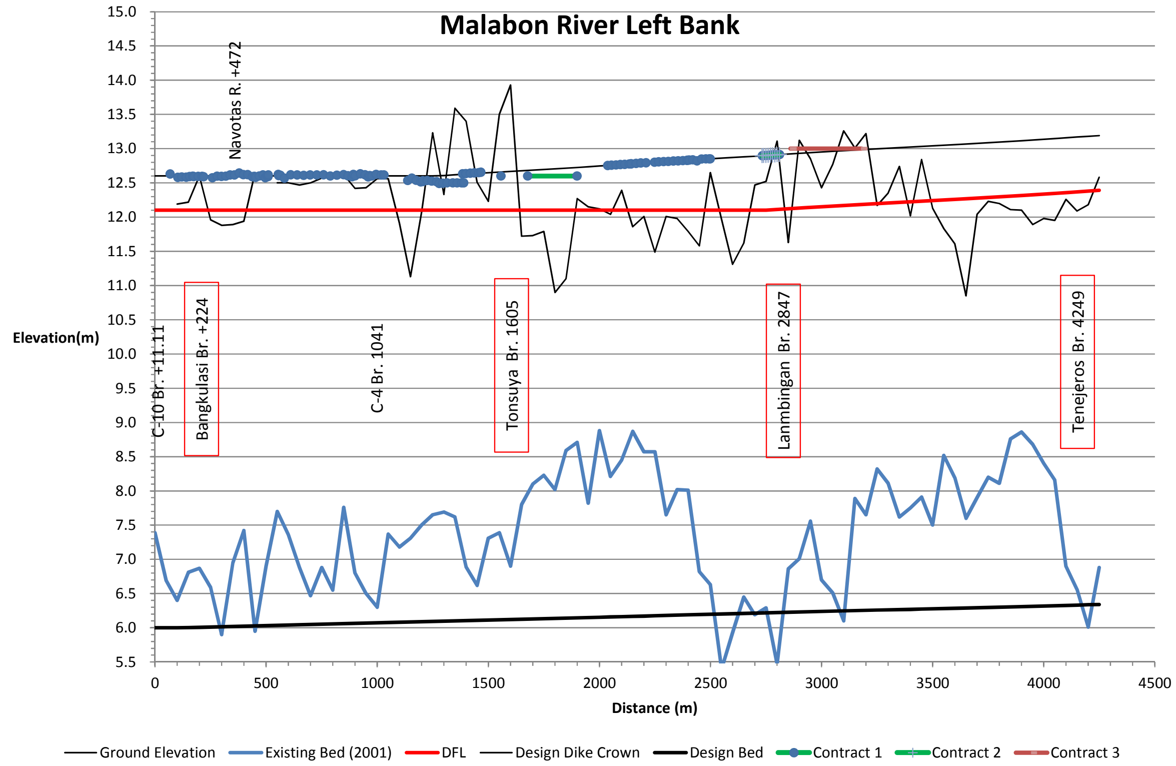
Source: JICA Study Team

Figure 2.6.2　Elevation of Polder Dike as at the onset of 2009 Typhoon "Ondoy"



Source: JICA Study Team

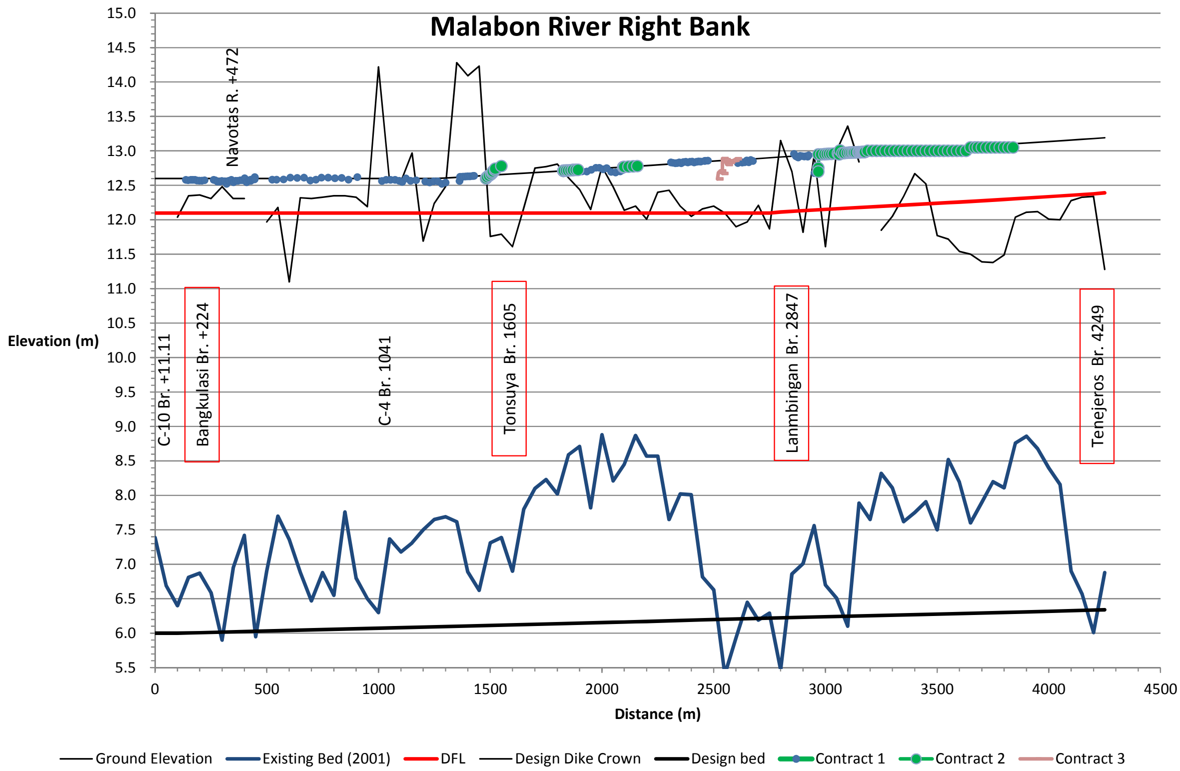
Figure 2.6.3　Elevation of Polder Dike as at the onset of 2012 Monsoon (Habagat)



Source: JICA Study Team

Figure 2.6.4 Elevation of River Wall on Left Bank of Malabon River as at the onset of 2009 Typhoon "Ondoy"

(note: at the time of 2012 monsoon (Habagat), the river wall was raised to the Design Dike Crown, however, the bridges sections (out of the KAMANAVA Project) were not completed)



Source: JICA Study Team

Figure 2.6.5 Elevation of River Wall on Right Bank of Malabon River as at the onset of 2009 Typhoon "Ondoy"

(note: at the time of 2012 monsoon (Habagat), the river wall was raised to the Design Dike Crown, however, the bridges sections (out of the KAMANAVA Project) were not completed)

2.7 Additional Projects

2.7.1 Additional Works in the KAMANAVA Project (within Project Area)

In 2013 DPWH (KAMANAVA PMO) made Contract 5 with a local contractor for a project, namely, Raising/strengthening of river walls along Malabon River, Catmon Creek and Longos Creek KAMANAVA Area Flood Control and Drainage System Improvement Project using GOP funds. According to the as-staked plan, the project components and contents are as follows,

Table 2.7.1 Components of Additional Works by Contract 5

Component	Section
Malabon River	Left Bank Wall Raising P3, 0+500 to 1+030 (530m) Left Bank Wall Raising P3, 1+300 to 1+540 (240m) Left Bank Revetment Wall R2, 1+578 to 1+605(27m) Left Bank Wall Raising P3, 1+617 to 1+687 (70m) Left Bank Wall Raising P3, 1+833 to 1+997 (164m) Left Bank Revetment Wall R2, 2+098 to 2+353(255m) Left Bank Wall Raising P3, 2+353 to 2+840(487m) Right Bank Wall Raising P3, 0+400 to 0+462(62m) Right Bank Wall Raising P3, 0+495 to 0+891(396m) Right Bank Wall Raising P3, 1+375 to 1+440(65m) Right Bank Revetment Wall R2, 1+551 to 1+570(18m) Right Bank Wall Raising P3, 1+570 to 1+587(17m) Right Bank Wall Raising P3, 1+598 to 2+221(623m)
Catmon Creek	Left Bank Earth Dike/Embankment 1370m including wet stone masonry 253 m Right Bank Earth Dike/Embankment 430m including wet stone masonry 240 m
Longos Creek	Box culvert 36.6 m , Concrete U-type open channel 64.4m

Source: JICA Study Team

For Malabon river, the top elevation of the river wall will be raised from +12.60 m (DPWH Datum) as constructed by KAMANAVA Project to +13.50 m (DPWH Datum) considering a free board of 50 or 60 cm. This additional raising was decided by the experiences of dike overflowing by the recent flooding in 2009 typhoon “Ondoy” and 2012 monsoon (Habagat).

2.7.2 Navotas “Bombastik” Pumping Stations (within Project Area)

The construction of pumping stations in different parts of Navotas city was greatly appreciated by LGUs and Navotas residents since the former Mayor’s administration era. At present, there are a total of 39 “Bombastik” pumping stations in Navotas City (Figure 2.7.1) by the City funds and other financial assistance from an individual. These pumping stations benefited the majority of the population by eradicating the problem of perennial flooding. It has definitely improved the living condition of the residents.

2.7.3 Valenzuela- Obando- Meycauayan (VOM) Area Drainage System Improvement Project

The KAMANAVA Project and its objective area is divided into two areas; 1) Area for project works (18.48 km^2) and 2) Area for feasibility study (Valenzuela- Meycauayan - Obando = 21.03 km^2). This VOM project is proposed through the feasibility study on drainage system improvement in Valenzuela-Obando- Meycauayan Area.

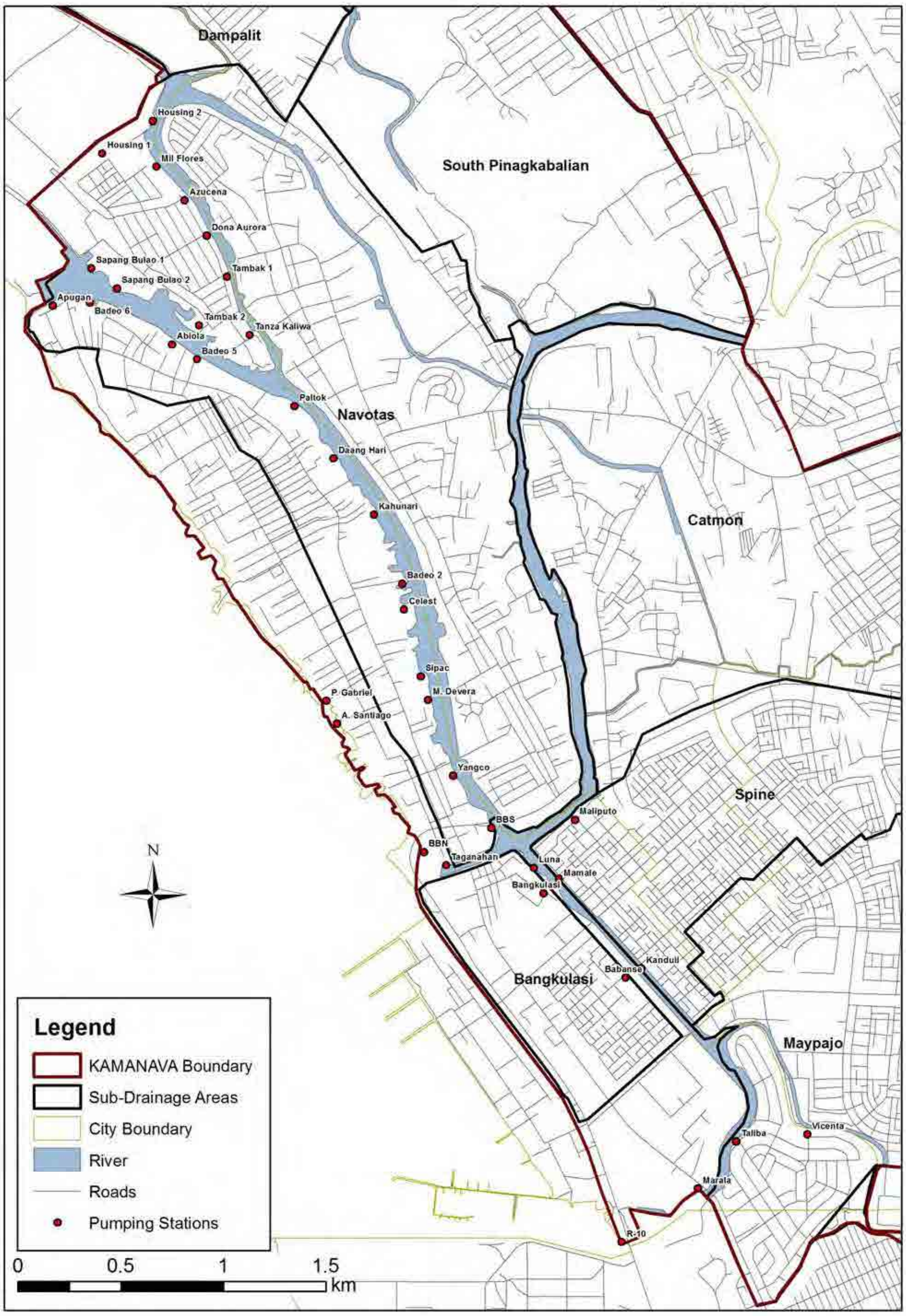
In November 2013, UPMO-FCMC disclosed the document entitled “Project Status 5 Billion Pesos Priority Flood Control Project as of 25 October 2013”. According to the document, as a part of VOM Projects, the following projects are completed or on-going.

- Construction of flood control wall at elevation 13.5 m (DPWH Datum) for approximately 3.2 km stretch along Meycauayan River in Valenzuela City to prevent entry of flood waters during high tide and heavy flows.
- Construction of flood control wall at elevation 13.5 m (DPWH Datum) for approximately 9.0 km stretch along Palasan and Meycauayan Rivers in Obando, Bulacan to prevent entry of flood waters during high tide and heavy flows including storm surge from Manila Bay.
- Desilting of Meycauayan River in Obando, Bulacan, to improve conveyance capacity/increase flow
- Improvement of river wall along Meycauayan River, Meyacauayan City.

2.7.4 Navotas Coastal Dike Construction

Navotas Coastal Dike was deferred in the Review in 1998. However, the coastal dike shall be implemented, as the western half of the Navotas Island was seriously flooded in September 1999, July 2000 and September 2006.

The construction of a coastal dike was started in July 31, 2013 by MNDEO-DPWH using GOP funds. As of November 2013, about a 500 m length from the right bank of the Malabon river along the Navotas coastal line was finished.



Source: JICA Study Team. Prepared based on CAD file provided by Navotas City.

Figure 2.7.1 Location of "Bombastik" Pumping Stations in Navotas City

Source: JICA Study Team

Figure 2.7.2 "Bombastik" Pumping Station along Marala River, Navotas City

Source: JICA Study Team

Figure 2.7.3 Constructed Coastal Dike in Navotas City Area

3. The Current Conditions

3.1 Population of Barangays in the KAMANAVA Project Area

In the KAMANAVA Project Area, the following Barangays are included as shown in Table 3.1.1. The location map of the barangays is shown in Figure 3.1.1.

Table 3.1.1 List of Barangays in the KAMANAVA Project Area

LGUs	No.	Names
Malabon	20	Tanong, San Augstin, Ibaba, Concepcion, Baritan, Flores, Bayan Bayanan, Hulong Duhat, Longos, Tonsuya, Niugan, Catmon, Muzon, Dampalit, Maysilo, Panghulo, Tugatog, Acacia, Tinajeros, Potrero
Navotas	14	San Rafael Village, North Bay Boulevard South, North Bay Boulevard South, Bangkulasi, Bagumbayan South, Bagumbayan North, Navotas East, Navotas West, Sipac Almacen, San Jose, Daang Hari, San Roque, Tangos, Tanza
Caloocan	4 (zone)	Zone 3,2,1, and 7
Manila	3	Barangays 125, 126 and 127

Source: DPWH, Main Design Report, 2001, Fig.2.6

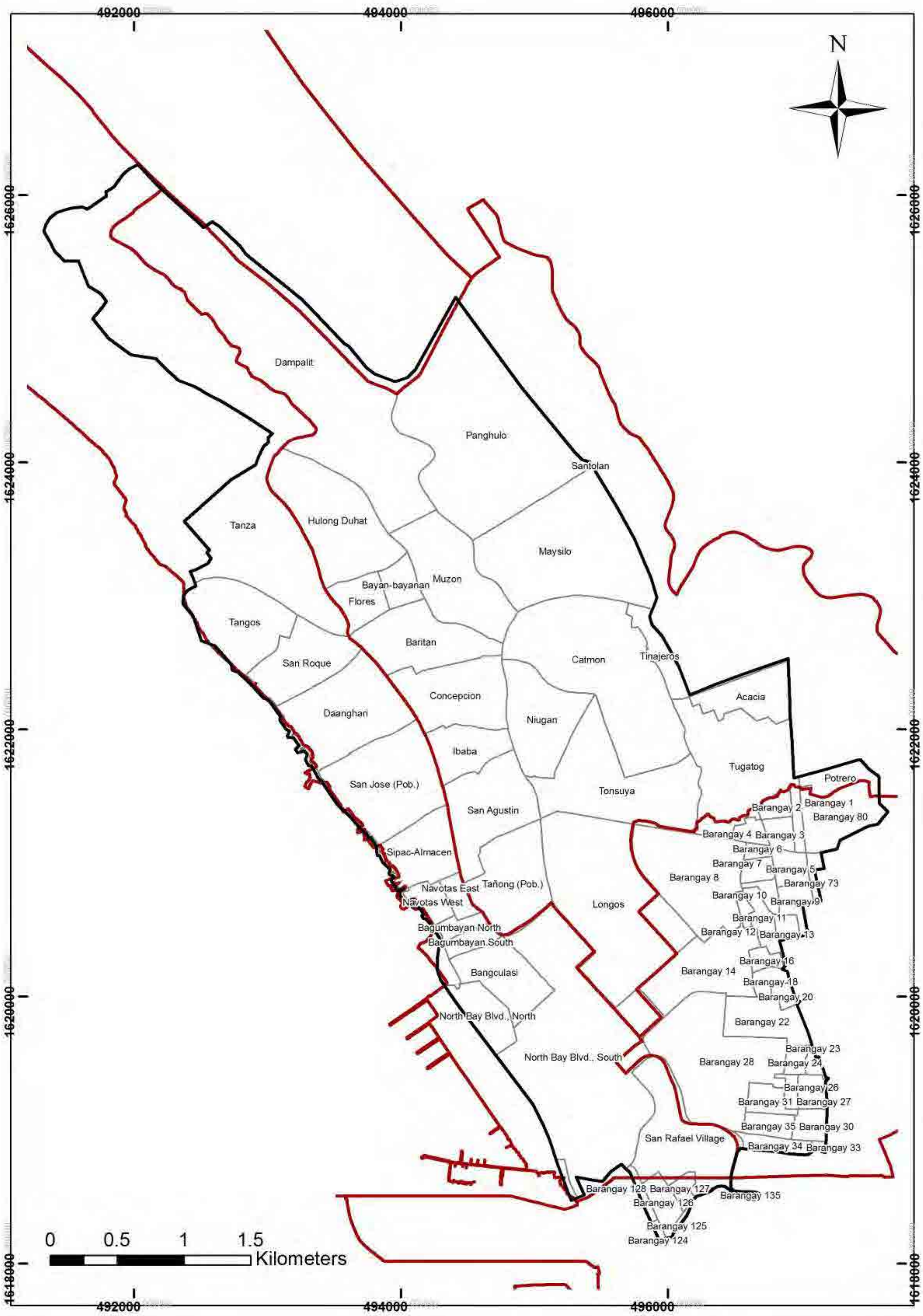
Table 3.1.2 shows the population for each Barangay in 2010 according to the National Statistics Office. Among the barangays, only Barangay Santulan in Malabon city does not belong to the KAMANAVA Project area. The population of Malabon and Navotas cities in the KAMANAVA Project area is about 580,000 in 2010.

Table 3.1.2 Population of Barangays in Malabon City and Navotas City in 2010

Malabon City	Population in 2010		Navotas City	Population in 2010
Acacia	5,735		Sipac-Almacen	11,541
Baritan	11,476		Bagumbayan North	2,652
Bayan- Bayanan	7,326		Bagumbayan South	4,524
Catmon	36,450		Bangculasi	8,263
Concepcion	11,806		Daanghari	19,179
Dampalit	11,245		Navotas East	2,241
Flores	4,282		Navotas West	8,698
Hulong Duhat	10,466		North Bay Blvd., North	16,201
Ibaba	7,630		North Bay Blvd., South	68,375
Longos	48,039		San Jose (Pob.)	28,153
Maysilo	11,213		San Rafael Village	3,530
Muzon	5,689		San Roque	17,916
Niugan	5,938		Tangos	32,941
Panghulo	12,772		Tanza	24,917
Potrero	41,407			
San Agustin	11,156			
Santulan(*1)	15,872			
Tanong (Pob)	14,620			
Tinajeros	17,901			
Tonsuya	39,354			
Tugatog	22,960			
Total	353,337		*Total*	249,131

Source: NSO in 2010

Remark: *1) out of KAMANAVA Project Area



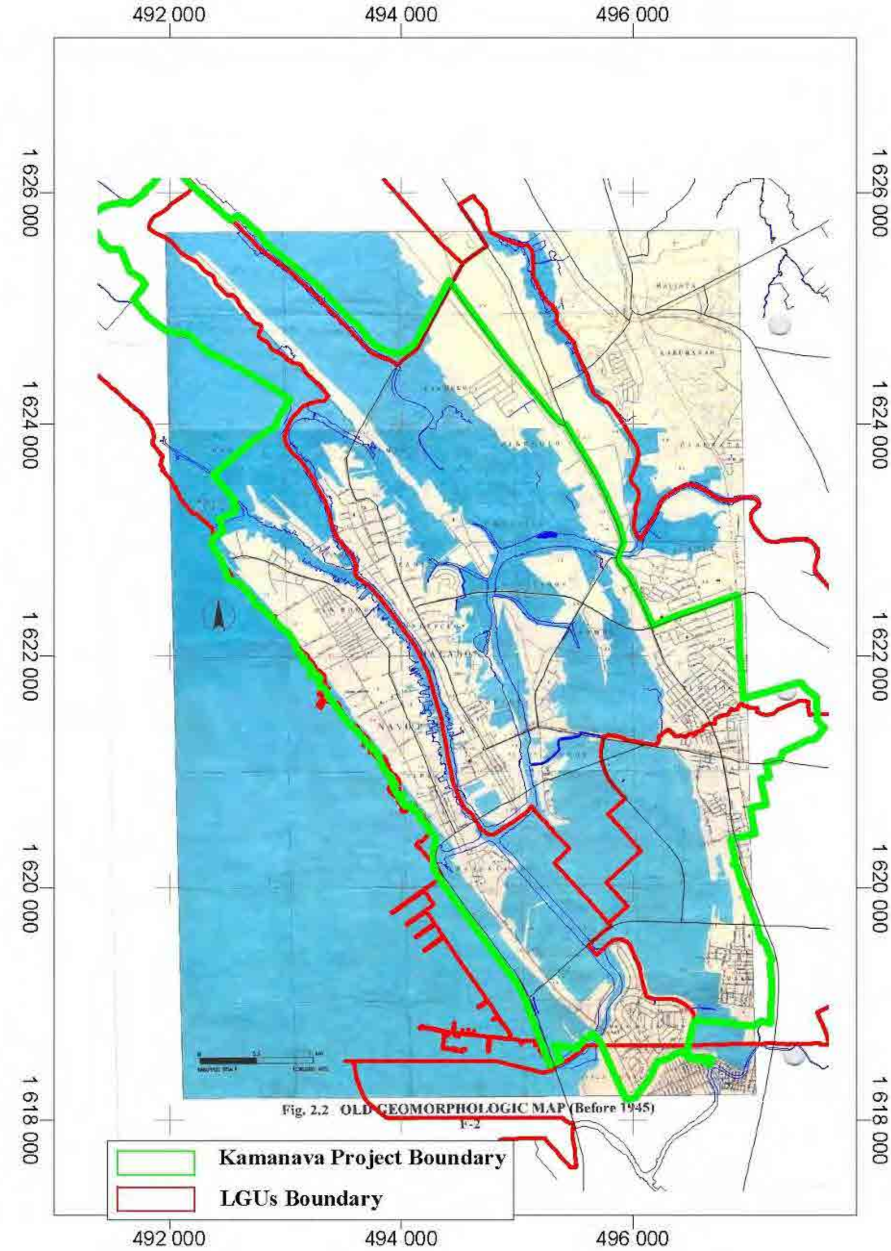
Source: JICA Study Team

Figure 3.1.1 Location Map of Barangay in the KAMANAVA Project Area

3.2 Topography

3.2.1 Land Subsidence

It has been widely said that most of the current KAMANAVA Area used to be under sea water except for Navotas higher ground area. Figure 3.2.1 shows an old map introduced as the situation before 1945 in the Main Design Report in 2001. According to this figure, in the KAMANAVA Project area the land on both sides of the current Navotas river were higher elevations before 1945, however, the present Malabon river course was not clearly formed yet. The most of the south area of Malabon river and the Dampalit and Pinagkabalian area of the area north of the Malabon river were submergible areas in the past.



Source: This was prepared by JICA Study Team using Figure in Main Design Report by DPWH-CTI 2001.

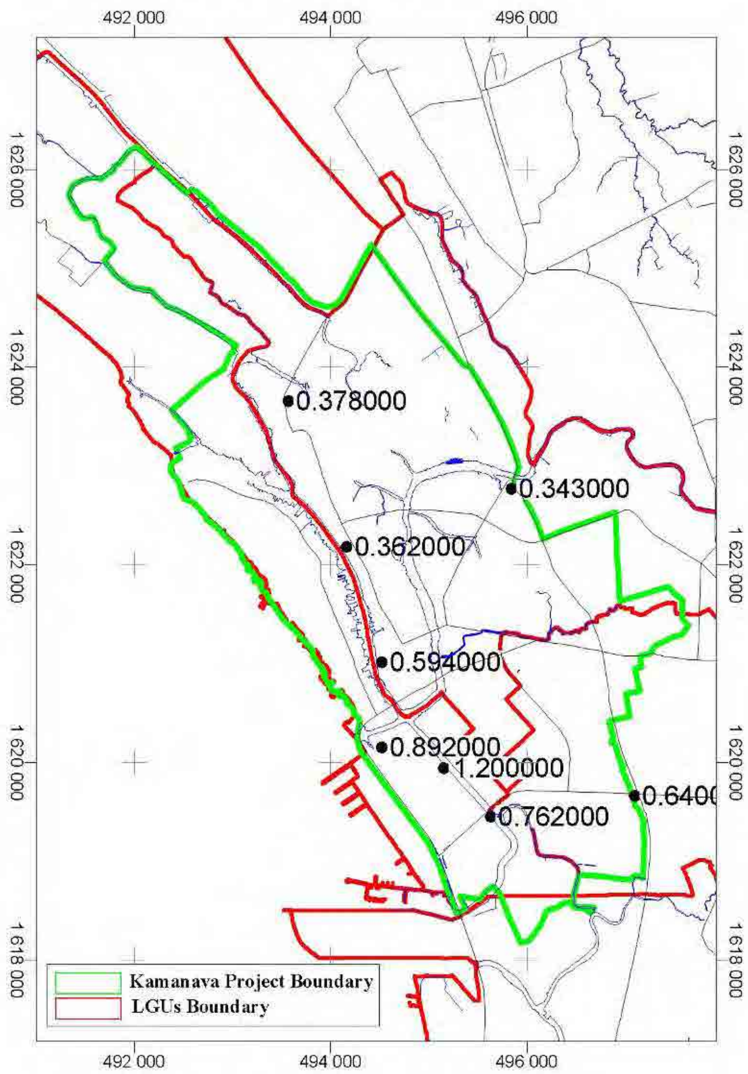
Figure 3.2.1 Old Map before 1945 of the KAMANAVA Project Area

Regarding the land subsidence in the KAMANAVA Project area, KAMANAVA DPWH-PMO Office does not have any specific (local) data and/or information on this subject.

First Order Geodetic Leveling in the Metro Manila Project (herein after called the NAMRIA Report)[1] was conducted by NAMRIA to check for elevation changes of previously known benchmarks and to establish new ones as needed along the way. The NAMRIA Report said that Navotas and Malabon

1 NAMRIA, First Order Geodetic Leveling; Determining Elevation Changes in Metro Manila(TECHNICAL REPORT GGD-001),2011

areas are land subsidence areas within Metro Manila. Figure 3.2.2 shows the land subsidence value in meters as evaluated by the NAMRIA Report for the last 38 years. In Navotas, 1.2 m subsidence was evaluated.



Source: NAMRIA, Area of Substantial Subsidence, Geodesy and geophysics Division

(unit: meter)

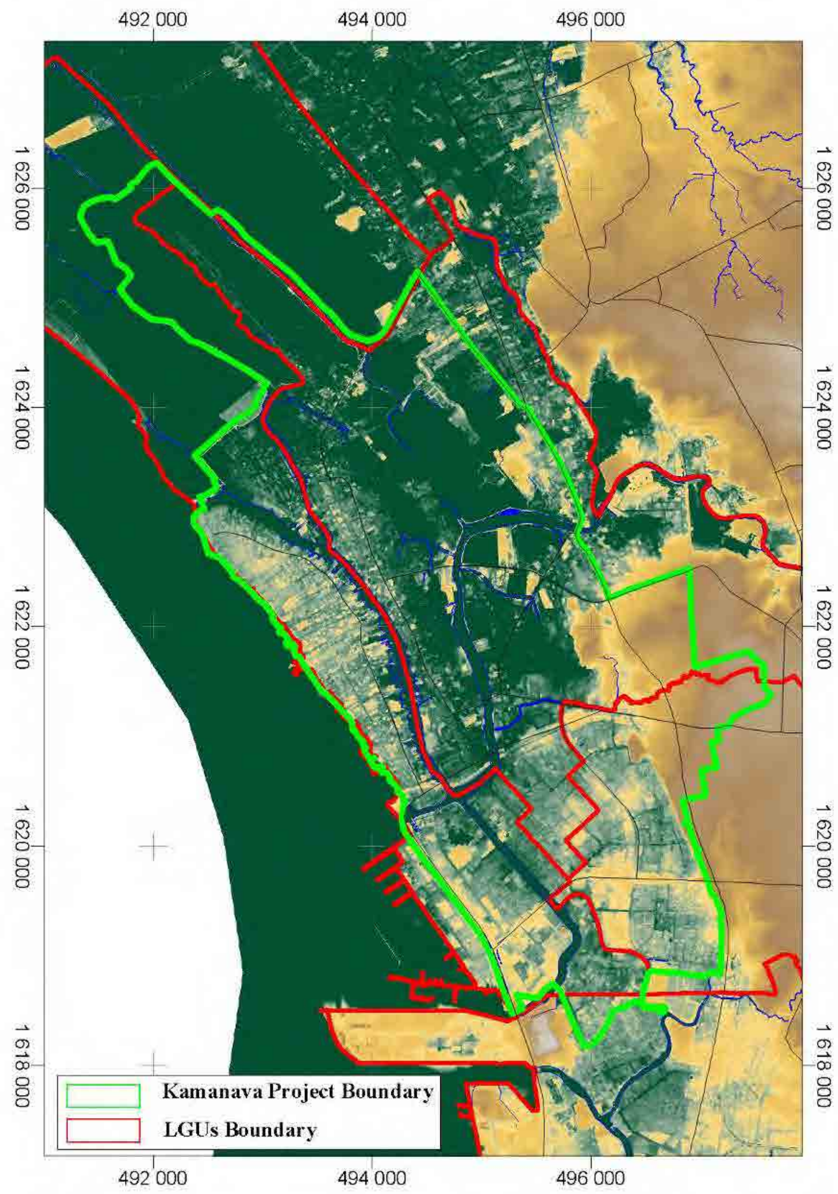
Figure 3.2.2 Land Subsidence evaluated by NAMRIA

3.2.2 Micro Topography Observation by LIDAR Data

Micro topography in the KAMANAVA Project Area was investigated using laser intensity direction and ranging (LIDAR) data obtained from DPWH.

The resolution of the obtained LIDAR data showed values from 1 meter, to 2.5 meters and 5 meters. The JICA Study Team selected the 2.5 meter data for the site visualization, hydrological analysis for ease of data handling in the GIS software and the structure size on site.

Figure 3.2.3 shows the Topographic Relief of the KAMANAVA Project Area by LIDAR Data.

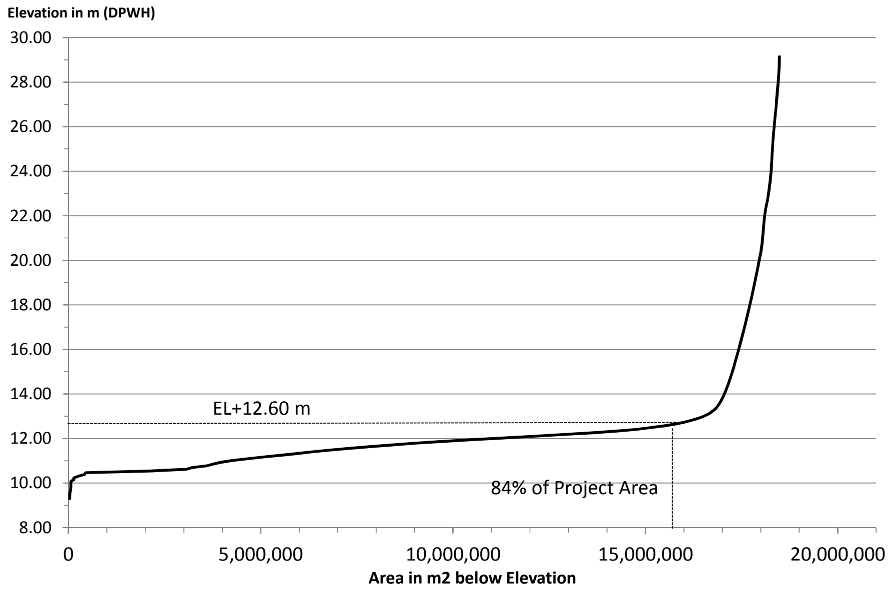


Source: JICA Study Team

Figure 3.2.3 Topographic Relief of KAMANAVA Project Area by LIDAR Data

Figure 3.2.4 shows the relationship between elevation and the area below the elevation in the KAMANAVA Project Area based on the LIDAR data. The elevation shown in the figure is based on DPWH datum which was calculated adding 11.48 m to the LIDAR data value. The conversion value +11.48 m was obtained from the comparison between the As-Built-Drawing by Contract 1 in 2009 and the corresponding elevation value in the LIDAR data.

The design crown elevation along the Malabon and Marala rivers is 12.6 m (DPWH Datum). The percentage of the area below 12.6 m to the KAMANAVA Project Area is 84 %.



Source: JICA Study Team

Figure 3.2.4 Histogram of Elevation in KAMANAVA Project Area

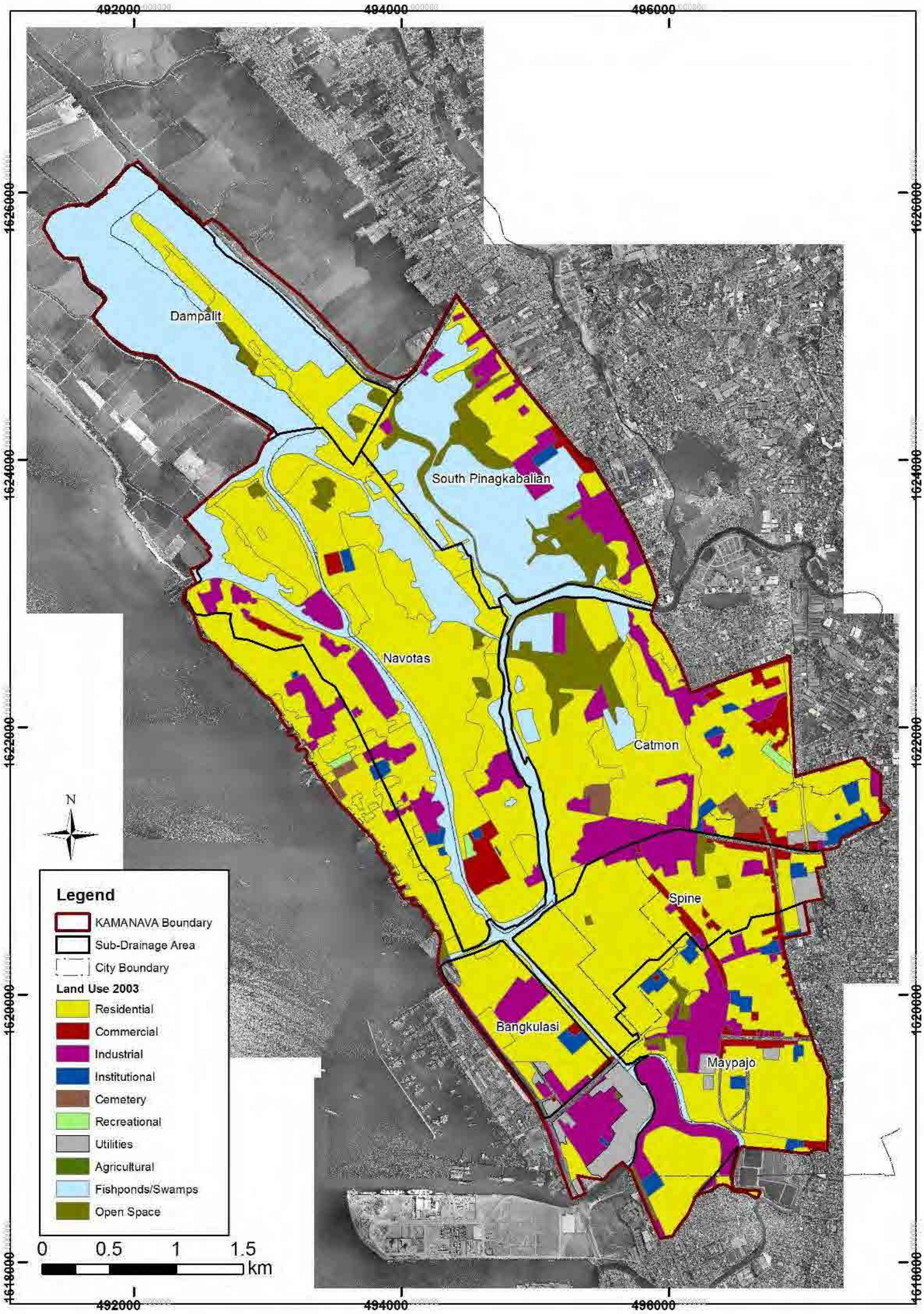
3.3 Landuse

3.3.1 Comparison of Landuse Conditions in 2003 and 2013

Landuse conditions before the Project and at present were surveyed for comparison and confirmation of landuse change. As the landuse condition before the Project, landuse condition in 2003 was used referencing the result of the past study of the “Earthquake Impact Reduction Study for Metropolitan Manila (JICA), 2004”. Present landuse condition in 2013 was prepared by updating of landuse condition in 2003 referencing the image data corresponding to the LIDAR data in 2011 and the result of a field survey that was carried out in this SAPS Study focusing on change of fishponds/swamps and open space, which may have high impact on the runoff condition.

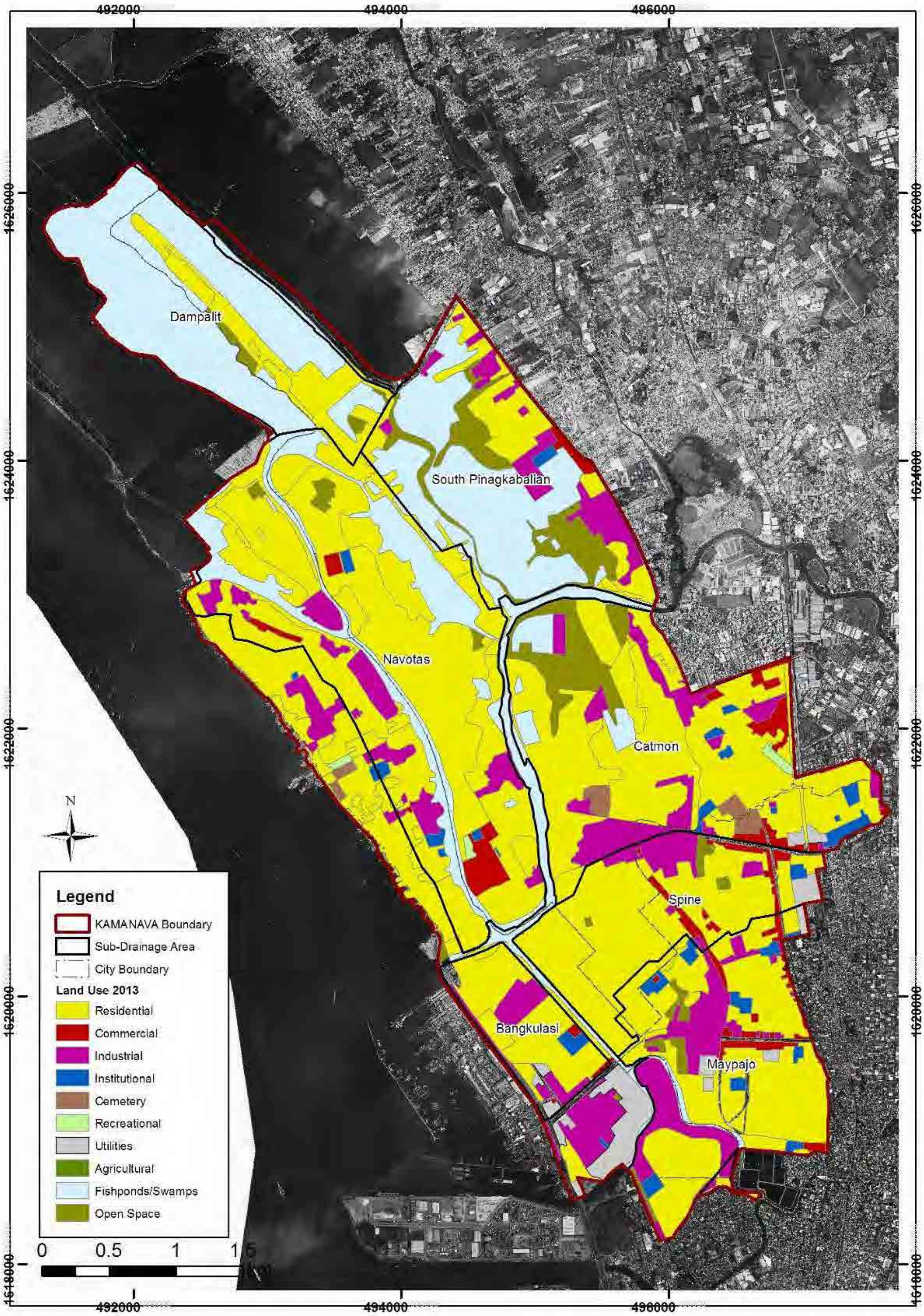
Landuse conditions in 2003 and 2013 are shown in Figures 3.3.1 and 3.3.2. Tables 3.3.1 and 3.3.2 show a comparison of landuse conditions in 2003 and 2013 in the entire Project Area and each sub-drainage area, respectively.

As a result of the comparison between 2003 and 2013, there is no significant change of landuse condition in the Project Area.



Source: JICA Study Team

Figure 3.3.1 Landuse Condition in 2003



Source: JICA Study Team

Figure 3.3.2 Landuse Condition in 2013

Table 3.3.1 Comparison of Landuse Conditions in Entire Project Area in 2003 and 2013

Land Use	2003		2013	
	ha	%	ha	%
Residential	1,069	53.9%	1,072	54.1%
Commercial	53	2.7%	53	2.7%
Industrial	218	11.0%	218	11.0%
Utilities	35	1.8%	35	1.8%
Institutional	32	1.6%	32	1.6%
Cemetery	11	0.6%	11	0.6%
Park	4	0.2%	4	0.2%
Fishponds/ Swamps	463	23.4%	462	23.3%
Open Space	97	4.9%	96	4.8%
Agricultural	0	0.0%	0	0.0%
Total	1,982	100.0%	1,982	100.0%

Source: JICA Study Team

Table 3.3.2 Comparison of Landuse Conditions in Sub-Drainage Areas in 2003 and 2013

Sub-drainageArea	Bangkulasi				Catmon				Maypajo				Spine			
Year	2003		2013		2003		2013		2003		2013		2003		2013	
Area	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Residential	50.2	70.2	50.2	70.2	223.1	62.8	224.1	63.1	154.8	65.1	154.8	65.1	133.7	79.1	133.7	79.1
Commercial	1.3	1.8	1.3	1.8	13.6	3.8	13.6	3.8	10.3	4.3	10.3	4.3	9.6	5.7	9.6	5.7
Industrial	15.1	21.1	15.1	21.1	43.0	12.1	43.0	12.1	45.0	18.9	45.0	18.9	16.2	9.6	16.2	9.6
Utilities	2.5	3.5	2.5	3.5	2.7	0.8	2.7	0.8	5.0	2.1	5.0	2.1	4.0	2.3	4.0	2.3
Institutional	2.4	3.4	2.4	3.4	9.3	2.6	9.3	2.6	11.6	4.9	11.6	4.9	1.4	0.8	1.4	0.8
Cemetery	0.0	0.0	0.0	0.0	9.0	2.5	9.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Park	0.0	0.0	0.0	0.0	1.9	0.5	1.9	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fishponds/ Swamps	0.0	0.0	0.0	0.0	21.0	5.9	18.5	5.2	4.0	1.7	4.0	1.7	0.6	0.4	0.6	0.4
Open Space	0.0	0.0	0.0	0.0	31.7	8.9	33.1	9.3	7.0	2.9	7.0	2.9	3.6	2.1	3.6	2.1
Total	71.5	100.0	71.5	100.0	355.2	100.0	355.2	100.0	237.8	100.0	237.8	100.0	169.0	100.0	169.0	100.0

Sub-drainage Area	Navotas				Dampalit				South Pinagkabalian			
Year	2003		2013		2003		2013		2003		2013	
Area	ha	%	ha	%	ha	%	ha	%	ha	%	ha	%
Residential	322.1	67.4	324.7	68.0	46.5	20.1	45.9	19.9	49.1	19.7	48.9	19.6
Commercial	14.4	3.0	14.4	3.0	0.0	0.0	0.0	0.0	2.9	1.2	2.9	1.2
Industrial	37.1	7.8	37.1	7.8	0.0	0.0	0.0	0.0	29.2	11.7	29.2	11.7
Utilities	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Institutional	4.6	1.0	4.6	1.0	0.0	0.0	0.0	0.0	1.5	0.6	1.5	0.6
Cemetery	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Park	1.0	0.2	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Fishponds/ Swamps	91.9	19.2	90.9	19.0	178.5	77.3	180.1	78.0	126.2	50.5	126.8	50.8
Open Space	6.6	1.4	5.2	1.1	6.0	2.6	5.0	2.2	40.7	16.3	40.3	16.2
Total	477.7	100.0	477.7	100.0	231.0	100.0	231.0	100.0	249.7	100.0	249.7	100.0

Source: JICA Study Team

3.3.2 Comparison of Landuse Condition in Detailed Design Stage in 2001

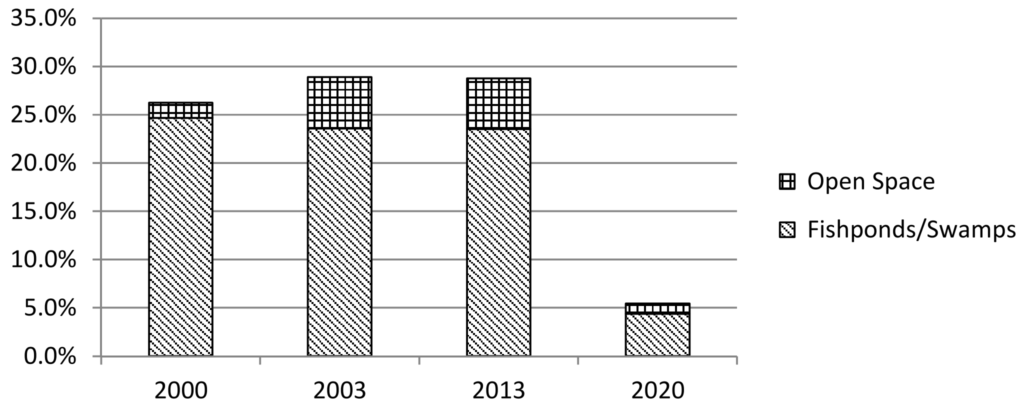
In the detailed design stage in 2001, present landuse in 2000 and future landuse in 2020 were investigated and summarized as shown in Table 3.3.3.

Table 3.3.3 Landuse Condition in 2000 and Estimated Future Landuse Condition in 2020 in Sub-Drainage Areas in Detailed Design Stage in 2001

Sub-drainage Area	Bangkulasi		Catmon		Maypajo		Spine		Navotas		Dampalit		South Pinagkabalian	
Year	2000 %	2020 %	2000 %	2020 %	2000 %	2020 %	2000 %	2020 %	2000 %	2020 %	2000 %	2020 %	2000 %	2020 %
Residential	59.5	72.0	53.2	54.3	58.5	46.0	75.1	70.0	67.1	63.8	17.4	55.3	28.1	85.8
Commercial	28.4	19.4	8.0	22.2	12.4	4.4	17.1	16.8	10.2	13.9	0.0	0.0	0.0	2.2
Industrial	7.3	8.6	19.3	16.8	25.8	33.3	6.0	3.1	2.9	3.4	1.3	36.7	12.8	6.0
Utilities	0.0	0.0	0.0	0.0	0.0	5.6	0.0	6.5	0.0	0.0	0.0	0.0	0.3	0.0
Institutional	3.2	0.0	1.5	3.3	2.8	7.4	1.8	2.3	1.8	2.3	0.3	0.0	0.0	0.4
Cemetery	0.0	0.0	0.7	1.4	0.0	0.0	0.0	0.0	0.9	0.1	0.0	3.9	0.0	0.0
Park	1.6	0.0	1.1	1.1	0.0	3.3	0.0	1.2	1.0	0.4	0.0	2.1	0.0	0.0
Fishponds/ Swamps	0.0	0.0	9.9	1.0	0.5	0.0	0.0	0.0	16.1	12.1	78.4	1.9	58.8	5.6
Open Space	0.0	0.0	6.3	0.0	0.0	0.0	0.0	0.0	0.0	3.9	2.6	0.0	0.0	0.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: JICA Study Team

Since the methodology for classification of landuse may be slightly different between the "Earthquake Impact Reduction Study for Metropolitan Manila (JICA), 2004" and the detailed design in 2001, the percentages of each category of landuse are also different. Especially, it can be found that the ratio of residential, commercial and industrial areas is different between the results of these studies. However, regarding the classification of fishponds/swamps and open space, those classifications are considered as comparatively similar in those studies and it is also considered that the tendency of landuse can be grasped by comparing those ratios. Figure 3.3.3 shows the ratios of fishponds/swamps and open space against total area of the seven sub-drainage basins. From the figure, it can be said that landuse condition has had almost no change since 2000 and may not change as future landuse condition estimated in the detailed design stage in 2001.

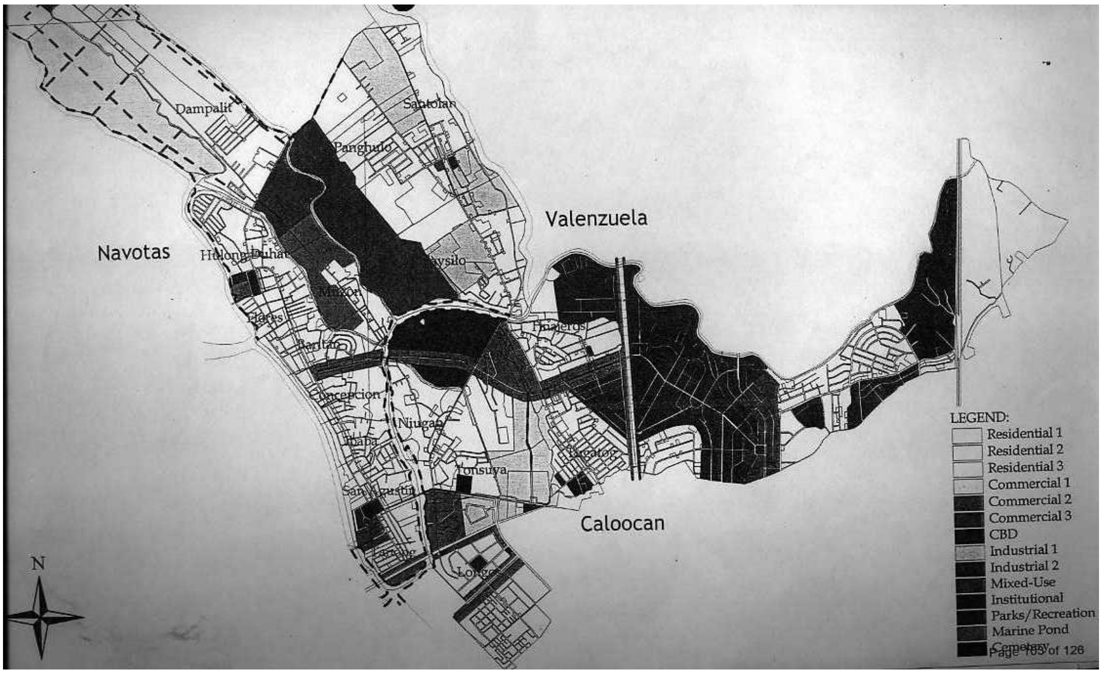


Source: JICA Study Team

Figure 3.3.3 Comparison of Ratios of Fishponds/Swamps and Open Space against Total Area of Seven Sub-Drainage Basins

3.3.3 Latest Landuse Plan by LGUs

Maps of the latest landuse plan by LGUs, which were obtained through this SAPS Study, are shown below.



Source: Malabon City

Figure 3.3.4 Landuse Plan in 2003 in Malabon City

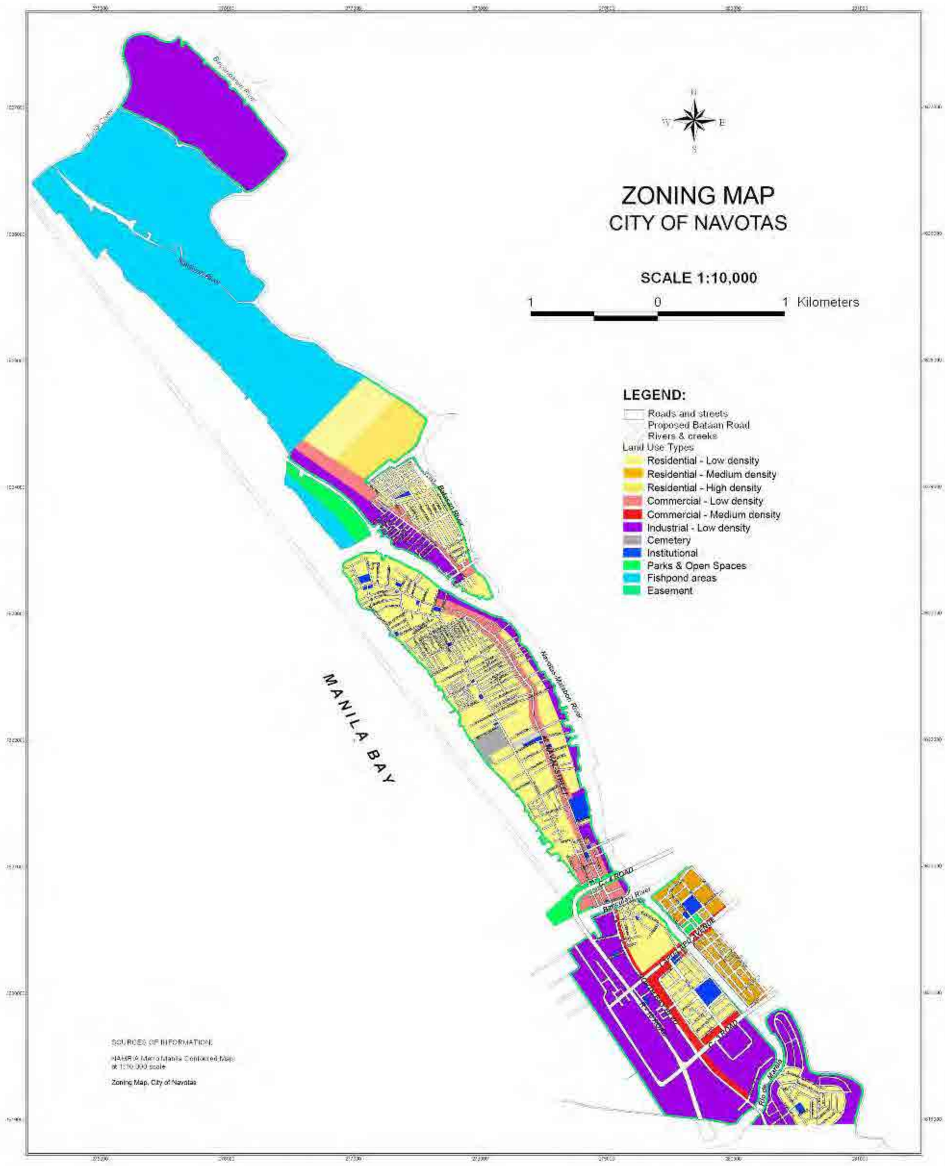
The City Development Plan 2012-2014 by Malabon City states that the Malabon City Land Use Plan was approved in March 2003 and enacted through Municipal Order 04-2000, as amended by City Ordinance 07-2002 and City Ordinance 04-2004 known as the “Zoning Ordinance”. A total of 597.28 hectares or 38.01% of the 1,571 hectares total land area of Malabon is residential (largest part), while 19.45 % are classified as commercial areas. The rest of the landuses in the city are classified as industrial, Institutional, Agricultural& Fishery, Open spaces and Cemeteries.

The landuse area shown in Table 3.3.4 is future landuse according to The City Development Plan 2012-2014. Compared with the projected land use in 2020 in the KAMANAVA Project, each category and landuse distributions are different, however, the basic policy of conversion from fish pond to residential/industrial area is the same.

Table 3.3.4 Summary of Malabon City’s Landuse Plan

Use	Hectare	%
Residential	597.29	38.01
Commercial	305.64	19.45
Industrial	516.99	32.90
Institutional	99.19	6.32
Agricultural/Fishery	20.00	1.27
Open Spaces	14.62	0.93
Cemetery	17.67	1.12
TOTAL	1,571.40	100.00

Source: The City Development Plan 2012-2014 by Malabon City



Source: Navotas City

Figure 3.3.5 Zoning Map for Future Development in Navotas City

Figure 3.3.5 is the zoning map for future development in Navotas City.

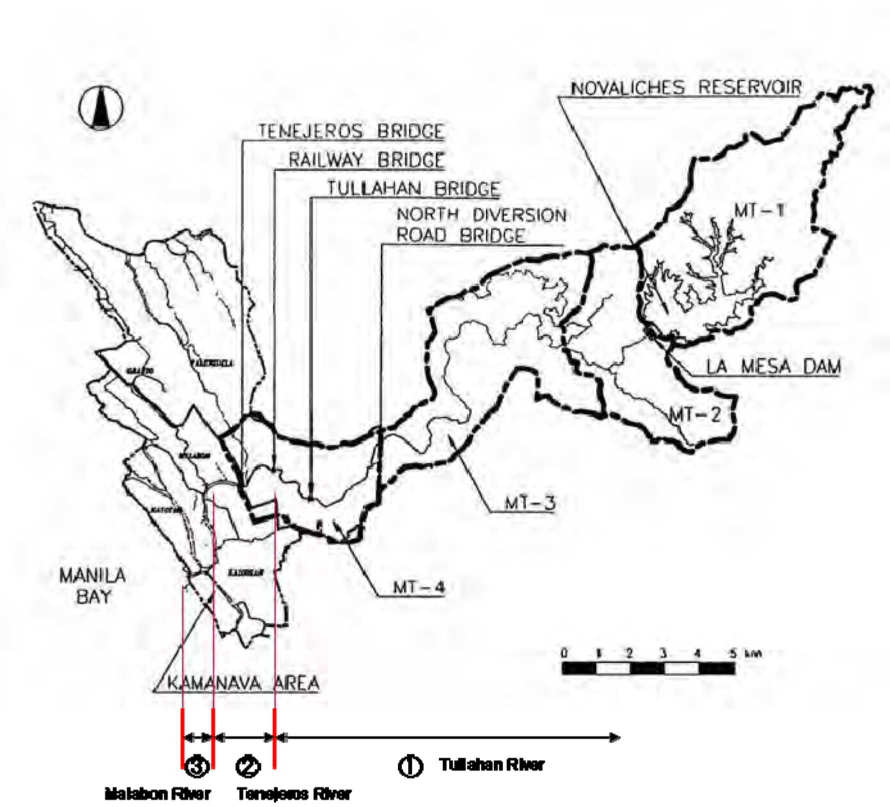
According to the "Socio-Economic Profile Navotas City 2013", fishponds were the largest land users in Navotas. However, these fishponds are not currently in use and have not been productive for some time now and have been left as water-filled open areas. The fishponds, concentrated in Barangay Tanza, are located in the northern portion of the city and comprised almost half of the area of Navotas. In the past, these areas were productively serving the locality as an economic base sustaining the livelihood of the locality and providing the metropolis with water-based resources since Navotas is a coastal city and has traditionally in its history functioned as the fishing center of the metropolis. However, over the time these fishponds slowly lost their intended function and because of this unproductive scenario the land use of Fish Ponds reduced to 37.97% equivalent to 405.94 hectares, 39.67 hectares of the area converted into Sanitary Landfill, 8.4 hectares converted into Socialized Housing, and 10.9 hectares converted into Control Disposal Facilities. In light of this, it can be viewed that the largest land use activity in the locality is residential at 38.51% comprising 411.63 hectares of the town's 1069 hectares. Residential landuse dominates the entire city and is widespread mostly in the central portion of the elongated profile of Navotas.

3.4 Malabon-Tullahan River

3.4.1 General

The Malabon-Tullahan River originates from the Novaliches watershed with a catchment area of 70 km^2 at Tenejeros Bridge. The river is flowing southwestward into Manila Bay. The main stream of this river system is called by different names such as Tullahan, Tenejeros, and Malabon depending on the location. The Main Design Report defines the river name along the Malabon-Tullahan river as shown in Figure 3.4.1. The Tullahan River is from La Mesa Dam to the Railway Bridge (PNR). The Tenejeros River is from the Railway Bridge to the confluence of Pinagkabalian River to the main stream. The Malabon River is downstream of the Pinagkabalian river confluence to the Manila Bay.

The catchment areas at La Mesa Dam and Tenejeros Bridge are 24.85 km^2 and 69.25 km^2, respectively.



Source: JICA Study Team arranged based on Sectoral Report C, 2001.

Figure 3.4.1 Watershed of Malabon-Tullahan River and River Name Definition

3.4.2 River Cross Section Survey

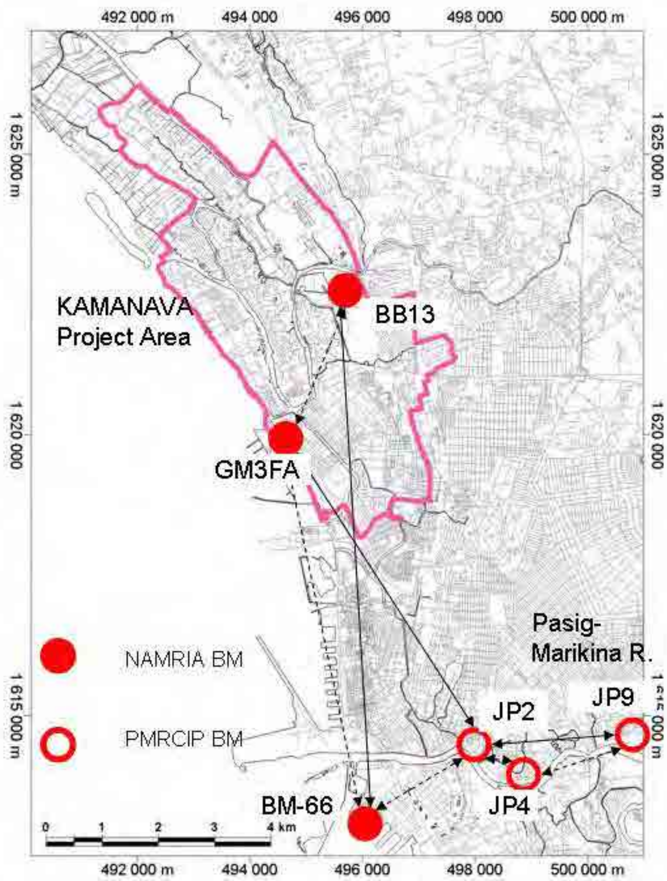
(1) General

Longitudinal and cross sectional survey at intervals of about 500m were carried out in the Malabon River in the Project target area and in the Tullahan river upstream of the Malabon River.

The quantity and area in the survey were about 8km for the longitudinal survey (from the river mouth to the downstream section of the Tullahan river through the Malabon river) and 18 cross sections for cross sectional survey with 250m of surveyed distance of each section as shown in Figure 3.4.3. Surveyed sections were determined considering past surveyed points/cross sections so as to utilize them for comparing with surveyed results in the past

(2) Selection of Base Bench Mark

In the survey, in order to select a base bench mark for establishment of the control points, NAMRIA official first order control points and the three control points along the Pasig River, which were installed in Pasig-Marikina River Channel Improvement Project (Phase III) (hereinafter referred to as "PMRCIP III"), were checked in terms of the levelling. The location of the referred six (6) bench marks are shown in Figure 3.4.2.



Source: JICA Study Team

Figure 3.4.2 Locations of Referred Bench Marks for the River Cross Section Survey

As a result of comparison of the referred six (6) bench marks, GM-3FA an NAMRIA official first order control point, which is located in the KAMANAVA Project area, was considered as suitable for the base bench mark in the survey. Table 3.4.1 is the result of the leveling survey for bench marks of GM-3FA and Pasig Marikina Project. The leveling started from GM-3FA and the elevations above MSL based on GM-3FA were calculated for JP2, JP4 and JP9. The certified elevation of GM-3FA is 2.230 m above MSL.

Table 3.4.1 Result of Leveling Survey for Bench Marks of GM-3FA and PMRCIP III

BM	Authority	Calculated Elevation from **GM-3FA**	DPWH Datum Elevation (Calculated)	PMRCIP III Elevation	Discrepancy
		①	②	③	②-③
		MSL, m	DPWH, m	DPWH, m	m
JP2	PMRCIP	1.487	11.962	12.005	-0.043
JP4	PMRCIP	1.739	12.214	12.240	-0.026
JP9	PMRCIP	2.291	12.766	12.808	-0.042

note: PMRCIP III Elevation means the bench mark elevations established by Pasig Marikina River Channel Improvement Project Phase III.

note: DPWH Datum Elevation = (Calculated Elevation from GM-3FA)+10.475.

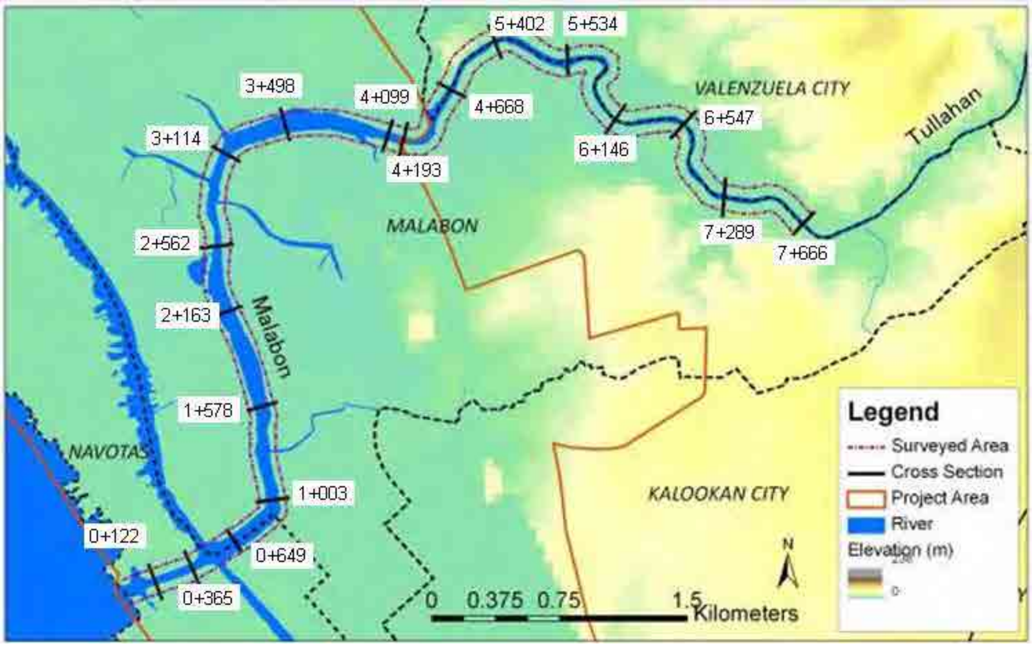
Source: JICA Study Team

The discrepancy in elevation between GM-3FA and PMRCIP III bench marks is small. There is 2-4 cm difference between GM-3FA-based elevation and the PMRCIP III-confirmed elevations of JP-2, 4 and 9.

In this SAPS Study, GM-3FA which can be used to calculate the elevations of the bench marks of PMRCIP III in the range 4 cm, is used as the base bench mark because of its consistency with the PMRCIP III.

(3) Survey Result

Figure 3.4.3 shows the locations of the survey cross sections in 2013. There are 18 cross sections from near the river mouth of the Malabon river (Station 0+122) to Macarthur Highway bridge of the Tullahan river (Station 7+666).

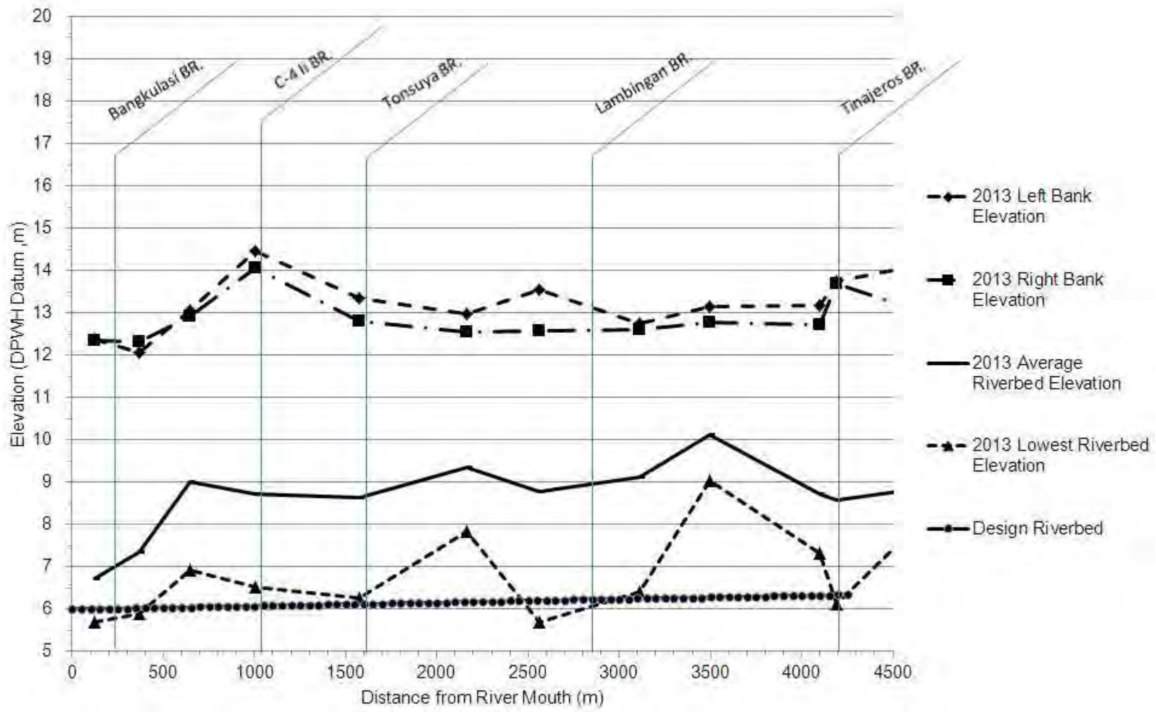


Source: JICA Study Team

Figure 3.4.3 Locations of Surveyed Cross Sections

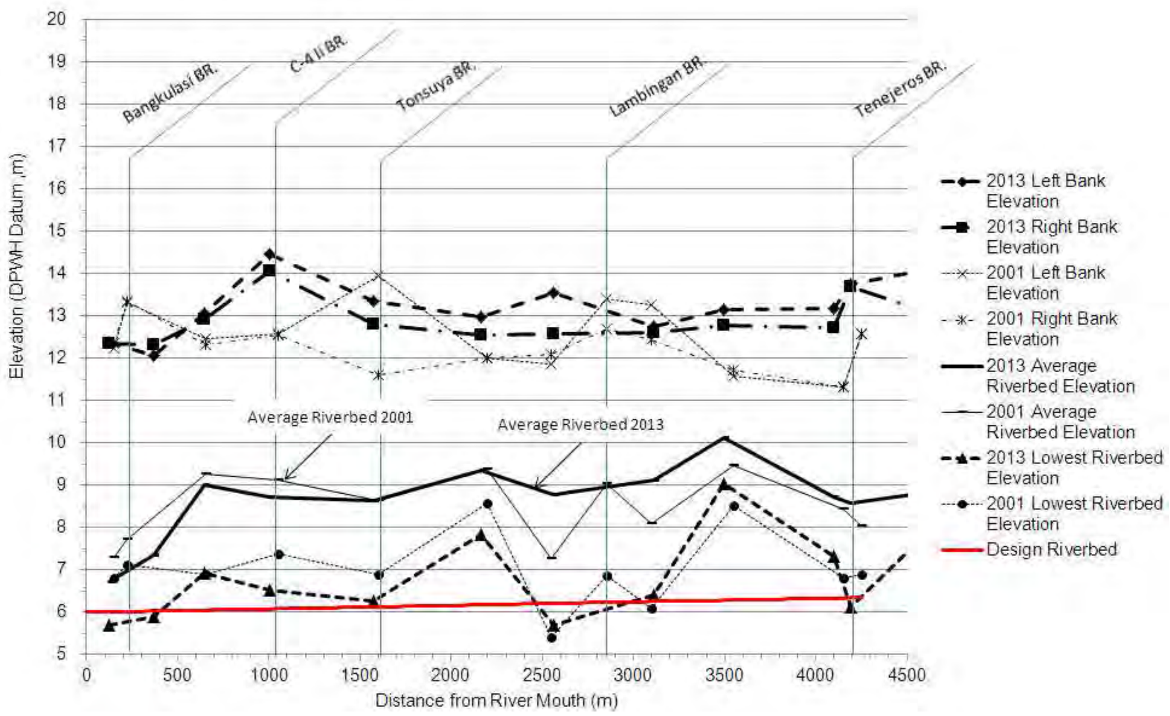
As outputs from the survey, the longitudinal profile in 2013 is shown in Figure 3.4.4. Compared with the design riverbed level, the average riverbed is about 3 meters higher.

As a reference, the comparison of longitudinal profile between 2001 and 2013 is shown in Figure 3.4.5. The elevation of 2001 was based on the Bench Mark called BM-4B. While the base bench marks of both years are not the same, the general tendencies in terms of the lowest riverbed and the average riverbed are similar. Even in 2013, the average riverbed profile is about 3 meters higher than the design riverbed.



Source: JICA Study Team

Figure 3.4.4 Longitudinal Profile of Malabon river in 2013



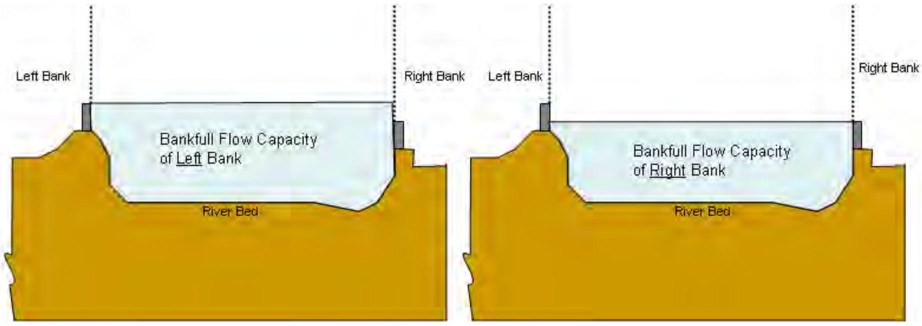
Source: JICA Study Team

Figure 3.4.5 Comparison of Longitudinal Profile of Malabon river in 2001 and 2013

3.4.3 Analysis of Channel Flow Capacity

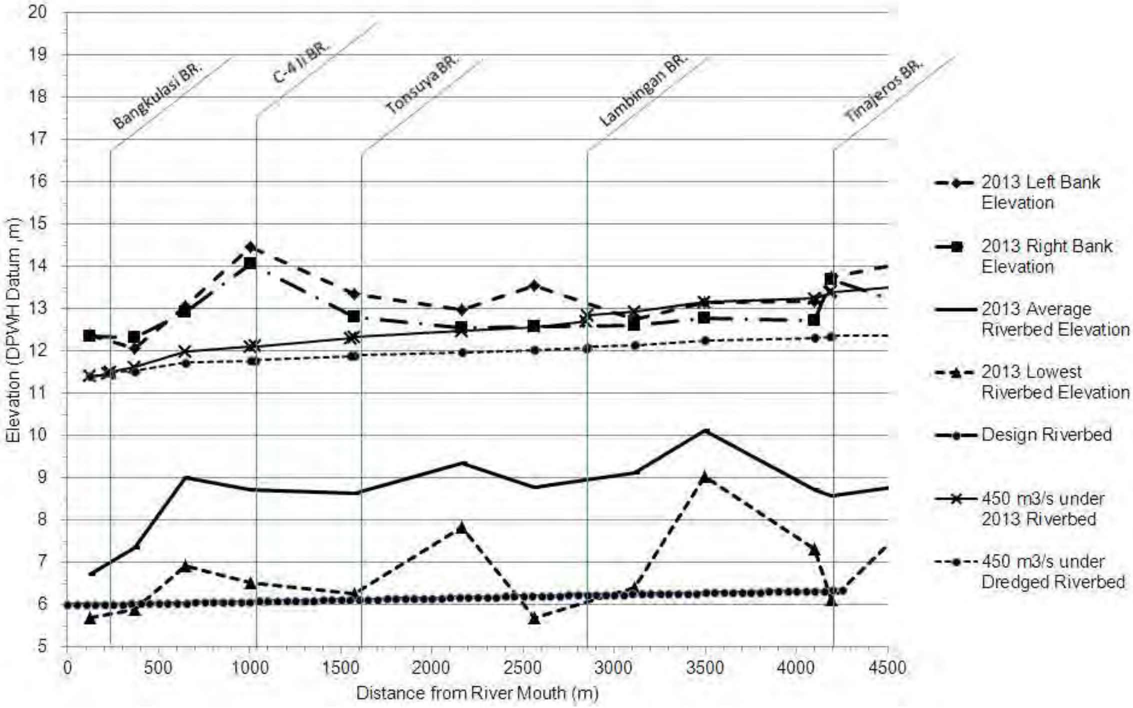
Channel flow capacity in the surveyed cross section conditions in 2001 and at present (2013) was calculated by non-uniform computation.

The channel flow capacity was evaluated for the left bank and right bank separately. As to the Malabon river, the dike alignment was decided by the Detailed Design and its channel capacity is increased by raising the dike height (river wall raising). Generally both bank elevations are not exactly the same, as shown in Figure 3.4.6 the channel flow capacity is defined within the dike alignment for the dike elevation of each left and right bank. If the left bank elevation is higher than the right bank, the left bank flow capacity does not consider overflow from the right bank.



Source: JICA Study Team

Figure 3.4.6 Concept of Channel Flow Capacity for Left and Right Banks of Malabon River



Source: JICA Study Team

Figure 3.4.7 Calculated Water Level for 450 m^3/s under 2013 Cross section and Dredged Cross Section

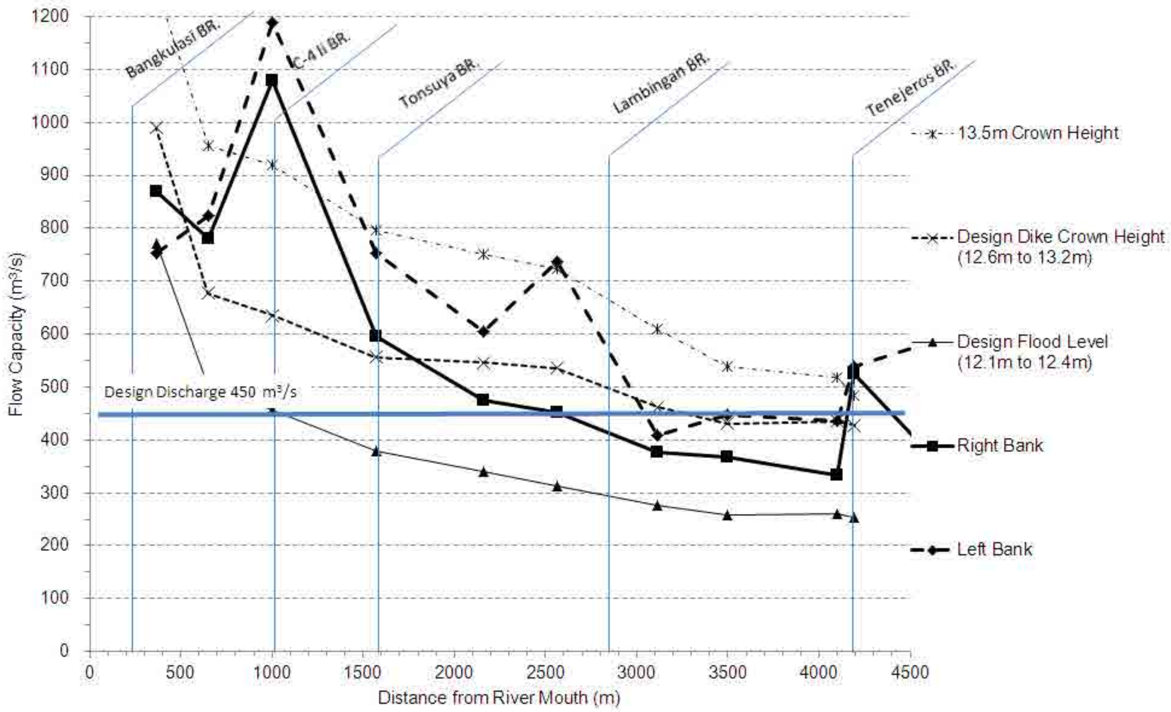
Figure 3.4.7 is the result of the non-uniform flow computation, where

- Downstream water level was set to be Design HWL +11.40 m (DPWH Datum).
- The Manning's roughness was set to be 0.03 based on the Detailed Design.
- Discharge is 450 m^3/s as the design discharge of the Malabon river.

The water level calculation was done for the 2013 cross section and the cross section dredged to design riverbed.

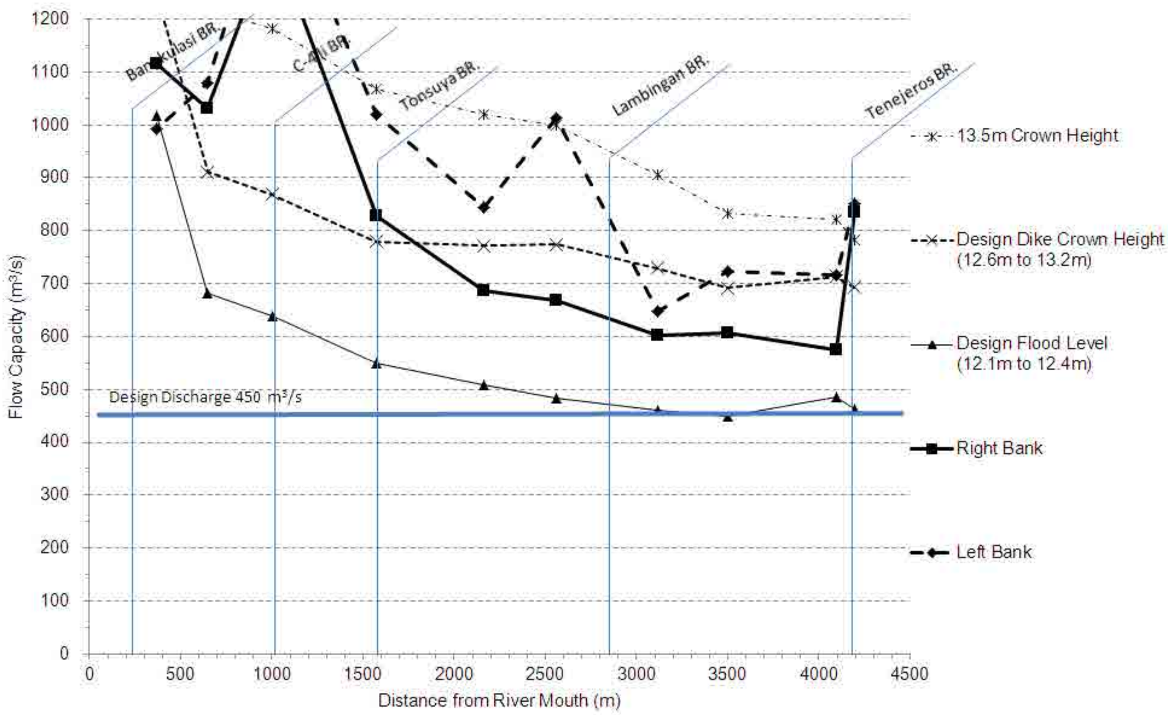
This figure indicates, under the 2013 cross section, upstream of station 2+500 would cause overflow for the design discharge case.

Next, based on the non-uniform calculation shown in Figure 3.4.7, the channel flow capacity for each cross section was evaluated. Figure 3.4.8 and Figure 3.4.9 are the profiles of channel flow capacity for the cross sections in 2013 and the dredged riverbed, respectively. The figures include not only flow capacities for the left bank and right bank heights but also those of design flood level, design dike crown height and raising crown height to 13.5m (DPWH Datum).



Source: JICA Study Team

Figure 3.4.8 Flow Capacity of Cross Section Conditions in 2013

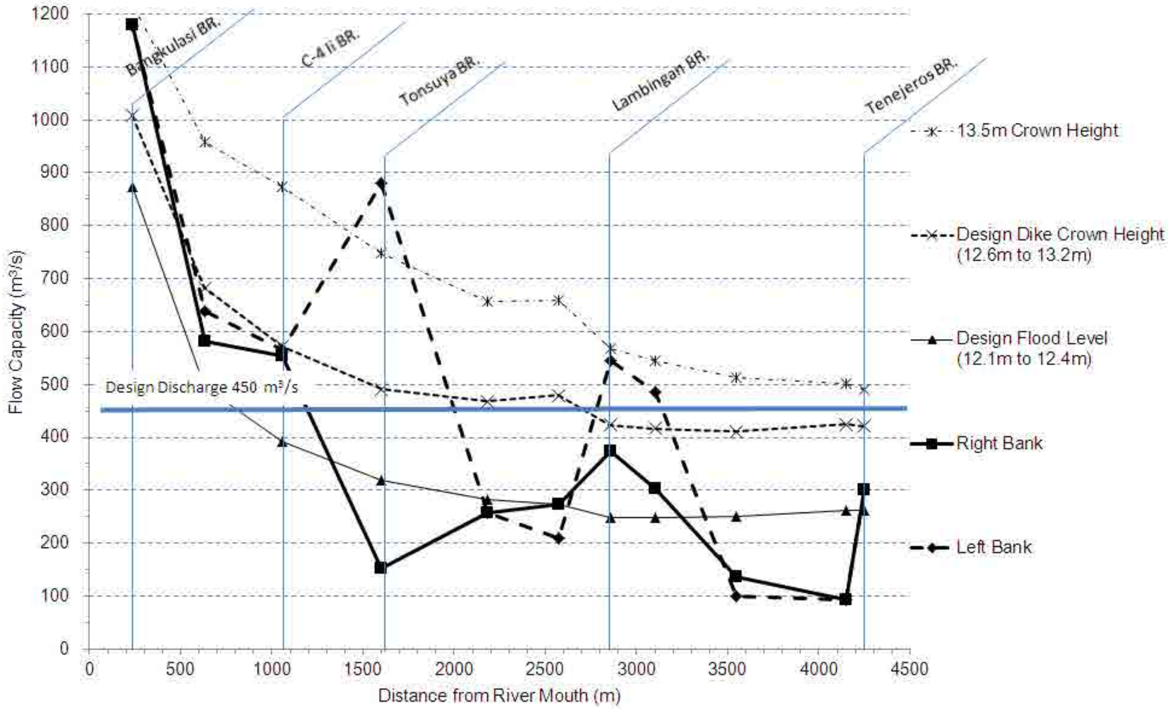


Source: JICA Study Team

Figure 3.4.9 Flow Capacity of Cross Section Conditions in 2013 with Dredged Riverbed

As reference, Figure 3.4.10 shows the profiles of channel flow capacity for the cross sections in 2001 (the design stage). Compared with Figure 3.4.8, the flow capacity at the height of DFL is similar to it, this means only raising the river wall along the Malabon river cannot increase the flow capacity. From this result, it is understood that at the time of the Detailed Design, without the dredging of the Malabon river, the design discharge of 450 m^3/s could not flow under DFL in the section of 800 m to 4250 m.

In order to let the design discharge pass under DFL, the riverbed dredging is necessary.



Source: JICA Study Team

Figure 3.4.10 Flow Capacity of Cross Section Conditions in 2001 Cross Sections

3.4.4 Bench Mark Issue for KAMANAVA Project Area

In the course of the SAPS Study, the JICA Study Team recognized not small differences between NAMRIA Tide data in the Tide Table and the monitored water levels by KAMANAVA PMO at the Flood Gate/ Pumping Stations. In order to clarify such elevation discrepancies in the Project area, the JICA Study Team checked spot elevations of some of the structures in the KAMANAVA Project as a part of the River Cross Section survey. The locations of surveyed structure and the results are shown in Figure 3.4.11 and Table 3.4.2, respectively.

As shown in Table 3.4.2, the elevation values surveyed in this SAPS Study are lower than the elevations indicated in the construction drawings (as-built drawings) in the KAMANAVA Project. The difference is 51 cm at Bangkulasi Floodgate and also at Spine Floodgate, which are located downstream of the Malabon river. The difference becomes smaller moving upstream of the Malabon river, and at the Tinajeros Bridge the difference is 12 cm.

Basically the elevation of the KAMANAVA Project was based on the bench mark called BM-4B, according to the Main Design Report 2001 of the Project[2]. The elevation of BM-4B is 13.220 (DPWH Datum, m) which is 2.745 m above MSL and 3.220 m above MLLW.

[2] The exact location of the BM-4B could not be confirmed in the SAPS Study because it is said it was destroyed and there is no data to explain the relationship between recent NAMRIA BMs and BM-4B in terms of elevation. At present, in South Harbor, Manila, there is a bench mark called BM-66 of NAMRIA. This is also designated as a primary tide station in the Tide Table by NAMRIA.

The base bench mark of the SAPS Study (the River Cross Section survey) is GM-3FA of NAMRIA. The surveyed elevations in Table 3.4.2 are all based on GM-3FA and converted to DPWH Datum in meters as follows.

Elevation (DPWH Datum, m) = 10.486 + Elevation (MSL, m)

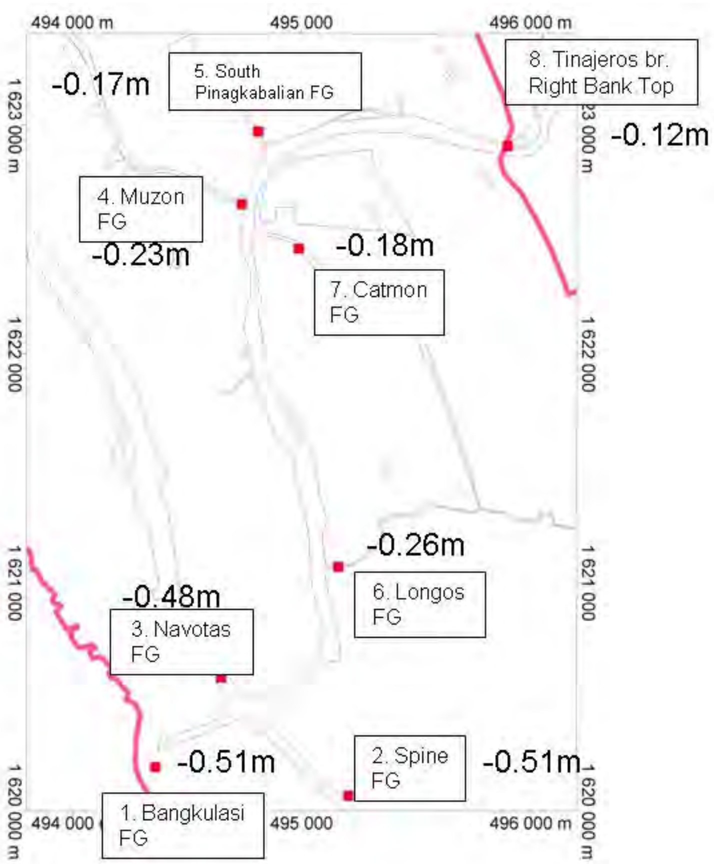
Both the KAMANAVA Project elevations and the SAPS Study elevations are expressed in DPWH Datum in meters, which is 10 m below MLLW. In this sense, they are referring to a certain sea level plane, so the difference indicated in Table 3.4.2 might have some effects on KAMANAVA Project Design parameters.

Table 3.4.2 Comparison of Spot Elevations for Specific Locations in the KAMANAVA Project Structure

No	Location	Surveyed Elevation in SAPS Study		Elevation Values in Construction Drawings in KAMANAVA Project	Difference
		MSL,m	DPWH Datum, m (①)	DPWH Datum, m(②)	①−②, m
1	Bangkulasi FG	1.80	12.29	12.800	-0.51
2	Spine FG	1.81	12.29	12.800	-0.51
3	Navotas FG	1.83	12.32	12.800	-0.48
4	Muzon FG	2.42	12.90	13.135	-0.23
5	South Pinagkabalian FG	2.53	13.01	13.183	-0.17
6	Longos FG	2.07	12.55	12.815	-0.26
7	Catmon FG	2.53	13.02	13.200	-0.18
8	Tinajeros Bridge Right Bank	2.90	13.38	13.500	-0.12

Note: Surveyed Elevation (DPWH Datum, m) = 10.486+ Surveyed Elevation (MSL,m)

Source: JICA Study Team

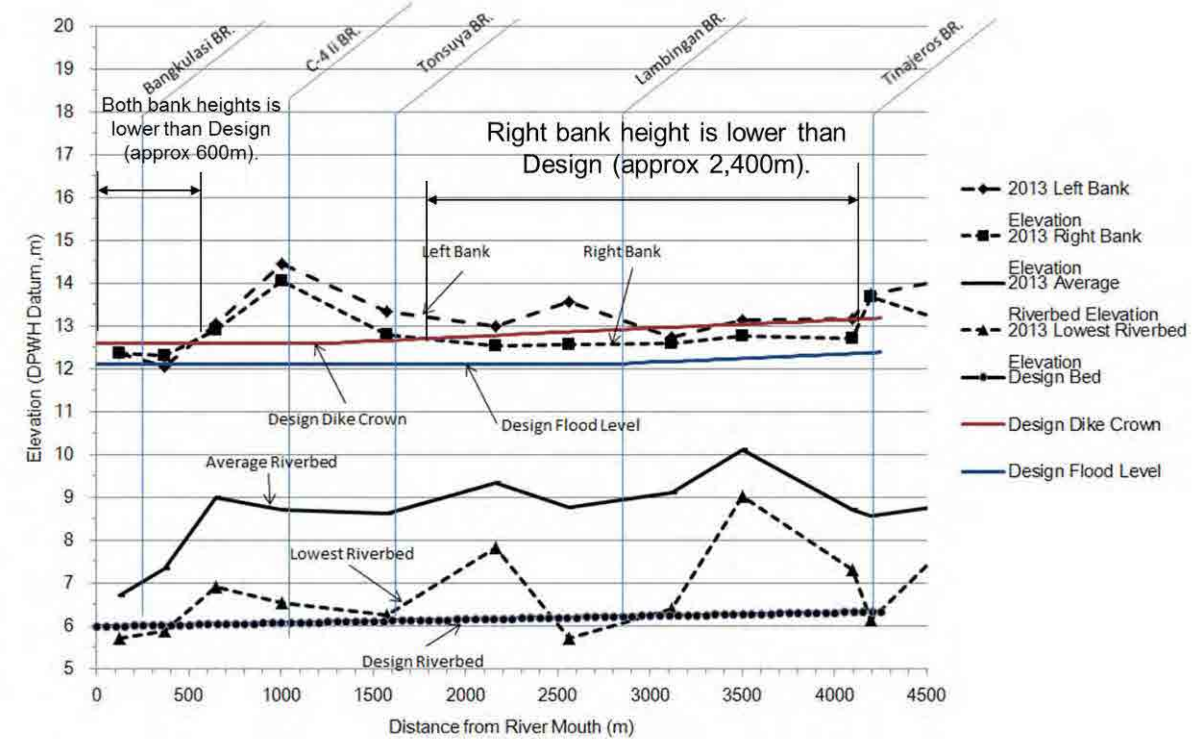


Source: JICA Study Team

Figure 3.4.11 Location of Surveyed Structures and Differences in Elevation Values

(1) Effect 1: Freeboard is being reduced

Figure 3.4.12 shows the longitudinal profiles of river banks, design dike crown, and design flood level. As shown in the figure, both the bank heights near the river mouth (600 m *2 =1,200 m) and the right bank from Sta.1+700 to Sta.4+100 (2,400 m) are lower than the design dike crown which was specified in the tender drawing of the KAMANAVA Project, while those sections are higher than the design flood level. It could be said that if the GM-3FA based elevation is applied for the KAMANAVA Project, the freeboard is regarded to be lower compared with the design.



Source: JICA Study Team

Figure 3.4.12 Longitudinal Profiles of River Banks, Design Dike Crown, and Design Flood Level

Also, the additional river wall raising has been conducted based on an old KAMANAVA BM, thus there is a possibility that the new wall top does not match the design height.

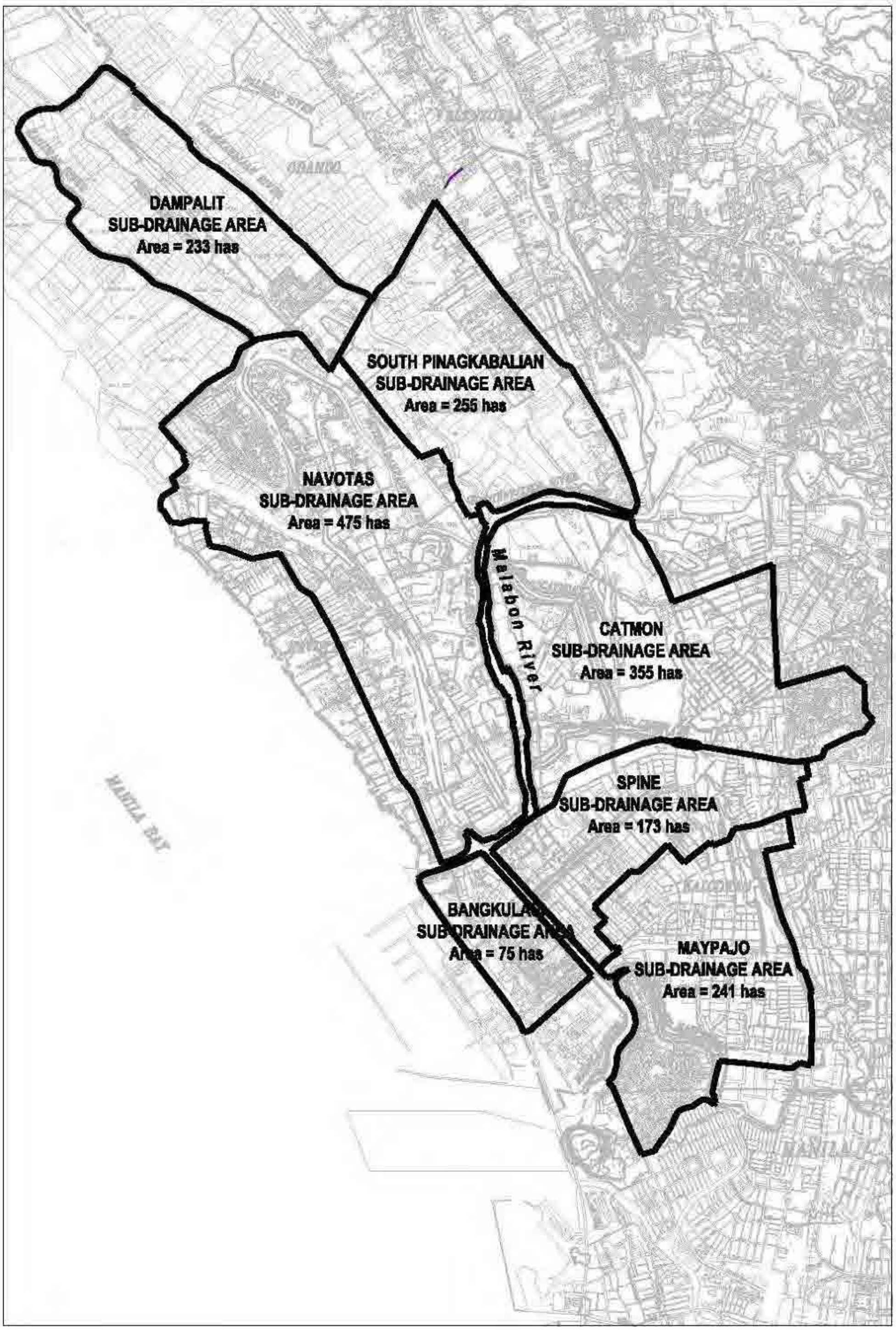
(2) Effect 2: Confusion on operation in pumping stations and floodgate stations

At the pumping stations and floodgate stations in the Project, the water levels are measured by the operators and they use the operation rule based on a KAMANAVA Project BM. The measured values and operation rule value do not match with NAMRIA tide levels. Also there are local floodgates and pumping stations built by LGUs in the Project area. Some confusion is anticipated among stakeholders.

3.5 Sub-drainage Areas

3.5.1 General

In the KAMANAVA Project Area, there are seven (7) sub-drainage areas as shown in Figure 3.5.1. The drainage area in ha for each sub-drainage area is also shown in the figure.



Source: DPWH, Main Design Report 2001

Figure 3.5.1 Sub-Drainage Areas in KAMANAVA Project Area

3.5.2 Pumping Stations and Flood Gates

In the northern area of the Malabon river, Dampalit, Navotas and South Pinagkabalian sub-drainage areas form one protected area and rainfall inside the protected area is assumed to flow to the mouth of the Navotas river. In the southern area of the Malabon river, there are Bangkulasi, Maypajo, Spine and Catmon sub-drainage areas that are drained separately at the locations of the pumping stations into the Marala river and Malabon river. All flood gates have the function to prevent river water from flowing into the protected area. Table 3.5.1 shows the floodgates and pumping stations built by the KAMANAVA Project in each sub-drainage area. Dampalit and S. Pinagkabalian, sub-drainage areas do not have major pumping stations at present.

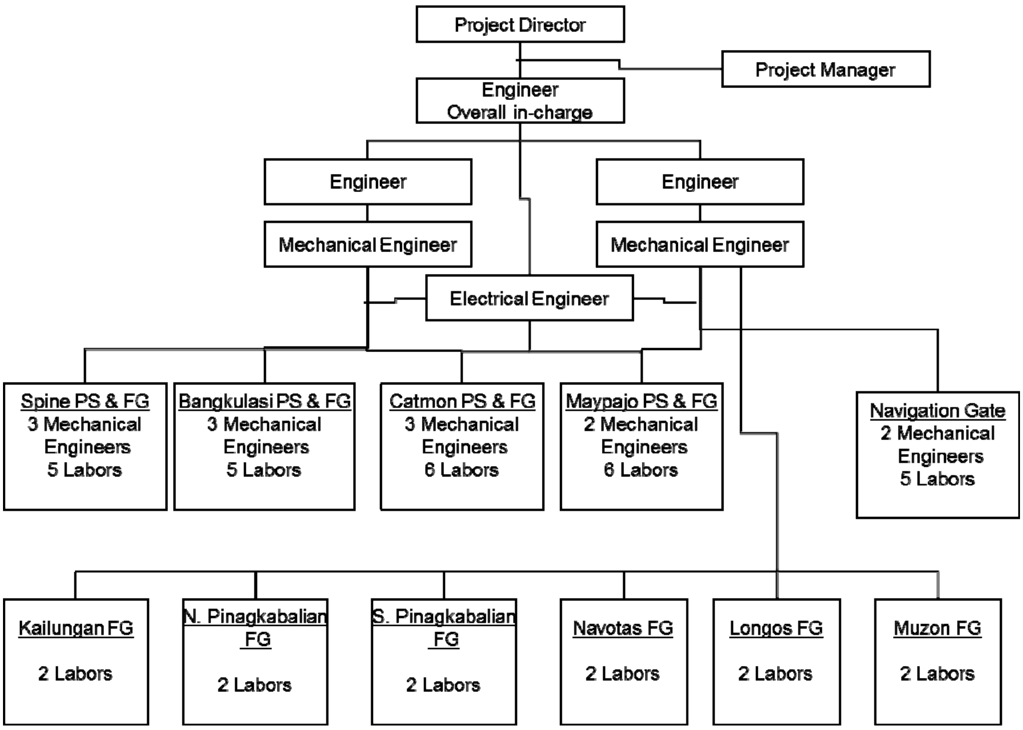
Table 3.5.1 Flood Gate and Pumping Stations in each Sub-drainage Area

Sub-drainage Area	Area (ha)	Flood Gate	Pumping Station
Bangkulasi	75.4	Bangkulasi	Bangkulasi
Spine	173.1	Spine	Spine
Maypajo	241.2	Maypajo	Maypajo
Catmon	355.5	Catmon, Longos	Catmon
Dampalit	233.1	Kailugan	-
Navotas	475.5	Navotas, Muzon	North Navotas
S. Pinagkabalian	254.6	N. Pinagkabalian, S. Pinagkabalian	-

Source: JICA Study Team

3.5.3 Operation of Pumping Stations and Flood Gates

All flood gates and pumping stations listed in Table 3.5.1 were completed by 2008. The KAMANAVA PMO has been conducting operation and maintenance since then under the organization shown in Figure 3.5.2.



Source: JICA Study Team Made based on the Chart provided by KAMANAVA PMO

Figure 3.5.2 Organization Chart of KAMANAVA PMO on Operation for Flood Gates and Pumping Stations

The daily gate and pump operations are directed by the Engineer in the KAMANAVA PMO with a monthly pre-defined calendar based on projected tide data.

The operators in each flood gate and pumping station are manually recording the water levels of both the river side and inland channel side on an hourly basis. The water level readings are done by staff gauge measurement or automatic water level gauge. Most of the automatic water level gauges which were installed in the KAMANAVA Project are not functioning properly.

Table 3.5.2 shows the months in which the pumping station and flood gate operation records were collected. The record in 2009 typhoon "Ondoy" was not available. KAMANAVA PMO said for this reason that they had been used by other organization during the SAPS Study. Also it should be certain that archiving of the operation record of flood gate just started in October 2013.

Table 3.5.3 shows the actual flood gate and pumping operation based on the interview for DPWH operators on site by the JICA Study Team. There are 5 pumping stations constructed in the KAMANAVA Project. The pump operation rules in general are set based on the starting and stopping water levels, which are varied on the weather in Bangkulasi and Catmon stations. In these stations, when there is rain, the pump is started from lower elevation.

Table 3.5.2 Months in which the Pumping Station and Flood Gate Operation Records were Collected from the KAMANAVA PMO

Name of PS and FG	2012												2013											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Bangkulasi PS+FG							■	■										■	■	■				
Spine PS+FG							■	■																
Maypajo PS+FG																		■	■	■				
Catmon PS+FG							■	■										■	■	■	■	■		
North Navotas PS+Navigation Gate																								
Navotas FG																						■		
Longos FG																						■		
Muzon FG																						■		
South Pinaglabalian FG																						■		
North Pinagkabalian FG																						■		
Kailugan FG																						■		

Note: PS: Pumping Station, FG: Flood Gate ■: Collected Month by JICA Study Team

Source: JICA Study Team

Table 3.5.3 Actual Flood Gate and Pumping Station Operation in each Sub-drainage Area

Name of Sub-basin	Basin Area (ha)	Name of P/S	Design Q (m^3/s)	Pumping Operation/ WL m					Gate Opening Condition	Operator (No)	Remarks
				Start Time / Stop Time			Operation in Peak Flood				
				Fine	Cloud	Rain	2009 Typhoon Ondoy	2012 Habagat			
Maypajo Sub-Basin	241	Maypajo	6.6	11.30	11.30	11.20	Operated	No operation, Gate opened	5cm rule & Tide Table	3	
				10.90	10.90	10.9m (if rain continued 10.6m)					
Spine Sub-Basin	173	Spine	13.0	11.00	11.00	11.00	Operated		5cm rule & Tide Table	3	
				10.00	10.00	10.00					
Bangkulasi Sub-Basin	75	Bangkulasi	4.4	11.10	11.10	11.00	Operated		5cm rule & Tide Table	3	
				9.70	9.70	9.70					
Catmon Sub-Basin	355	Catmon	10.5	10.70	10.70	10.60	No pump operation, Gate opened		5cm rule & Tide Table	3	Operating 2-3 units for the fine day, Rainy day 3-4 units.
				10.30	10.30	10.30					
North Navotas Sub-Basin	475	North Navotas	9.6	11.00	11.00	11.00	Operated, but not full units		10cm rule & Tide Table	3	
				11.00	11.00	11.00					

Operating System
- Instruction by KAMANAVA PMO by Telephone
- Water Level monitoring :Every hour by manual gauging due to the devices disorder
- Inventory Location of Record: KAMANAVA PMO
- Any troubles during the floods: No problems have been reported from the site

Note:
1) 5 cm rule: Gate opened if Inner water level is higher than outer level more than 5cm
2) Tide Level: Following the Tide level information by NAMRIA

Source: JICA Study Team

In the course of the SAPS Study, the JICA Study Team recognized a kind of conflict of interest between Navotas city and Malabon city regarding the pump / gate operations, especially for North Navotas Navigation Gate.

The main function of the navigation gate is to provide flood protection from high tide. The gate must be closed for two reasons; to protect the inland area against flooding from high tide and to complete the regulation pond. As a regulation pond, it is desirable to close the tide gate at low tide levels thereby providing more channel storage. Unfortunately, this directly conflicts with keeping the gate open as long as possible for vessel/boat passage into and out of the Navotas River.

Therefore the navigation gate needs to be carefully operated as to fulfill its maximum flood protection function considering the needs of the users of the river. The KAMANAVA Project Plan originally proposed the gate close level was 10.5 m (DPWH Datum), but now it has been changed to 11.0 m (DPWH Datum) according to the interview with the KAMANAVA PMO.

The JICA Study Team held a series of workshops and technical meetings with LGUs, ship users and barangay representatives. According to the discussions, the following conflicts of interest are revealed as shown in Table 3.5.4.

Table 3.5.4 Main Issues and Needs regarding Navotas Navigation Gate Closure Level among LGUs

	Navotas side	Malabon side
Issues	For the ship traffic through the Navotas river and dock operation, the gate close level should be 11.5 m. Even at this level, some navigation routes are shallow and there is not enough draft for safe passage. Even in Navotas high elevation areas, the existing drainage pipes are positioned at low elevation. Thus the gate close level of 11.5 m (DPWH Datum) is problematic for the drainage, so the City has been constructing the river wall up to elevation 13.5 m (DPWH Datum) along the Navotas river except for the ship yard portion and local pumping stations using the city funds.	The high closing level of the gate causes inundation in the low elevation areas in Malabon.
Needs	Dredging of the navigation route to keep necessary draft. Construction of breakwater structure near the Navigation gate to avoid siltation. The raising of the river wall system and providing pumps along the Navotas river is needed to cope with high level of gate closing.	The gate should be closed at lower tide elevation as much as possible from the flood control viewpoint. The river wall system along the Navotas river along with pumps is needed to cope with high level of gate closing.

Source: JICA Study Team

3.5.4 Salient Features of Sub-drainage Area

(1) Bangkulasi Drainage Area

Bangkulasi drainage area is 75.4 ha. At present, there is Bangkulasi pumping station in this area and all drainage is by pumping during high tide and by gravity during low tide. Storm water is generally drained eastward into the Marala River through sluice gates in the Marala River wall. However, there are some areas subjected to flood inundation during high tide when gravity drainage is not possible.

(2) Catmon Drainage Area

Catmon drainage area includes both Catmon Creek and Longos Creek with a total drainage area of 355.5 ha. The Longos Creek collects water from the hill located west of the PNR and then, the Longos Creek flows westward along the Letre Road, before flowing into the Malabon River. The Catmon Creek separates from the Longos Creek 800 m upstream from the confluence of Malabon River, and enters into the Malabon River.

Catmon Creek is approximately 1.7 km long and Longos Creek extends 1.8 km. Those creeks were improved by the Project.

(3) Spine Drainage Area

Spine Drain is a rectangular concrete channel, which drains 173.1 ha of the northern Dagat-Dagatan Area. Storm water flows westward through the Spine Drain and enters the Marala River by gravity during low tide, and is pumped through the Spine PS, when the water level of the Marala River is high.

(4) Maypajo Drainage Area

Maypajo drainage area has an area of 241.2 ha. The Maypajo drainage area is divided into four sub-areas, namely: 1) Isla de Cocomo (west side of Maypajo), 2) Southern Drain, 3) Northern Drain and 4) Saluysoy Drain. The latter three sub-drainage areas are located in the Dagat-Dagatan area; the former is located west of Estero de Maypajo. The Saluysoy, Northern and Southern drains are open channels flowing into the Estero de Maypajo. These channels are shallow and the widths of the Saluysoy and Northern drains are approximately 5 m and 2.5 m, respectively.

Storm water flows into the Estero de Maypajo from three main drains along the eastern side (Saluysoy Drain, Northern Drain and Southern Drain) and smaller laterals on the western side of the Estero de Maypajo. The Estero de Maypajo drains to the Marala River at the Maypajo RPS by gravity flow during low tide.

Historically, the Estero de Maypajo received water from the Estero de Sunog Apog. At present, a concrete wall has been constructed to prevent flowing water from the Estero de Sunog Apog. The Estero de Maypajo has a length of 1.8 km.

(5) North Navotas Drainage Area

North Navotas drainage area has a total area of 475 ha. The Navotas River, Tanza River and Muzon-Dampalit River, divide this area into four sub-areas. Seven RPSs are installed in this area.

In the Navotas sub-area, storm water from the west half from the middle of the Gov. A. Pascual Street and Mariano Naval Road (85.9 ha) flows into the Manila Bay, while the remaining east half to the Navotas River. In the sub-area surrounded by the Navotas, and the Muzon-Dampalit and the Malabon rivers, storm water runs from the south to north along the main roads of C. Arellano St. and Gen. A. Luna St. and drains to Navotas, Muzon-Dampalit and Malabon rivers. In the Tanza sub-area, water is drained into both the Navotas and Tanza Rivers, while in the sub-area located east of the Muzon-Dampalit River, storm water is drained into the Muzon-Dampalit River.

(6) Dampalit Drainage Area

Dampalit drainage area is surrounded by the Pinagkabalian and the Kailugan rivers with an area of 233.1 ha. A total of 44.3 ha or 19% of the total area drains storm water mainly to Chungkang River. At present, there is one RPS in Merville-Dampalit, which drains to the Pinagkabalian River.

The Chungkang River, which runs through the middle of the Dampalit drainage area, has a length of 2.8 km with varying width of 9 m to 20 m. The flow capacity of the Chungkang River ranges from $10m^3/s$ to $15m^3/s$ in most stretches.

(7) South Pinagkabalian Drainage Area

South Pinagkabalian drainage area has a total area of 254.6 ha. In this drainage area, there are two rivers or creeks, namely: the Pinagkabalian River and the Panghulo River. The Pinagkabalian River runs between the Malabon River and Meycauayan River and stretches 2.0 km connecting to the Malabon River and is included in this drainage area, while the Panghulo River is a short channel of 600 m flowing to the Malabon River.

3.6 Solid Waste Management by LGUs

In general, deposition of garbage to channel/riverbed reduces flow capacity of channel/river, and clogging of secondary and tertiary drainage disturbs not only proper flow of water but also fully function of a pumping station. According to Malabon city engineers, during the 2012 flood, the Lambingan bridge trapped many garbage from upstream of Tullahan river watershed and caused flooding upstream reach due to its backwater effect. From the view of flood control, solid waste management is quite important and should be carried out properly.

3.6.1 Malabon City

The present situation on solid waste management in Malabon city is described as follows, according to the interview with CENRO of Malabon.

Malabon domestic garbage collection is about 155 tons per day. Domestic garbage means from residences and public markets;

At present, collection of garbage from industial/commercial establishments and toxic wastes from hospitals are not covered by the LGU. But they are now collaborating with the private sector and the Department of Health to have a common system for garbage collection and they target to start it at the soonest by 2014.

In terms of waste segregation, the Malabon LGU (thru the CENRO) is collaborating with a non-government office named the Mother Earth Foundation and they target to implement the wastes segregation program based on the Memorandum of Understanding that will be forged before the year (2013) ends. Initially, they will pilot this program in four (4) barangays (with newly elected barangay chairs) in Tinajeros, Maysilo, San Agustin and Concepcion. The program will also include the installation of a material recovery facility (MRF) and composting facility;

The LGU is also starting to collaborate with another NGO, the Zero Wastes Philippines;

In compliance with the Supreme Court (SC) mandamus (no wastes/garbage that will contribute to pollution of the Manila Bay by 2015), the LGU has installed trash traps near the Tullahan River and strategic river channels. But their problem is that these traps cannot withstand the garbage (particularly during flooding) because there is also garbage coming from upstream cities like Quezon City. The city recommends that the other upstream cities should also do something with their garbage dumping system. Also in compliance with the SC mandamus, the LGU has already started the relocation of the informal settlers staying near the river and water channels.

LGU started with an annual budget of PhP 70 million and it has gone up to PhP 90 million (this current year). One of their projects (by next year) is a transfer station so as not to delay the conveying of the trash to the Navotas landfill in Binuangan'

As far as the implementation of their Anti-littering ordinance is concerned, they have started apprehending those who litter with accorded penalties (e.g. community service, cash penalty and imprisonment for three days), and the LGUs have started planting mangrove species near the Tullahan River but they have temporarily suspended the planting in-between the polder dikes in lieu of future flood control improvement, (per advice by the LGU Engineer).

3.6.2 Navotas City

Navotas City[3] had an estimated waste generation in 2010 of 172.74 tons/day or a per capita generation of 0.686 kg. This waste generation capacity represents an increase of about 50-70 tons/day from the 2003 level of 100-120 tons/day. Such increase is mainly due to the increase in the City's local population.

In compliance with the provisions of the Clean Air Act, Navotas city has entered into a memorandum of agreement with a private entity, the PHIL-ECO for the development and operation of the Navotas Controlled Disposal Facility (NCDF). The facility is located in a ten hectare area in a northwestern

[3] NAVOTAS CITY, SOCIO ECONOMIC PROFILE, 2013

portion of Barangay Tanza. The area was formerly fishpond which has already been acquired by the City. The wastes are hauled by trucks to a holding area (near Vitas, Tondo), treated and loaded onto a barge and subsequently brought to the NCDF. About 70% of the wastes generated in Navotas are disposed of in this site.

4. Effectiveness of the Project

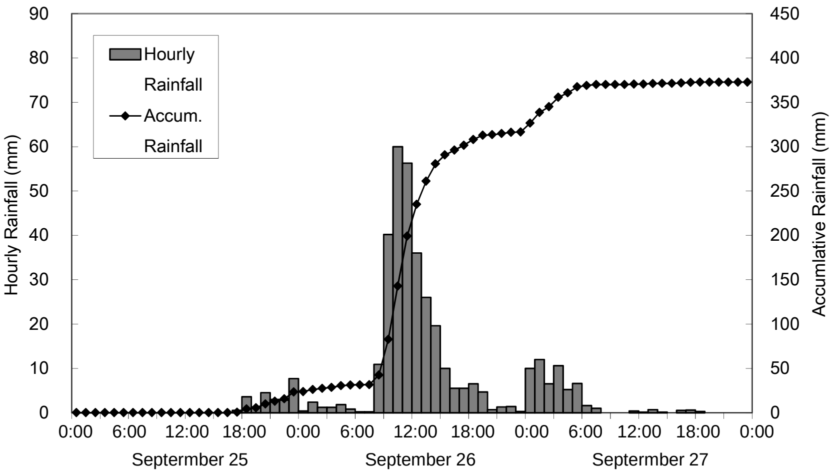
4.1 Effectiveness during 2009 Typhoon "Ondoy"

4.1.1 Condition

(1) Rainfall

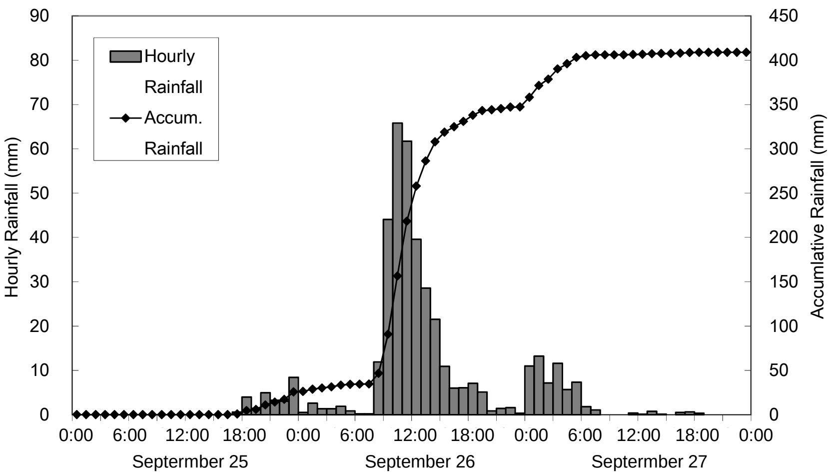
Through data collection activities from relative agencies like PAGASA and previous reports, rainfall data in the target floods was collected. Regarding 2009 "Ondoy", processed hourly rainfall data prepared in the study of the "Master Plan for Flood Management in Metro Manila and Surrounding Areas (The World Bank), 2012" was selected for analysis in this SAPS Study. The data was prepared for each sub-basin that divides the Malabon-Tullahan basin into six consisting of one for KAMANAVA Project Area and five for areas upstream of the Project area (upstream of the Tinajeros Bridge).

The following figures show hourly rainfall and accumulative rainfall during 2009 "Ondoy". Rainfall in 2009 "Ondoy" concentrated in a short time (half a day) and the rainfall intensity is comparatively high (more than 60 mm per hour), but accumulative rainfall amount was not very large.



Source: JICA Study Team

Figure 4.1.1 Rainfall Condition in KAMANAVA Project Area in 2009 "Ondoy"



Source: JICA Study Team

Figure 4.1.2 Rainfall Condition in Areas Upstream of the Project Area (Upstream of Tinajeros Bridge) in 2009 "Ondoy"

According to the above data, maximum hourly rainfall and maximum two-day rainfall (maximum 48 hours rainfall) are summarized in the table below.

Table 4.1.1 Maximum Two day and Hourly Rainfall in 2009 "Ondoy"

Flood Event	Area	Maximum Two day (48 hour) rainfall (mm/2day)	Maximum hourly rainfall (mm/hour)
2009 "Ondoy"	Project area	371.9	60.0
	Upstream area of Tinajeros bridge	407.9	65.8

Source: JICA Study Team

In the detailed design stage in 2001, probable rainfall intensity was analyzed using the Port Area rainfall intensity data as shown in the table below. Comparing using these data, two day rainfall of 371.9mm in the Project area in 2009 "Ondoy" is assessed to correspond to about a 10-year return period.

Table 4.1.2 Result of Probability Analysis on Rainfall in Detailed Design Stage in 2001

	Probable Rainfall with Various Flood Return Period							
	500 yr	100yr	50 yr	**30 yr**	20 yr	**10 yr**	5 yr	2 yr
Two-day rainfall (mm/2-day)	750.6	601.4	536.8	**489.0**	450.8	**384.2**	314.8	210.0
One-hour rainfall (mm/hr.)	131.4	109.8	100.5	**93.6**	88.1	**78.4**	68.4	53.3

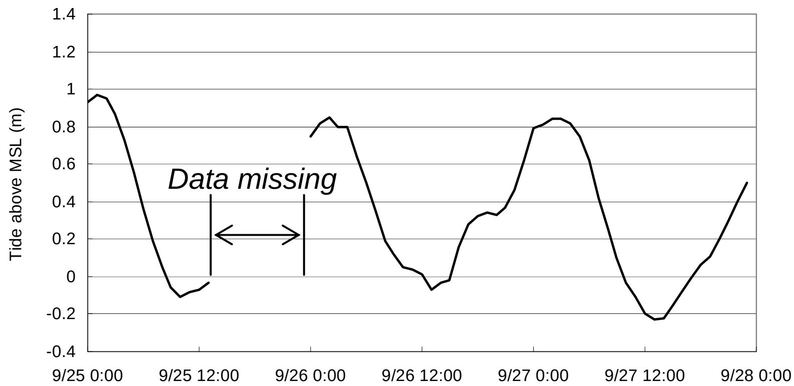
Source: JICA Study Team

In the detailed design stage in 2001, rainfall with a 10-year return period and 30-year return period were applied to develop a model hyetograph for the drainage area and for the Malabon-Tullahan River.

(2) Tide

Tide level data was collected from NAMRIA and KAMANAVA PMO. The collected data were tide tables, observed tide level data in Manila Bay and observed tide level data in gates and pumping stations installed in the KAMANAVA Project area by the Project.

Figure 4.1.3 shows observed tide level data for Manila Bay in 2009 "Ondoy". More than 0.8m above MSL are recorded in high tide.

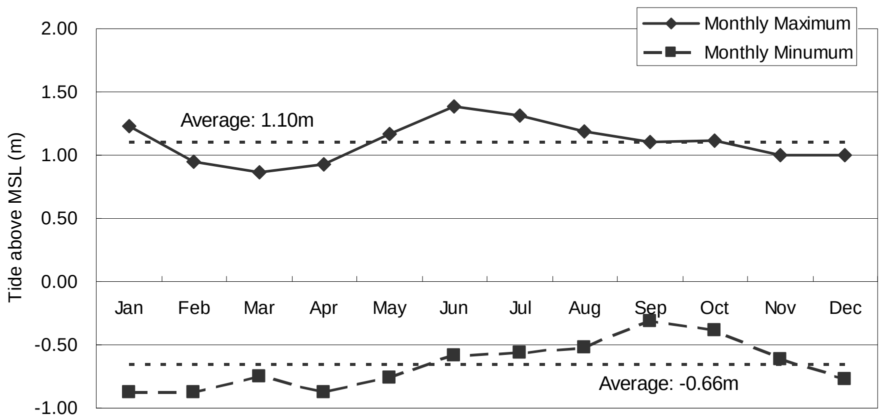


Source: JICA Study Team

Figure 4.1.3 Tide Level Condition in Manila Bay in 2009 "Ondoy" after NAMRIA

On the other hand, according to Malabon city, the highest tide elevation of DPWH+12.20 m was recorded at North Navotas Navigation Gate at 1am Sep.27, 2009. This elevation is equivalent to 1.73 m above MSL, which is about 90 cm higher than NAMRIA's record for Manila bay.

Figure 4.1.4 shows monthly tide level variation in 2009. Monthly maximum and minimum tide levels are plotted. From this figure, it is revealed that September 2009 during "Ondoy" is averaged maximum tide level period through the year of 2009.



Source: JICA Study Team

Figure 4.1.4 Maximum/Minimum Monthly Tide Level in 2009

In the detailed design stage in 2001, the following design levels were adopted using DPWH Datum regarding tide condition for the Project. Meanwhile, the DPWH Datum Plane of the Manila Flood Control and Drainage Project is defined as 10.00m below MLLW (Mean Lower Low Water).

Table 4.1.3 Design Tide Levels in Detailed Design Stage in 2001

	Abbreviation/ Definition	Tide level by DPWH Datum (m)	Difference from MSL (m)
Mean Sea Level	MSL	10.6	0.0
Maximum Tide Level	Max. Design Level	12.1	1.5
Mean High Water Spring	MHSW	11.4	0.8
Mean Higher High Water	MHHW	11.1	0.5
Mean Lower Low Water	MLLW	10.1	-0.5
Lowest Tide Level	Min. Design Level	9.4	-1.2

Source: JICA Study Team

Comparing the max. design level of 12.1m (DPWH Datum) and maximum tide level of 12.2m (DPWH Datum) at North Navotas Navigation Gate during 2009 “Ondoy”, it is revealed that the tide level during Ondoy was beyond the design tide level.

(3) Wind, Air Pressure and Waves

1) Wind

According to the information collected from PAGASA, the maximum 6-hour wind speeds at Port Area station are recorded as 8.5 m/s on September 26 during 2009 “Ondoy”.

In the detailed design stage in 2001, wind speeds for various return periods were estimated using the data for the Port Area as shown in the table below.

Table 4.1.4 Result of Probability Analysis on Maximum Wind Speed in Detailed Design Stage in 2001

Return Period	6-Hour Wind Speed (m/s)	Instantaneous Wind Speed (m/s)
Mean Annual	5.0	18
2 Year	7.5	28
5 Year	9.3	34
10 Year	10.3	38
20 Year	11.3	42
50 Year	12.5	47
100 Year	13.4	51

Source: JICA Study Team

In the detailed design stage in 2001, the maximum wind speed of 10.8m/s for the 6-hour wind speed, which is equivalent to about a 15 year return period, was adopted for design since duration of at least 4 hours would be required to develop waves in Manila Bay.

From the above data, wind speed in 2009 “Ondoy” is assessed as less than a 5-year return period scale.

2) Air Pressure

According to the information collected from PAGASA, the minimum air pressures as MSLP (mean sea level pressure) at Port Area station are 990.0 hPa on September 26 during 2009 “Ondoy”.

Referencing the data of the detailed design stage in 2001, minimum and average air pressures of typhoons passing the Port Area between 1981 and 2000 were 980.9 and 998.0 hPa, respectively. Incidentally, maximum instantaneous wind speed of the typhoon with minimum air pressure is recorded as 33.34m/s.

From the above data, it can be said that air pressures during 2009 “Ondoy” were not significantly low.

3) Waves

In the detailed design stage in 2001, the design wave approaching the Navotas Navigation Gate was calculated using a design wind speed of 11m/s, and the design wave was set at a 1.0m wave height, a wave period of 4.0 seconds and a wave length of 23.6m. On the other hand, the calculated riverside wind generated wave for an assumed depth of 3.0m, a fetch of 1.5 km and a wind velocity of 11m/s was set as a wave with a wave height of 0.3m and period of 2.0 seconds and a wave length of 6.0m.

Although there is no wave data found for the 2009 “Ondoy”, maximum wave height can be assumed as smaller in 2009 “Ondoy” comparing with the design wave height since the maximum 6-hour wind speed was less in the 2009 “Ondoy” than the design wind speed.

(4) Flood Mark

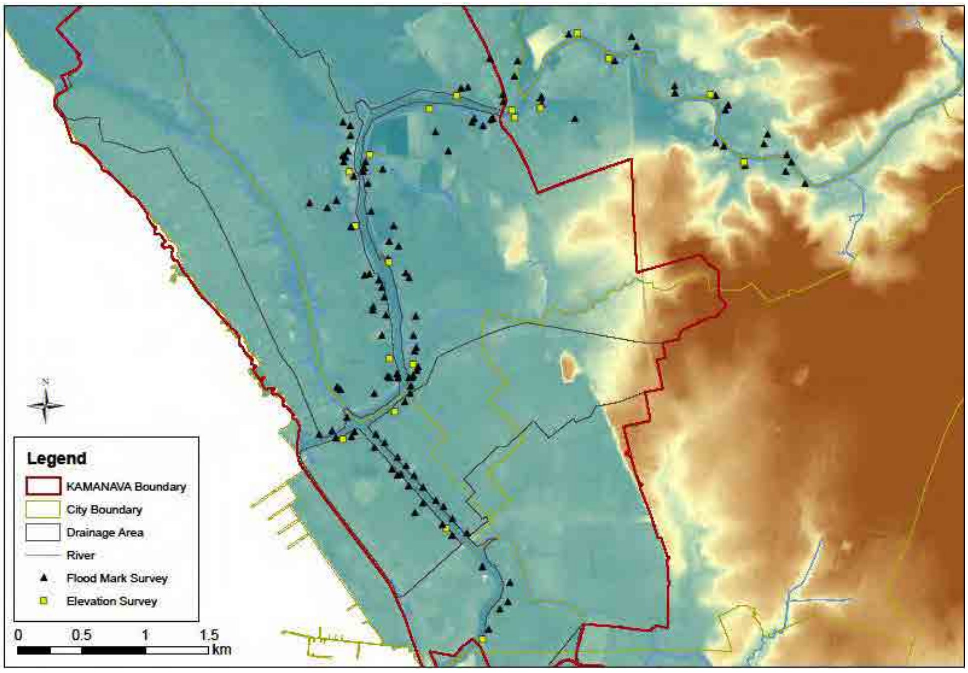
A flood mark survey was conducted in order to identify flood marks of the 2009 typhoon “Ondoy” and 2012 Habagat along the Malabon river and the Marala river. The total survey numbers by LGUs and their locations are shown in Table 4.1.5 and Figure 4.1.5, respectively.

Also among the flood mark survey locations, the spot elevations above MSL were surveyed for hydraulic analysis. The surveyed points of the spot elevations are also shown in Figure 4.1.5.

Table 4.1.5 Number of Flood Mark Survey Points (n = 142)

LGUs	Number	Barangays
Navotas	36	Bangculasi, Bagumbayan south, San Rafael village, North bay Boulevard
Malabon	92	Maysilo, Tinajeros, Catmon, Niugan, Tonsuya, Longos, Potrero, Conception, Ibaba, San Agustin, Tanong
Valenzuela	14	Marulas, Malinta

Source: JICA Study Team



Source: JICA Study Team

Figure 4.1.5 Location map for flood mark survey

The survey was an interview survey with local people using questionnaire and GPS cameras. The following items were included in the interviews and flood marks and their locations were recorded with GPS cameras. Actual photos of flood marks are shown in Figure 4.1.6 and an example questionnaire is shown in Figure 4.1.7.

In this questionnaire questions concerned with inundation condition were also included.

Table 4.1.6 Items in the Questionnaire (Flood Mark Survey)

Category	Question Items
Personal details of interviewee	Age, Gender, Occupation, Residence years, Frequency to be affected by past flood
Flood characteristics	Water level, time of high water level and destroyed structures during “Ondoy” and Habagat

Source: JICA Study Team

Water Level in 2009 Typhoon "Ondoy" | Water Level in 2012 Habagat

Source: JICA Study Team

Figure 4.1.6 Photos of Flood Mark

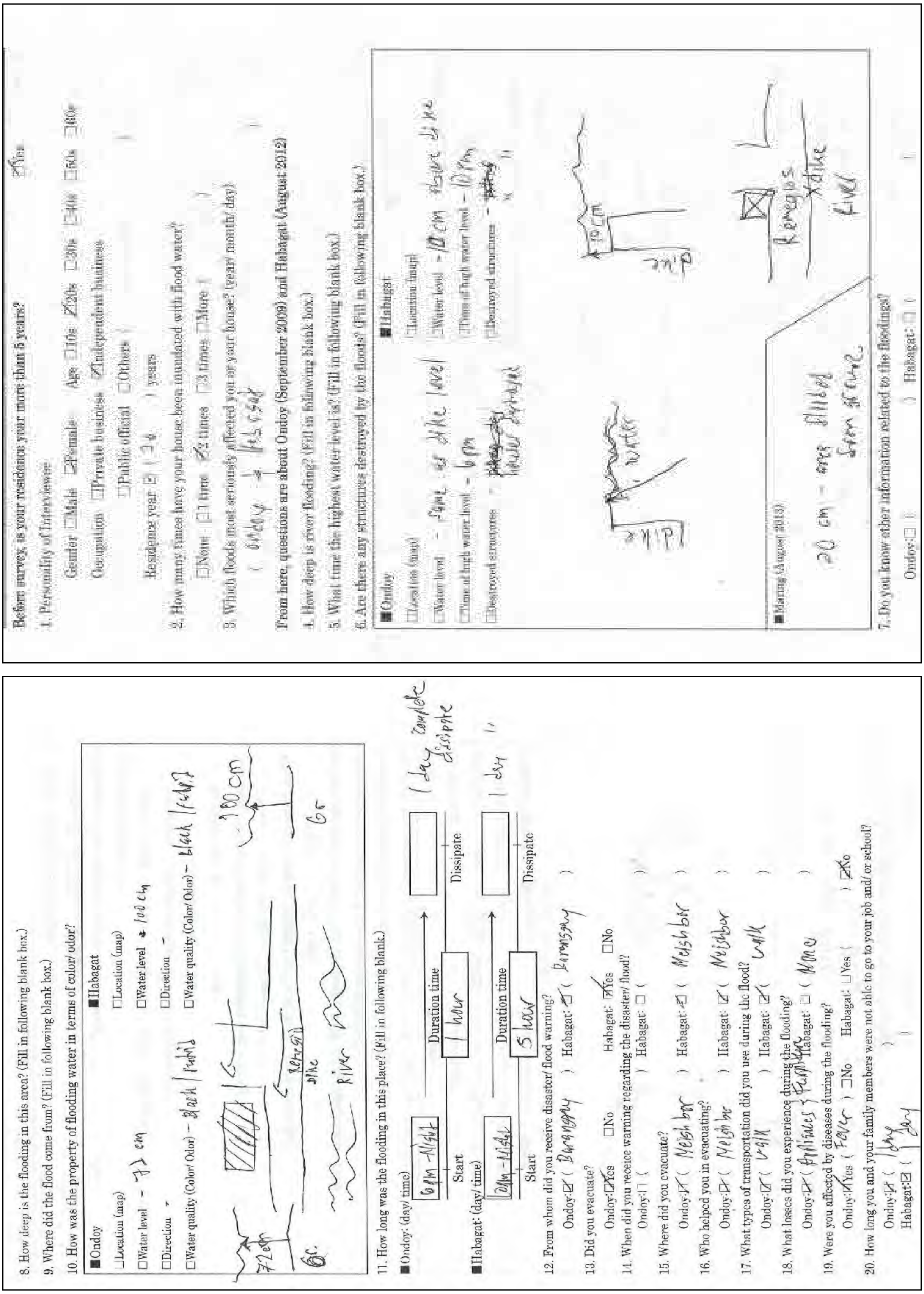
Whenever it was hard to find actual flood marks of 2009 typhoon "Ondoy" and 2012 Habagat, the water levels during 2009 typhoon "Ondoy" and 2012 Habagat was asked of the local people and the level was assumed as the water depth at the location. Figure 4.1.6 shows the indicated water level in each flood.

The locations where interviewees reported that river water overflowed from Malabon river or Marala river during "Ondoy" are shown in Figure 4.1.8.

As a result, it was indicated that river water overflowed from many locations on Malabon river and Marala river as well as the Tullahan river (upstream of Malabon river, outside of the Project area).

The many respondents stated that river water was overflowing during "Ondoy". On the other hand, the respondents who live near Manila bay said the river water overflowed during Habagat rather than during "Ondoy".

Figure 4.1.9 is the profile of the flood marks along the Malabon-Tullahan river for "Ondoy". The continuous lines in the figure are the bank elevation in 2013. It is seen that upstream of Tinajeros Bridge had overflow from the banks. In the downstream reaches below the Tinajeros bridge, the flood marks are located lower than the bank elevation, however, at the time of the 2009 "Ondoy", some reaches were lower in elevation than in 2013, so that the flood level was nearly bank elevation.


Before survey, is your residence year more than 5 years? ☑Yes

1. Personality of Interviewee

Gender ☐Male ☑Female Age ☐10s ☑20s ☐30s ☐40s ☐50s ☐60s

Occupation ☐Private business ☑Independent business ☐Public official ☐Others ( )

Residence year ☑ (26) years

2. How many times have your house been inundated with flood water?

☐None ☐1 time ☑2 times ☐3 times ☐More ( )

3. Which floods most seriously affected you or your house? (year/ month/ day)

(Ondoy & Habagat)

From here, questions are about Ondoy (September 2009) and Habagat (August 2012)

4. How deep is river flooding? (Fill in following blank box.)

5. What time the highest water level is? (Fill in following blank box.)

6. Are there any structures destroyed by the floods? (Fill in following blank box.)

■Ondoy
☐Location (map)
☐Water level - same as dike level
☐Time of high water level - 6 pm
☐Destroyed structures - houses destroyed

■Habagat
☐Location (map)
☐Water level - 10 cm above dike
☐Time of high water level - 10 pm
☐Destroyed structures - "

■Maring (August 2013)
20 cm - area flooded from ground

7. Do you know other information related to the floodings?

Ondoy:☐ ( ) Habagat:☐ ( )

8. How deep is the flooding in this area? (Fill in following blank box.)

9. Where did the flood come from? (Fill in following blank box.)

10. How was the property of flooding water in terms of color/ odor?

■Ondoy
☐Location (map)
☐Water level - 72 cm
☐Direction -
☐Water quality (Color/ Odor) - black / rubid

■Habagat
☐Location (map)
☐Water level - 100 cm
☐Direction -
☐Water quality (Color/ Odor) - black / [illegible]

11. How long was the flooding in this place? (Fill in following blank.)

■Ondoy: (day/ time) Start: 6pm - Night; Duration time: 1 hour; Dissipate: 1 day complete dissipate

■Habagat: (day/ time) Start: 8pm - Night; Duration time: 5 hour; Dissipate: 1 day "

12. From whom did you receive disaster/ flood warning?
Ondoy:☑ (Barangay) Habagat:☑ (Barangay)

13. Did you evacuate?
Ondoy:☑Yes ☐No Habagat: ☑Yes ☐No

14. When did you receice warning regarding the disaster/ flood?
Ondoy:☐ ( ) Habagat: ☐ ( )

15. Where did you evacuate?
Ondoy:☑ (Neighbor) Habagat:☑ (Neighbor)

16. Who helped you in evacuating?
Ondoy:☑ (Neighbor) Habagat: ☑ (Neighbor)

17. What types of transportation did you use during the flood?
Ondoy:☑ (walk) Habagat: ☑ (walk)

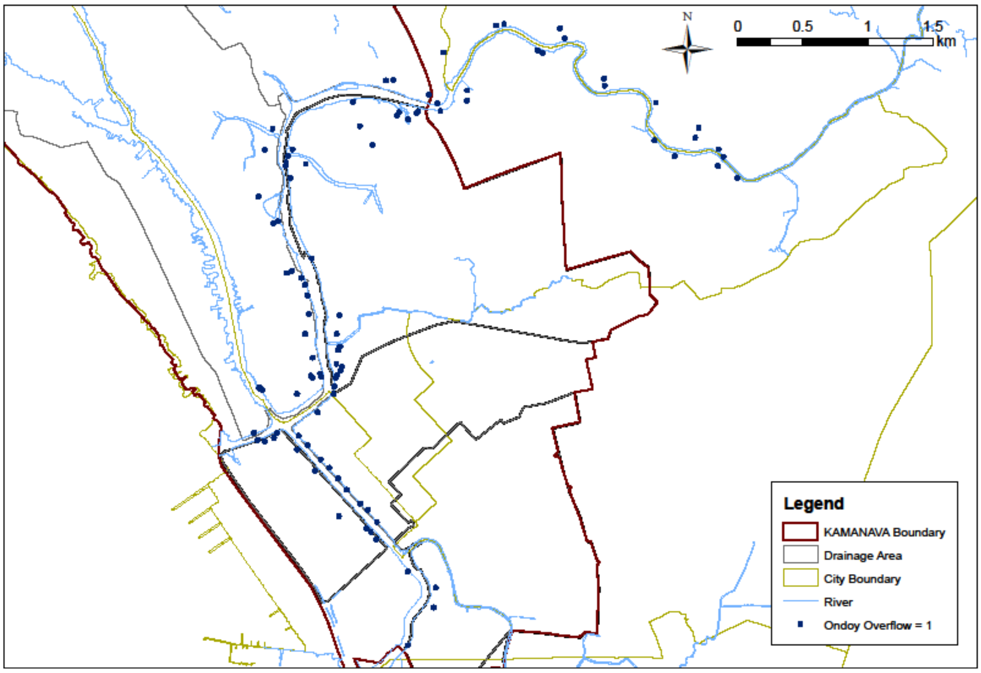
18. What losses did you experience during the flooding?
Ondoy:☑ (Appliances & Furniture) Habagat: ☐ (None)

19. Were you affected by diseases during the flooding?
Ondoy:☑Yes (Fever) ☐No Habagat: ☐Yes ( ) ☑No

20. How long you and your family members were not able to go to your job and/ or school?
Ondoy:☑ (1 day)
Habagat:☑ (1 day)

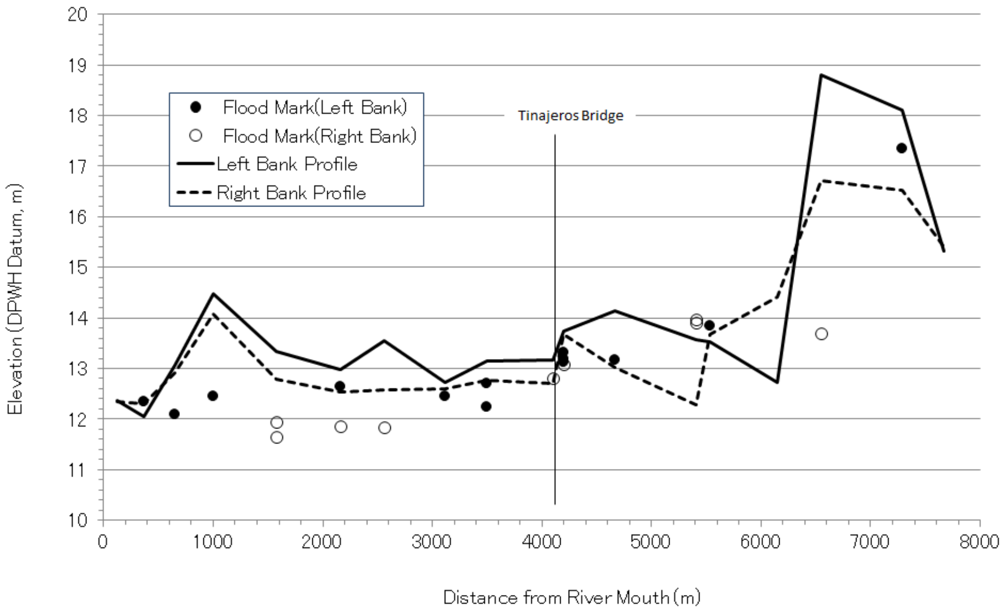
Source: JICA Study Team

Figure 4.1.7 Example of Questionnaire (2 sides)



Source: JICA Study Team

Figure 4.1.8 Locations at which People Reported that River Water Overflowed during "Ondoy"



Source: JICA Study Team

Figure 4.1.9 Profile of Flood Mark Elevations along Malabon-Tullahan river during "Ondoy"

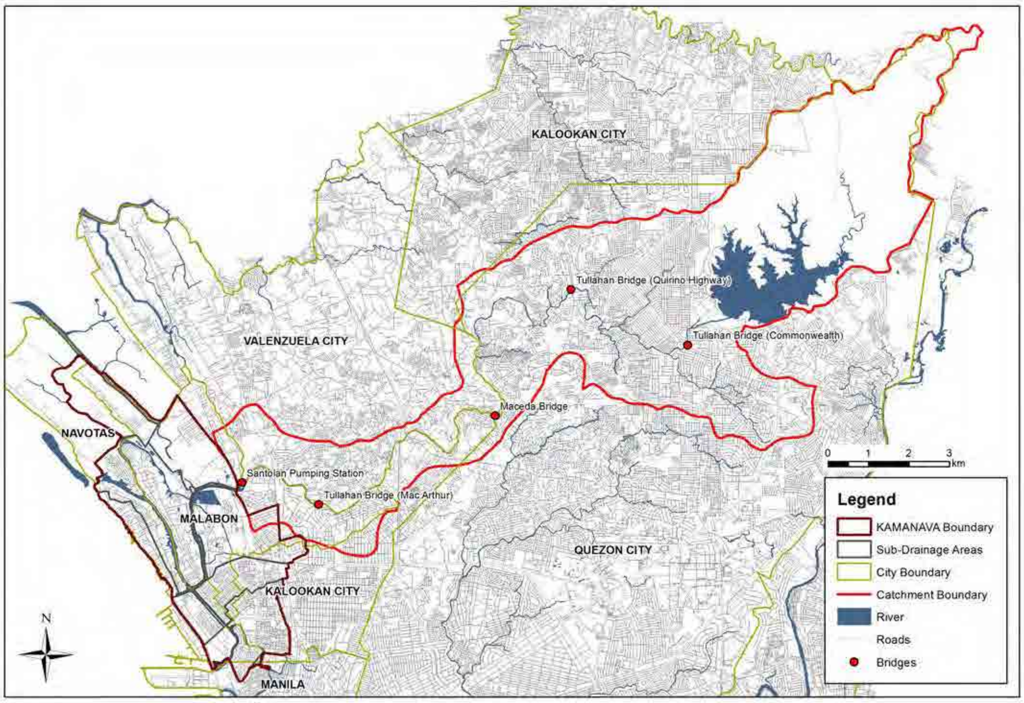
(5) River Water Level / Discharge

There are no water level gauging stations in the Project area. Although there are five water level gauging stations at present along the Tullahan River upstream of Tinajeros Bridge as shown in Table 4.1.7 and Figure 4.1.10, discharges are not observed and therefore are estimated for those stations. This means there is no available discharge data for in and around the Project Area.

Table 4.1.7 List of Water Level Gauges in the Tullahan River

No.	Bridge Name	Barangay	City	Latitude (deg.)	Longitude (deg.)
1	Santolan Pumping Station	Santolan P.S Compound Barangay Malinta	Valenzuela City	14.6755	120.9644
2	Tullahan Bridge (Mac Arthur)	Mac Arthur Highway, Barangay Marules	Valenzuela City	14.6706	120.9820
3	Maceda Bridge	Barangay Ugong	Valenzuela City	14.6905	121.0225
4	Tullahan Bridge (Quirino highway)	Quirino Highway Barangay Nobaliches Proper	Quezon City	14.7186	121.0399
5	Tullahan Bridge (commonwealth)	Commonwealth Ave. Barangay Fairview	Quezon City	14.7063	121.0666

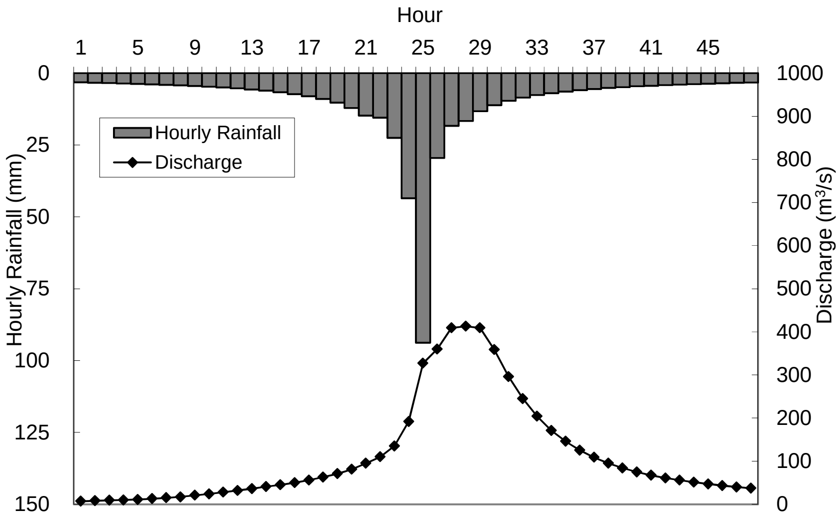
Source: JICA Study Team



Source: JICA Study Team

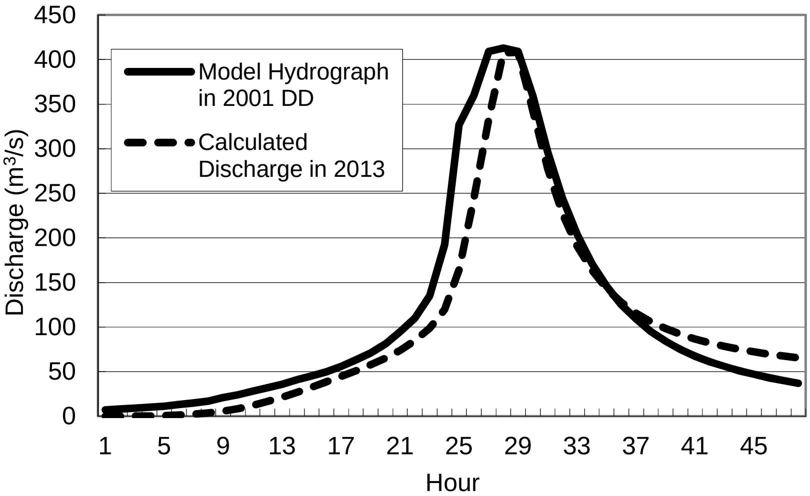
Figure 4.1.10 Location of Water Level Gauges along Tullahan River

This SAPS Study, tried to produce a hydrograph using a rainfall-runoff model (NAM model) using a model hyetograph with a 30-year return period and referencing the corresponded model hydrograph in the detailed design stage in 2001. Figure 4.1.11 shows the referred hyetograph and hydrograph at Tinajeros Bridge in 2001, and Figure 4.1.12 indicates the comparison between the model hydrograph in 2001 and the reproduced hydrograph by this SAPS Study. It can be judged that peak discharges are well reproduced and shapes of the hydrographs are almost matched, therefore, the hydrograph in 2009 "Ondoy" was prepared using this rainfall-runoff model.



Source: JICA Study Team

Figure 4.1.11 Model Hyetograph and Hydrograph with 30-year Return Period at Tinajeros Bridge in Detailed Design Stage in 2001

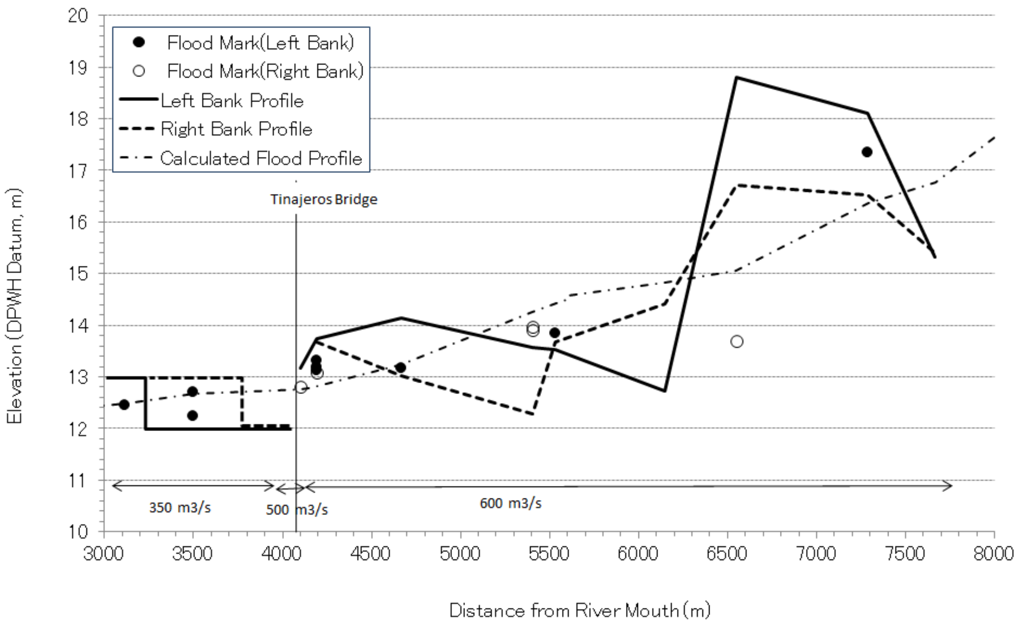


Source: JICA Study Team

Figure 4.1.12 Comparison between Model Hydrograph in 2001 DD and Reproduced Hydrograph by NAM Model in 2013

As shown in Figure 4.1.9, during the 2009 typhoon “Ondoy” the flood level was beyond the river bank upstream of Tinajeros Bridge and the flood level was lower than the river bank downstream of the bridge. So the flood water discharge from the Tullahan river basin should be confirmed in order to estimate the flood water distribution in the Project area.

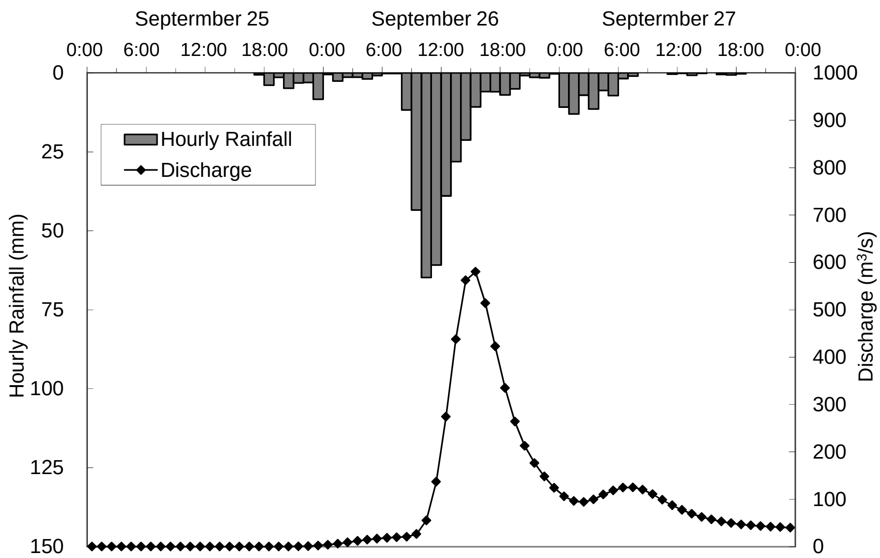
By non-uniform hydraulic calculation, the profile of the flood marks was reproduced as shown in Figure 4.1.13. This is the result of several trials for various discharge distributions from the river mouth to the Tullahan river section. From this result, the peak flood water discharge can be estimated to be 600 m^3/s.



Source: JICA Study Team

Figure 4.1.13 Calculated Flood Level Profile for 2009 typhoon "Ondoy" by HEC-RAS

The calculated hydrograph by the rainfall-runoff model was adjusted and calibrated using the estimated peak discharge of 600 m^3/s. Figure 4.1.14 shows the hyetograph and the calibrated hydrograph for 2009 "Ondoy".



Source: JICA Study Team

Figure 4.1.14 Hourly Rainfall in Upstream Area of Tinajeros Bridge and Calibrated Discharge (Hydrograph) at Tinajeros Bridge in 2009 "Ondoy"

In the detailed design stage in 2001, probable peak discharge was analyzed in the Malabon-Tullahan River as shown in Table 4.1.8. Comparing with these values, peak discharges in 2009 "Ondoy" is assessed to correspond to more than a 100-year return period.

Table 4.1.8 Result of Probability Analysis on Discharge in Detailed Design Stage in 2001

	Probable Peak Discharge with Various Flood Return Periods (m^3/s)						
	100yr	50 yr	**30 yr**	20 yr	10 yr	5 yr	2 yr
Tinajeros Bridge	520	460	**420**	380	340	280	200

Source: JICA Study Team

(6) Inundation Condition

1) Survey Methodology

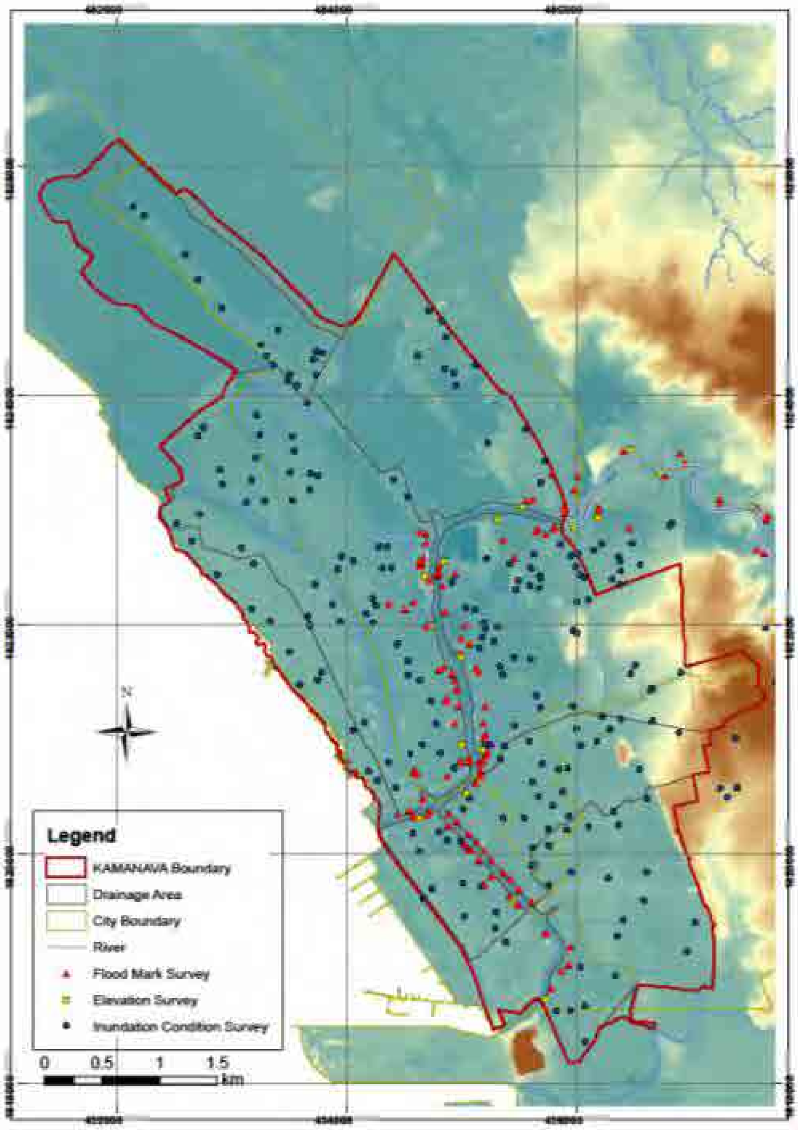
An inundation condition survey was conducted to confirm inundation conditions of Typhoon “Ondoy” and Monsoon (Habagat). The number of survey points by LGUs and their locations are shown in Table 4.1.9 and Figure 4.1.15, respectively.

Table 4.1.9 Number of Inundation Condition Survey Points (*n* = 219)

LGUs	Number	Barangays
Navotas	51	North bay boulevard, Sipac Almacen, Tanza, San Rafael, Tangos, San Roque, Navotas east, Navotas west, San Jose, Daang Hari, Bangculasi
Malabon	128	Tinajeros, Catmon, Niugan, Tonsuya, Tugatog, Longos, Maysilo, Panghulo, Baritan, Ibaba, Flores, Hulong Duhat, Tanong, San Agustin, Conception, Dampalit, Muzon, Potrero
Kaloocan	40	Sangandaan, Dagat dagatan, Maypajo

Source: JICA Study Team

The survey also included an the interview survey with the local people using a questionnaire and GPS cameras. The following items were included in the interviews and water depths and the locations were recorded with a GPS camera.



Source: JICA Study Team

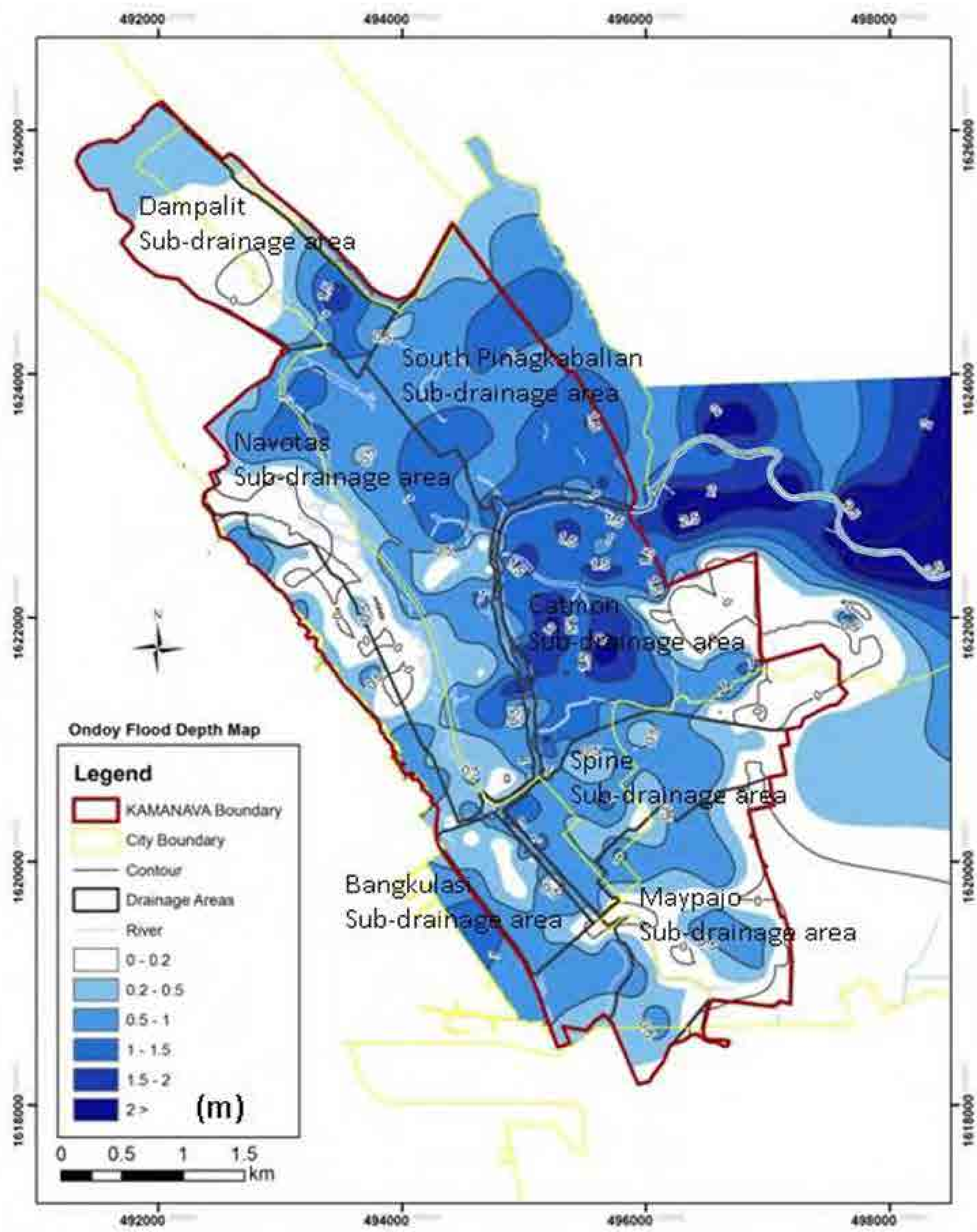
Figure 4.1.15 Location map of Inundation Condition Survey (including Flood Mark Survey)

The following items were included in the interviews in the flood mark survey as well. Therefore the following shows the results of the interviews including the flood mark survey.

Table 4.1.10 Items of Questionnaire (Inundation Condition Survey)

Category	Question Items
Personal details interviewee	Age, Gender, Occupation, Residence years, Frequency to be affected by past flood
Inundation condition	Water level, time of high water level and destroyed structures during “Ondoy” and monsoon(Habagat)
Flood evacuation	Transmission of warning system, the situation to evacuate during “Ondoy” and monsoon(Habagat)
Flood damage	Losses, diseases, Rehabilitation period

Source: JICA Study Team



Source: JICA Study Team

Figure 4.1.16 Flood Depth Contour Map of 2009 Typhoon "Ondoy"

2) Result

Flood depth contour lines based on each survey location were generated by GIS software and shown in Figure 4.1.16 for "Ondoy". This contour map does not consider the topography (ground elevation) or structure such as railways and streets, so that it indicates general seriousness of inundation only.

It is revealed that most parts of the Project area were inundated during "Ondoy". Especially the left bank of Malabon river and the area near Tinajeros bridge were flooded with the high level of water depth at around 2 meters. As shown in Figure 4.1.8, river water overflowed in many areas along Tullahan-Malabon river, so it is understood the river water from Malabon river caused inundation in a large area, especially the inundation depths along the left bank were larger.

In addition the flooded water depth was very high, over 3 meters, along the Tullahan river (upstream of Tinajeros bridge) near MacArthur Highway.

Figure 4.1.17 shows the flood water direction during "Ondoy" based on the people's answers. It is shown that the reach upstream of Tinajeros bridge was already flooded and flowed down toward the Project area. Then the water depth around Tinajeros bridge rose and flowed into low elevation areas such as Catmon sub-drainage area. On the other hand on the right bank upstream of Malabon river, river water also overflowed at high water but some of the water could flow to the northern area. On the north side of South Pinagkabalian sub-drainage area, it was revealed that water overflowed from outside of the Project area.

According to the survey results, Sanciangco street, which is a main street that runs from Tinajeros bridge downstream, acted as a channel to convey the flood water and had a great effect on the water depth south of Catmon sub-drainage area. The effect also expanded to Spine sub-drainage area and the respondents who live near Marala river said water came from inland even though Marala river overflowed. In Maypajo sub-drainage area, the effect from upstream was small.

In Navotas sub-drainage area, rather than the water from Malabon river, the effect of high tide was more significant. Dampalit and Bangkulasi sub-drainage areas were also affected by high tide.

Average water depth for each sub-drainage area is shown in Table 4.1.11. The highest depth area was Catmon sub-drainage area including Sanciangco street. The water depth of Spine sub-drainage area was 0.69(m) for "Ondoy". It was noted the average water depth was higher in the areas on the left bank of Malabon river compared with the right bank.

Table 4.1.11 Inundation Depth in Each Sub-drainage Area

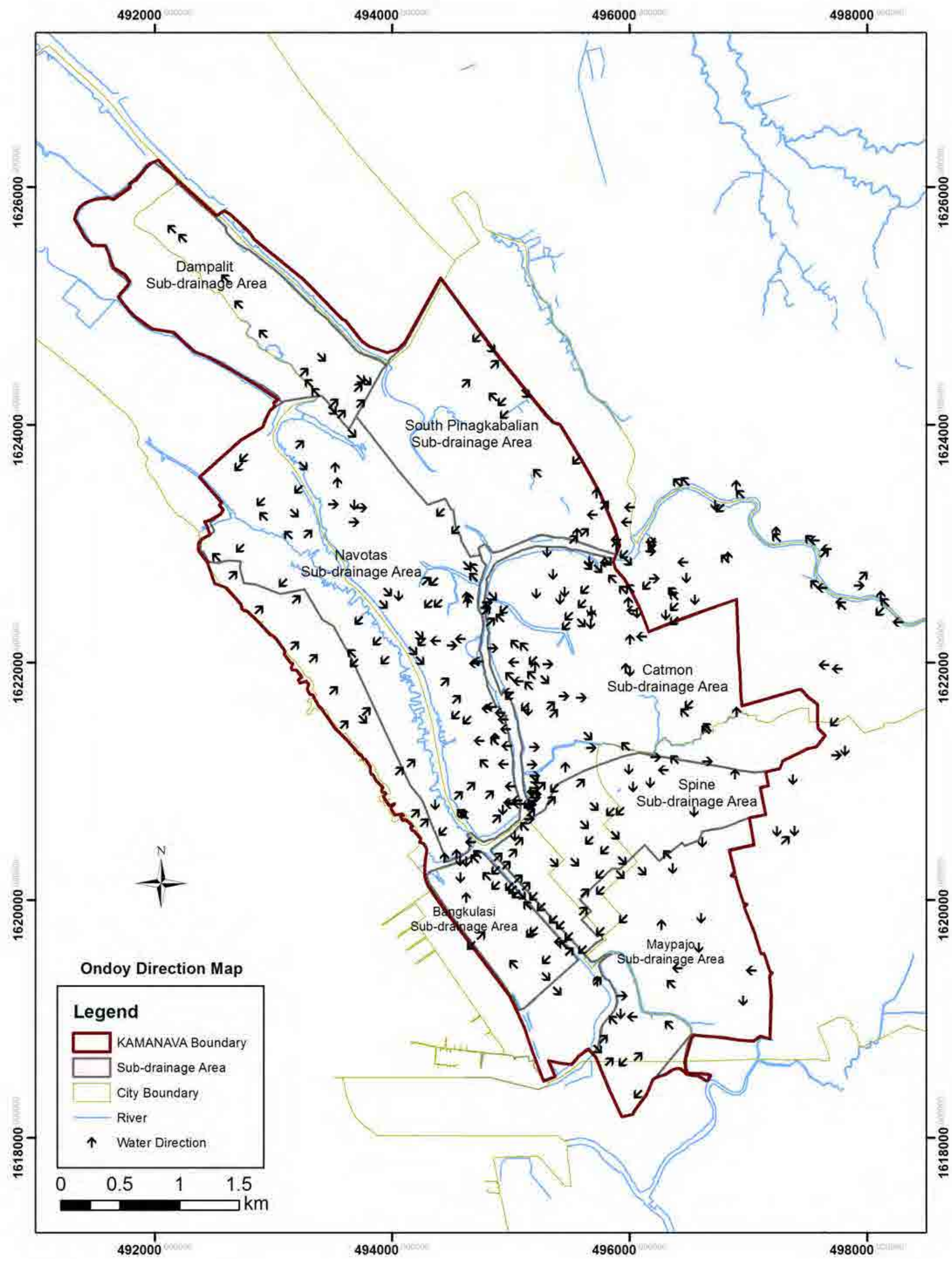
Sub-drainage area	North/South	Number	Average Inundation Depth (m) in 2009 "Ondoy"
Bangkulasi	South (Left Bank side of Malabon River)	24	0.47
Spine		39	0.69
Maypajo		26	0.47
Catmon		79	1.29
Damplalit	North (Right Bank side of Malabon River)	15	0.61
Navotas		87	0.61
South Pinagkabalian		18	1.06

Source: JICA Study Team

In Catmon, Navotas and Dampalit sub-drainage areas, differences between "Ondoy" and Habagat were found.

As for Catmon, many respondents in this area said that river water came from downstream during 2009 "Ondoy", therefore high tide had an effect on this area in addition to water from the upstream reacheds of Malabon river.

Average duration time of inundation was 2.1 (days) for "Ondoy". Especially the time was the longest in Dampalit sub-drainage area, 7.3 (days) for "Ondoy". In South Pinagkabalian the time was 5.5 (days) for "Ondoy". In these areas duration time for Habagat was shorter than "Ondoy" although the time for other areas came out the opposite.



Source: JICA Study Team

Figure 4.1.17 Flood Direction Map of 2009 Typhoon "Ondoy"

(7) Operation of Facilities

The polder dike in the northern fringe of the KAMANAVA Project area and the river wall along the Malabon River were partially completed as shown in Figure 2.6.1, Figure 2.6.2, Figure 2.6.4, and Figure 2.6.5 in Chapter 2. The river wall along the Marala river was completed.

As to the Pumping stations and Flood gates, all of them were completed.

As shown in Table 3.5.3, the Catmon pumping station was not operated during the 2009 typhoon "Ondoy" because the station was flooded critically. Other pumping stations, Maypajo, Bangkulasi, Spine and North Navotas, were reportedly operated during the "Ondoy".

4.1.2 With / Without Analysis (Confirmation of the Effectiveness)

(1) Analysis Condition

In terms of flood control in the KAMANAVA Project, it can be understood that the polder dike in the northern part of the Project area and the river wall along the Malabon - Marala rivers are expected to function against river flood and high tide. In this Study, the following cases are assumed for with Project/ without Project conditions (hereinafter referred to as “with /without condition”).

Table 4.1.12 Definition of With and Without Conditions for River Flood

Case	Conditions for Case
Without condition	Without Polder dike, River wall (Condition in 2001)
With condition (existing)	With Polder dike and River wall in 2009
With condition (existing and dredging)	With Polder dike and River wall with dredging

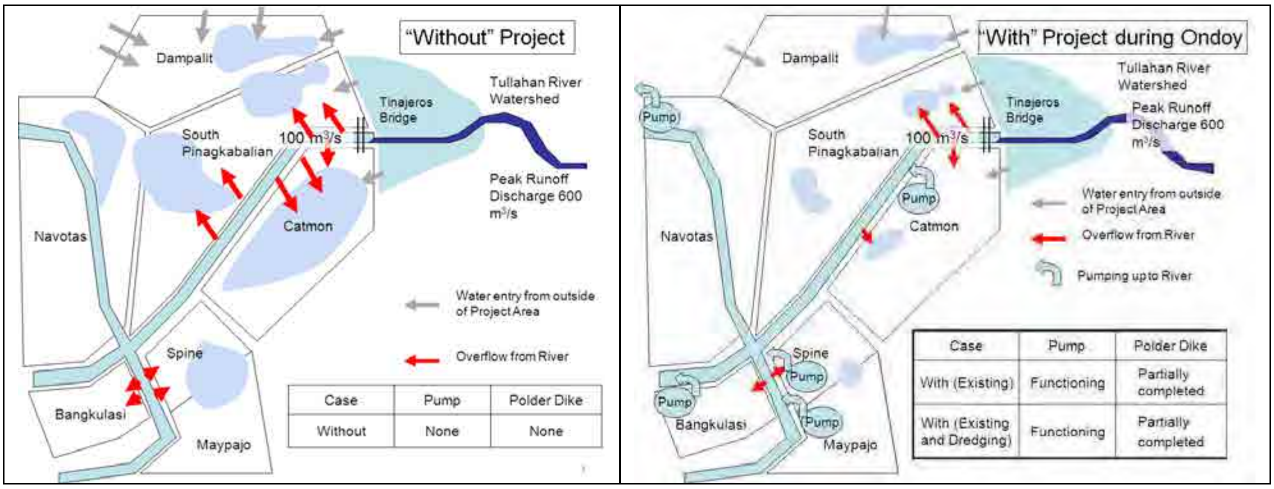
Source: JICA Study Team

For the “with” condition, 2 conditions are assumed. The “with” condition (existing) is assumed with the Malabon river channel capacity in 2009 and the “with” condition (existing and dredging) is assumed with the Malabon river dredged to the design riverbed.

The boundary conditions for with/without analysis are as follows;

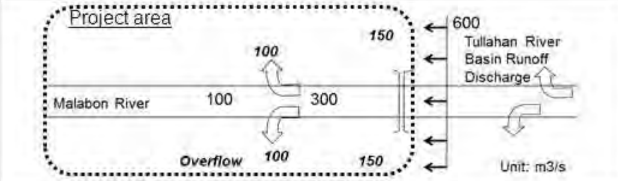
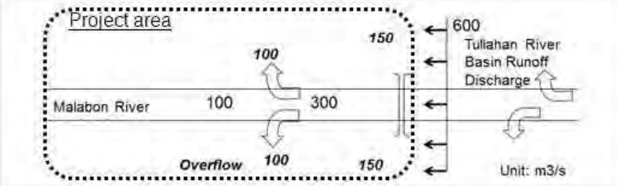
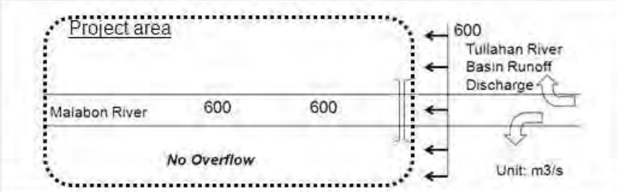
- Rainfall: 371.9 mm (00:00 Sep.26 to 24:00 Sep.27, 2009)
- Tide level : +12.20 m (DPWH Datum) (according to the observed tide on Sep.27, 2009 from Malabon city documents)
- Flood water discharge from Tullahan river Basin: 600 m^3/s
- Malabon river Channel capacity : 100 to 600 m^3/s based on the existing Malabon riverbed profile

The schematic image of the “without” and the “with” conditions are illustrated in Figure 4.1.18 and Figure 4.1.19.



Source: JICA Study Team

Figure 4.1.18 Schematic Image for “With” and “Without” Conditions in 2009 typhoon “Ondoy”

Case	Pump	Polder Dike	Flood Water Distribution
Without	None	None	
With (Existing)	Functioning	Partially completed	
With (Existing and Dredging)	Functioning	Partially completed	

Source: JICA Study Team

Figure 4.1.19 Structure Conditions for "With" and "Without" Conditions in 2009 typhoon "Ondoy"

(2) Effectiveness of the Project

The effectiveness of the KAMANAVA Project at the time of the 2009 typhoon "Ondoy" can be explained as follows,

For the high tide of +12.20 m (DPWH Datum), under the without condition, about 13 km^2 of the Project area could be submerged completely (refer to Figure 3.2.4), however, the area along the downstream reaches of the Malabon river and the Marala river were protected by the completed river wall up to +12.60 m (DPWH Datum).

For the said high tide, the polder dike protected the sub-drainage areas such as North Navotas, Dampalit and South Pinagkabalian, while the northern edge of the Project area allowed overflow because some portion was not completed to the top elevation of +12.60 m at the time of "Ondoy".

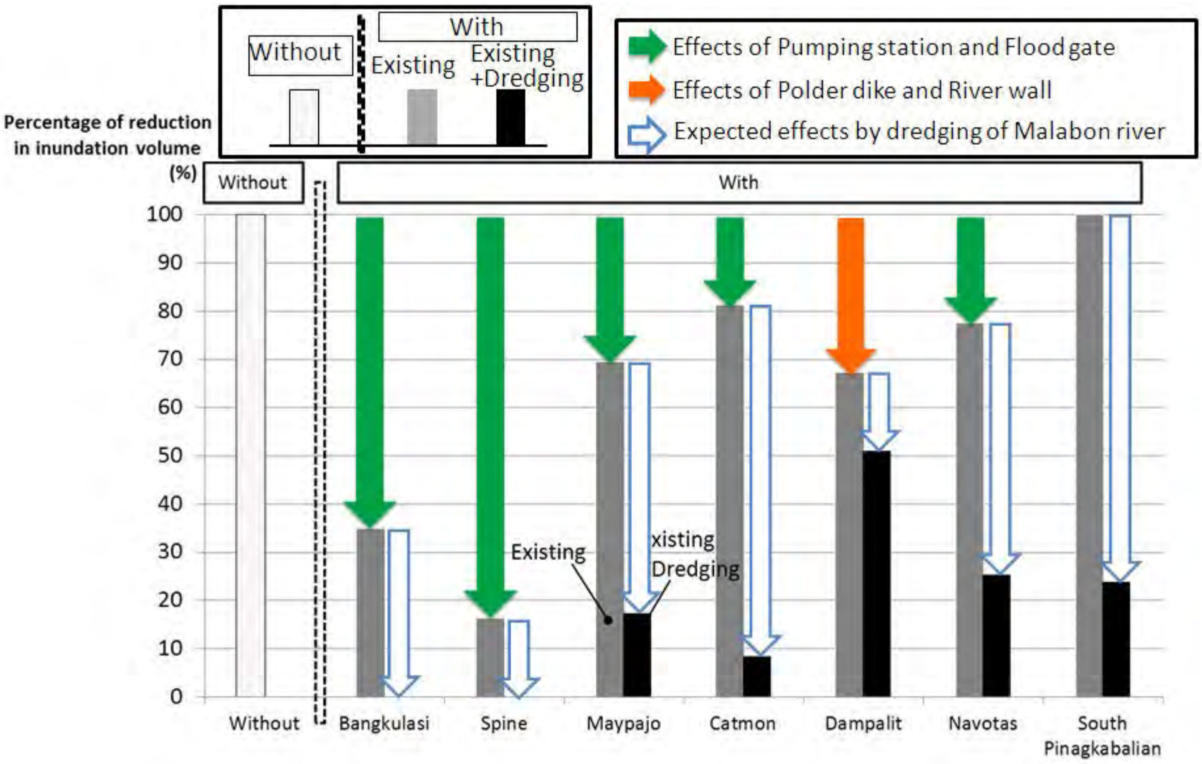
For the flood water discharge of 600 m^3/s from the Tullahan river basin (upstream of Tinajeros Bridge), which overflowed in the area due to shortage of flow capacity in the Tullahan river, the upstream end of the Malabon river also could not accommodate the said discharge, resulting in the overflow toward the inland area (sub-drainage areas such as Catmon sub-drainage area and South Pinagkabalian sub-drainage area). This phenomenon cannot be regarded as the positive effectiveness of the Project, however, it is a very important point because it affected the effectiveness of the facilities for inland flood.

The above phenomena and the effectiveness of the Project are illustrated in Figure 4.1.20. This figure is a schematic one, but it can show the general picture, as explained in the above about what happened in the 2009 typhoon "Ondoy".

This figure shows for each sub-drainage area, the ratio (%) of inundation volume for the "with" condition to that for the "without" condition. Also in the figure, the extent of such reduction rate is shown by arrow marks.

For Bangkulasi and Spine sub-drainage areas, the pumps can reduce the inundation volume by 60-80 % compared with the "without" conditions. For Maypajo, Catmon, Dampalit, Navotas and South Pinagkabalian sub-drainage areas, the reduction by the pumps is only 30 % or less. Especially in South Pinagkabalian and Dampalit, there is no effect from the pumps. While in Catmon there is a pumping station, but the reduction rate is small because of the overflow volume from the Malabon river. In Dampalit, the polder dike is effective to reduce the flood water volume.

This figure also shows the effectiveness of dredging of the Malabon river. By improvement of the Malabon river, the overflow from the river can be eliminated, so that Bangkulasi and Spine sub-drainage areas could become free from flood. For Maypajo, Catmon, Navotas and South Pinagkabalian sub-drainage areas, the reduction by the dredging is as large as 50 % or so.



Source: JICA Study Team

Figure 4.1.20 Effectiveness of the KAMANAVA Project at 2009 Typhoon "Ondoy"

(3) Inland Flood Consideration

From the rainfall data during the 2009 typhoon "Ondoy", the return period of maximum hourly rainfall around the Project area was about 10 years. Therefore, the pumping stations constructed in the KAMANAVA Project were supposed to be functioning during the typhoon because the design scale is a 10 year return period.

Actual detailed operation condition could not be confirmed. This is because the operation record for each pumping station and floodgate during the 2009 typhoon "Ondoy" are not available since at that time the hourly operation was not recorded. Therefore, it is difficult to reproduce the inland water level condition during the 2009 typhoon "Ondoy" for detailed analysis.

However, results of the inundation condition survey show the inundation facts in the sub-drainage areas. It was probably caused by the river water entry from the Malabon river and from outside of the Project Area.

Table 4.1.13 Simulation of Flood Water Volume Balance for 2009 Typhoon "Ondoy"

Without

Name of Subdrainage Area	Area (ha)	Pump (m3/s)	Rainfall (m3)	Water Entry from outside (m3)		Water Entry from river (m3)		Total(m3)	Pumping Up (m3)	Inundation Volume (m3)	Inundation Depth (m)
			①	②		③		④=①+②+③	⑤	⑥=④−⑤	
Bangkulasi	75.4	0.0	280,413	0		304,369	Overflow from Marala R.	584,781	0	584,781	0.78
Spine	173.1	0.0	643,759	0		698,756	Overflow from Malabon, R. Marala R.	1,342,515	0	1,342,515	0.78
Maypajo	241.2	0.0	897,023	0		973,656		1,870,679	0	1,870,679	0.78
Catmon	355.5	0.0	1,322,105	2,100,000	From Tullahan	1,435,053	Overflow from Malabon R.	4,857,158	0	4,857,158	1.37
Dampalit	233.1	0.0	866,899	4,000,000	From Overflow of Polder Dike	940,959		5,807,858	0	5,807,858	2.49
Navotas	475.5	0.0	1,768,385			1,919,459		3,687,844	0	3,687,844	0.78
South Pinagkabalian	254.6	0.0	946,857	2,000,000	From Tullahan	1,027,748	Overflow from Malabon R.	3,974,606	0	3,974,606	1.56
	1808.4									22,125,440	1.22

With (Existing)

Name of Subdrainage Area	Area (ha)	Pump (m3/s)	Rainfall (m3)	Water Entry from outside (m3)		Water Entry from river (m3)		Total(m3)	Pumping Up (m3)	Inundation Volume (m3)	Inundation Depth (m)
			①	②		③		④=①+②+③	⑤	⑥=④−⑤	
Bangkulasi	75.4	2.2	280,413	0		304,369	Overflow from Marala R.	584,781	380,160	204,621	0.27
Spine	173.1	6.5	643,759	0		698,756	Overflow from Marala R.	1,342,515	1,123,200	219,315	0.13
Maypajo	241.2	3.3	897,023	0		973,656		1,870,679	570,240	1,300,439	0.54
Catmon	355.5	5.3	1,322,105	2,100,000	From Tullahan	1,435,053	Overflow from Malabon R.	4,857,158	907,200	3,949,958	1.11
Dampalit	233.1	0.0	866,899	2,097,900	From Overflow of Polder Dike	940,959		3,905,758	0	3,905,758	1.68
Navotas	475.5	4.8	1,768,385			1,919,459		3,687,844	829,440	2,858,404	0.60
South Pinagkabalian	254.6	0.0	946,857	2,000,000	From Tullahan	1,027,748	Overflow from Malabon R.	3,974,606	0	3,974,606	1.56
	1808.4									16,413,100	0.91

With (Existing+Dredging)

Name of Subdrainage Area	Area (ha)	Pump (m3/s)	Rainfall (m3)	Water Entry from outside (m3)		Water Entry from river (m3)		Total(m3)	Pumping Up (m3)	Inundation Volume (m3)	Inundation Depth (m)
			①	②		③		④=①+②+③	⑤	⑥=④−⑤	
Bangkulasi	75.4	2.2	280,413	0		0		280,413	380,160	0	0.00
Spine	173.1	6.5	643,759	0		0		643,759	1,123,200	0	0.00
Maypajo	241.2	3.3	897,023	0		0		897,023	570,240	326,783	0.14
Catmon	355.5	5.3	1,322,105	0		0		1,322,105	907,200	414,905	0.12
Dampalit	233.1	0.0	866,899	2,097,900	From Overflow of Polder Dike	0		2,964,799	0	2,964,799	1.27
Navotas	475.5	4.8	1,768,385	0		0		1,768,385	829,440	938,945	0.20
South Pinagkabalian	254.6	0.0	946,857	0		0		946,857	0	946,857	0.37
	1808.4									5,592,288	0.31

Source: JICA Study Team

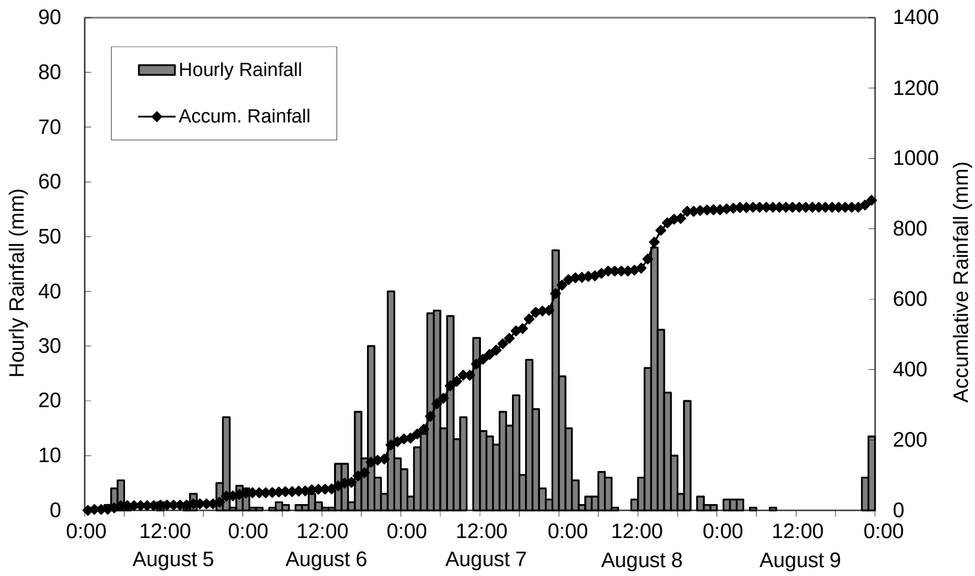
4.2 Effectiveness during 2012 Monsoon (Habagat)

4.2.1 Condition

(1) Rainfall

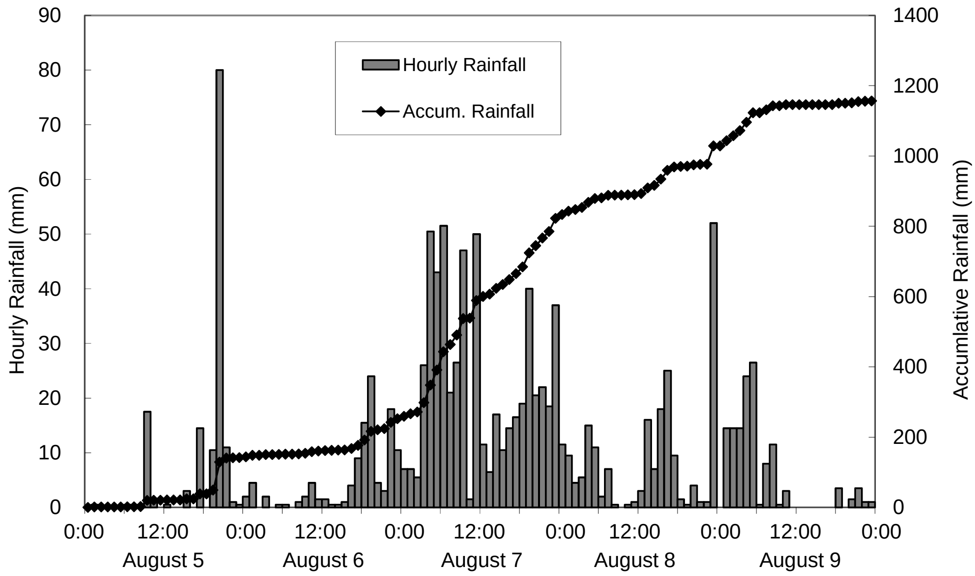
Through data collection activities from relative agencies like PAGASA and the previous reports, rainfall data for the target floods was collected. As for 2012 Habagat, hourly rainfall data in the Port Area and La Mesa Dam stations was selected for analysis.

The following figures show hourly rainfall and accumulative rainfall during 2012 Habagat. The rainfall in 2012 Habagat continues over a long time period and the accumulative rainfall amount is quite large.



Source: JICA Study Team

Figure 4.2.1 Rainfall Condition in Port Area Station in 2012 Habagat



Source: JICA Study Team

Figure 4.2.2 Rainfall Condition in La Mesa Dam Station in 2012 Habagat

According to the above data, maximum hourly rainfall and maximum two-day rainfall (maximum 48 hour rainfall) are summarized in the table below.

Table 4.2.1 Maximum Two day and Hourly Rainfall in 2012 Habagat

Flood Event	Station	Maximum Two day (48 hour) rainfall (mm/2day)	Maximum hourly rainfall (mm/hour)
2012 Habagat	Port Area	737.5	48.0
	La Mesa Dam station	792.0	80.0

Source: JICA Study Team

In the detailed design stage in 2001, probable rainfall intensity was analyzed using the Port Area rainfall intensity data as shown in the table below. Comparing using these data, two day rainfall of 737.5 mm during the 2012 Habagat in the Port Area station, is assessed to correspond to about a 500-year return period.

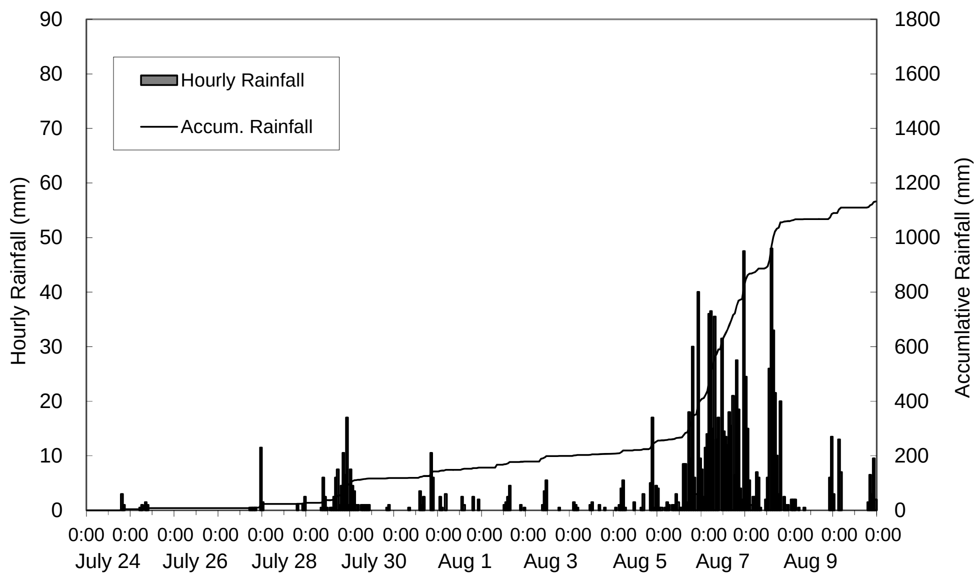
Table 4.2.2 Result of Probability Analysis on Rainfall in Detailed Design Stage in 2001

	Probable Rainfall with Various Flood Return Periods							
	500 yr	100yr	50 yr	**30 yr**	20 yr	**10 yr**	5 yr	2 yr
Two-day rainfall (mm/2-day)	750.6	601.4	536.8	**489.0**	450.8	**384.2**	314.8	210.0
One-hour rainfall (mm/hr.)	131.4	109.8	100.5	**93.6**	88.1	**78.4**	68.4	53.3

Source: JICA Study Team

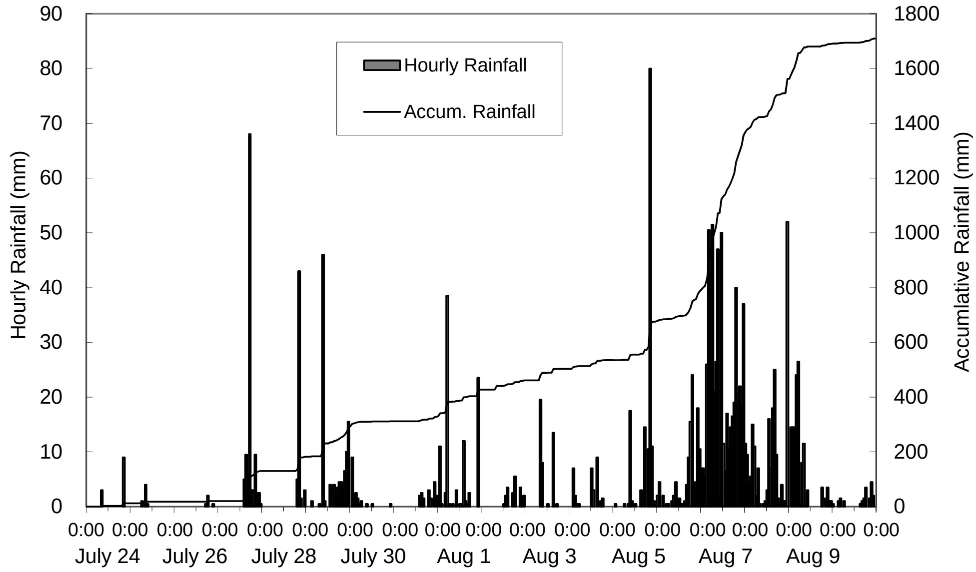
In the detailed design stage in 2001, rainfalls with a 10-year return period and 30-year return period were applied to develop a model hyetograph for the drainage area and for the Malabon-Tullahan River, respectively.

In addition, although the heaviest rainfall period in 2012 Habagat was from August 5 to August 9, a certain degree of rainfall was also recorded before August 5. This may have affected the flood event. The following figures show long-term rainfall conditions at two stations from July 24 to August 10 in 2012 Habagat.



Source: JICA Study Team

Figure 4.2.3 Long Term Rainfall Condition at Port Area Station in 2012 Habagat



Source: JICA Study Team

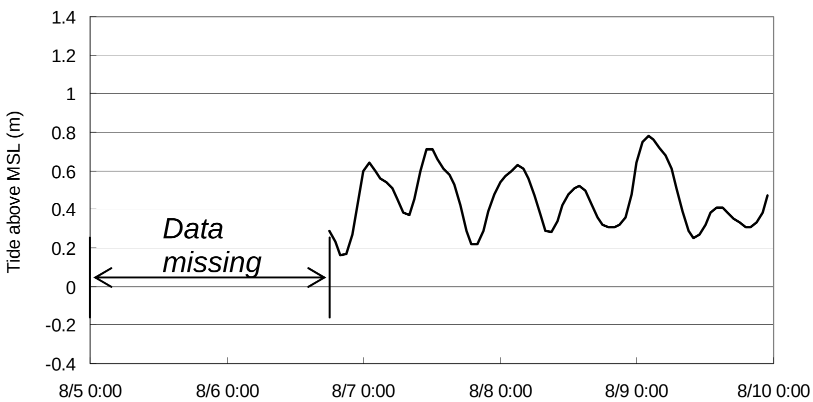
Figure 4.2.4 Long Term Rainfall Condition at La Mesa Dam Station in 2012 Habagat

(2) Tides

Tide level data was collected from NAMRIA and KAMANAVA PMO. The collected data were tide tables, observed tide level data in Manila Bay and observed tide level data at gates and pumping stations installed in the KAMANAVA Project area by the Project.

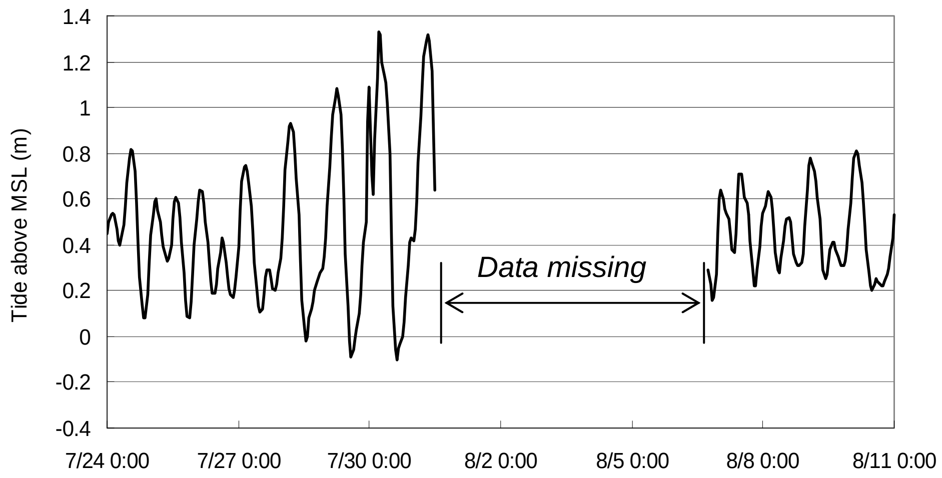
Figure 4.2.5 and 4.2.6 shows observed tide level data in the short term and long term in Manila Bay in the 2012 monsoon (Habagat), respectively. Though there are also some periods missiong data, it is revealed that the tide levels are quite high from the end of July to the beginning of August, which is the period that the rainfall amount was not large, but tide levels are not very high after August 6 when the high rainfall started and continued, comparing with rainfall data shown in Figure 4.2.3 and 4.2.4.

In addition, Figure 4.2.7 shows observed tide level recorded at the Bangkulasi pumping station. Its fluctuation tendency is the same as Manila Bay, and the highest tide level was recorded on August 2.



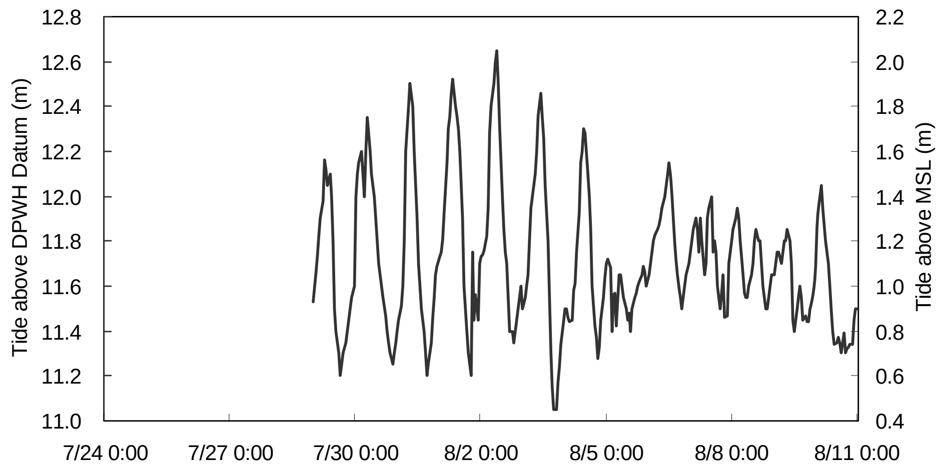
Source: JICA Study Team

Figure 4.2.5 Tide Level Condition in Manila Bay during 2012 Habagat after NAMRIA



Source: JICA Study Team

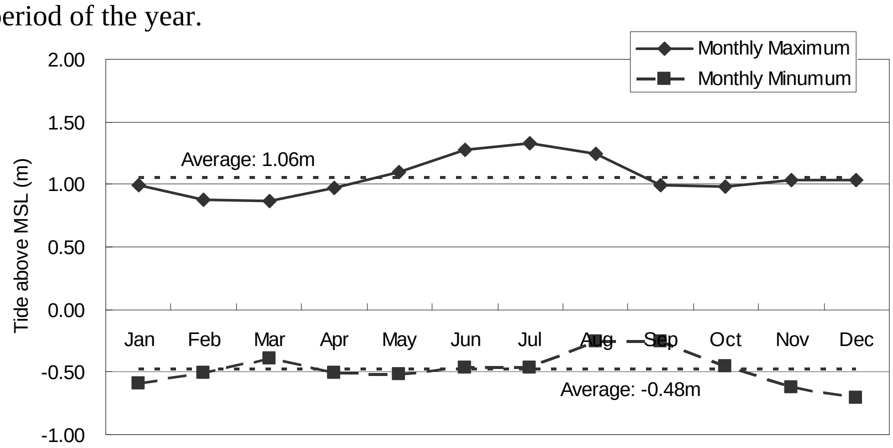
Figure 4.2.6 Long Team Tide Level Condition in Manila Bay during 2012 Habagat after NAMRIA



Source: JICA Study Team

Figure 4.2.7 Tide Level recorded at Bangkulasi Pumping Station during 2012 Habagat

Figure 4.2.8 shows monthly tide level variations in 2012. Monthly maximum and minimum tide levels are plotted. From this figure, it is revealed that July-August 2012 during Habagat is the highest tide period of the year.



Source: JICA Study Team

Figure 4.2.8 Maximum/Minimum Monthly Tide Levels in 2012

In the detailed design stage in 2001, the following design levels were adopted using DPWH Datum regarding tide condition for the Project. Meanwhile, DPWH Datum Plane of the Manila Flood Control and Drainage Project is defined as 10.00m below MLLW (Mean Lower Low Water).

Table 4.2.3 Design Tide Levels in Detailed Design Stage in 2001

	Abbreviation/ Definition	Tide level by DPWH Datum (m)	Difference from MSL (m)
Mean Sea Level	MSL	10.6	0.0
Maximum Tide Level	Max. Design Level	12.1	1.5
Mean High Water Spring	MHSW	11.4	0.8
Mean Higher High Water	MHHW	11.1	0.5
Mean Lower Low Water	MLLW	10.1	-0.5
Lowest Tide Level	Min. Design Level	9.4	-1.2

Source: JICA Study Team

Comparing the design tide level of 12.1m (DPWH Datum) and maximum tide level during 2012 Habagat in Figure 4.2.7, it reveals that the tide level was quite high during 2012 Habagat.

(3) Wind, Air Pressure and Waves

1) Wind

According to the information collected from PAGASA, maximum 6-hour wind speeds at the Port Area station are recorded as 11.0 m/s on July 29 during 2012 Habagat.

In the detailed design stage in 2001, wind speeds for various return periods were estimated using the data for the Port Area as shown in the table below.

Table 4.2.4 Result of Probability Analysis on Maximum Wind Speed in Detailed Design Stage in 2001

Return Period	6-Hour Wind Speed (m/s)	Instantaneous Wind Speed (m/s)
Mean Annual	5.0	18
2 Year	7.5	28
5 Year	9.3	34
10 Year	10.3	38
20 Year	11.3	42
50 Year	12.5	47
100 Year	13.4	51

Source: JICA Study Team

In the detailed design stage in 2001, the maximum wind speed of 10.8m/s for the 6-hour wind speed was adopted for design since a duration of at least 4 hours would be required to develop waves on Manila Bay.

From the above data, wind speed in Habagat was less than 20-year though it is slightly beyond design wind speed.

2) Air Pressure

According to the information collected from PAGASA, minimum air pressures as MSLP (mean sea level pressure) at Port Area station were 995.7 hPa on July 29 during 2012 Habagat.

Referencing the data of the detailed design stage in 2001, minimum and average of the air pressure of typhoons passing the Port Area between 1981 and 2000 were 980.9 and 998.0 hPa, respectively. Incidentally, instantaneous wind speed of the typhoon with minimum air pressure is recorded as 33.34m/s.

From the above data, it can be said that air pressures during 2012 Habagat were not significantly high.

3) Waves

In the detailed design stage in 2001, the design wave approaching the Navotas Navigation Gate was calculated using a design wind speed of 11m/s, and the design wave was set at a 1.0m wave height, a wave period of 4.0 seconds and a wave length of 23.6m. On the other hand, the calculated riverside wind generated wave for an assumed depth of 3.0m, a fetch of 1.5 km and a wind velocity of 11m/s was set as a wave with a wave height of 0.3m and period of 2.0 seconds and a wave length of 6.0m.

Although there is no wave data found for 2012 Habagat, maximum wave height in 2012 Habagat can be assumed as almost the same as the design wave height since the maximum 6-hour wind speed in 2012 Habagat is the same as the design wind speed.

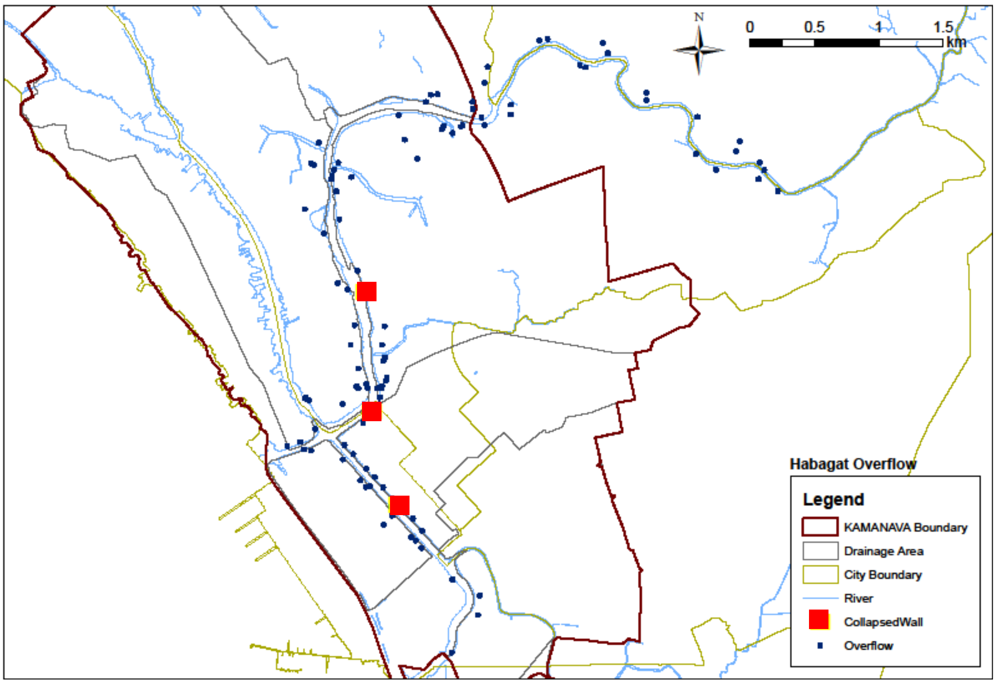
(4) Flood Mark

The locations where interviewees said that river water overflowed from Malabon river or Marala river as well as the locations of collapsed river walls are illustrated in Figure 4.2.9.

As a result, it was indicated that river water overflowed from many locations on Malabon river and Marala river as well as the Tullahan river (upstream of Malabon river, outside of the Project area).

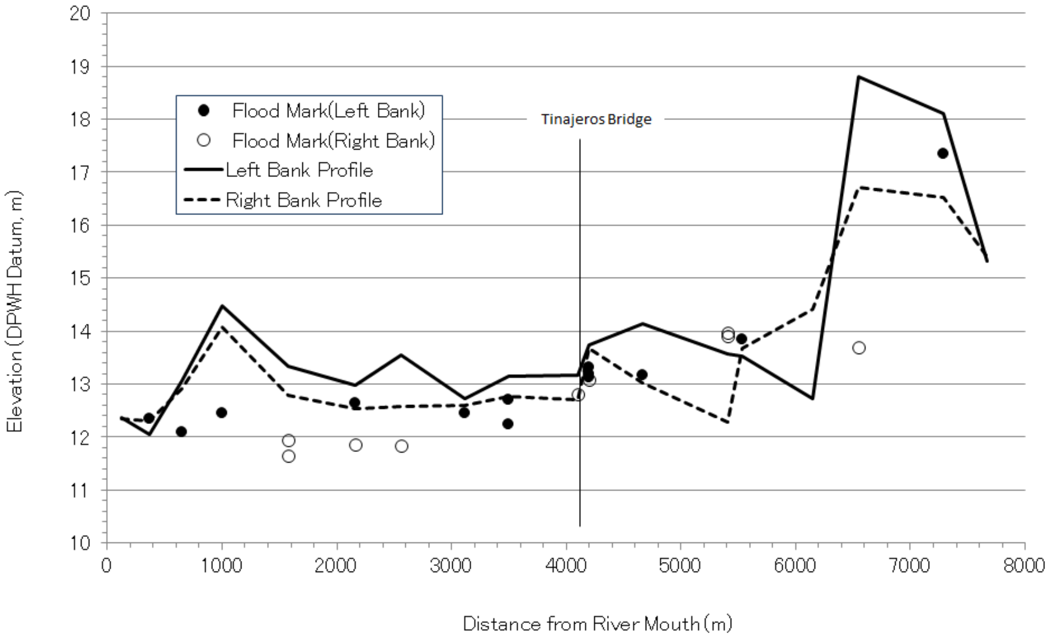
Many respondents said that river water did not overflow from Malabon river between Lambingan bridge and Tonsuya bridge during Habagat. On the other hand, the respondents who live near Manila bay said that the river water overflowed during Habagat rather than during “Ondoy”.

Furthermore, three walls reportedly collapsed during Habagat to accelerate the inundation.



Source: JICA Study Team

Figure 4.2.9 Locations at which People Said that River Water Overflowed and Reported Collapsed River Walls during 2012 Monsoon (Habagat)



Source: JICA Study Team

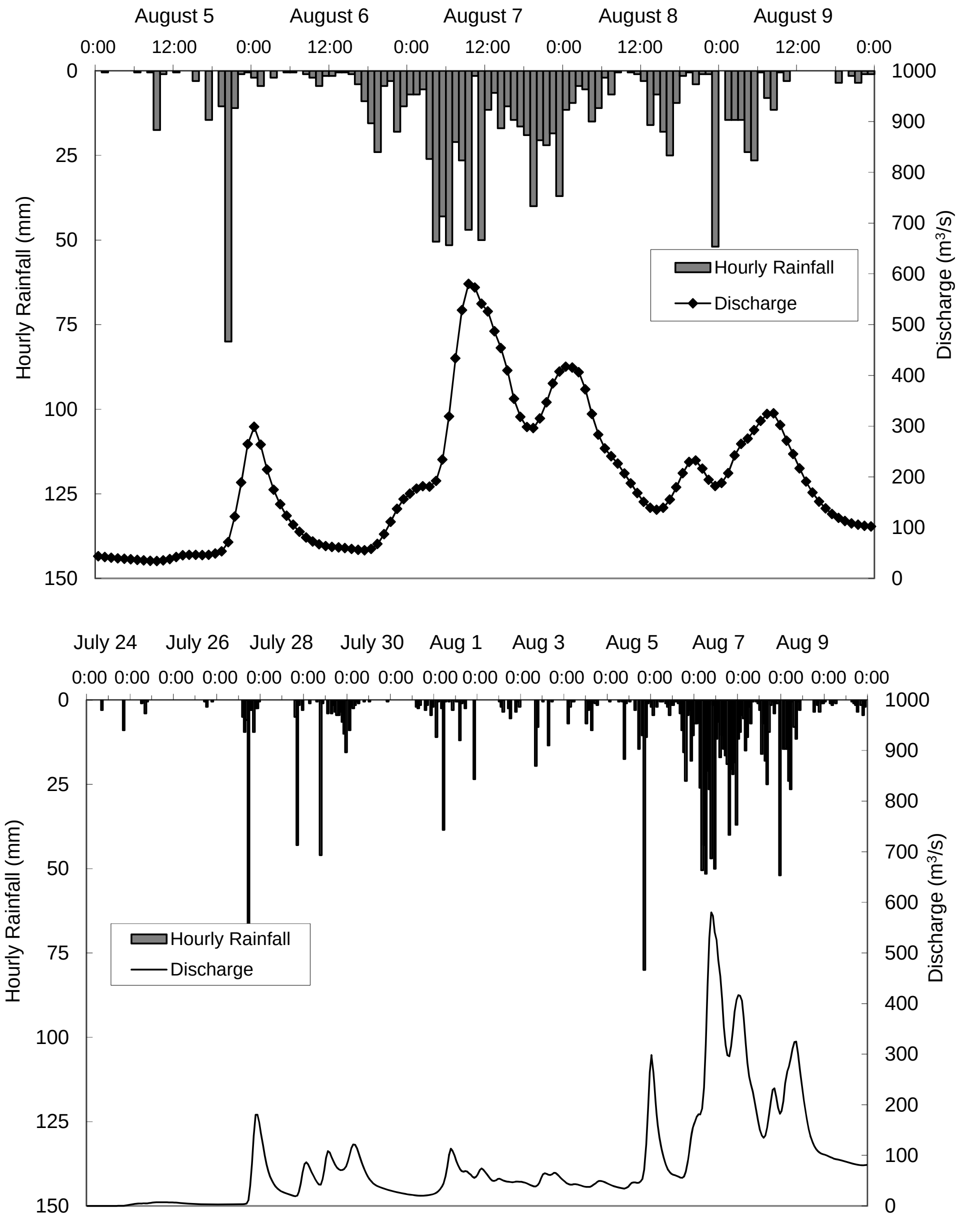
Figure 4.2.10 Profile of Flood Mark Elevations along Malabon-Tullahan River during 2012 Monsoon (Habagat)

(5) River Water Level / Discharge

Peak discharges were separately investigated using maximum water levels in 2012 Habagat, which were surveyed through a flood mark survey in this SAPS Study. As shown in Figure 4.2.10, the flood marks in the 2012 monsoon (habagat) were almost the same as those in the 2009 typhoon "Ondoy"(Figure 4.1.9).

By non-uniform hydraulic calculation, the profile of the flood marks were reproduced as shown in Figure 4.1.13. This is the result of several trials for various discharge distributions from the river mouth to the Tullahan river section. From this result, the peak flood water discharge can be estimated to be 600 m^3/s. The peak discharge during the 2012 monsoon (habagat) was evaluated as 600 m^3/s.

The calculated hydrograph using the rainfall-runoff model were adjusted and calibrated using the investigated peak discharge of $600m^3/s$. Figure 4.2.11 shows a hyetograph and the calibrated hydrograph for the 2012 Habagat.



Source: JICA Study Team

Figure 4.2.11 Hourly Rainfall at La Mesa Dam Station and Calibrated Discharge (Hydrograph) at Tinajeros Bridge in Short Term (Top figure) and Long Term (Bottom figure) for 2012 Habagat

In the detailed design stage in 2001, probable peak discharge was analyzed in the Malabon-Tullahan River as shown in the table below. Comparing with these values, peak discharges in the 2012 Habagat are assessed to correspond to more than a 100-year return period.

Table 4.2.5 Result of Probability Analysis on Discharge in Detailed Design Stage in 2001

	Probable Peak Discharge with Various Flood Return Period (m^3/s)						
	100yr	50 yr	**30 yr**	20 yr	10 yr	5 yr	2 yr
Tinajeros Bridge	520	460	**420**	380	340	280	200

Source: JICA Study Team

(6) Inundation Condition

The water depth contour lines based on the survey location were generated by GIS software and shown in Figure 4.2.12 for Habagat. It is revealed that most parts of the Project area were inundated during Habagat. Especially the left bank of Malabon river and the area near Tinajeros bridge were deeply flooded with around 2 meters of water. As shown in Figure 4.2.12, river water overflowed at many areas along Malabon river, so it is understood the river water from Malabon river caused the inundation in large area, especially the left bank.

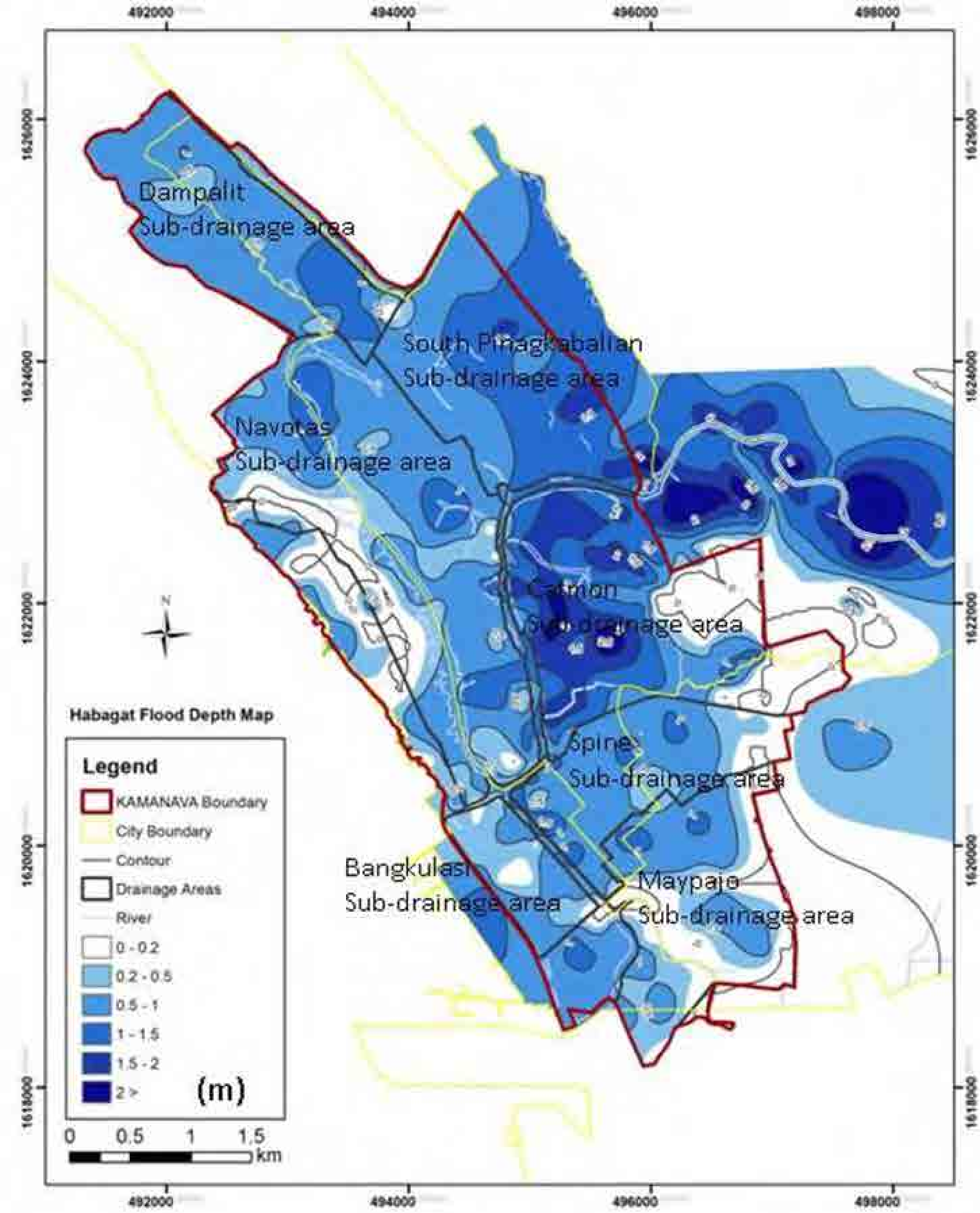
In addition the water depth was very high, over 3 meters, along the Tullahan river (upstream of Malabon river) near MacArthur Highway.

Figure 4.2.13 shows the flood water direction during Habagat based on the people's answers. It is considered the some of the water which overflowed the left bank upstream of Malabon river flowed down and into the Project area. Then water depth around Tinajeros bridge rose and flowed to low elevation areas such as Catmon sub-drainage area. On the other hand, on the right bank upstream of Malabon river, river water also overflowed at high water depth but some water could drain to the northern area. On the north side of South Pinagkabalian sub-drainage area, it was revealed water overflowed from outside of the Project area.

According to the survey results, Sanciangco street, which is a main street that runs from Tinajeros bridge to downstream, acted as a channel for flood water and had a large effect on the water depth south of Catmon sub-drainage area. The effect also expanded to Spine sub-drainage area and the respondents who live near Marala river said water came from inland areas even though Marala river overflowed.

In Mayapajo sub-drainage area, the effect from upstream was small.

In Navotas sub-drainage area the water from Malabon river did not have much of an effect compared with the left bank, but the effect of the high tide was significant in this area. Dampalit and Bangkulasi sub-drainage areas were also affected by high tide.



Source: JICA Study Team

Figure 4.2.12 Flood Depth Contour Map of 2012 Monsoon (Habagat)

Average water depth for each sub-drainage area is shown in Table 4.2.6. The highest depth area was Catmon sub-drainage area including Sanciangco street. The tendency was also reflected in the water depth of Spine sub-drainage area, 0.83m for Habagat. It was noted the average water depth was higher in the areas on the left bank of Malabon river compared with the right bank.

Table 4.2.6 Inundation Depth in Each Sub-drainage Area

Sub-drainage area	North/South	Number	Average Inundation Depth (m) in 2012 Monsoon (Habagat)
Bangkulasi	South (Left Bank side of Malabon River)	24	0.51
Spine		39	0.83
Maypajo		26	0.59
Catmon		79	1.38
Damplalit	North (Right Bank side of Malabon River)	15	0.77
Navotas		87	0.66
South Pinagkabalian		18	1.06

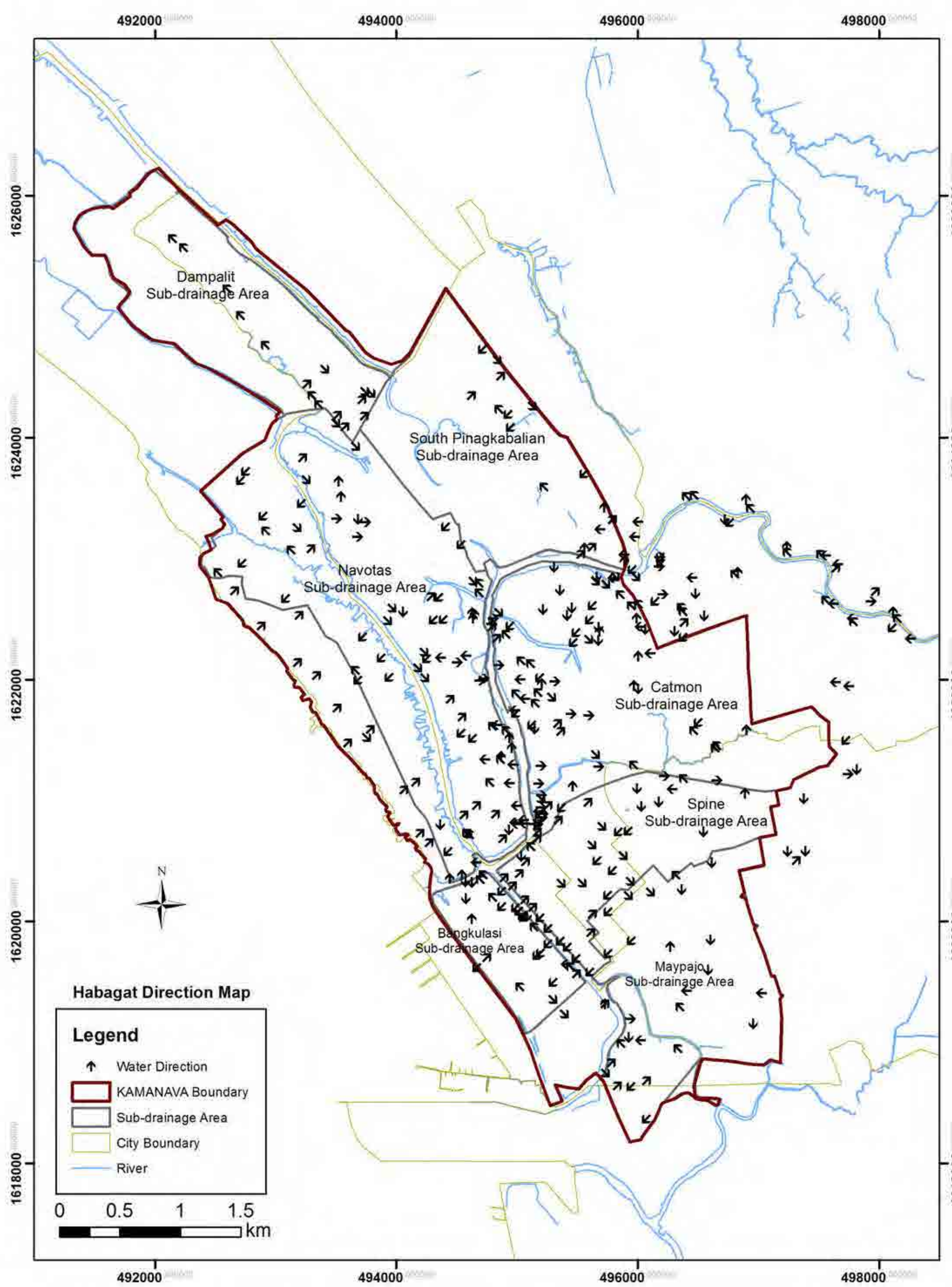
Source: JICA Study Team

In Catmon, Navotas and Dampalit sub-drainage areas, differences between “Ondoy” and Habagat were found.

As for Catmon, the area with over 1.5 m of water depth was large during 2012 Habagat. Many respondents in this area said that river water came from downstream during 2009 “Ondoy”, therefore, high tide had an effect on this area in addition to water from upstream of Malabon river.

In Navotas and Dampalit the inundation area was larger during Habagat compared with “Ondoy”. This result also shows the effect of high tide. The time at which the respondents reported that the inundation started was almost the same as the time of high tide.

Average duration time of inundation was 2.4 days for Habagat. Especially the time was the longest in Dampalit sub-drainage area, 6.8 days for Habagat. In South Pinagkabalian the time was 4.1 days for Habagat. In these areas the duration time for Habagat was shorter than “Ondoy” although the time for other areas came out the opposite.



Source: JICA Study Team

Figure 4.2.13 Flood Direction Map of 2012 Monsoon (Habagat)

(7) Operation of Facilities

The polder dike on the northern fringe of the KAMANAVA Project area and the river wall along the Malabon River were completed as shown in Figure 2.6.1, Figure 2.6.3, Figure 2.6.4, and Figure 2.6.5 in Chapter 2. The river wall along the Marala river was also completed.

As to the Pumping stations and Flood gates, all of them were completed.

The Table below shows the pump and gate operation records that were collected by the JICA Study Team. According to KAMANAVA PMO, there are Bangkulasi, Catmon and Spine stations' records during the 2012 monsoon (Habagat) that are available. Other pumping stations' records are not available at the time of SAPS Study. Also it should be pointed out that the archiving of the operation record of the flood gate just started in October 2013. Therefore there is no operation record of flood gate during 2009 and 2012.

Table 4.2.7 Months in which Records were Collected for the Flood Gate and Pumping Stations from KAMANAVA PMO

Name of PS and FG	2012												2013											
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12
Bangkulasi PS+FG							■	■										■	■	■				
Spine PS+FG							■	■																
Maypajo PS+FG																		■	■	■				
Catmon PS+FG							■	■										■	■	■	■	■		
North Navotas PS+Navigation Gate																								
Navotas FG																						■		
Longos FG																						■		
Muzon FG																						■		
South Pinaglabalian FG																						■		
North Pinagkabalian FG																						■		
Kailugan FG																						■		

Note: PS: Pumping Station, FG: Flood Gate ■: Collected Month by JICA Study Team

Source: JICA Study Team

4.2.2 With/Without Analysis (Confirmation of the Effectiveness)

(1) Analysis Condition

In terms of flood control in the KAMANAVA Project, it can be understood that the polder dike in the northern part of the Project area and the river wall along the Malabon - Marala rivers are expected to function against river flood and high tide. In this Study, the following cases are assumed for with / without conditions.

Table 4.2.8 Definition of With and Without Conditions for River Flood

Case	Conditions for Case
Without condition	Without Polder dike or River wall (Condition in 2001)
With condition (existing)	With Polder dike and River wall in 2012
With condition (existing and dredging)	With Polder dike and River wall with dredging

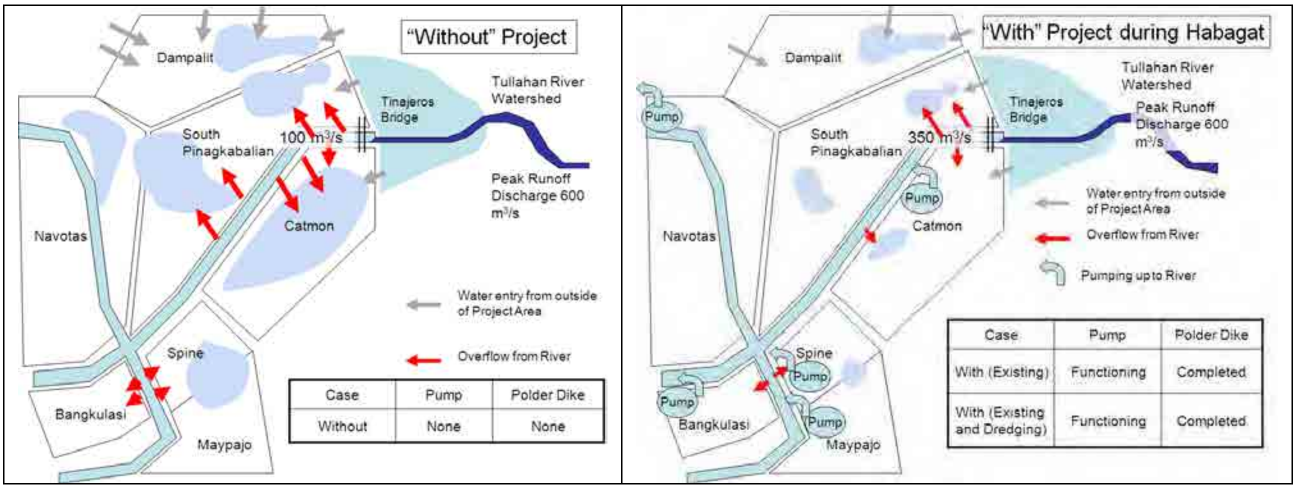
Source: JICA Study Team

For the "with" condition, 2 conditions are assumed. The "with" condition (existing) is assumed with the Malabon river channel capacity in 2012 and the "with" condition (existing and dredging) is assumed with the Malabon river dredged to the design riverbed.

The boundary conditions for with/without analysis are as follows,

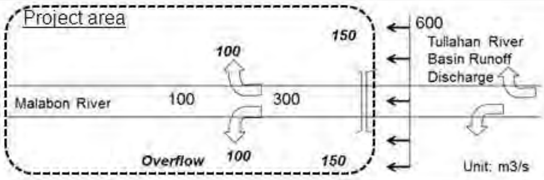
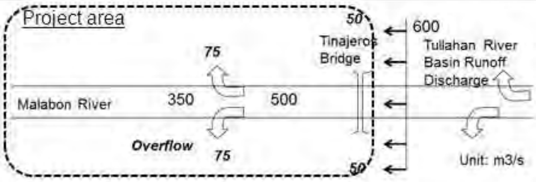
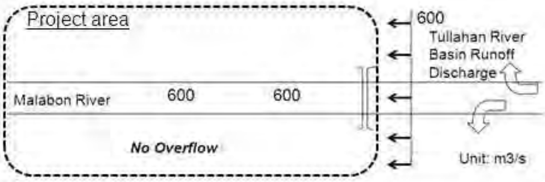
- Rainfall: 737.5 mm (Port Area, 17:00 Aug.6 to 17:00 Aug.8, 2012)
- Tide level : +12.65 m (DPWH Datum) (according to the observed tide on Aug.2, 2012 at Bangkulasi PS)
- Flood water discharge from Tullahan river Basin: 600 m^3/s
- Malabon river Channel capacity : 350 m^3/s based on existing Malabon river bed profile

The schematic image of the "without" and the "with" conditions are illustrated in Figure 4.2.14 and Figure 4.2.15.



Source: JICA Study Team

Figure 4.2.14 Schematic Image for "With" and "Without" Conditions in 2012 Monsoon (Habagat)

Case	Pump	Polder Dike	Flood Water Distribution
Without	No	No	
With (Existing)	Functioning	Completed	
With (Existing and Dredging)	Functioning	Completed	

Source: JICA Study Team

Figure 4.2.15 Structure Conditions for "With" and "Without" Conditions in 2012 Monsoon (Habagat)

(2) Effectiveness of the Project

The effectiveness of the KAMANAVA Project during the 2012 monsoon (Habagat) can be explained as follows;

For the high tide of +12.65 m (DPWH Datum), the area along the downstream reaches of the Malabon river and the Marala river were not protected by a river wall completed up to +12.60m (DPWH Datum).

For the said high tide, the polder dike protected the sub-drainage areas such as North Navotas, Dampalit and South Pinagkabalian, while there were 3 sections that allowed overflow because some portion was lower compared with the top elevation of +12.60m (DPWH Datum).

For the flood water discharge of 600 m^3/s from the Tullahan river basin (upstream of Tinajeros Bridge), which came overflowing in the area due to shortage of flow capacity in the Tullahan river, the upstream end of the Malabon river could not accommodate the said discharge, resulting in the overflow toward the inland area (sub-drainage areas such as Catmon sub-drainage area and South Pinagkabalian sub-drainage area). This phenomenon cannot be regarded as positive effectiveness of the Project, however, it is a very important point because it affected the effectiveness of the facilities for inland flood.

Compared with “Ondoy”, the right bank of Malabon river (From Tonsuya bridge to Lambingan bridge) were protected because of the progress of the river wall raising.

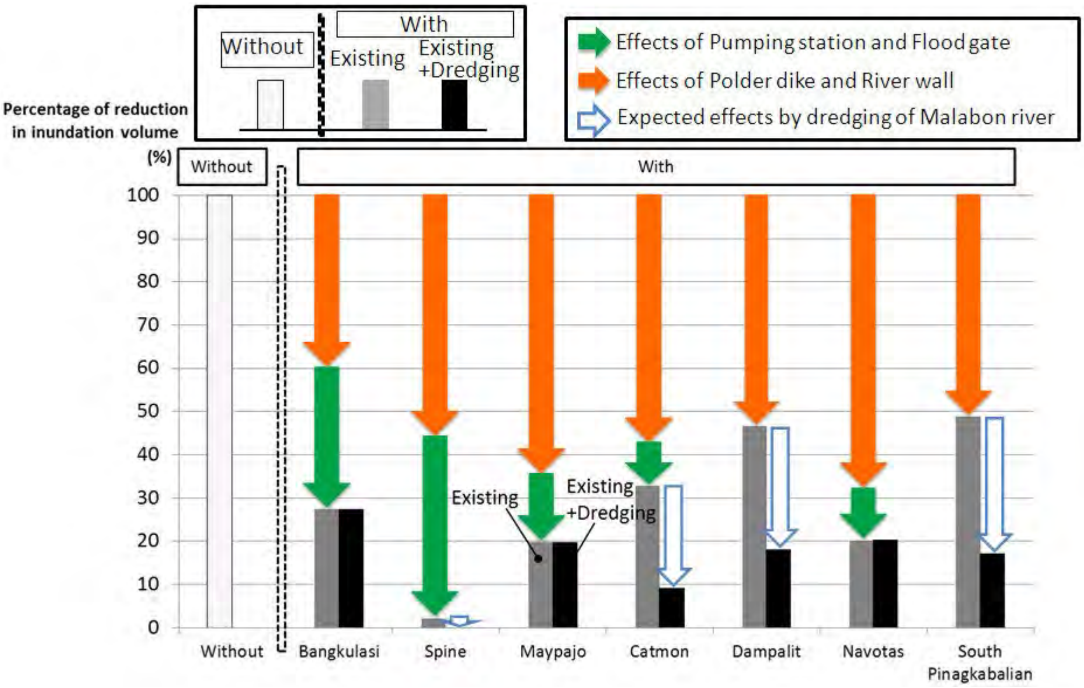
The above phenomena and the effectiveness of the Project are illustrated in Figure 4.2.16. This figure is a schematic one, but it can show the general picture, as explained above about what happened in the 2012 monsoon (Habagat).

For each sub-drainage area this figure shows the ratio (%) of inundation volume for the “with” condition to that for the “without” condition. Also in the figure, the extent of such reduction rate is shown by arrow marks.

Different from the effectiveness for 2009 typhoon “Ondoy”, the polder dike and raising of the river wall are effective in all sub-drainage areas especially because the raising of the river wall of Malabon river was completed before the 2012 monsoon (Habagat) so that the channel capacity increased from 100 m^3/s to 350m^3/s. Because of this, the overflow volume from the Malabon river was reduced.

For Bangkulasi, Spine and Maypajo sub-drainage areas, the pumps can reduce the inundation volume by 20-30 % compared with the “without” conditions. For Catmon, Dampalit, Navotas and South Pinagkabalian sub-drainage areas, the reduction by the pumps is only 10 % or less. Especially in South Pinagkabalian and Dampalit, there is no effect from the pumps. Even though there is a pumping station in Catmon, the reduction rate is small because of the overflow volume from the Malabon river.

This figure also shows the effectiveness of dredging of the Malabon river. By improvement of the Malabon river, the overflow from the river can be eliminated, so that Bangkulasi, Spine and Maypajo sub-drainage areas could become free from flooding. For Catmon, Dampalit and South Pinagkabalian sub-drainage areas, the reduction due to dredging is as large as 20 to 30 % or so.



Source: JICA Study Team

Figure 4.2.16 Effectiveness of the KAMANAVA Project during the 2012 monsoon (Habagat)

(3) Detailed Analysis on Inland Flooding

In terms of drainage improvement in the KAMANAVA Project, it can be understood that the pumping stations and flood gates in the sub-drainage areas confined by the flood control facilities that protect against high tide and river flood are also expected to function against inland flood. In this Study, the following cases are assumed for with / without conditions.

Table 4.2.9 Definition of With and Without Conditions for Inland Flood

Case	Inland Flood
With condition	Pump stations and drainage channels are available in the sub-drainage area confined by polder dike and river wall with flood gates
Without condition	No Pump stations or drainage channels in the sub-drainage area confined by polder dike and river wall with flood gates (hypothetical conditions for the analysis)

Source: JICA Study Team

In KAMANAVA Project, flood gates and pumping stations were constructed as explained in Chapter 2.

The inland flood calculations were made as explained below. From the results of the effectiveness of the Project, the with/without conditions in terms of the inundation water level and time for inundation water level to reach to serious level were as follows,

Table 4.2.10 Calculation Results (Difference of Inundation Water Level and Time for Inundation Water Level to Reach to Serious Level) with/without Pumping Stations

Sub-drainage Area	Difference of Inundation Water Level with/without Pumping Stations	Difference of Time for Inundation Water Level to Reach Serious Level with/without Pumping Stations	Reference
Bangkulasi	Between 2.0 m to 2.2 m	0 hour	Figure 4.2.19
Spine	2.5 m	1.5 hours	Figure 4.2.20
Catmon	1.5 m	23 hours	Figure 4.2.21

Source: JICA Study Team

1) Inland Flood Calculation

In order to understand the inland flood situation in each drainage area, inland waters calculation, the water level in each basin from the relationship of emissions of the pump and the total amount of rain that fell - from flooding calculation using storage amount (H-V curve) was carried out for checking the effect of reducing pump.

a) Calculation method

Inland water level is calculated based on the total amount of rainfall, total amount of pump, and H-V table of each drainage area, as follows;

$WL_{Navota}s > WL_{Estero}$

$V = \Sigma R - \Sigma Qpump$

$WL_{Estero} =$ Conversion from the volume by H-V table

$WL_{Navotas} \leqq WL_{Ester}o$

$WL_{Estero} = WL_{Navotas}$

※ WL_{Estero} : Water Level of inland side

※ $WL_{Navotas}$: Water Level of river side

b) Considered flood

The calculation was conducted for 2012: Large scale flood.

Table 4.2.11 Probable Rainfall Intensity

(Gumbel-Chow Method)

Year	Rainfall (mm/hr)						Rainfall (mm/day)	
	5 min.	10 min.	20 min.	30 min.	60 min.	120 min.	1 day	2 day
2	147.4	118.0	93.6	77.7	53.3	38.8	147.2	105.0
3	166.6	133.3	105.7	88.2	60.4	44.2	177.2	129.8
5	187.9	150.3	119.3	100.0	68.4	50.3	210.6	157.4
8	206.2	165.0	130.9	110.1	75.3	55.5	239.3	181.1
10	214.7	171.8	136.3	114.8	78.4	57.9	252.5	192.1
20	240.3	192.3	152.6	129.0	88.1	65.1	292.7	225.4
30	255.1	204.2	162.0	137.1	93.6	69.3	315.9	244.5
40	265.5	212.5	168.6	142.9	97.5	72.3	332.2	258.0
50	273.6	219.0	173.8	147.3	100.5	74.6	344.8	268.4
60	280.1	224.2	177.9	150.9	103.0	76.4	355.1	276.9
80	290.5	232.5	184.5	156.6	106.8	79.4	371.3	290.3
100	298.5	238.9	189.6	161.1	109.8	81.6	383.8	300.7
150	313.0	250.5	198.9	169.1	115.3	85.8	406.6	319.5
200	323.3	258.8	205.4	174.8	119.1	88.7	422.7	332.9
500	356.0	285.0	226.2	192.9	131.4	98.0	474.0	375.3

Source: Sectoral Report-C Hydrological Study 2001

2) Calculation Conditions

a) Inland waters calculation condition

The relationship between the water level and reservoir volume (H-V) is set using LIDAR data. Distribution and difference of ground elevation from the pump start water level of each basin are shown in Figure 4.2.17 and Figure 4.2.18.

b) Runoff calculation conditions

- Rainfall data : Port area (PAGASA)

- Runoff Coefficient (f) : f = 1 (Assuming that the total amount of rainfall is stored)

c) Pump capacity and operation

Pump capacity and operation is shown in the table below.

Table 4.2.12 Assumed Pump Operation

Sub-Drainage Area	Area (ha)	Pumping Capacity (m^3/s)	Starting Operation WL (DPWH Datum, m)	Stopping Operation WL (DPWH Datum, m)
Maypajo	241.2	6.6	11.3	10.9
Spine	173.1	13.0	11.0	10.0
Catmon	355.5	10.5	10.7	10.3
Bangkulasi	75.4	4.4	11.1	9.7

※Plan : Starting WL 10.5m Stopping WL 9.5m

Source: JICA Study Team

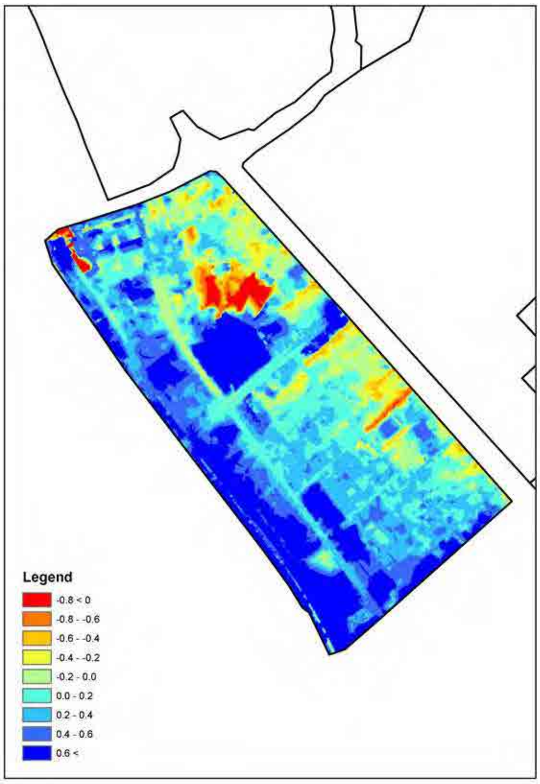
d) Lowest ground level

The lowest ground elevation of each sub-drainage area according to LIDAR data is shown in the table below. The values are between EL+10.0 and +10.5m (DPWH Datum). Compared with the Detailed Design parameters, they are approximately 50 cm lower.

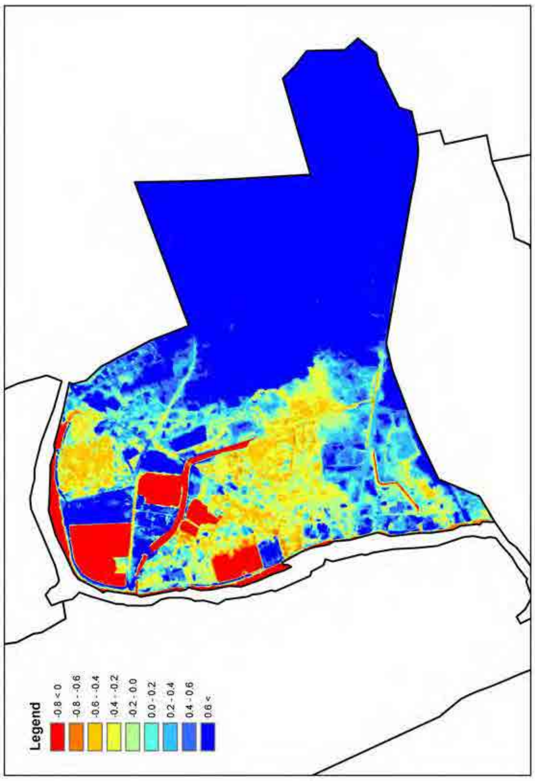
Table 4.2.13 Lowest Ground Elevation of Sub-drainage Area

Sub-Drainage Area	Area (ha)	Lowest Ground Level (DPWH Datum, m)	
		DD in 2001	LIDAR
Maypajo	241.2	11.1	10.5
Spine	173.1	11.0	10.2
Catmon	355.5	10.3	10.0
Bangkulasi	75.4	11.2	10.3
Dampalit	233.1	10.8	-
South Pinagkalian	254.6	10.8	-
North Nabotas	417.6	10.4	-

Source: JICA Study Team



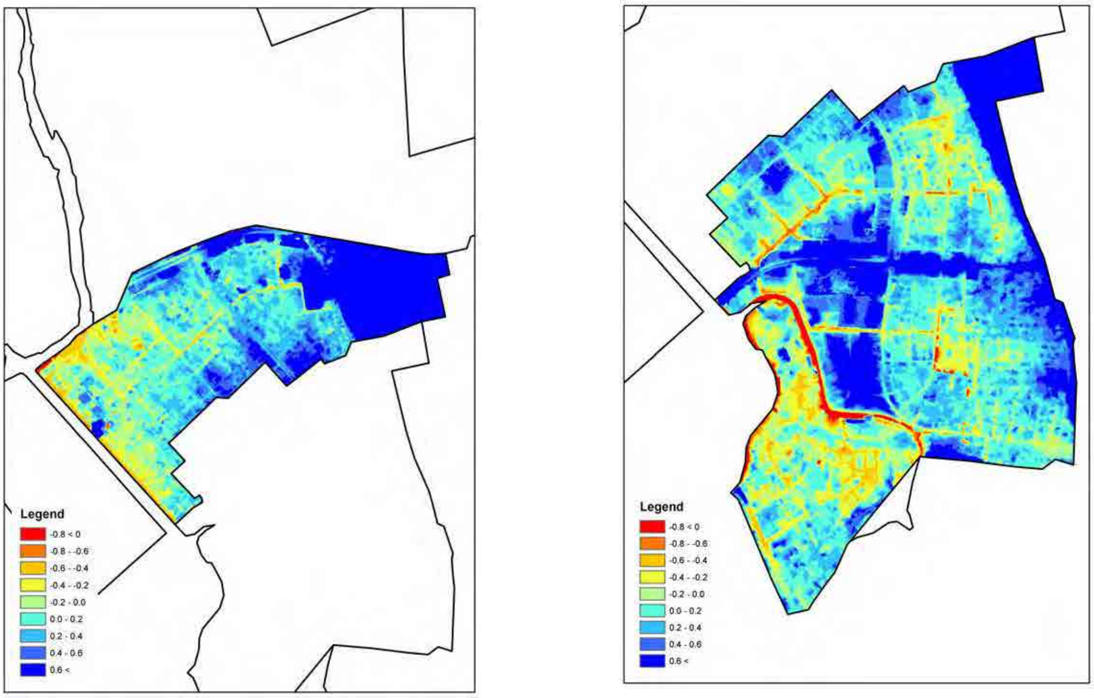
Elevation in meters based on pump operation starting WL EL11.1m (DPWH Datum) of Bangkulasi Pumping station



Elevation in meters based on pump operation starting WL EL10.7m (DPWH Datum) of Catmon Pumping station

Source: JICA Study Team

Figure 4.2.17 Distribution of Low Elevation Areas in Bangkulasi and Catmon Sub-drainage Areas



Elevation in meters based on pump operation starting WL EL11.0m (DPWH Datum) of Spine Pumping station

Elevation in meters based on pump operation starting WL EL11.3m (DPWH Datum) of Maypajo Pumping station

Source: JICA Study Team

Figure 4.2.18 Distribution of Low Elevation Areas in Spine and Maypajo Sub-drainage Areas

3) Result of 2012 Flood

Inland flood calculations were carried out to understand the operation rules for planning and operation of the current rules and the impact of differences in the operational rules. As case studies, the calculations were done for Bangkulasi, Spine and Catmon sub-drainage areas because the gate and pump operation data during the flood were collected.

a) Bangkulasi Drainage area

From the result of the inland flood simulation, the following observations were made.

As to the Detailed Design, the operation rule was set to reduce flood damage up to the target under the pump capacity.

After Aug. 3, 2012, only one pump was operated as the rainfall was getting heavier, however, it can be regarded as possible to maintain the allowable depth of 20 cm if 2 pumps were operated.

On July 31 and Aug. 2, 2012, the inland water level rose even though there was no rainfall in the area. From this fact, it is assumed that, underground water and sewage or outside water may have produced the rise.

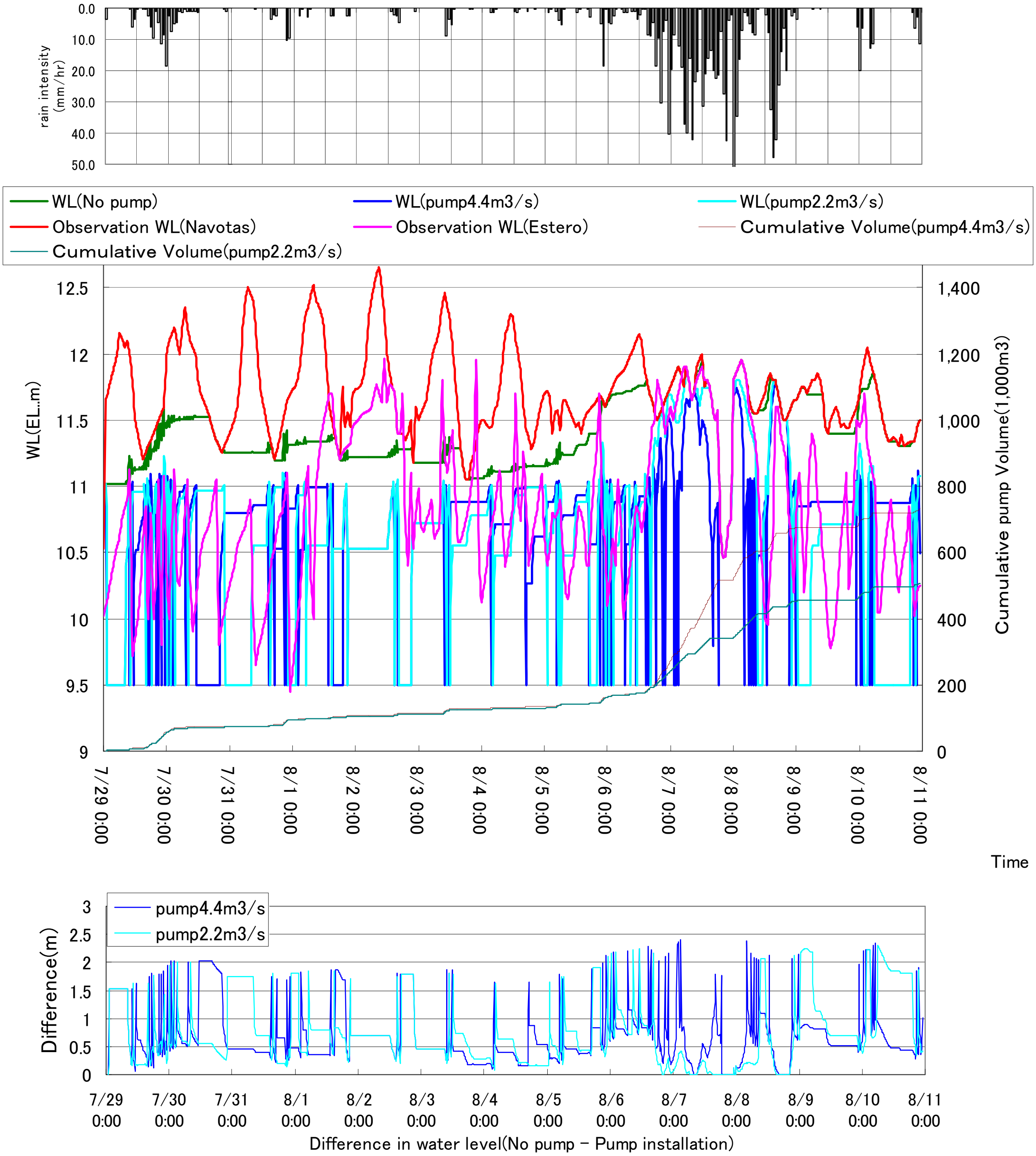
Therefore in the August 2012 flood in Bangkulasi drainage area, the pump capacity of Bangkulasi PS was sufficient, the current operation procedure is determined to be valid.

Figure 4.2.19 shows the simulation result of inland water level and pump operation from July 29 to Aug. 11, 2012.

The pump operation starts at 11.1 m (DPWH Datum).

The line of "WL (No Pump)" shows the estimated water level if no pumps are operated. In July 30, if there was no pump in this area, the water level would rise to 11.5m (DPWH Datum). But if a pump with 2.2 m^3/s capacity is operated, the maximum water level is 11.0 m (DPWH Datum) only on July 30, 2012. The 2.2 m^3/s is 50 % of the full capacity in Bangkulasi PS, so if 100 % capacity (4.4 m^3/s) is operated, the water level would be reduced more.

Also if no pump is operated, the water level would reach 11.75 m (DPWH Datum) on August 6, but if a pump of 2.2 m^3/s capacity is operated, the maximum water level is only 11.0 m (DPWH Datum) on August 6, 2012.



Source: JICA Study Team

Figure 4.2.19 Inland Flood Simulation in Bangkulasi Sub-drainage Area in Aug. 2012

b) Spine Drainage area

From the result of the inland flood simulation, the following observations were made.

Water level at lowest ground elevation is +0.2 m or more during the flood, therefore, the pump capacity is inadequate.

It is anticipated that the increase of the water level was caused by water entry from other areas.

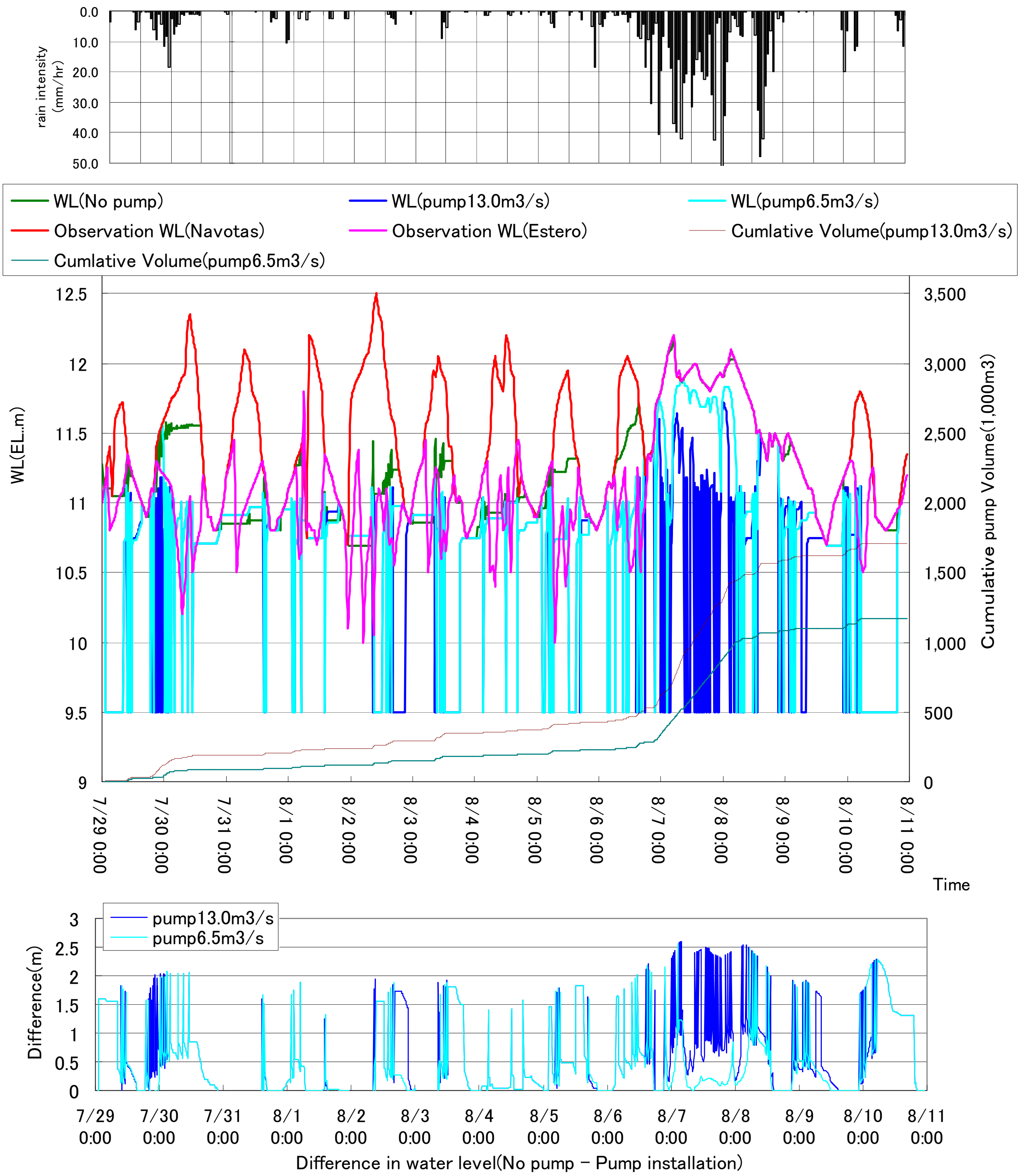
In actual operation the gates were opened during the flood, but if there was no water entry from the other basin or overflow from dike, there is a possibility that closing the gates and operating pumps could reduce flood damage in the simulation .

The Figure 4.2.20 shows the simulation result of the inland water level and pump operation from July 29 to Aug. 11, 2012.

The pump operation starts at 11.0 m (DPWH Datum).

The "WL (No Pump)" line shows the estimated water level if no pumps are operated. In July 30, if there is no pump in this area, the water level would rise to 11.55 m (DPWH Datum). But if pump of 6.5 m^3/s capacity is operated, the maximum water level is only 11.0 m (DPWH Datum) on July 30, 2012. The 6.5 m^3/s is 50 % of the full capacity in Spine PS, so if 100 % capacity (13.0 m3/s) is operated, the water level would be reduced more.

Also if no pump is operated, the water level would reach 11.75 m (DPWH Datum) on August 6, but if a pump of 6.5 m^3/s capacity is operated, the maximum water level is only 11.0 m (DPWH Datum) on August 6, 2012.



Source: JICA Study Team

Figure 4.2.20 Inland Flood Simulation in Spine Sub-drainage Area in Aug. 2012

c) Catmon Drainage area

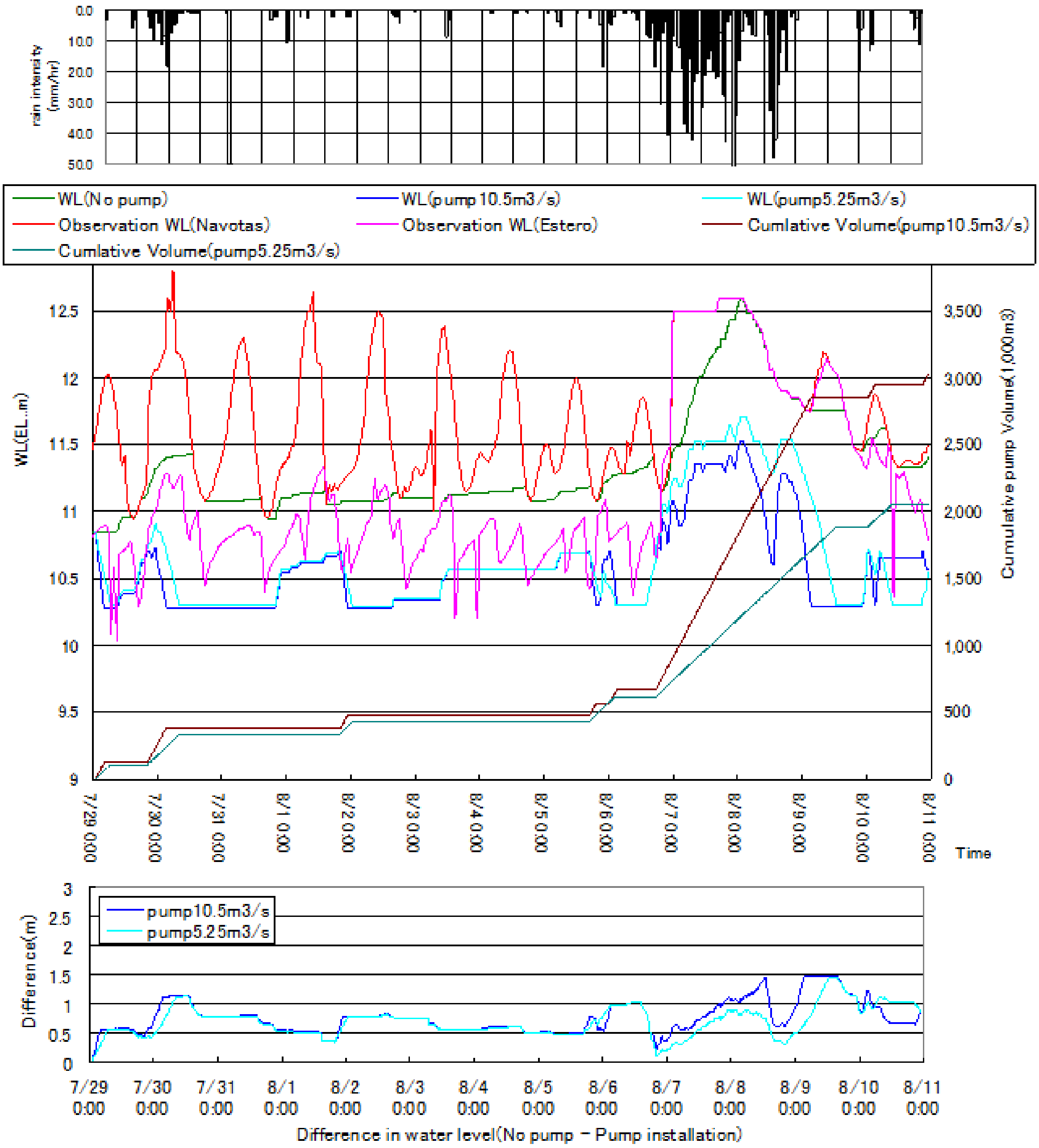
From the result of the inland flood simulation, the following observations were made.

Water level at lowest ground elevation is +0.2 m or more during the flood, therefore, pump capacity is inadequate.

In actual operation the gates were opened during the flood, but if there was no water entry from the other basin or overflow from the dike, there is a possibility that closing the gates and operating the pumps could reduce flood damage in the simulation.

In Figure 4.2.21, the "WL (No Pump)" line shows the estimated water level if no pumps are operated. In July 30, if there is no pump in this area, the water level would rise to 11.4 m (DPWH Datum). But if a pump of 5.25 m^3/s is operated, the maximum water level is only 10.3 m (DPWH Datum) on July 30, 2012. The 5.25 m^3/s is 50 % of the full capacity in Catmon PS, so if 100 % capacity (10.5 m^3/s) is operated, the water level would be reduced more.

Also if no pump is operated, the water level would reach 12.5 m (DPWH Datum) on August 8, but if the pump of 5.25 m^3/s capacity is operated, the maximum water level is only 11.7 m (DPWH Datum) on August 8, 2012.



Source: JICA Study Team

Figure 4.2.21 Inland Flood Simulation in Catmon Sub-drainage Area in Aug. 2012

Table 4.2.14 Simulation of Flood Water Volume Balance for 2012 Monsoon (Habagat)

Without

Name of Subdrainage Area	Area (ha)	Pump (m3/s)	Rainfall (m3)	Water Entry from outside (m3)		Water Entry from river (m3)		Total(m3)	Pumping Up (m3)	Inundation Volume (m3)	Inundation Depth (m)
			①	②		③		④=①+②+③	⑤	⑥=④−⑤	
Bangkulasi	75.4	0.0	556,075	0		1,213,305	Overflow from Marala R.	1,769,380	0	1,769,380	2.35
Spine	173.1	0.0	1,276,613	0		2,785,451	Overflow from Malabon, R. Marala R.	4,062,064	0	4,062,064	2.35
Maypajo	241.2	0.0	1,778,850	0		3,881,287		5,660,137	0	5,660,137	2.35
Catmon	355.5	0.0	2,621,813	5,500,000	From Tullahan	5,720,554	Overflow from Malabon R.	13,842,367	0	13,842,367	3.89
Dampalit	233.1	0.0	1,719,113	4,000,000	From Overflow of Polder Dike	3,750,946		9,470,058	0	9,470,058	4.06
Navotas	475.5	0.0	3,506,813	0		7,651,543		11,158,355	0	11,158,355	2.35
South Pinagkabalian	254.6	0.0	1,877,675	5,000,000	From Tullahan	4,096,914	Overflow from Malabon R.	10,974,589	0	10,974,589	4.31
	1808.4									56,936,950	3.15

With (Existing)

Name of Subdrainage Area	Area (ha)	Pump (m3/s)	Rainfall (m3)	Water Entry from outside (m3)		Water Entry from river (m3)		Total(m3)	Pumping Up (m3)	Inundation Volume (m3)	Inundation Depth (m)
			①	②		③		④=①+②+③	⑤	⑥=④−⑤	
Bangkulasi	75.4	2.2	556,075	0		500,000	Overflow from Marala R.	1,056,075	570,240	485,835	0.64
Spine	173.1	6.5	1,276,613	200,000	From Catmon	300,000	Overflow from Marala R.	1,776,613	1,684,800	91,813	0.05
Maypajo	241.2	3.3	1,778,850	0		200,000	Overflow from Marala R.	1,978,850	855,360	1,123,490	0.47
Catmon	355.5	5.3	2,621,813	400,000	From Tullahan	2,900,000	Overflow from Malabon R.	5,921,813	1,360,800	4,561,013	1.28
Dampalit	233.1	0.0	1,719,113	2,700,000	From Overflow of Polder Dike	0		4,419,113	0	4,419,113	1.90
Navotas	475.5	4.8	3,506,813	0		0		3,506,813	1,244,160	2,262,653	0.48
South Pinagkabalian	254.6	0.0	1,877,675	600,000	From Tullahan	2,900,000	Overflow from Malabon R.	5,377,675	0	5,377,675	2.11
	1808.4									18,321,590	1.01

With (Existing+Dredging)

Name of Subdrainage Area	Area (ha)	Pump (m3/s)	Rainfall (m3)	Water Entry from outside (m3)		Water Entry from river (m3)		Total(m3)	Pumping Up (m3)	Inundation Volume (m3)	Inundation Depth (m)
			①	②		③		④=①+②+③	⑤	⑥=④−⑤	
Bangkulasi	75.4	2.2	556,075	0		500,000	Overflow from Marala R.	1,056,075	570,240	485,835	0.64
Spine	173.1	6.5	1,276,613	0		300,000	Overflow from Malabon, R. Marala R.	1,576,613	1,684,800	0	0.00
Maypajo	241.2	3.3	1,778,850	0		200,000		1,978,850	855,360	1,123,490	0.47
Catmon	355.5	5.3	2,621,813	0		0		2,621,813	1,360,800	1,261,013	0.35
Dampalit	233.1	0.0	1,719,113	0		0		1,719,113	0	1,719,113	0.74
Navotas	475.5	4.8	3,506,813	0		0		3,506,813	1,244,160	2,262,653	0.48
South Pinagkabalian	254.6	0.0	1,877,675	0		0		1,877,675	0	1,877,675	0.74
	1808.4									8,729,778	0.48

Source: JICA Study Team

4.3 Effectiveness of the Project from Social Aspect

The Social Survey in the SAPS Study, which was conducted in November 2013, revealed that the people in the Project Area have strong willingness to participate to improve flood management. This enlightenment for the people can be regarded as the effectiveness of the KAMANAVA Project.

One hundred and twenty or 76 percent of the respondents were willing to participate in improving the flood control management in their area. The Table below shows the type of participation that they were willing to do.

Table 4.3.1 Type of Participation that they were willing to do

City/ Barangay	Willingness to Participate to Improve Flood Management				
	No or No Answer	Yes	Implementation of Household Waste Segregation	Consultations on Planning, Monitoring &Evaluation	Community Cleaning
Malabon City	**27**	**62**	**32**	**42**	**30**
Catmon	1	14	6	12	4
Dampalit	5	4	1	4	1
Hulong Duhat	3	6	1	4	0
Maysilo	4	10	10	14	13
Tanong	7	14	3	7	2
Tinajeros	0	9	9	0	9
Tonsuya	7	5	2	1	1
Navotas City	**10**	**58**	**26**	**30**	**32**
Banculasi	0	14	13	13	13
North Bay Boulevard-North	7	16	2	4	10
North Bay Boulevard-South	1	14	4	7	1
San Jose	1	6	4	5	6
Tangos	1	8	3	1	2
Grand Total	**37**	**120**	**58**	**72**	**62**
Rank			**3**	**1**	**2**

Source: JICA Study Team, Social/Institutional Survey, November 2013

The following is the list of Opinions/Comments on Improving the Flood Control and Drainage in KAMANAVA based on the Social Survey in this SAPS Study.

- Construction of/ Continue the Megadike and Flood Control Projects
- Improvement of and well -maintained pumping station to prevent flooding
- Educate people on how to control flood etc.
- Regular cleaning of Clogged Canals/Drainage systems
- Dredging of river section and river mouth
- Effective planning, implementation, and Monitoring & Evaluation of flood control projects
- Immediate action and proper budget - government
- Strict Implementation of Waste Segregation and Proper Disposal
- Community Cleaning of Clogged Drains
- Construction of Floodgates
- Completion of Flood control Projects

It is understood that because of the KAMANAVA Project implementation so far, the people in the Project area became seriously aware of flood control and drainage improvement as a part of their lives.

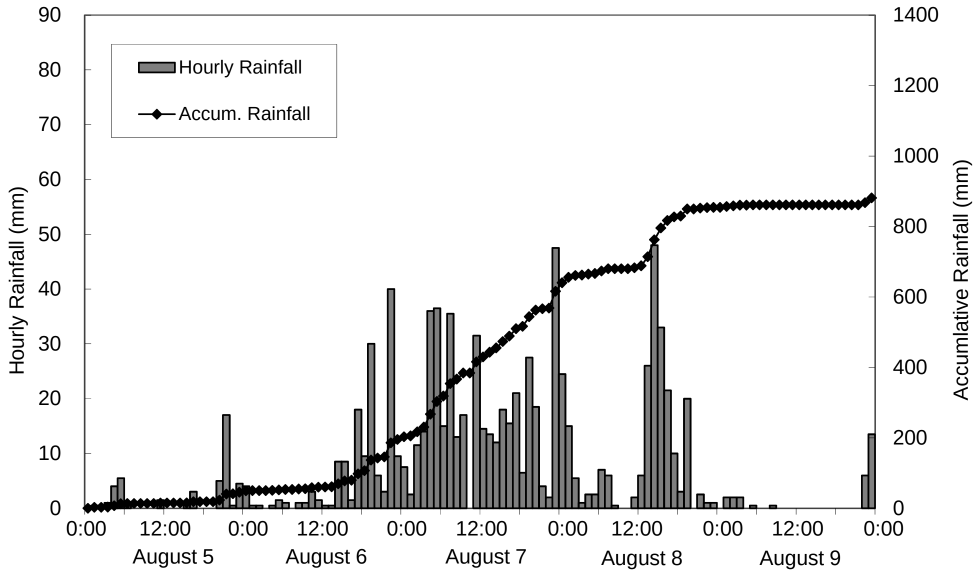
5. Detailed Analysis for 2012 Monsoon (Habagat)

5.1 Introduction

The technical background of the flood during the 2012 August Monsoon (Habagat), was verified by confirming and analyzing the gaps between assumptions in the planning phase and the present condition. Data/information for this analysis was effectively collected utilizing the results of relevant existing studies.

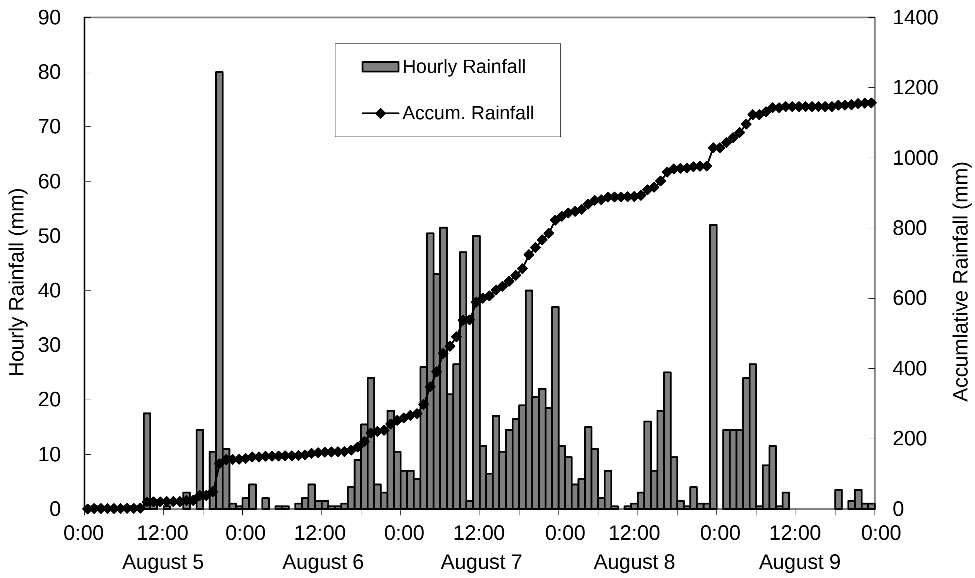
5.2 Rainfall

It can be pointed out that the total rainfall during the 2012 Monsoon (Habagat) in and around the Project area was extremely high according to the statistics shown below.



Source: JICA Study Team

Figure 5.2.1 Rainfall Condition in Port Area Station in 2012 Habagat



Source: JICA Study Team

Figure 5.2.2 Rainfall Condition in La Mesa Dam Station in 2012 Habagat

According to the above data, maximum hourly rainfall and maximum two-day rainfall (maximum 48 hours rainfall) are summarized in the table below.

Table 5.2.1 Maximum Two day and Hourly Rainfall in 2012 Habagat

Flood Event	Station	Maximum Two day (48 hour) rainfall (mm/2day)	Maximum hourly rainfall (mm/hour)
2012 Habagat	Port Area	737.5	48.0
	La Mesa Dam station	792.0	80.0

Source: JICA Study Team

In the detailed design stage in 2001, probable rainfall intensity was analyzed using the Port Area rainfall intensity data as shown in the table below. Using these data, two days rainfall of 737.5 mm in 2012 Habagat in the Port Area station was assessed to correspond to almost a 500-year return period.

The maximum hourly rainfall in the Port Area was 48 mm/hr and the 80 mm/hour at La Mesa Dam. It is understood that the rainfall intensity within the Project areas was equal to or less than a 10 years return period.

Consequently, it can be said that one of the key factors of 2012 Habagat was long term rainfall, which is extremely beyond the design scale rainfall with a 30 year return period for river flood and with a 10 year return period for inland flood.

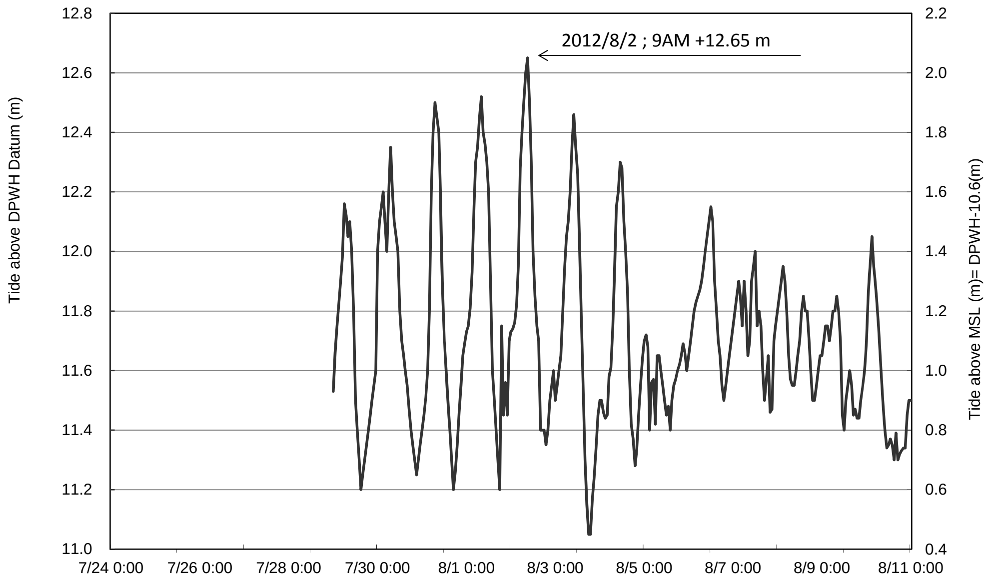
Table 5.2.2 Result of Probability Analysis on Rainfall in Detailed Design Stage in 2001

	Probable Rainfall with Various Flood Return Periods							
	500 yr	100yr	50 yr	**30 yr**	20 yr	**10 yr**	5 yr	2 yr
Two-day rainfall (mm/2-day)	750.6	601.4	536.8	**489.0**	450.8	**384.2**	314.8	210.0
One-hour rainfall (mm/hr.)	131.4	109.8	100.5	**93.6**	88.1	**78.4**	68.4	53.3

Source: JICA Study Team

5.3 Tide and Storm Surge

At Bangkulasi Pumping Station which is located near the river mouth of the Malabon river, the maximum tide level of 12.65 m (DPWH Datum) was observed on August 2, at 9AM, 2012. The maximum tide level assumed in the detailed design was 12.10 m (DPWH Datum). The Figure below shows the tide level at the Bangkulasi Pumping Station during July 28 to August 10, 2012.



Source: JICA Study Team

Figure 5.3.1 Observed Tide at Bangkulasi PS in 2012 Habagat

According to the information collected from PAGASA, maximum 6-hour wind speeds at Port Area station were recorded as 11.0 m/s on July 29 during 2012 Habagat. However, during the high tide period such as August 2, there is no supporting data / record which can explain the extreme high tide.

Generally a historical (extreme) high tide happens related with other meteorological factors such as wind and low pressure. In this line, it is recognized that the recorded high tide (+12.65m (DPWH Datum)) was actual, but other meteorological factors such as storm surge have not been confirmed.

5.4 River Water Level

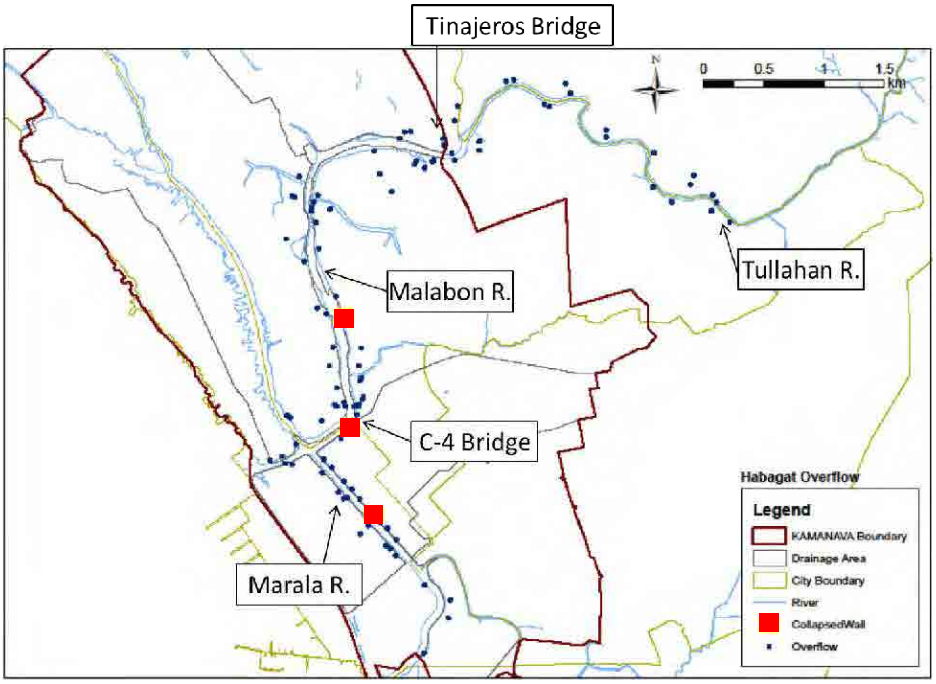
Figure 5.4.1 (Photo) shows a picture of the high tide condition taken on August 2, 2012 by Malabon City Engineer. The location is the right bank downstream of C-4 Bridge, whose distance from the river mouth is 1 km. The top elevation of the submerged river wall was 12.60 m (DPWH Datum). It is understood that the highest tide level exceeded the 12.60 m (DPWH Datum).

Figure 5.4.1 High Tide on August 2, 2012 at C-4 Bridge of Malabon River Right Bank

Figure 5.4.2 High Tide on August 2, 2012 at C-4 Bridge of Malabon River Left Bank

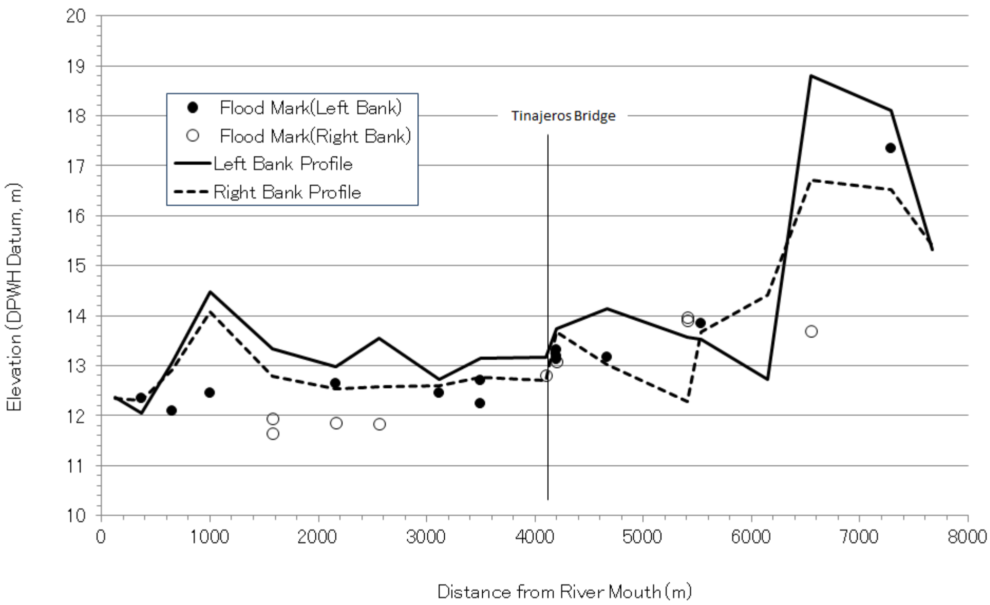
The Figure below shows the location in which local people informed the JICA Study Team that the flood water came from the river according to the Flood Mark survey. It is understood that the overflow from the Marala river as well as the Malabon river stretch took place.

Also it should be pointed out that the Tullahan river, which is upstream of the Tinajeros Bridge as shown in the Figure below, was flooded during the 2012 monsoon (Habagat).



Source: JICA Study Team

Figure 5.4.3 Locations at which People Reported that River Water Overflowed and of Collapsed River Walls during 2012 Monsoon (Habagat)



Source: JICA Study Team

Figure 5.4.4 Flood Marks along the Tullahan-Tenejeros-Malabon River during 2012 Monsoon (Habagat)

Figure 5.4.4 is the longitudinal profile of the flood mark elevations along the Tullahan-Tenejeros-Malabon River based on the topographic survey in this SAPS Study[1]. The design top (crown) level of the river wall at Tinajeros Bridge is 13.2 m (DPWH Datum) (DFL=12.4m (DPWH Datum)). The

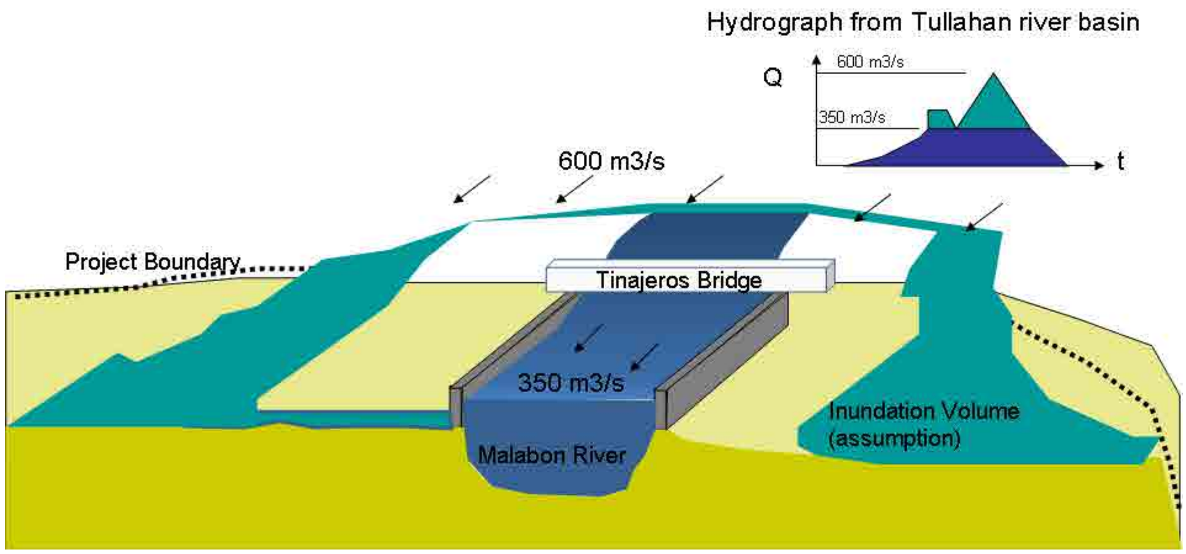
[1] This profile is datum GM-3FA, which is not the same bench mark as used in the Detailed Design Stage.

flood water level was beyond the dike at this bridge.

The flooding at the Tullahan River section arrived at the KAMANAVA project area boundary, the Tinajeros Bridge on the Malabon river as illustrated in overflow in 2012 Habagat as shown in Figure 5.4.5.

The flood discharge which could enter the Malabon river channel is limited to the channel flow capacity. The discharge over the channel capacity could drain out of the Project area as well as the overland flow in the Project area.

The flood water entered the sub-drainage area. In the KAMANAVA Project design, such flood water entering in the sub-drainage area, if it is equal to or less than design scale, was not assumed.



Source: JICA Study Team

Figure 5.4.5 Flooding Situation at KAMANAVA Project Boundary

5.5 Land Subsidence

In the Detailed Design, the Main Design Report Page 61 says that regarding the gate structure design, the expected (land) subsidence of 0.20 m should be added to the said freeboard corresponding with the design discharge. It is understood that it was calculated based on a 0.65 cm subsidence per year for 30 years.

According to KAMANAVA PMO, DPWH does not have any information on the land subsidence in the Project area.

As a reference, NAMRIA published TECHNICAL REPORT GGD-001, First Order Geodetic Leveling: Determining Elevation Changes in Metro Manila in 2011. First Order Geodetic Leveling in the Metro Manila Project was conducted to check for elevation changes to previously known benchmarks and to establish new ones as needed along the way. A tidal benchmark in the Port Area, Manila (TBM-66) was used as reference in the survey upon examination of the changes in differences in elevation (D.E.) of the old benchmarks and after considering the lithology of the region. Results indicated that there were considerable changes in elevation (subsidence) to previously known benchmarks in Navotas, Caloocan, Tondo, Binondo, Sampaloc (Manila), Malabon and Pateros.

According to this NAMRIA report and the JICA Study Team interview with NAMRIA, the maximum subsidence in the Project area is 1.2 m in 40 years in Navotas city as shown in Chapter 3. While this 1.2 m in Navotas area is reported, other points also indicate 0.3 m to 0.9 m subsidence in 40 years. This means that the average land subsidence is 1.5 cm / year (= (0.3+0.9)/40).

Table 5.5.1 Comparison of Land Subsidence Assumption

Design/Present	Description	Source
Assumption at the time of Detailed Design (2001)	Before 1965: 0 cm/year 1965 - 1979: 2.07 cm/year 1979 - 1990: 0.65 cm/year	Main Design Report P.6
2012 Monsoon (Habagat)	Land subsidence 1.2 m in Navotas area during 40 years (3 cm /year)	NAMRIA

Source: JICA Study Team

From the site reconnaissance by the JICA Study Team in the Project area, it is understood that the area has a tendency for land subsidence in general.

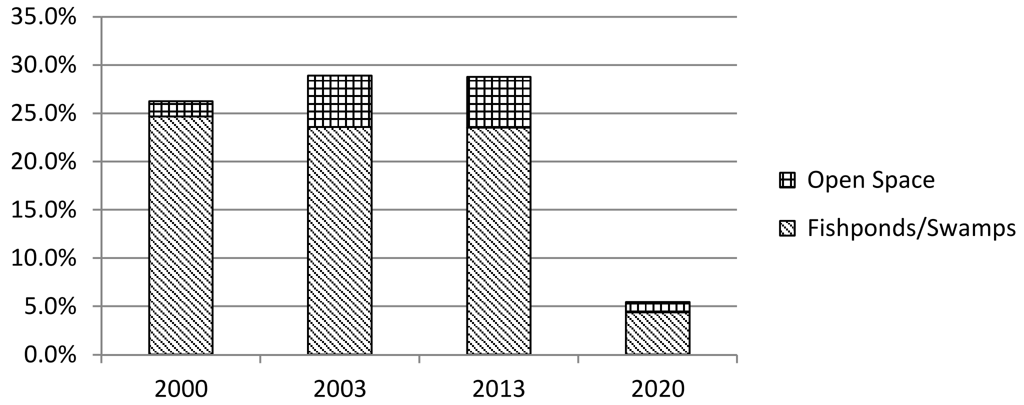
Therefore it is understood that the present tendency of land subsidence is beyond the assumption at the Detailed Design. And this could cause more negative impact to the 2012 monsoon (Habagat) flood situations such as

- Enlargement of low-lying areas (to have greater inundation depth)
- Settlement of dikes and other Project Structure in general (to provide less free board)
- Settlement of bridges (to reduce clearance)

5.6 Landuse

As shown in Chapter 3.3, there has been no significant change of land use between 2003 and 2013.

Figure 5.6.1 shows the ratio of fishponds/swamps and open space against the total area of seven sub-drainage basins. In 2003, the ratio of fish pond/swamps and open space to the total Project areas was 28.3 %. And the ratio in 2013 was 28.1 %. In the Detailed Design stage, the future land use of those categories in 2020 was only 5% of the total Project area.



Source: JICA Study Team

Figure 5.6.1 Comparison of Ratio of Fishponds/Swamps and Open Space against Total Area of Seven Sub-Drainage Basins

Regarding the gap between the land use plan as of 2020 as assumed at the Detailed Design stage and the present condition, it is pointed out that conversion from fishponds to residential/industrial area has not yet been realized. In the Projected Land Use in 2020, most of the fish pond will be converted to residential and industrial area. In terms of the degree of flood damage, the present land use tendency (fish ponds remain) would not cause a negative impact, rather technically speaking it has mitigated the flooding impact because such fish ponds and open space can store rainfall and flood water as natural retarding ponds.

At present, most of the fish ponds are located in Dampalit (Malabon city). This barangay has suffered from overflow incidents over the polder dike in 2012 monsoon (Habagat). It could be said that because of the fish pond land use, physical damage during the flood has been mitigated.

5.7 Progress of Construction Works

At the time of 2012 monsoon (Habagat), as shown in Table 5.7.1, the original KAMANAVA Project Plan was completed althouhg there were some adjustments due to the local conditions. All the adjustments were anticipated at the time of the Detailed Design and during the construction stage they were officially solved according to the Variation Order dated June 2006.

As shown in Chapter 2 the Northern Area of the Malabon river has only one pumping station, which is located at North Navotas Navigation Gate. If the deferred 2 pumping stations were constructed, the inland flooding in Dampalit and South Pinagkabalian sub-drainage areas would have been mitigated. However, the conversion of land use from fishpond to others (such as residential/industrial) should be the precondition for the efficient and effective operation of pumping stations in the Dampalit and South Pinagkabalian sub-drainage areas, hence the deferral of the 2 pumping stations. We should say that because at the time of the 2012 monsoon (Habagat) all the planned works of the Project were completed, there were no significant impacts regarding flood damage that were related to the construction progress.

Table 5.7.1 Main Civil Works of the Project

Work Item	Plan	As of August 2012
Northern Area of Malabon River		
Construction of Polder Dike	8.6 km	8.6 km
Raising of River Wall (Right Bank of Malabon River)	4.4 km	3.5 km
Construction of Navigation (Tide) Gate (Submersible Radial Type)	25 m (width) 9.0 m (draft)	25 m (width) 9.0 m (draft)
Construction of Independent Flood Gates	5 sites	5 sites
Construction of Pumping Station w/FG	2 sites (5.2 m^3/s and 5.3 m^3/s) Construction to be deferred.	Construction to be deferred.
Construction of Pumping Station w/o FG	1 site (13.0 m^3/s)	1 site (13.0 m^3/s)
Southern Area of Malabon River		
Raising of River Wall (Left Bank of Malabon River)	3.9 km	3.9 km
Raising of River Wall (Navotas and Marala Rivers)	4.1 km	3.2 km
Construction of Independent Flood Gates	1 site	1 site
Construction of Pumping Station w/ FG	4 sites (34.5 m^3/s in total) with construction of new retention pond=6.0 ha attached to Catmon PS	4 sites (34.5 m^3/s in total) with construction of new retention pond=6.0 ha attached to Catmon PS
Improvement of Existing Drainage Channels	6.4 km in total	5.6 km
Construction of New Drainage Channels	1.8 km	2.1 km

Source: Project Completion Report on KAMANAVA Area Flood Control and Drainage System Improvement Project, January 2013.

5.8 Progress of Related Projects by DPWH and LGUs

As shown in Chapter 2, the related projects by DPWH and LGUs to complement the KAMANAVA Project are the raising of Bangkulasi bridge, Tonsuya bridge, Lambingan bridge and Tinajeros bridge.

(1) Raising of Bridges

At the time of the 2012 monsoon (Habagat), those bridges remained in their original conditions.

The hydraulic analysis shows that the existing Lambingan bridge caused the upstream water level to rise by back water effect during the 2012 monsoon (Habagat). Because lack of clearance of the bridge trapped debris from the upstream, therefore, the flow capacity at the bridge section was decreased.

(2) Secondary and Tertiary Drainage Improvement

Even at present, both Malabon and Navotas Cities do not have large scale new drainage system improvement because of lack of funds. This situation does not allow the Project facilities such as pumping station to fully function.

(3) Solid Waste Management

The LGU’s efforts on solid waste management have been improved. In this line, during the 2012 flood, the Lambingan bridge trapped a great deal of garbage from upstream of Tullahan river watershed and caused flooding in upstream reaches due to its backwater effect according to Malabon city engineers.

The above situation is summarized in the table below.

Table 5.8.1 Summary of Status of Related Projects by DPWH and LGUs

Description	Planning (2000)	As of August 2012
Raising of Bridges by DPWH	Bangkulasi	Not raised yet
	Tonsuya	Not raised yet
	Lambingan	under construction
	Tenejeros	Not raised yet
Secondary & Tertiary Drainage by LGUs	Scope not quantified	Partially
Solid Waste Management by LGUs	Scope not quantified	On-going

Source: JICA Study Team

5.9 Gates and Pumping Stations

At the time of the 2012 monsoon (Habagat), the floodgates such as South Pinagkabalian, Muzon, Navotas, Longos, Kailugan and Pinagkabalian floodgates were operated and closed during the flood.

The North Navotas Navigation Gate was also operated and closed during the flood.

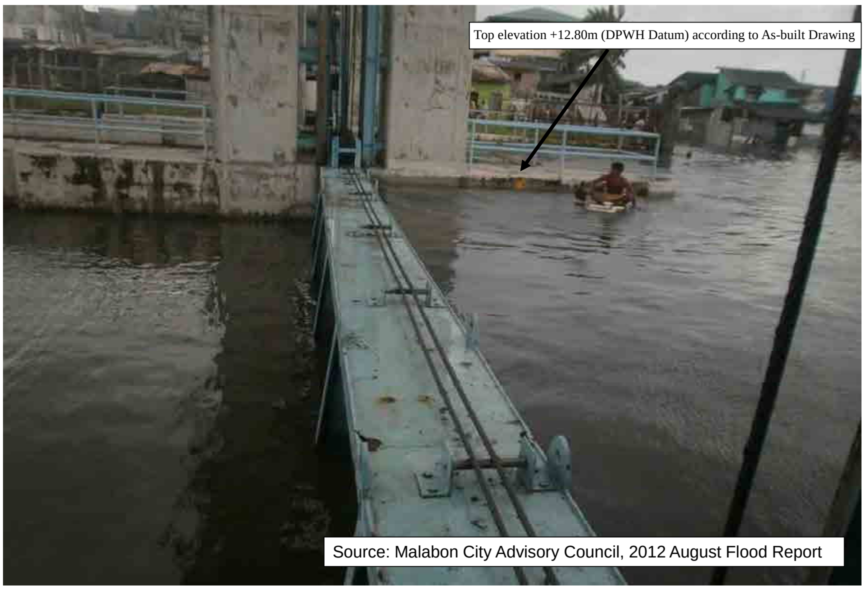


Figure 5.9.1 Navotas Floodgate in August 1, 2012

Regarding the starting elevation of the Pumping stations constructed in the KAMANAVA Project, all the 5 pumping stations had been starting at higher elevation than those proposed in the Detailed Design. In the Detailed Design, the starting elevation was 10.50 m (DPWH Datum). This actual pumping operation allowed more inundation in the sub-drainage areas than that was expected in the Detailed Design.

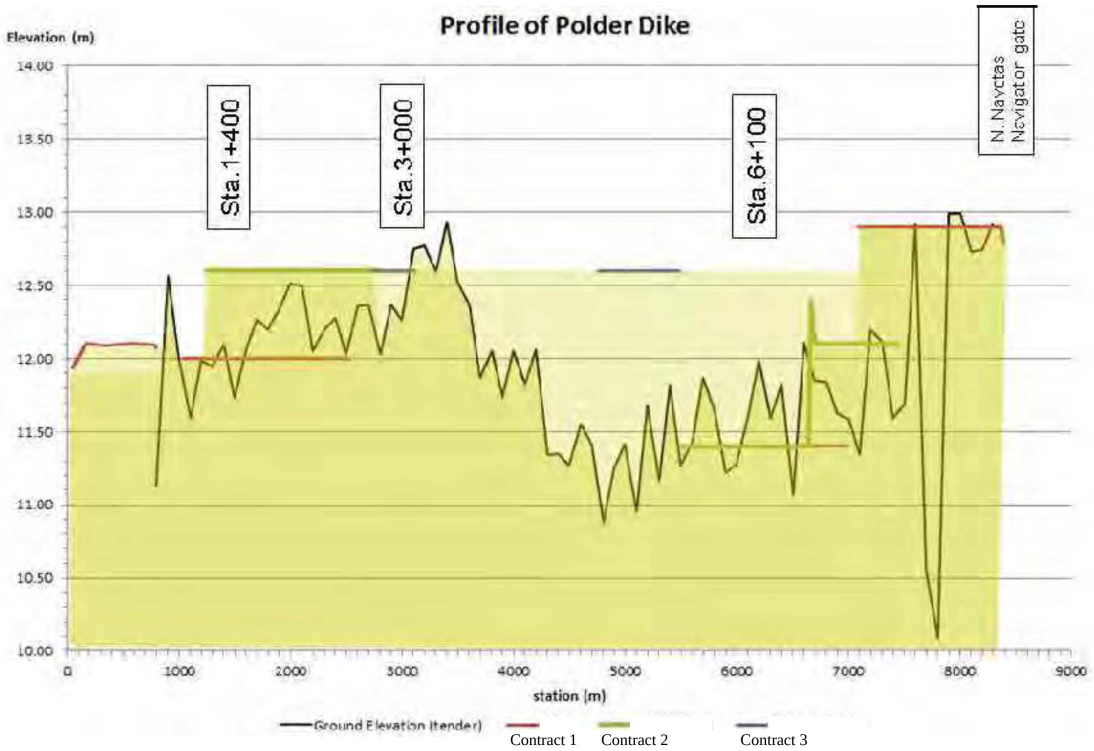
Also Catmon, Bangkulasi and Spine stations were not always operated using 100% of the pump capacity during the flood. It may be considered that there were some factors to disturb full functioning of the pump capacity, for example, clogging of secondary and tertiary drainage, mechanical problems (impeller mixed with garbage) of the pumps due to long term operation, and high water level in the river side. However, it can be confirmed that pump operation contributed to decrease inundation volume in the Project area and to delay the time when inundation water level reached serious level although the inundation might be decreased more if these pumps could be operated at 100 %.

5.10 Others

5.10.1 Flood Water inflow from outside of Project Area

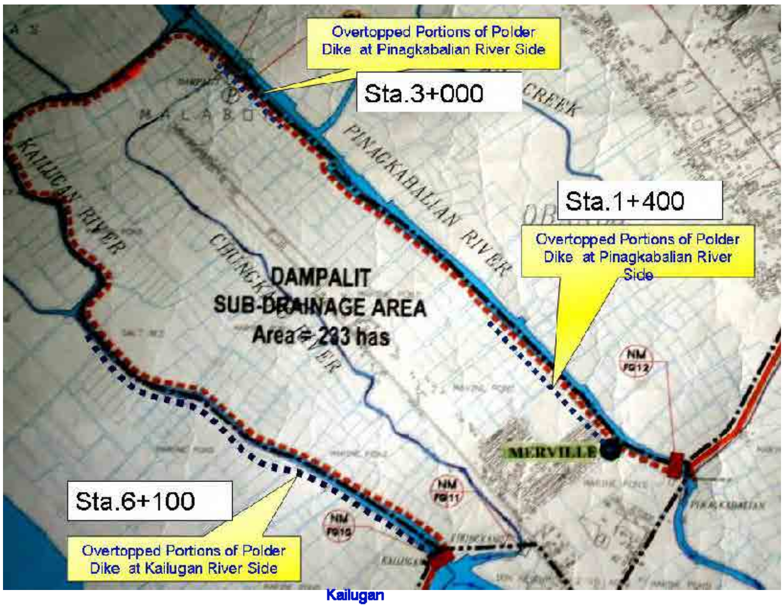
At the time of the 2012 monsoon (Habagat), the polder dike was completed as per design, however, as shown in Figure 5.10.1 and Figure 5.10.2, there were 3 sections of overflow from outside of the Project Area. The maximum tide level was +12.65 m (DPWH Datum) in the Bangkulasi Pumping Station, while the top elevation of the polder dike was +12.60 m (DPWH Datum). It is understood that a locally low portion due to dike settlement and erosion allowed the overflow.

Such overflow from outside of the project area was not considered in the KAMANAVA Project design, especially for the inland flood protection area. Therefore, the flooding extent in the project area was made worse.



Source: JICA Study Team

Figure 5.10.1 Profile of Polder Dike Section during 2012 Monsoon (Habagat)



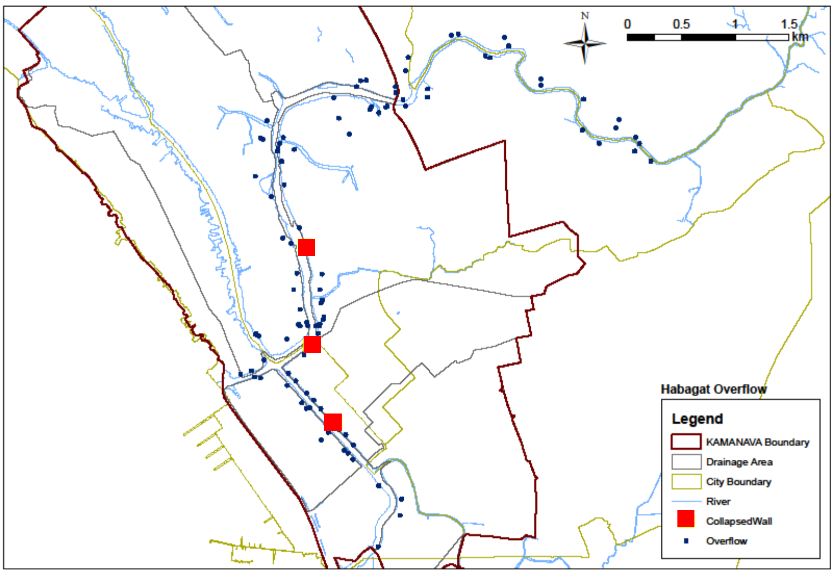
Source: Malabon City

Figure 5.10.2 Location Map of Overflow in Polder Section during 2012 monsoon (Habagat)

5.10.2 Collapsed Flood Wall and Leakage from River Wall

At the time of the 2012 monsoon (Habagat), the river wall was completed as per design, however, as shown in Figure 5.10.3 and Figure 5.10.4, there were 3 sections of collapsed river wall that resulted in overflow from the river side into the protected Area. The maximum tide level was +12.65 m (DPWH Datum) in the Bangkulasi Pumping Station, while the top elevation of the river wall was +12.60 m (DPWH Datum) along the Malabon and Marala rivers. It is understood that weak foundation of the river wall allowed the collapse.

Such overflow from the river side to the protected area was not considered in the KAMANAVA Project design, especially for the inland flood protection area. Therefore, the flooding extent in the project area was made worse.



Source: JICA Study Team

Figure 5.10.3 Locations at which People Reported that River Water Overflowed and of Collapsed River Walls during 2012 Monsoon (Habagat)

Figure 5.10.4 Photo of Collapsed River Wall at Left Bank of Marala River

5.11 Overall Evaluation

5.11.1 Analysis

Based on the above contributing factors, the flooding event caused by the 2012 monsoon (Habagat) after the completion of the KAMANAVA Project can be explained as follows.

Both the 2 day rainfall amount and the high tide level exceeded the design scale. The 2 day rainfall, which was evaluated as almost a 500 year return period produced the high peak discharge of 600 m^3/s in August 6, 2012 upstream of the Tinajeros Bridge, which came from the Tullahan river basin overflowing into the area due to shortage of flow capacity in the Tullahan river. While the design discharge for the Malabon river was 450 m^3/s, which is a 30 year return period, due to the fact of not dredging river bed of the Malabon river, the channel flow capacity was less than 450 m^3/s. It was estimated to actually be 350 m^3/s.

Consequently, the flood water which could not be accommodated in the Malabon river channel spread across the Project boundary line toward both sides of the Malabon river. This overland flow across the project boundary was not considered in the KAMANAVA Project design, so the pumping stations in the sub-drainage areas such as Catmon, Spine PS were affected.

Also, regarding the river water level of the Malabon river, it was close to the river wall top elevation during the peak discharge because of the small channel flow capacity and the backwater effect of the Lambingan bridge. This situation caused some over flows from the Malabon river to the sub-drainage area such as South Pinagkabalian and Catmon.

Another unprecedented factor was the extremely high tide of +12.65 m (DPWH Datum) observed on August 2, 2012 at Bangkulasi PS. This tide elevation was higher than the top elevation of the river wall of Marala river and the downstream reaches of the Malabon river. Consequently, the overflow from those rivers took place. This overflow was not considered in the KAMANAVA Project design, so the pumping stations in the sub-drainage areas such as Bangkulasi, Catmon and Spine PS were affected.

Also in the northern part of the Project area, there were 3 locations along the polder dike where overflow took place.

In addition to the above phenomena beyond the design scale, the river walls collapsed at 3 locations along the Marala and Malabon river during the flood in August 2012.

The pumping stations of Bangkulasi, Catmon and Spine had been working properly before August 6, 2012, however, as the inundation depth increased because of the inflow to the sub-drainage areas from the river, all pumps revealed a lack of capacity to lower the inland water level.

Thus, most of the Project area was inundated during the 2012 monsoon (Habagat) even though the flood control and drainage improvement facilities of the Project had been completed.

5.11.2 Evaluation

The flood event at the time of the 2012 monsoon (Habagat) in the KAMANAVA can be regarded as beyond the design scale in terms of the river flood and the inland flood. The hourly rainfall in the Project area was evaluated to be design scale or less, however, the inundation volume and the inundation water level were beyond the design assumptions. That was why Maypajo and Catmon PS were not operated during the flood peak period.

The 2012 monsoon (Habagat) started in the end of July 2012. In the initial period, the flood control and drainage improvement facilities in the KAMANAVA Project area functioned properly. But in the unprecedented conditions after August 2, 2012, those facilities could not respond to the historically rare external force. The critical contributing factors were natural ones, and the accidental issue was only the river wall collapse.

In conclusion, although most of the Project area was inundated by the unprecedented conditions during the 2012 monsoon (Habagat), it can be said that the Project surely contributed to mitigate flood damage in the Project area during the 2012 monsoon (Habagat). This is because average inundation volume can be assessed to have decreased by 68 % as well as the time for inundation water level to reach a serious level can be confirmed to have been delayed for about one day at a maximum by the effect of the Project comparing with the case that the Project was not implemented (“Without Conditions”).

6. Recommendations

6.1 Introduction

In previous Chapters, the progress of the KAMANAVA Project since 2001 was reviewed and the current conditions in the Project area were confirmed by field survey and various documents of the Project. Next, in terms of the flooding in 2009 typhoon "Ondoy" and 2012 monsoon (habagat), what happened in the Project area and why such serious floodings happened while most of the KAMANAVA Project was completed at the time of the typhoon and monsoon were determined. Also the effectiveness of the KAMANAVA Project was analyzed by the comparison between without project and with project conditions, which clarified the remarkable effectiveness of the pumping stations, floodgates, polder dikes, river walls and drainage channel improvement. However, there are several conditions to be improved in order to achieve the intended benefits/impact of the Project. At the same time, there are more conditions to stakeholders for enhancement of the effectiveness of the KAMANAVA Project in order to guarantee the sustainability of the Project.

Based on the findings and analysis described in previous chapters, the following recommendations for DPWH are made by the SAPS Team. It is expected that DPWH shall implement the high priority recommendations immediately and materialize the implementation schedule for other recommendation by closely coordinating with all the Project- related stakeholders such as LGUs.

Table 6.1.1 summarizes the recommendation items together with relevant stakeholders. The table categorizes the recommendations into "the Recommendations to achieve intended benefits/impact of the Project" and "the Recommendations to further enhance benefits/impact of the Project". Basically the recommendations in the table are those that DPWH should implement or coordinate with LGUs and the relevant stakeholders are shown as well as the status in the beginning of 2014. Also the priority and proposed implementation schedule for each recommendation was reflected into the table. The on-going and programmed items should be given high priority as well as the Malabon river dredging.

Table 6.1.1 List of Recommendations

Purpose		Actions , Promoting of DPWH			in charge			Status in 2014	Priority	Implementation	
										2014-16	2017-20
to achieve intended benefits/impact of the Project	a	Coordination among stakeholders	Coordinate	Periodical meeting once per 6 months with all concerned agencies for exchange of information on the Project	DPWH	LGU			High		
			Implement	Coordinate in the planning, design and implementation of structure measures such as river wall construction	DPWH	LGU			High		
	b	Replacing of Bridges	Implement	Replacing of Lambingan bridge of Malabon river	DPWH			Ongoing	High		
			Implement	Replacing of Bangkulasi, Tonsuya, Tinajeros bridges of Malabon river	DPWH			Planned	High		
	c	Dredging of Rivers	Implement	Dredging of the navigation route in Navotas river	DPWH	LGU			Middle		
			Implement	River bed dredging of Malabon river from the Navotas river bifurcation point to Tinajeros bridge	DPWH			Planned	High		
	d	Construction of deferred works	Confirm	Future land use plan in Malabon city, especially in Barangay Dampalit		LGU			High		
			Implement	Upgrading of the Polder Dike to Road dike	DPWH				High		
			Implement	Construction of deferred Pumping stations in Northern area of the Malabon river	DPWH				High		
	e	Solid waste management	Manage	Solid waste in wider area covering the upper area's LGUs such as Kalookan, Valenzuela and Quezon cities.		LGU			High		
	f	Drainage Channel Improvement	Promote	Improvement of secondary/tertiary drainage channel		LGU			High		
			Maintain	Existing drainage channel (dredging)		LGU	Barangay	Ongoing	High		
	g	Monitoring	Monitor	Flood situation and operation of their own small pumping station and gates		LGU	Barangay		Middle		
			Implement	Tide measurement at Bangkulasi Pumping station and North Navotas Navigation Gate	DPWH			Ongoing	High		
to further enhance benefits/impact of the Project	a	Additional Works for upgrading of the Project	Implement	River wall raising/ strengthening along Malabon and Marala river	DPWH			Ongoing	High		
	b		Implement	River improvement works from Tinajeros bridge to Macarthur Highway along the Tinajeros-Tullahan River	DPWH			Ongoing	High		
	c		Implement	Construction of Navotas coastal dike	DPWH			Ongoing	High		
	d	Study/Design for upgrading of the Project	Study/Design	Countermeasure for siltation at North Navotas Navigation Gate in the Manila Bay side	DPWH				Middle		
			Study/Design	Measure for rainwater storage on site	DPWH				Middle		
			Formalizing/upgrading	Longos RPS	DPWH	LGU			High		
	e	Monitoring	Implement	Capacity Building for Operators of Floodgate and Pumping stations	DPWH			Ongoing	Middle		
			Implement	Discharge Measurement at Tenejeros River and Malabon rivers	DPWH				High		
			Implement	Rainfall Measurement at North Navotas Navigation Gate, Pinagkabalian Floodgate, Muzon Floodgate, Catmon Pumping station, Spine, Maypajo, Bangkulasi Pumping station.	DPWH	LGU	Barangay		High		
		Landuse regulation	Promote	Control/regulation of land use in and around retarding ponds		LGU	Barangay		Middle		
		Education and Sharing of Information	Promote	Enhancement of flood-fighting activity (ex. Storing of Sand bag at Polder dike)		LGU	Barangay		High		
			Promote	Dissemination of Information on the Project to Barangay		LGU	Barangay		High		

Structural Measures (grey)
Non-Structural Measures (yellow)

Source: JICA Study Team

6.2 Recommendations to achieve intended benefits/impact of the Project

(a) Coordination among stakeholders

As primary recommendation to achieve intended benefits for the whole the Project, SAPS Team's evaluations and recommendations for coordination among stakeholders are as follows;

Evaluation	Recommendations
Establishment of cooperative relationship with stakeholders was a challenge before the SAPS Study since LGUs/barangays deemed that coordination/information sharing should have been more active before/during the project implementation for their better understanding and proper actions. However, the LGUs and barangays expressed their appreciation to DPWH for the coordination/consultation and information sharing regarding the Project during the workshops of the SAPS Study, and committed further cooperation with flood control efforts of DPWH. In the course of the SAPS Study, it was made clear that the communication among DPWH, LGUs, communities and MMDA could be activated more if some organized meetings are provided. Also if such opportunities become periodical, the information exchange among stakeholders is expected to be promoted.	DPWH shall hold periodical meetings, once every 6 months, with all the concerned stakeholders (LGUs, MMDA and communities) for exchange of information regarding the Project. DPWH should organize a working group on the KAMANAVA Project and specify members from each stakeholder. The most important stakeholders are LGUs, such as Malabon and Navotas cities in the Project area including MMDA. Also DPWH should invite other stakeholders such as NAMRIA, PAGASA depending on the agenda of the periodical meeting. The level of invited personnel is the city engineer and officer in charge of the environmental section and city planning and representative from project-affected barangay.

In the course of such periodical meeting especially between DPWH, LGUs and MMDA, the coordination in relation to the Project facility is needed as shown in the agendas below for example.

Agenda 1 Adjustment of structures of the Project and local structures

The alignment of the raised river walls are provided with various structures such as local drainage gate, openings, etc. because of the complicated nature in the densely urbanized Project area. DPWH should coordinate with LGUs for the Project facilities and the local structure. For example, the connections between the river wall of the Project and local gates should be checked in order to avoid any dysfunction of the river wall.

Agenda 2 Updating of Information regarding Site conditions

The old MMDA pumping station in front of Longos Floodgate (the Malabon river side) is affecting the drainage function of the floodgate. DPWH should share information with the LGUs and take necessary measures if needed. The old pumping station in front of Longos Floodgate should be removed immediately under collaboration among DPWH and Malabon city.

Agenda 3 Sharing of Information of On-going projects and Study Project

At present, most of the on-going / additional works and study projects were those that LGUs requested to DPWH. DPWH should share information on the progress and status of those works and studies with LGUs and other stakeholders in the proposed periodical meetings. Also hydrological data measured by DPWH should be shared as monthly or seasonal summary table in the meeting.

The main items to be shared and presented in the meeting are as follows,

- Progress of on-going and planned projects
- Status / Result of Study on Drainage system improvement in Navotas

Drainage area

- Result of Hydrological Measurement (tide and waterlevel measurement)

Agenda 4 Preparation for Integrated Operation of Facilities in the Project area

The integrated operation system of the constructed facilities in the Project and other hydraulic facilities by other stakeholders is expected in the future in order to operate them effectively and link to flood early warning system in the Project area. For such future plan, as the first step, the following data preparation, analysis and study are needed and handled by DPWH. In the periodical meeting, the following item should be discussed and confirmed one by one and it is expected that an implementation schedule is prepared among all stakeholders.

- Inventory of all local gates, pumps and river walls with their main specifications
- Collection of operation records for each gate and pumps
- Analysis and evaluation of the operation record
- Study on possible integration of the gates and pumps

(b) Replacing of Bridges

As one of the preconditions of the KAMANAVA Project, the Lambingan bridge replacement is ongoing near Barangay Catmon. For these preconditions, SAPS Team's evaluations and recommendations are as follows;

Evaluation	Recommendations
As of the beginning of 2014, the bridges of Bangkulasi, Tonsuya and Tinajeros are not yet replaced / strengthened according to the KAMANAVA Project Design.	DPWH (NCR) has already planned the replacement/strengthening of the said bridges. DPWH should implement them in 2014 as planned.
Replacing of Lambingan Bridge over the Malabon river is on-going work. Design drawing of the Lambingan Bridge by DPWH (NCR) use different elevation datum from KAMANAVA Project. The DFL at the bridge in the drawing cannot be confirmed as to whether it is following the Malabon river flood control profile or not.	DPWH should establish a common bench mark network within DPWH (UPMO and NCR) to avoid confusion in terms of elevations among stakeholders.
The design parameters for bridge replacement of Bangkulasi, Tonsuya and Tinajeros were specified in the Design Report 2001. However in the Report it is not clear if the bridge parameters were considered in the calculated design waterlevel in Malabon river. Also the hydraulic effect on the flood waterlevel by bridges has been one of the serious concerns in LGUs.	DPWH should confirm the bridge clearance of the design for the Bangkulasi, Tonsuya and Tinajeros bridges and study their compatibility with the completed river wall elevation in upstream and downstream of those bridges using the latest and detailed cross section data of the Malabon river.

(c) Dredging of Rivers

In order to make the KAMANAVA Project works fully function, DPWH shall conduct the river bed dredging of the Malabon river from the Navotas river bifurcation point to Tinajeros Bridge in order to accommodate the Design Discharge for a 30 year return period. For this work, SAPS Team's evaluations and recommendations are as follows;

Evaluation	Recommendations
SAPS Study confirmed by the river cross section survey (Nov. 2013) the present river bed of the Malabon river is higher than the design because of the sedimentation from upstream area. The channel capacity of the Malabon river under DFL is evaluated to be less than the design discharge of the Project. This is because the river bed dredging as a precondition for the design discharge was not conducted in the Project period.	DPWH should conduct the river bed dredging of the Malabon river. In the present Malabon river, especially, stations 2+200 and 3+500 are comparatively shallow. DPWH should prioritize these shallow sections in the implementation schedule.
The water depth in the Navotas river near North Navotas Navigation Gate is very shallow and therefore to prevent interference with the dock operation a high gate closure level is needed for the ship users in Navotas city, however such high level causes frequent inundation in Malabon city as well as reverse flow of the drainage channel in Navotas city.	DPWH in collaboration with LGUs should conduct the river wall raising along the Navotas river and provide pumps in addition to the river bed dredging of the Navotas river in order to allow the gate closure level high to be as high as needed.

(d) Construction of Deferred Works

In order to make the KAMANAVA Project works fully functional, DPWH shall implement either the deferred work in the original plan or some alternate plans if they are needed.

Evaluation	Recommendations
Due to the deferred works in the Project, Dampalit and South Pinagkabalian sub-drainage areas do not have major pumping stations for drainage. Especially in barangay Dampalit there is no major facility to control waterlevel of fishpond at present. Malabon city desires the early implementation of the deferred construction as planned.	DPWH should confirm the latest land use plan in Malabon city if the fishponds or swampy areas are developed. If the latest land use plan is confirmed to be urban area, DPWH should start the following actions. 1. Review and update of the drainage improvement plan / design in the Project based on the latest land use plan. 2. Some measures which were not included in the Project shall be studied. For example, retarding ponds and upgrading of the polder dike are to be studied comprehensively.
It was recognized that there is an idea that upgrading of the Polder Dike to a Road Dike to accelerate the development work in the subject area by improving the access for developers to convert the fish ponds for residential, industrial and commercial properties. According to the community workshop held on Jan.23, 2014. Barangay Dampalit desires the upgrading of the polder dike as a cycling road.	DPWH should decide the use of the polder dike as the project plan. In the plan DPWH should consider the followings. 1. Since such area is on soft ground basically, countermeasures for land subsidence as well as erosion control are to be included. 2. A comprehensive feasibility study is needed for the upgrading of the polder dike in Malabon city.

(e) Solid Waste Management

In order to make the KAMANAVA Project works fully functional, LGUs shall recognize the necessity of solid waste management in the Project area.

Evaluation	Recommendations
In Malabon river, at Lambingan bridge it was reported by Malabon city that during 2009 "Ondoy" the garbage clogged and caused flooding around the bridge. Also it was said due to the clogging in drainage channels, the water flow into the pumping stations was reduced. Most of the garbage is those coming from upstream area . In this sense the solid waste management issue cannot be regarded as a separate one for each LGU.	DPWH should collaborate with LGUs of Navotas and Malabon cities and the upper areas' LGUs such as Kalookan, Valenzuela and Quezon cities as well as MMDA to promote solid waste management in the Project area from viewpoint of the wider areas.
Local people's awareness for solid waste management is well rooted in the Project area according to a series of discussions with LGUs. However, for the more effective solid waste management, local people's activity is needed to be organized and continuous in community basis.	DPWH should promote LGUs to frequently disseminate information on the importance of solid waste management as DPWH conducted in the Workshop on Jan.23-24, 2014 and collaborate with the LGUs to educate the people on solid waste management to use simple material such as comic (Refer to Annex 4 of this Report) .

(f) Drainage Channel Improvement

In order to make the KAMANAVA Project works fully functional, DPWH and LGUs must recognize the necessity of drainage channel (secondary / tertiary) improvement in the Project area.

Evaluation	Recommendations
The improvement of secondary / tertiary drainage channel is a precondition of the Project in order to achieve the full effectiveness of the constructed pumping stations in the Project.. It is regarded as an obligation of LGUs, however the full implementation of the work is too great a burden for LGUs because of lack of funds.	DPWH should collaborate with LGUs to support the technical aspect on local drainage for LGUs. DPWH should provide LGUs with all the information on the completed drainage facilities in the Project. Regarding the necessary funds for the improvement of secondary / tertiary drainage channel in LGUs, DPWH should collect information on other area's example such as subsidiary system and involvement of the private sector for urban drainage improvement and study the applicability in the Project area.
Local people's awareness for dredging of local channel is well rooted in the Project area.	DPWH should promote the LGUs to disseminate information and DPWH should collaborate with the LGUs to educate the people on how effective the periodical maintenance such as dredging of local channel and garbage disposal is in the course of IEC.

(g) Monitoring

In order to make the KAMANAVA Project works fully functional, DPWH shall recognize the necessity of monitoring of site conditions and tide in the Project area.

Evaluation	Recommendations
The past flood situation at the local level is not recorded in DPWH. Also operation records of small, local pumps and gates are not shared with DPWH. This is important information for monitoring the effectiveness of the Project continuously. Also this information can contribute to more effective operation and maintenance of the Project facilities.	DPWH should collaborate with the LGUs to commonly share and effectively utilize information regarding local conditions. DPWH should materialize such information sharing with LGUs in the course of the periodical meetings as proposed in the above (a).
The tide elevations are measured hourly at Bangkulasi Pumping station/Floodgate and North Navotas Navigation Gate as outside water level. These locations are north and south of the Project area, so their locations are well balanced. However, while the measured tide data is quite valuable, the data is not utilized for comparison with NAMRIA's Manila Bay tide and is not shared with stakeholders in electric form.	DPWH should continue the tide level measurement at Bangkulasi PS and North Navotas Navigation Gate in order to check and compared with the NAMRIA tide data. DPWH should convert the measured tide data at those pumping stations based on NAMRIA bench mark, by which the relation between the Project area and the Manila Bay in terms of the tide level can be studied. DPWH should store the measured tide level data in electric form and share with the stakeholders (especially LGUs) for the purpose of effective operation of the Project facilities and further review of the design of the Project in the future.

6.3 Recommendations to further enhance benefits/impact of the Project

(a) Additional Works for Upgrading of the Project: Raising of River wall

DPWH has already started in 2013 the additional works of the river wall raising/strengthening as observed along the Malabon and Marala rivers areas in order to protect the area from high tide and river flood. For this additional works, SAPS Team's evaluations and recommendations are as follows;

Evaluation	Recommendations
The additional raising / strengthening of the river wall constructed by DPWH can be assessed as a quite practical and realistic measure because during the 2012 monsoon (Habagat), the tide and flood water level exceed the existing top elevation. Some portion of the floodwall has been constructed on the old wall structure, in which the stability should be assured.	DPWH should extend the additional river wall raising to the Marala river and the Navotas river up to 13.5m (DPWH Datum) as top elevation. DPWH should undertake checking and rehabilitation / strengthening of the sections which were constructed on the old wall structure.
According to the leveling results of bench marks in the SAPS Study based on newly established benchmarks by NAMRIA and PMRCIP III, some discrepancies in elevation among the KAMANAVA Project elevations and the leveling results were observed.	DPWH should carefully check the elevation of bench marks of the ongoing additional works (raising of river wall) to utilize some recent bench marks of NAMRIA as reference.
The Top elevation of 13.5m (DPWH Datum) is uniformly applied regardless of the sections of the river based only on the situation of downstream section although it should be designed based on the actual condition of each river section.	DPWH should review the relation between design high water level and proposed 13.5m (DPWH Datum) as river wall top elevation for the whole reach of planned sections in order to formalize the design top elevation of the said additional works.

(b) Additional Works for Upgrading of the Project: River Improvement Works

In parallel to (a), the river improvement works from Tinajeros Bridge to Macarthur Highway along the Tenejeros-Tullahan River have been funded by DPWH. For this work, SAPS Team's evaluations and recommendations are as follows;

Evaluation	Recommendations
In 2009 and 2012, the Tullahan river was flooded and the flooded water entered the KAMANAVA Project boundary, which resulted in inland inundation. This section of the Tullahan river is outside the scope of the Project, however, the work is necessary for the sustainability of the Project. The current channel capacity of the Malabon river is 350 m^3/s at the lowest section because the riverbed dredging was not conducted during the Project. The river wall raising along the Tullahan river is planned and implemented. An increase in peak discharge because of this work is anticipated, so it should be planned in accordance with the progress of the Malabon river improvement in terms of flood discharge continuity.	DPWH should conduct the Tullahan river improvement work in close coordination with the Malabon river improvement in the Project area. DPWH should review the flood control plan for Tullahan- Malabon river. DPWH should prioritize the Malabon river improvement (dredging for downstream of Tinajeros bridge) in order to accommodate the design discharge (450 m^3/s).

(c) Additional Works for Upgrading of the Project: Construction of Navotas Coastal Dike

Construction of Navotas Coastal Dike is on-going work. For this work, SAPS Team's evaluations and recommendations are as follows;

Evaluation	Recommendations
Navotas area was seriously flooded in September 1999 and July 2000 as well as partially affected in 2009 typhoon "Ondoy" and 2012 monsoon (Habagat) as a result of high tide. Considering the recent high tide events like 12.65m (DPWH Datum) at 2012 monsoon (habagat), the Navotas Coastal dike is regarded as an urgently necessary measure. The proposed top elevation 13.5m (DPWH Datum) is appropriate as urgent measure.	DPWH should complete the ongoing Navotas coastal dike construction and formalize the planning, design, implementation and funding to integrate with the local drainage system .

(d) Study/Design for upgrading of the Project

Study / design for upgrading of the Project are required at first. For this work, SAPS Team's evaluations and recommendations are as follows;

Evaluation	Recommendations
In order to satisfy the flood control need of Malabon and Navotas cities and the ship passage needs, the siltation of the Navotas river and its river mouth is to be mitigated.	As to the siltation along the navigation route in the Navotas river, DPWH should conduct the maintenance dredging periodically. As to the siltation at the river mouth (Manila Bay side), DPWH should conduct a study to investigate the origin of the sedimentation materials as well as topographical survey for appropriate structural measures. Applicability of breakwater should be carefully examined based on the results of the said study.
In Catmon sub-drainage area, the area of the retarding pond was reduced in the construction stage to less than design due to the difficulty of land acquisition. Also the improvement of secondary and tertiary drainage channel will take a long time, therefore, the reduction of rainwater runoff from the urban area is necessary in the short term.	Also in order to mitigate the inundation condition, DPWH should plan the development of retarding ponds in accordance with the latest land use plan by the LGUs. DPWH should conduct a study and design the rainwater retention measure for the urban area.
It is observed that in addition to the Project facilities, some pumping stations (e.g. 2 RPS at Longos FG, etc.) were constructed by DPWH. These structures are regarded in DPWH and LGUs as alternate measures to make up for the reduced size of the retarding ponds near Catmon pumping station.	DPWH should formalize and upgrade of selected RPS (e.g. 2 RPS at Longos FG, etc.) In order to enhance and upgrade the Project facility based on the formal planning, DPWH should conduct a review study for Catmon drainage area.

(e) Monitoring, Landuse Regulation and Education and Sharing of Information

Other recommendations to further enhance benefits/impact of the Project are explained below.

- In order to institute a standard level of operation data monitored for the pumping station and flood gates under the KAMANAVA Project, DPWH (the KAMANAVA PMO) shall hold periodical workshops for operators and laborers for capacity building. For example, training on how to read the water level and how to compare it with NAMRIA tide table. DPWH has already conducted a workshop once and it is expected to be programmed continuously within DPWH and MMDA in the future.
- DPWH should start rainfall and river water level / discharge measurement / monitoring in the KAMANAVA Project area in order to use the information for the planning, design and implementation of the flood control and drainage structure. DPWH should install automatic rain gauges at Floodgate/Pumping stations such as North Navotas Navigation Gate, Kailungan, Pinagkabalian, South Pinagkabalian, Muzon, Catmon, Longos, Spine, Maypajo, Navotas and Bangkulasi. Those locations are already protected, and the operators can be the ones in charge of the rainfall measurement. DPWH should understand that the hydrological monitoring activities (tide, waterlevel, discharge and rainfall) are emphasized by the SAPS Team because the hydrological measurement and its accumulation are the basis of flood control and drainage improvement projects for evaluation of the effectiveness and proper operation and maintenance in general. DPWH, as an implementation agency for flood control and drainage improvement in KAMANAVA area, shall have its own data using its own funds.
- In relation to the development of retarding ponds in the Project area, it is necessary to control and monitor the land use development activities by LGUs as well as communities. DPWH shall disseminate information on the planning of retarding ponds to the LGUs and coordinate with the LGUs land use plan.
- As has already been conducted in the Project area along the polder dike section, DPWH should promote and provide support to LGUs and communities for flood fighting activities. One of the prioritized actions is to store sand bags along the polder dike.

In relation with the bench mark issue in the above (a) of 6.3, the SAPS Team recommends the following actions.

- DPWH should determine immediately a primary bench mark of NAMRIA defining mean sea level or mean lower low water level for the KAMANAVA Project area in order to link the KAMANAVA Project elevation with NAMRIA tide level.
- Next, like the SAPS Team‘s spot elevation survey, DPWH should conduct an additional spot elevation survey for North Navotas Navigation Gate, Kailugan Gate, Pinagkabalian Gate, Polder dike top and Marala river wall top based on the new primary bench mark to check the actual elevations.
- Then, for the on-going projects such as raising of the river wall and VOM, DPWH should apply the selected new bench mark for construction. DPWH should conduct necessary modification of the structure if needed.

6.4 Other Recommendations

In order to make the structures completed in the KAMANAVA Project fully function, the contributions of Navotas and Malabon cities, NAMRIA, MMDA and PAGASA are indispensable. SAPS Team’s recommendations are as follows,

- In North Navotas Navigation Gate, there is a conflict of interest in terms of the gate closure level between Navotas ship associations (the ship users) and Malabon city. The ship users prefer a higher elevation for gate closure such as 11.5m (DPWH Datum) to facilitate dock operation while the Malabon city prefers a lower elevation for gate closure such as 10.5m (DPWH Datum) as per the KAMANAVA original plan because there are low elevation areas that could be inundated. At present, as a compromise solution, the elevation of 11.0m (DPWH Datum) is selected for gate closure by DPWH; however, continuous discussion are needed among stakeholders. The actions toward the solutions were already discussed between the LGUs and DPWH during the SAPS

Study. One of the issues to be solved is the shallow draft in the Navotas river. Basically the passable water depth at the gate is decided by the sill elevation (3.6m) and the tide level. Therefore the dredging of the navigation route below the sill level in Navotas river is not a substantial solution. Of course the dredging of the sedimentation above the sill level should be conducted by relevant stakeholders. The countermeasure (a breakwater) to prevent siltation in the Manila Bay side is also to be studied to check the origin of the present sedimentation.

- In relation to the North Navotas Navigation Gate's closure level issue, in Navotas City, in order to mitigate the impact of high water in Navotas river, the Navotas City has been building a river wall with small pumping stations (Bombastik) along the Navotas river bank with its own fund. This measure would lead divide the Navotas Sub-drainage area into more sub-drainage areas. Under this situation, the Malabon city side along the Navotas river shall be protected by a similar river wall to protect the lowland area. Therefore, in Navotas Sub-drainage area, the protection of the left and right bank along the Navotas river is a common interest of Navotas City and Malabon City. For intervention by structural measure such as river wall construction floodgates and pumping stations, both Cities as well as DPWH should organize a working group to coordinate the planning, design and implementation. It should be pointed out that these river walls along the Navotas river would mitigate the conflicts on the gate closure level for the 2 cities because they can allow higher water level in the river.
- In Malabon City, especially in the Barangay Dampalit area, the future land use plan shall be confirmed in accordance with the KAMANAVA Project Plan immediately. For the land use issue, Malabon city should take initiative to make the future plan clearer.
- In order to establish fixed Bench Marks for the KAMANAVA Project area, DPWH and NAMRIA should have an immediate meeting to verify the existing bench mark elevations and update the water level parameters for flood control and drainage improvement planning.
- The Project area is most vulnerable when high tide and river flood coincide. DPWH should review flood control plans and designs in the future stage taking into account of the actual conditions. The review of high water level for flood control is the most important. The rainfall monitoring data by other organizations such as PAGASA, MMDA and other sectors shall be shared with DPWH and LGUs in a timely manner. Also a flood warning system shall be studied based on the measured and accumulated hydrological data.

7. Information Dissemination on Effectiveness of the Project

7.1 Workshop

Before starting the SAPS Study, it was reportedly said that people and LGUs in the Project area had a few questions / concerns about the effectiveness of the KAMANAVA Project. Some of those concerns are shown in the Social Survey which was conducted in November 2013 (refer to Annex 2). In this line, in order to enhance the understanding of the Project and increase the effectiveness of the Project, workshops were planned and held by DPWH.

The objectives of the planned workshops are:

- The presentation of the results of the study by DPWH
- City / Residents grouping to share future visions in KAMANAVA area using the result of the study.
- Discussion among all stakeholders regarding the sustainable implementation of the project.

The workshops were held 3 times in the middle of January, 2014. The workshops were conducted after the results of the specific technical and social/institutional studies were undertaken by DPWH to make use of the SAPS Study results. The matrix below shows the schedules of the conducted study and the participants who actually attended the said workshops.

Table 7.1.1 Participants of Workshops

Date and Venue	Type of Workshop	Participants who Attended the Workshops
21 January 2014 UPMO=FCMC DPWH Conference Room	Joint Workshop of DPWH-LGU (city level)	• DPWH officials including KAMANAVA Project • Malabon City Mayor, Planning Officers and Engineers • Officials and representatives from MMDA, PAGASA, NAMRIA • JICA Philippines
24 January 2014 Navotas Mayor's Conference Room	Continuation of the 21 January Workshop to Resolve the Transboundary Issue on the North Navotas Navigation Gate Operation	• DPWH officials including KAMANAVA Project • Navotas City Mayor and the City Engineer • JICA Philippines • Malabon City Engineers
23 January 2014 Penthouse, Malabon City Hall	Community Workshop for Malabon City	• DPWH officials including KAMANAVA Project • Malabon City LGU including representatives from local agencies • JICA Philippines • Barangay LGUs and respective Sector representatives (e.g. youth, women, senior citizens, and homeowners associations) from eight (8) barangays in Malabon City
24 January 2014 Palaisdaan Hall, Navotas City Hall	Community Workshop for Navotas City	• DPWH officials including KAMANAVA Project • Navotas City LGU including representatives from local agencies • JICA Philippines • Barangay LGUs and respective Sector representatives (e.g. youth, Women, senior citizens, and homeowners associations) from SEVEN (7) barangays in Navotas City

Source: JICA Study Team

Joint Workshop of DPWH-LGU was held on 21 January.

Meeting to resolve the transboundary issue at Navotas Mayor's room on 24 January

Community Workshop for Malabon was held on 23 January.

Community Workshop for Navotas was held on 24 January.

Source: JICA Study Team

Figure 7.1.1 Photos of Workshops

7.2 Concept of Presentation

Based on the results of the SAP Study on the affected Barangays in the Cities of Navotas and Malabon, the workshops were conducted by DPWH to enable the project stakeholders to understand the Project itself and the effectiveness of the Project, and also to propose specific sustainable institutional roles and responsibilities for the sustainable implementation of the structural measures and non-structural measures. Likewise, the supporting measures, specifically on the Information, Education and Communication (IEC) Campaign of the SAPS Study. The recommended measures would be presented in the workshops to enhance the structural and non-structural measures developed for the sustainability of the KAMANAVA Project. The workshops were done in concurrence with the laws and provisions of the Cities and Barangays and the DPWH.

Structural measures refer to the construction of flood control structures that were not considered or not within the design of the KAMANAVA Project such as additional construction of river walls and raising these walls to a 13.5 m (DPWH Datum), additional pumping stations in strategic areas, dredging of rivers and drainage systems within the Project coverage, and other related measures relative to the structural sustainability of the Project.

On the other hand, the non-structural measures refer to specific measures that would deal with the institutional enhancements and or improvements to sustain the initiatives of the Project and likewise support the structural measures recommended. These non-structural measures refer to land use development, solid waste management, informal settlers and flood management.

Moreover, the workshops at the LGU or city level were also intended to resolve the transboundary issues of the two cities pertaining to the North Navotas navigation gate operation and the land use development for the present fish pond area, particularly on the Barangay Dampalit side of Malabon City.

DPWH would take the front stage in the workshops as they are the implementers of the KAMANAVA Project with the SAPS Study team assisting them. The presentation materials for the workshops are attached in Annex 4 in this Report.

7.3 Discussion among Stakeholders

Each of the Cities shall be chaired by the City Engineer. The CE shall collate the resulting outputs with the sectoral representatives and present the results in the plenary session.

In the barangays, the City Engineer collates the resulting output with the Barangay Chairpersons and presents the results in the plenary session.

(1) Joint DPWH –LGU City Workshop

The workshop with the city local governments basically discussed the transboundary issues on the North Navotas Navigational Flood gate operation. During the 24 January meeting at the City Mayor’s office in Navotas City, the recommended water elevation is at 11.0 m (DPWH Datum). The Navotas City Mayor advised that the shipyard owners should be consulted on this matter and if there is no negative response then necessary steps should be taken for DPWH to officially implement the 11.0 m (DPWH Datum). A joint resolution of the concerned cities may be the appropriate official document to be drafted as soon as possible.

The transboundary concerns on the updating of the land use were agreed to be addressed particularly on the existing fishponds near the polder dikes. It was emphasized by the Malabon City Planning Officer, that they have already planned the updating of their City Comprehensive Land Use Plan (CLUP) particularly with regard to the development of the Barangay Dampalit where fishpond owners control the use of the opening of the gates near the polder dikes.

Other points of discussions on the structural concerns were raised, mainly regarding the following:
(i) raising of the river walls to the 13.5 m (DPWH Datum); (ii) installation of additional pumping stations to address inland flood waters, dredging of rivers and other water systems, inability of local contractors to dispose of the dredged materials accordingly which also contributes to river water siltation and proliferation of informal settlers and other planned flood structure projects which are no longer within the coverage of the KAMANAVA Project but with the LGU and the District DPWH.

Both local chief executives appreciated the workshop for they now felt the presence of the KAMANAVA Project. They further accepted the fact that although the Project has not totally solved the problem on flooding it has been effective in lowering the inundation in the low lying areas. The design of the KAMANAVA Project was not intended to counter the extreme effects of the 2009 Typhoon “Ondoy” or the 2012 monsoon (Habagat) but they agreed that the Project had somehow lessened the gravity of the impact of both occurrences.

With the results and recommendations of the SAP Study Team, both local chief executives agreed to constantly collaborate with the DPWH and the KAMANAVA Project to address the flooding problem. They are amenable to the recommended structural and non-structural measures (based on the results of the SAP Study) presented by the DPWH.

(2) Community Level Workshops

The officials and sector representatives from the 15 invited barangays were able to comment on the presentations on the status of the KAMANAVA Project and they were able to raise their particular concerns on the status of the flood control structures in their respective areas. Common issues were on the raising of the river walls, negligence of contractors in disposing of the dredged materials, additional pumping stations and dredging. It was noted that the majority of the issues raised were regarding local projects under the responsibility of the DPWH District Office. In particular, the invited DPWH District Officer, who was present in the Navotas City workshop, addressed their concerns and they agreed to discuss this in a separate venue.

The barangays/communities were able to share their vision (through defining said vision) of their respective barangays in the next five years taking into consideration the improvements in their zero-flood environment which according to them would contribute to a better way of life for the residents in their areas.

Insights were also shared by the participants and they also confirmed the structural and non-structural measures recommended by the DPWH. They had appreciated the invitation of the DPWH to get themselves involved in this type of activity to initiate and sustain collaboration with the DPWH and their neighboring barangays, which shared the same concerns on flooding and the implementation and sustainability of flood control structures and their accorded roles and responsibilities.

7.4 Conclusions

In general, both the DPWH and the LGU stakeholders (city and barangay levels) were satisfied with the outputs of the workshops.

In this sense, it is understood that the questions / concerns raised by the communities as shown in the results of the Social Survey were to greate extent cleared.

The barangays/communities, in particular, appreciated the information on the status of the KAMANAVA Project in their respective barangays, the effectiveness of the KAMANAVA Project during the 2009 typhoon “Ondoy” and 2012 monsoon(Habagat) occurrences and the agreed structural and non-structural measures to sustain the KAMANAVA Project initiatives. The barangays further appreciated that they were given the chance to air out their concerns on the flood control structures and they are positive that their visions would be achieved if there will be constant collaboration and coordination between the DPWH and the Project stakeholders.

The city local governments of Malabon and Navotas accordingly agreed to take the necessary steps to address the transboundary issues regarding the navigation floodgate operation and land use development.

In both workshop levels (city and community), the DPWH emphasized the need for constant and regular collaboration between the DPWH and the project stakeholders to sustain the initiatives of the KAMANAVA Project. In particular, the structural and non-structural recommendations, as shown in Table 6.1.1, were presented and were confirmed by the project stakeholders.

8. Summary of Findings and Conclusions

8.1 Summary of Findings

To draw the conclusions in line with the objective of the SAPS study, the findings based on the discussions/descriptions hereto, are summarized below:

(a) There has been modifications/revision to KAMANAVA Project Plan at various stages of its implementation from the time of appraisal by JBIC in 1999 to completion of 2013.

(b) Modifications/revisions that may impact the functionality, (and therefore the project objectives), include:

- Lowering of top level of Polder Dike (Road Dike) to elevation +12.10 m (DPWH Datum) in the initial stretch (compared to +12.60 m (DPWH Datum) in the rest of the Polder Dike)
- Deferring the construction of Pumping Stations at two locations in Malabon River northern area (Dampalit and South Pinagkabalian areas) due to present land use conditions; and
- Downgrading of Navigation Lock to a Navigation Gate;

(c) Peak discharge in the Tullahan river before it enters the KAMANAVA Project Boundary, was estimated as 600 m^3/s for 2009 typhoon “Ondoy” based on the flood marks. The Tullahan river was already flooded and also because of the channel capacity in the upper section of the Malabon river was about 100 m^3/s(less than the design discharge 450 m^3/s for a 30 year return period), therefore, during typhoon “Ondoy”, over flow from the Malabon river took place in the Project area. One of the reasons for such small channel capacity was the river bed dredging as a precondition of the Project was not conducted in the Project.

(d) The channel flow capacity of the Malabon River at design flood level is below the Design Flow (450 m^3/s with a 30 year return period). One of the reason is the river bed dredging as a precondition of the Project was not conducted in the Project, according to the river cross section survey conducted in the SAPS Study.

(e) The highest tide elevation observed during typhoon “Ondoy” at North Navotas Navigation Gate was +12.20 m (DPWH Datum) against the design tide level of +12.1 m (DPWH Datum)

(f) At the onset of typhoon “Ondoy” in 2009, the northern part of the Malabon river and areas adjacent to the Malabon river were not fully protected as the Polder Dike and the Raising of River Walls were only partly accomplished.

(g) At the onset of typhoon “Ondoy”, there were some stretches where the existing or partly constructed Polder Dike’s embankment level was below +12.20 m (DPWH Datum). Therefore, during typhoon “Ondoy”, sea water escaped over the low stretches of the partly completed Polder Dike and contributed to flooding in the protected area in north of Malabon River, to some extent due to the unexpected condition.

(h) The return period of rainfall in the protected area during typhoon “Ondoy” was found to be 5 years which is less than the 10 year return period adopted in the design.

(i) During typhoon “Ondoy”, the incomplete Polder Dike compounded the flooding north of Malabon River.

(j) At the onset of monsoon (Habagat) in 2012, all flood protection facilities under KAMANAVA project were accomplished except some works in Catmon Creek drainage channel improvements.

(k) According to the Malabon City engineer, conveyance of drainage flow towards Catmon Creek Pumping Station was not effective as improvement of drainage channel including Retarding Ponds were not fully accomplished. This has resulted in flooding by inundation and diverted a portion of the drainage flow to Longos Creek. To avoid local flooding in the Longos area, the

LGU has installed two relieving pumping stations adjacent to Longos Flood Gate recently.

(l) Peak discharge in the Tullahan river before it enters the KAMANAVA Project Boundary, was estimated as 600 m^3/s for the 2012 monsoon (Habagat) based on the flood marks survey. The Tullahan river was already flooded and the channel capacity in the upper section of the Malabon river was 350 m^3/s (less than the design discharge 450 m^3/s for a 30 year return period), therefore, during the monsoon in 2012, over flow from the Malabon river took place in the Project area. One of the reasons for such small channel capacity was the river bed dredging as a precondition of the Project was not conducted in the Project.

(m) The highest tide elevation observed during monsoon (Habagat) in 2012 was more than +12.60 m (DPWH Datum) whereas the design tide level assumed was only +12.1 m (DPWH Datum).

(n) The return period of the rainfall in the protected area during monsoon (Habagat) in 2012 was found to be 10 years and was almost same as the 10 year return period assumed in the design.

(o) Deferring the construction of Two Pumping Stations and continuous rainfall events compounded the flooding north of Malabon River during monsoon (Habagat) in 2012.

(p) Examination of water levels on the river side and protected side at the Pumping Stations indicates that the Pumping Stations were effective in keeping the water level within the accepted levels (for example, during the period from the end of July, 2012 to August 1, 2012) except on occasions where rainfall intensity/duration, and spring tide levels are higher than the design (for example, the situations after August 2, 2012).

(q) Social survey results indicates that by the flood control and drainage improvement facilities in the KAMANAVA Project, their flooding extent have been decreasing and people in the flood-prone area are willing to have more protection by mega dike in Dampalit area, higher river wall, pumping stations and flood gates to be implemented by the governments.

(r) Social Survey results (November 2013) shows that basically people in the LGUs indicated that the system is effective. However some respondents in Malabon city expressed a kind of negative answer for the effectiveness of the Project. In the workshop held in January 2014 by DPWH, people in both Malabon city and Navotas city got information from DPWH on the effectiveness of the Project and understood the Project itself well in terms of the phenomenon during the recent floods.

(s) The drainage Systems for the areas are effective for the hydro-meteorological conditions that were adopted in the planning and design.

(t) The extreme hydro-meteorological conditions in the recent past have caused frequent flooding and the project area was exposed to unprecedented hydro-meteorological conditions with tides as high as 2.0 m above mean sea level.

(u) In response to the extreme floods experienced in the recent past, facilities constructed under KAMANAVA Plan are being augmented

(v) Considering the keen interest of the residents and stakeholders to protect the area against the extreme floods experienced in the recent past, the need to review the original planning criteria with the objective of long term sustainability of the project, considering climate change and more consistent topographic datum was recognized.

(w) There is no significant change in the land use from 2003 to date

(x) Conversion of the fish pond in Dampalit to residential, commercial and industrial use has not taken place as expected in planning and design stage. This is mainly due to the fact that the area protected by Polder Dike is not easily accessible and will not be attractive for developers until such time the Polder Dike is upgraded to a Road Dike facilitating easy access for heavy vehicles

(y) As the area is subject to high land subsidence, appropriate allowance for land subsidence should be made in the review of the planning/design criteria following the clarification of discrepancies in bench mark values for future modifications and augmentation of flood protection facilities for long term sustainability of the project.

(z) Regarding the proposal from a citizen in Malabon city for a new tide gate at the Malabon river mouth and relocation of Spine, Maypajo and Catmon PSs to the Malabon river mouth, the SAPS Team does not think it is appropriate.

8.2 Conclusions

Based on the SAPS study findings summarized above, the following can be concluded.

(1) On achievement of full effectiveness of the Project

At the 2012 monsoon (habagat), when the Project was almost completed, the flood volume was reduced by 68% because of the Project (river wall, polder dike and pumping station and drainage channel) compared with the condition under “without project”. As for the remaining 32 %, which is supposed to be reflecting the actual flooding, if the dredging of the Malabon river bed were conducted before those flood events, most of the flood volume could have been reduced in the Project area. In this line, it was presented that the effectiveness of the Project facilities should have been more apparent if the dredging of the Malabon river had been properly conducted before the 2012 monsoon.

Also, before the 2012 monsoon, the bridge raising, improvement of secondary/tertiary channels and solid waste management had not been implemented despite the fact that these were prescribed as the preconditions of the KAMANAVA Project. The necessity of urgent and proper implementation of these preconditions in collaboration with DPWH and LGUs was confirmed to contribute to achieve the full effectiveness of the intended impact of the Project.

However, at the event of 2012, the tide level was extremely high (up to +12.65m (DPWH Datum)) so that the flood water overflowed the completed river wall top and entered the inland flood area, in which the inundation condition exceeded the design condition.

It goes without saying that the construction of the deferred pumping stations (Dampalit and South Pinagkabalian) would contribute to the full effectiveness of the Project in terms of the inland flood mitigation. In order to implement the construction of these structures, the future land use plan in the Project areas shall be confirmed by the LGUs to convert the present fish pond to the residential and industrial area.

(2) On further enhancement of the Project

The raising of the river wall from the elevation of 12.60 m to 13.50 m (DPWH Datum) along the Malabon river has been implemented by DPWH as one of the major additional works in the Project area after the 2012 monsoon (habagat). This work can be assessed to be quite practical and realistic because it intends to prevent the overflow that happened during the high tide in 2012.

The Malabon river dredging is regarded as a precondition of the Project. The proper implementation of such dredging, together with the river improvement of the Tullahan river section, would reduce the flooding extent in the Project area in the case of extreme floods such as 2009 and 2012.

For inland flood area, the pumps which were constructed in the Project would function fully as long as the operation / maintenance are done properly and the land use of their drainage area is controlled properly.

(3) On sustainability of the Project

More coordination and sharing information on the KAMANAVA Project is required among stakeholders under the coordination of DPWH. The Project facilities such as river wall, polder dike, pumping station, floodgates and drainage channels shall be maintained and operated and also upgraded by DPWH, MMDA, LGUs and the communities.

In general, flood control and drainage improvement project take a long time from the start of the feasibility study, through detailed design, construction and to the operation / maintenance stages. The KAMANAVA Project is not an exception. In fact, during such long time, the Project area has been facing unavoidable changes in terms of climate change and socio-economic conditions. To cope with such changes, the accumulation of hydrological data and topographic data, land use control and communities' involvement in the Project in collaboration with the other stakeholders under the coordination of DPWH is needed.

Annex

Annex 1

Verification of Spilling from the La Mesa Dam in 2012 Monsoon (Habagat)

1. Background

It has been pointed out that, in the 2012 the monsoon (Habagat), the spillway discharge of La Mesa dam caused flooding in the downstream reaches of the Malabon-Tullahan river.

The following describes the verification calculation used to follow the process of discharge from the dam, the conclusion and proposed improvement plan.

2. Verification of Spillway discharge

(1) Verification of Dam Water Level

It has been reported that in the 2012 Monsoon (Hagabat), the spillway discharge of La Mesa Dam started on Aug. 6, at 2a.m.

The following is obtained by performing a calculation of the reservoir water level by providing hourly data of dam inflow and water intake.

1) Calculation condition

Table 1 Condition of Inflow

Item	Value	Reference
La Mesa Dam catchment area	24.85 Km^2	WB (2013)
Dam water area	3.2 Km^2	Measured from GIS (JICA Manila Core Study)
Hourly rainfall data		La Mesa Dam St.
Runoff rate	0.6	60% of rainfall is effective for dam storage

Source: JICA Study Team

Table 2 Condition of Intake

Item	Value	Reference
Intake volume by M.W	3,688m^3/hour	Total annual Water withdrawal is equivalent to 1,300 mm of rainfall in the basin
Spillway height	80.15m	From newspaper

Source: JICA Study Team

2) The process of calculation of the dam water level

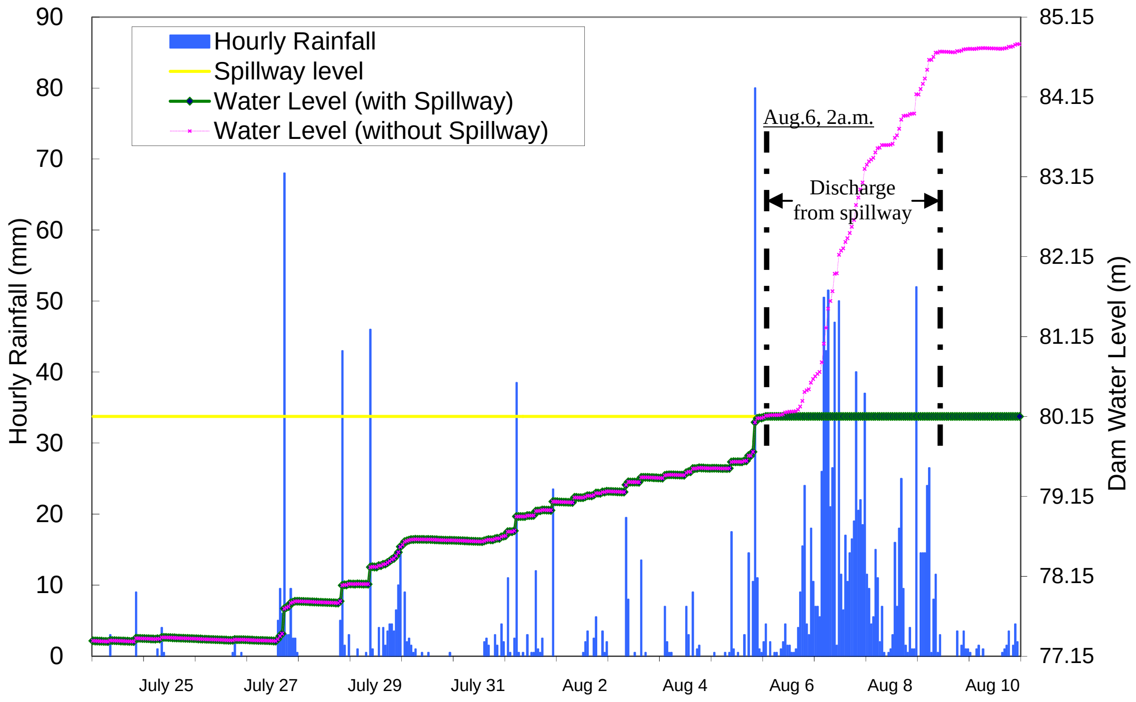
- Initial water level is assumed at the start of the calculation,
- Total rainfall of the dam is calculated on the basis of hourly rainfall data of La Mesa Dam station,
- 60% of the rainfall is assumed to be effective for dam storage by taking into account land use and amount of evaporation, then inflow to the dam is calculated per hour,
- Water is assumed to be withdrawn by the Water Company at 3,688 m^3 /h,
- Dam inflow and intake are summed up per hour, and then the change in the volume of the dam storage is calculated,
- Dam water level is calculated by the change in the dam storage volume

3) Result

Figure 3 shows the calculation result of reservoir water level of the Dam. The calculation starts at 0:00 a.m. on July 24, 2012.

The results show that.

- The reservoir water level was at 77.79m at 0:00 a.m. on July 24, and it reached 80.16m at 2:00 a.m. on August 6, then the spillway discharge started.
- Since the rainfall will continue thereafter, as a result, the spillway discharge continues till 11:00 a.m. on August 10.
- Because of the spillway shape, we assume that outflow from the spillway continues at a value equal to the dam inflow.



Source: JICA Study Team

Figure 1 Simulation of Reservoir Water Level

(2) Verification of Maximum Spillway Discharge

1) Condition

- After the water level of the dam reaches the spillway level, it is assumed that outflow from the spillway continues with a value equal to the dam inflow.

  "Qspillway = Qinflow"
- As the catchment area of the dam is less than 25km^2, the following rational formula can be applied.

  "Qinflow = (1 / 3.6 × f × r × A)
- After the spillway discharge started, the maximum rainfall intensity of 52mm/hr. was recorded at 0:00 a.m. on August 9.

Table 3 Calculation Conditions

Item	Value
Method	Rational method
La Mesa Dam catchment area	24.85 Km^2
Maximum rainfall density	52mm/hr
Discharge (runoff) coefficient	0.8

Source: JICA Study Team

2) Result

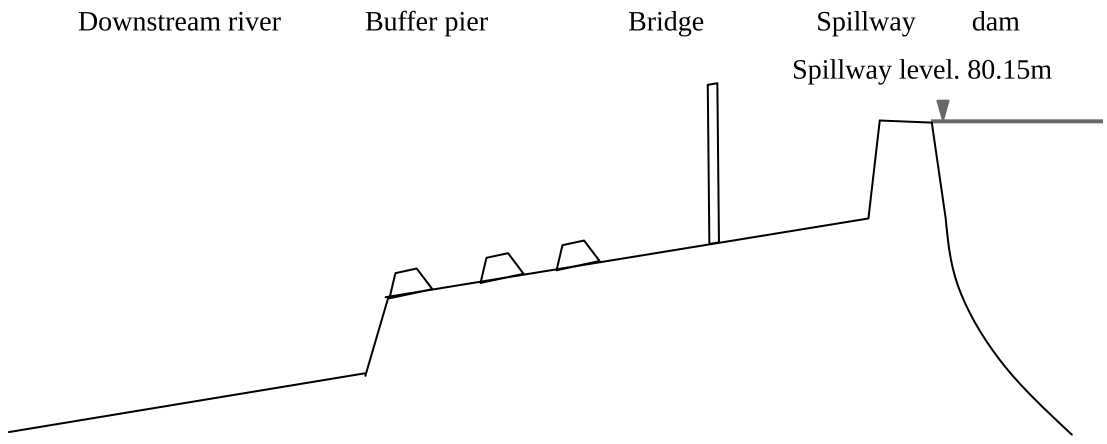
- Maximum spillway discharge is estimated at 287m^3/s.

3. Conclusion

- It was reported that in the 2012 Monsoon (Habagat), the spilling of La Mesa Dam started at 2 a.m. on August 6.
- As the rain continued after the water level reached the spillway level, the spilling continued for about 3 days.
- Maximum spilling was estimated at 287m^3/s.
- Since La Mesa Dam is a water supply dam, La Mesa Dam is regarded as having no flood control capacity from the viewpoint of flood control planning in Malabon River.
- Therefore, the spilling is unavoidable.
- Nevertheless, it can be said that the dam stored the rainfall runoff until August 6.
- On the other hand, it is presumed that on August 2 before the spilling started, the flooding by the high tide occurred in the Project area.
- And, it is assumed that on August 7 immediately after the spilling started, flooding occurred in the Upper Malabon area.
- For this reason, it is considered that the spilling was misunderstood as the cause of the flood.
- In conclusion, the cause of the flooding is considered to be 1) flood control project for Malabon River was still in progress and 2) total rainfall was greater than design rainfall.

4. Proposed Improvement plan

Present condition is shown in the figure below.



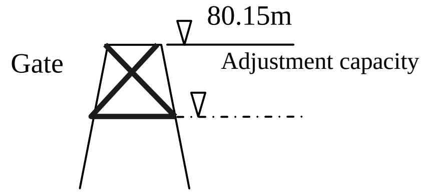
Source: JICA Study Team

Figure 2 Longitudinal Profile from Dam and Spillway to Downstream

"Option A": Construction of new gate with about 1m height at the upper end of the Spillway

1) Merit

- Water can be discharged by manual operation during a flood. Controlled discharge is assumed at 100m^3/s to be maximum.
- Modification of the current facility is relatively small.



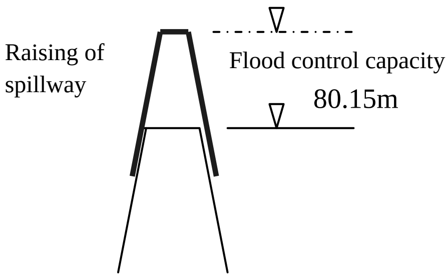
2) Issues

- It is expected that the water company is reluctant to lower the reservoir water level.
- Since the water storage capacity is not very large, there is a concern that the storage would be filled with flood water quickly.

"Option B": Raising of Spillway

1) Merit

- New flood control capacity is created.



2) Issues

- Raising of intake tower is also required.
- Ponding area due to the dam increases.

Annex 2

Summary of Social Survey

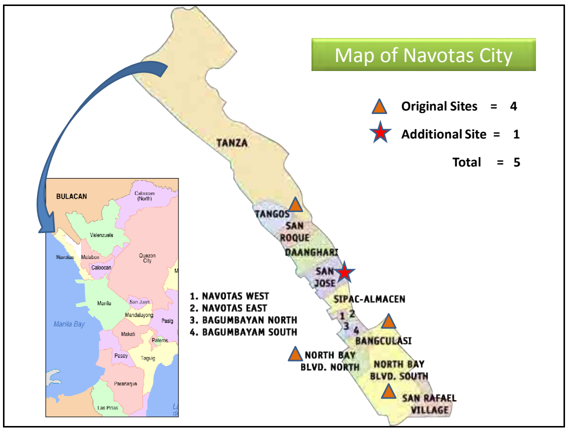
(1) General

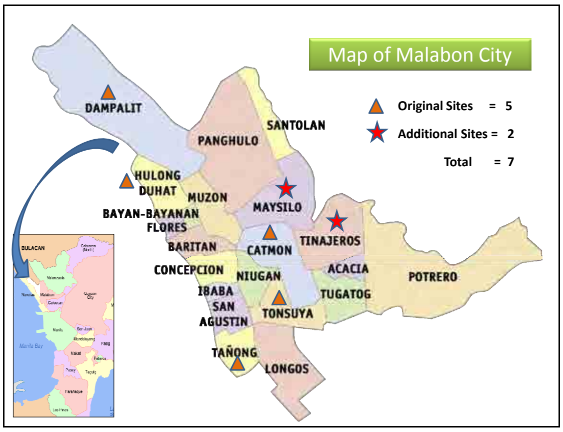
The Survey was carried out in November, 2013 as a part of the Study on the Special Assistance for Project Sustainability (SAPS) for the KAMANAVA Area Flood Control and Drainage Improvement Project;

The Social/Institutional Survey documented the basic conditions of the residents in Navotas and Malabon cities, and their experience regarding flooding and their respective opinions on the flood control projects in KAMANAVA as of November, 2013.

(2) Coverage of the Social/Institutional Survey:

The Social/Institutional Survey covers seven barangays in Malabon City and five in Navotas City. Refer to the maps below for the locations of said barangays.





Source: JICA Study Team

Figure 1 Selected Barangays for Social Survey

The main survey was implemented in nine barangays and an additional survey was done in three barangays giving a total of 12 barangays. In terms of the number of respondents, the planned number to be covered was 20 persons per barangay giving a total of 240 persons but actual coverage was only 157 persons or 65 percent, as shown in the table below.

Table 1 Number of Respondents by Barangay

City	Barangay					% Covered	Date of Survey
	No.	Name	Planned	Actual	Actual Corrected		
Malabon	1	Tañong	20	22	21	105%	5-Nov
	2	Tonsuya	20	22	12	60%	5-Nov
	3	Catmon	20	16	15	75%	5-Nov
	4	Dampalit	20	9	9	45%	6-Nov
	5	Hulong Duhat	20	9	9	45%	6-Nov
	6	Maysilo	20	14	14	70%	14-Nov
	7	Tinajeros	20	9	9	45%	14-Nov
Navotas	1	Tangos	20	9	9	45%	6-Nov
	2	Bangculasi	20	13	14	70%	13-Nov
	3	North Bay-North	20	24	23	115%	6-Nov
	4	North Bay-South	20	15	15	75%	6-Nov
	5	San Jose	20	7	7	35%	13-Nov
Total	12		240		157	65%	

Source: JICA Study Team, *Social/Institutional Survey, November 2013*

(3) Results of the Survey:

I. Respondents' Profiles

a. Malabon Respondents

i. Of the 89 respondents, 39 (44%) are males and 50 females (56%);

ii. **Civil Status**: 58 (65%) are Married; 20 (22%) are single and the rest (11 or 13%) are either widow/er or separated;

iii. **Age** of Respondents

Table 2 Age Bracket of respondents (Malabon city)

Parameter	Age Bracket				
	15-30	31-45	46-65	Above 65	Total
Number	8	19	50	12	89
Percentage	9%	21%	56%	13%	100%

Source: JICA Study Team, Social/Institutional Survey, November 2013

iv. **Varied Income sources:** 41 are employed; 12 have their own businesses; 7 are pensioners while the rest either have double sources or have varied sources of income (eg. Fishing, store, etc)

v. **Average Monthly Household Income:** PhP 15,182 for a family of 7

vi. **Average Monthly Household Expenditure:** PhP 25,772

vii. Overdraft (average of PhP6,945) is mostly due to Loans and Mortgages and Vices (average at PhP4,300) which accounts for 20% of total HH monthly expenditure

b. Navotas Respondents

i. Of the 68 respondents, 28 (41%) are males and 40 females (59%);

ii. Civil Status: 44 (64%) are Married; 12 (18%) are single and 12 (18%) are widow/er;

iii. **Age** of Respondents

Table 3 Age Bracket of respondents (Navotas city)

Parameter	Age Bracket				
	15-30	31-45	46-65	Above 65	Total
Number	5	22	30	11	68
Percentage	7%	32%	44%	16%	100%

Source: JICA Study Team, Social/Institutional Survey, November 2013

iv. **Varied Income Sources:** 50 are employed either in private and government; seven are pensioners while the rest either have double sources or have varied sources of income (eg. Fishing, store, etc)

v. **Average Monthly Household Income:** PhP 10,520 for a family of 7

vi. **Average Monthly Household Expenditure:** PhP 25,086

vii. Overdraft (average of PhP14,566) is due to Loans and Mortgages and Vices (average at PhP8,374) and a higher expense on food and recreation

II. Flooding Experience of the Respondents

Table 4 shows the number and percentage of respondents for those affected by Typhoon Ondoy in September 2009 and the Habagat in August 2012 (based on the survey for the original eight barangays).

Table 4 Flooding Experience of the Respondents

City	Affected		Not Affected		TOTAL
	Number	% of total	Number	% of total	
Malabon	62	97%	2	3%	64
Navotas	38	86%	6	14%	44
Total	100	93%	8	7%	108

Note: Dampalit in Malabon city affected by Pedring in 2011 but not Ondoy.

Source: JICA Study Team, Social/Institutional Survey, November 2013

The following table shows the Effects of Flooding (Normal Condition) based on the Three Additional Barangays Surveyed. Statistics have generally shown improvement of the conditions from before 2008 to the present (2013) periods.

Table 5 Effects of Flooding (Normal Condition)

City/ Barangay	Before 2008 (Normal)				After 2008 (Normal)				Present (2013) – Normal			
	Neck	Waist	Knee	Ankle	Neck	Waist	Knee	Ankle	Neck	Waist	Knee	Ankle
Navotas												
Banculasi	1	3	6	6	0	1	8	4	0	1	1	10
San Jose	0	1	3	3	0	1	3	4	0	1	3	3
Subtotal	**1**	**4**	**9**	**9**	**0**	**2**	**11**	**8**	**0**	**2**	**4**	**13**
Malabon												
Maysilo	1	1	12	1	1	2	8	1	1	2	8	1
Tinajeros	1	0	2	3	0	2	1	3	0	1	1	2
Subtotal	**2**	**1**	**14**	**4**	**1**	**4**	**9**	**4**	**1**	**3**	**9**	**3**
Total	**3**	**5**	**23**	**13**	**1**	**6**	**20**	**12**	**1**	**5**	**13**	**16**

Source: JICA Study Team, Social/Institutional Survey, November 2013

Table 6 shows the Effects of Flooding (Extreme Condition): Based on the Three Additional Barangays Surveyed. Statistics have generally shown improved conditions from before 2008 to the present (2013) periods.

Table 6 Effects of Flooding (Extreme Condition)

City/ Barangay	Before 2008 (Extreme)				After 2008 (Extreme)				Present (2013) - Extreme			
	Neck	Waist	Knee	Ankle	Neck	Waist	Knee	Ankle	Neck	Waist	Knee	Ankle
Navotas												
Bangculasi	0	5	6	2	0	3	9	2	0	3	9	2
San Jose	1	3	0	2	1	2	2	2	1	2	2	2
Subtotal	**1**	**8**	**6**	**4**	**1**	**5**	**11**	**4**	**1**	**5**	**11**	**4**
Malabon												
Maysilo	11	11	13	4	8	2	0	0	8	0	0	0
Tinajeros	1	3	1	0	5	1	0	1	5	1	0	1
Subtotal	**12**	**14**	**14**	**4**	**13**	**3**	**0**	**1**	**13**	**1**	**0**	**1**
Total	**13**	**22**	**20**	**8**	**14**	**8**	**11**	**5**	**14**	**6**	**11**	**5**

Source: JICA Study Team, Social/Institutional Survey, November 2013

In terms of the estimated damage in times of flooding, the Table shows the average estimated value for the original and additional barangays. Highest damage is to property, followed by business and sickness to family, respectively.

Table 7 Estimated damage in times of flooding

Barangays	Estimated Value (PhP) of Adverse Effect of Flooding		
	Sickness to the Family	Damage to Property	Damage to Business
Original	8,215.28	13,024.00	4,641.67
Additional	2,638.46	22,750.00	27,710.00
Average	**5,426.87**	**17,887.00**	**16,175.83**

Source: JICA Study Team, Social/Institutional Survey, November 2013

When the respondents were asked what they would do in times of flooding, the table below shows the details of actions that the respondents would take.

Table 8 Details of actions that the respondents would take

City/ Barangay	Action Taken in Times of Flooding				
	Call Barangay Official	Go to Evacuation Center	Arrange things not to be reached by flood water	Go to relatives outside flooded area	Others
Malabon City	**39**	**29**	**74**	**20**	Use submersible pump Prepare emergency equipment Use early warning system Help Others
Catmon	9	6	11	3	
Dampalit	1	2	8	1	
Hulong Duhat	6	4	7	3	
Maysilo	8	6	13	4	
Tanong	6	5	19	7	
Tinajeros	2	3	8	0	
Tonsuya	7	3	8	2	
Navotas City	**27**	**21**	**43**	**12**	
Bangculasi	12	12	12	5	
North Bay Boulevard-North	2	1	10	0	
North Bay Boulevard-South	4	1	8	1	
San Jose	7	5	7	3	
Tangos	2	2	6	3	
Grand Total	**66**	**50**	**117**	**32**	

Source: JICA Study Team, Social/Institutional Survey, November 2013

III. Awareness of Existing Flood Control Structures

The majority (105 out of 157 or about 67%) are aware of the existence of the flood control and drainage structures while about 33 % (52) are not, as shown in Table 9. A total of 99 or about 59% say that DPWH implements these flood structures while about 21% (33) say the LGU while 9 respondents or 6 percent do not know who. It is noted that the MMDA was mentioned in Maysilo.

Table 9 Awareness on Existing Flood Control Structures

City	Awareness		Who Built the Flood Structures			
	No	Yes	LGU	DPWH	Don't Know	Others
Malabon	26	63	19	57	2	MMDA
Navotas	26	42	14	36	7	
Total	**52**	**105**	**33**	**93**	**9**	
Percentage	**33%**	**67%**	**21%**	**59%**	**6%**	

Source: JICA Study Team, Social/Institutional Survey, November 2013

The following are the flood control structures identified by the respondents during the social survey conducted.

Table 10 Flood control structures identified by respondents

City/ Barangay	Flood Structures ID by Respondents				
	Earth Dike	Concrete Wall	Flood Gates	Pumping Station	Others
Malabon City	**39**	**46**	**33**	**69**	Submersible Pump
Catmon	6	8	4	13	
Dampalit	8	2	3	7	
Hulong Duhat	3	6	5	9	
Maysilo	8	11	9	12	
Tanong	4	16	6	13	
Tinajeros	0	1	1	4	
Tonsuya	10	2	5	11	
Navotas City	**7**	**27**	**31**	**53**	
Banculasi	1	2	7	12	
North Bay Boulevard-North	5	10	9	16	
North Bay Boulevard-South	1	11	3	13	
San Jose	0	1	4	7	
Tangos	0	3	8	5	
Grand Total	**46**	**73**	**64**	**122**	
Rank	**4**	**2**	**3**	**1**	

Source: JICA Study Team, Social/Institutional Survey, November 2013

Moreover, the survey also revealed that the LGUs also extend assistance to the residents affected by flooding and other type of disasters. Table 11 presents said forms of assistance extended by the local governments. The top common answers are the giving of relief goods, medical assistance and provision of evacuation center/s.

Table 11 Form of Assistance by the Barangay LGU

City/ Barangay	Form of Assistance by the Barangay Local Government Unit					
	Giving of Relief Goods	Rescue	Evacuation Center	Medical Assistance	Financial Assistance	Early Warning System
Malabon City	**63**	**25**	**30**	**33**	**10**	13
Catmon	12	1	5	3	3	0
Dampalit	7	1	1	5	0	0
Hulong Duhat	7	3	1	5	0	0
Maysilo	12	8	8	8	6	6
Tanong	11	4	7	1	0	0
Tinajeros	7	2	4	5	1	7
Tonsuya	7	6	4	6	0	0
Navotas City	**31**	**10**	**17**	**28**	**9**	**17**
Banculasi	9	7	9	12	6	9
North Bay Boulevard-North	8	0	1	9	1	2
North Bay Boulevard-South	4	1	1	0	0	0
San Jose	5	1	6	7	1	5
Tangos	5	1	0	0	1	1
Grand Total	**94**	**35**	**47**	**61**	**19**	**30**

Source: JICA Study Team, Social/Institutional Survey, November 2013

IV. Assessment of Present Condition of Environment

A total of 83 or 53% of the respondents said that the condition of the environment has improved while 68 or 43% said that the situation of the environment was getting worse. A total of 6 of the respondents opted not to answer. Reasons for the improvement and the getting worse of the environment are shown in the table below.

Table 12 Assessment of Present Condition of Environment

	Assessment		
	Has Improved	Getting Worse	No Answer
Malabon City	**28**	**56**	**5**
Catmon	3	12	0
Dampalit	5	3	1
Hulong Duhat	7	2	0
Maysilo	2	12	0
Tanong	7	13	1
Tinajeros	4	4	1
Tonsuya	0	10	2
Navotas City	**55**	**12**	**1**
Bangculasi	13	1	0
North Bay Boulevard-North	22	1	0
North Bay Boulevard-South	8	6	1
San Jose	6	1	0
Tangos	6	3	0
Grand Total	**83**	**68**	**6**

Reason	
Why It has Improved	Why Getting Worse
1. Good Flood Control Project	1. There is still flooding
2. Flood control project has served but not enough	2. The problem on flood is getting worst
3. Megadike helped in controlling floods	3.Sometimes the gates and pumping station are unserviceable
4. Active pumping station	4. There is flood when it rains
5. The water recedes quickly after heavy rains	5. Because they can't prevent the continuous flooding

Source: JICA Study Team, Social/Institutional Survey, November 2013

A total of 120 or 76% of the respondents were willing to participate in improving the flood control management in their area while the remaining 24% (or 37 respondents) either answered no or opted not to answer. The table below shows the type of participation that they were willing to do.

Table 13 Type of participation that they were willing to do

City/ Barangay	Willingness to Participate to Improve Flood Management				
	No or No Answer	Yes	Implementation of HH Waste Segregation	Consultations on Planning, M&E	Community Cleaning
Malabon City	**27**	**62**	**32**	**42**	**30**
Catmon	1	14	6	12	4
Dampalit	5	4	1	4	1
Hulong Duhat	3	6	1	4	0
Maysilo	4	10	10	14	13
Tanong	7	14	3	7	2
Tinajeros	0	9	9	0	9
Tonsuya	7	5	2	1	1
Navotas City	**10**	**58**	**26**	**30**	**32**
Bangculasi	0	14	13	13	13
North Bay Boulevard-North	7	16	2	4	10
North Bay Boulevard-South	1	14	4	7	1
San Jose	1	6	4	5	6
Tangos	1	8	3	1	2
Grand Total	**37**	**120**	**58**	**72**	**62**
Percentage	**24%**	**76%**			
Rank			**3**	**1**	**2**

Source: JICA Study Team, Social/Institutional Survey, November 2013

Annex 3

Annex 3.1:
Presentation material for Joint Workshop on KAMANAVA Project with LGUs

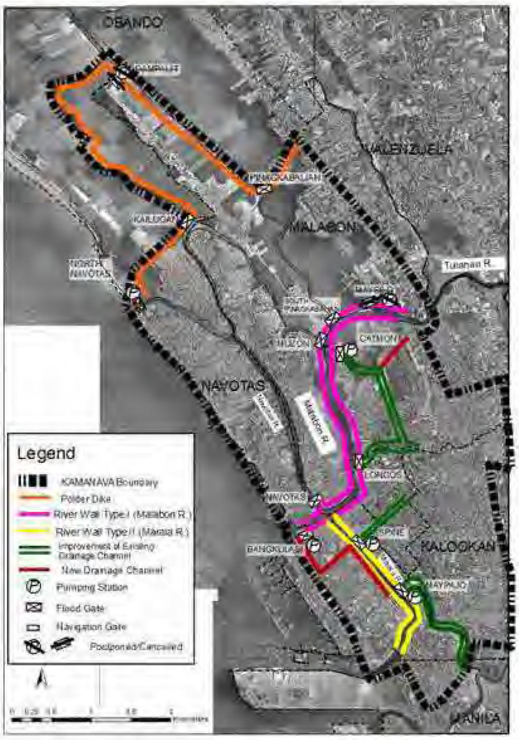
Joint Workshop on KAMANAVA Project with LGUs

DPWH

Today's Contents

- Background
- Results of SAPS
- Discussion of preconditions and common issues

Background ~ KAMANAVA Project

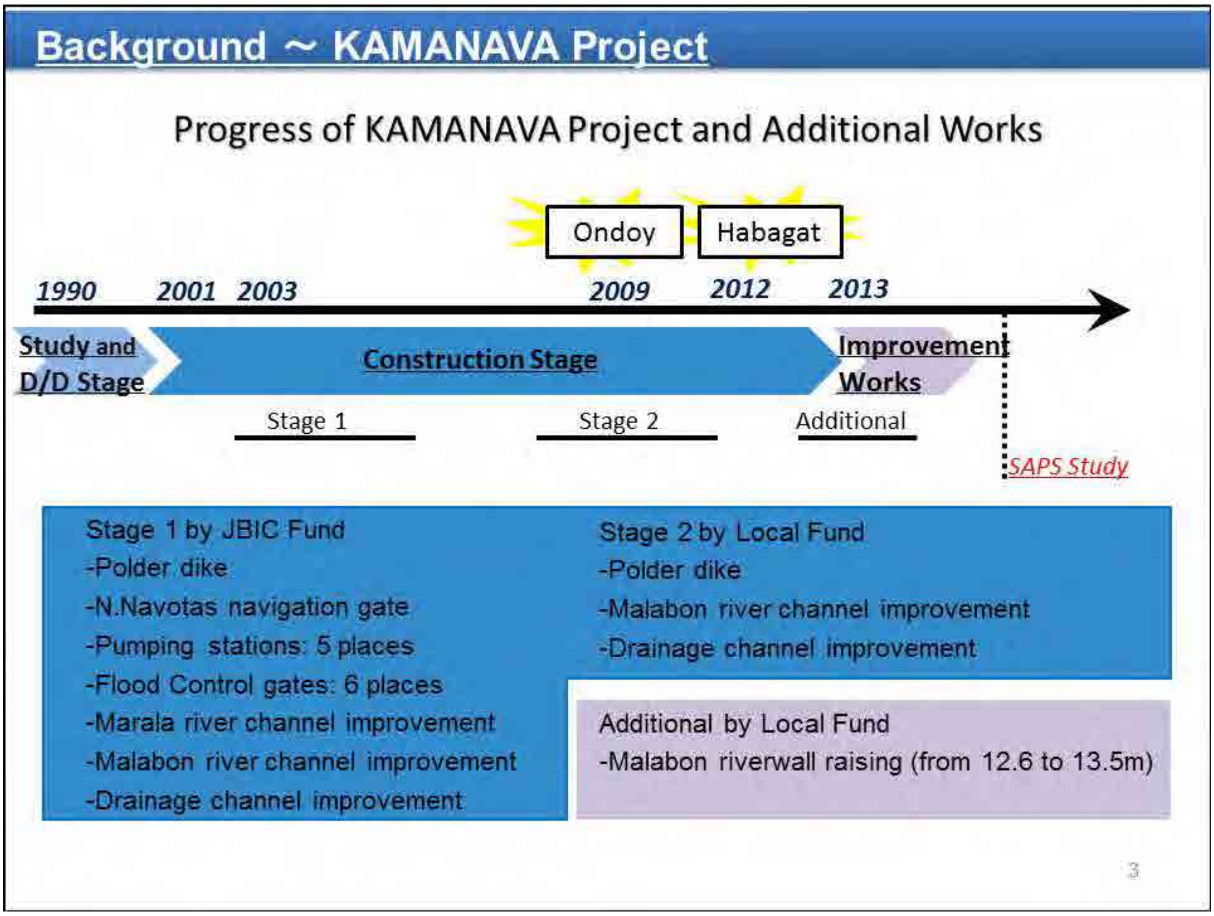


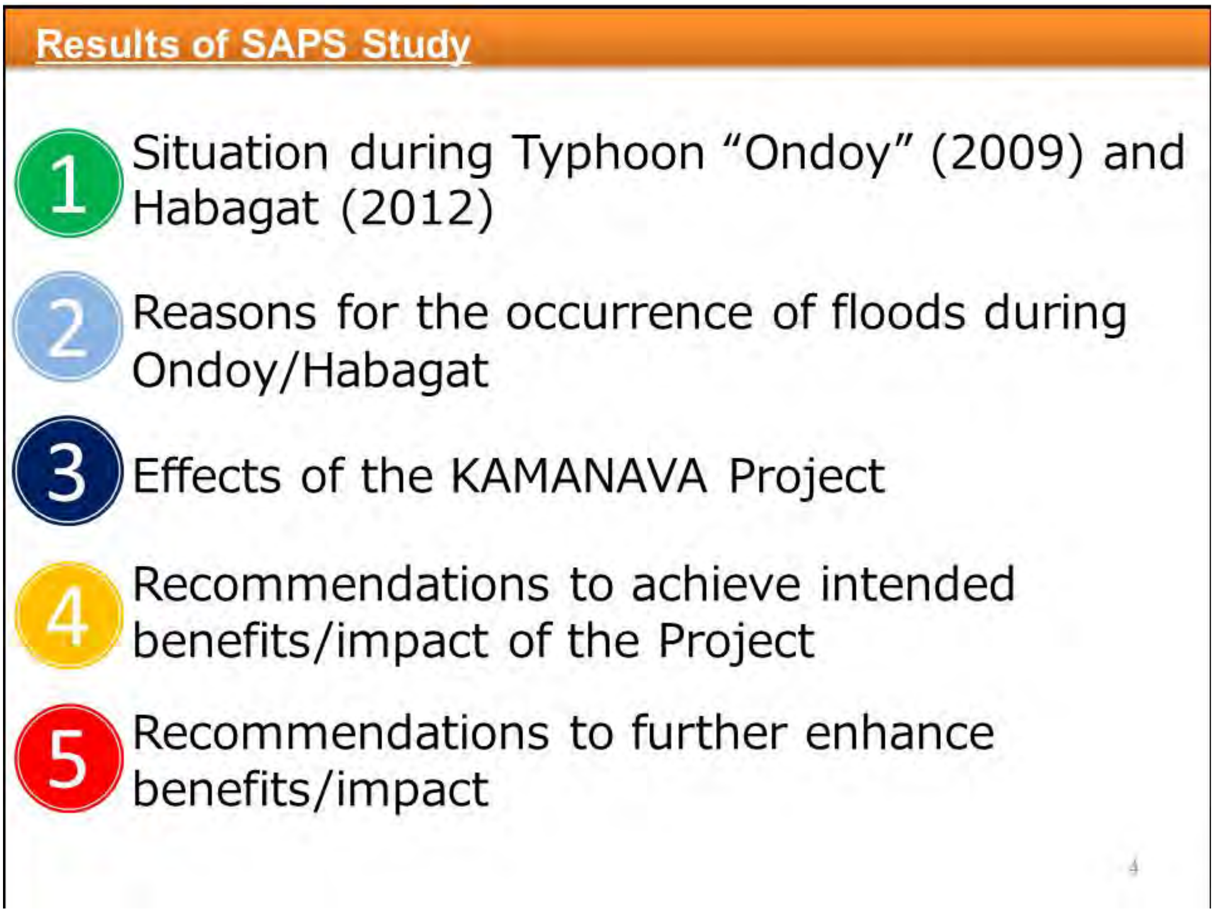
- KAMANAVA Project

Description	Planning	Design	Completion
	-2000	-2001	-2012
Polder Dike	8.0 km	8.6 km	Same as in design.(Partly accomplished using JICA funds. Balance completed using GOP funds)
Raising of River walls	12.4 km(two types only)	Malabon River 6.6 km (9 types) Marala River 3.9 km(3 types)	-do-
Navigation Lock/Gate	One Navigation Lock (facilitate navigation during	One Navigation Gate (navigation limited to low tide period only)	Same as in design.(Fully completed using JICA funds)
Pumping Stations without Flood Gates	1 Unit (adjacent to Navigation Lock)	1 Unit (adjacent to Navigation Gate)	-do-
Independent Flood Gates	6 Units	6 Units	-do-
Control Gates	2 Units	Nil	-do-
Pumping Stations with Flood Gates	6 Units	4 Units(Pumping Stations at Dampalit & South Pinagkabalian deferred)	-do-
Improvement of Existing Drainage Channels	6.4 km	5.6 km	-do-
New Drainage Channels	1.8 km	2.1 km	Same as in design.(Fully completed using JICA funds)

- Related Proiects

Description	Planning	Design	Completion
	-2000	-2001	-2012
Raising of Bridges by DPWH	Bangkulasi	Bangkulasi	Not raised yet
	Tonsuya	Tonsuya	-do-
	Lambingan	Lambingan	Being raised
	Tenejeros	Tenejeros	Not raised yet
Secondary & Tertiary Drainage by LGUs	Scope not quantified	Scope not quantified	
Solid Waste Management by LGUs	Scope not quantified	Scope not quantified	On-going
Dredging of Malabon River	Scope not quantified	Scope not quantified	Not yet

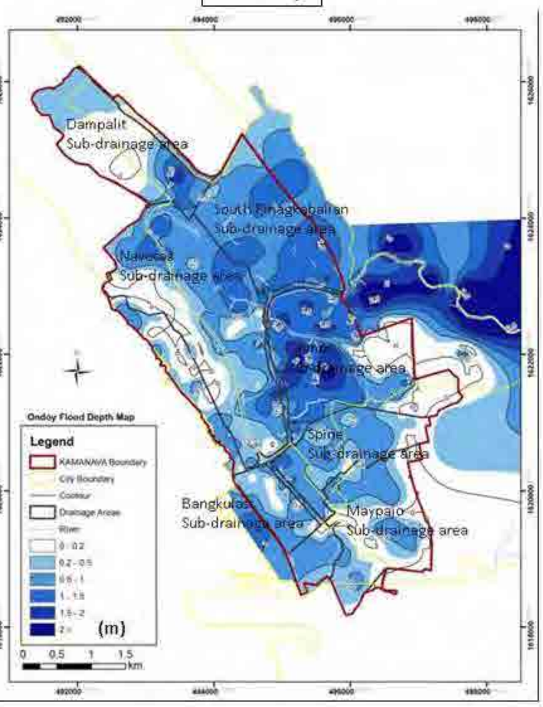

Background ~ KAMANAVA Project
Progress of KAMANAVA Project and Additional Works
Ondoy
Habagat
1990
2001
2003
2009
2012
2013
Study and D/D Stage
Construction Stage
Improvement Works
Stage 1
Stage 2
Additional
SAPS Study
Stage 1 by JBIC Fund
-Polder dike
-N.Navotas navigation gate
-Pumping stations: 5 places
-Flood Control gates: 6 places
-Marala river channel improvement
-Malabon river channel improvement
-Drainage channel improvement
Stage 2 by Local Fund
-Polder dike
-Malabon river channel improvement
-Drainage channel improvement
Additional by Local Fund
-Malabon riverwall raising (from 12.6 to 13.5m)
3


Results of SAPS Study
1 Situation during Typhoon “Ondoy” (2009) and Habagat (2012)
2 Reasons for the occurrence of floods during Ondoy/Habagat
3 Effects of the KAMANAVA Project
4 Recommendations to achieve intended benefits/impact of the Project
5 Recommendations to further enhance benefits/impact
4

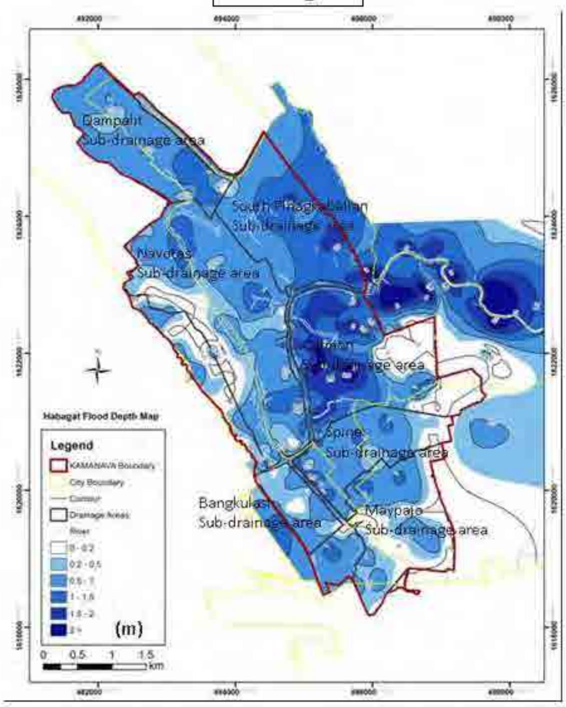
1 Situation during Typhoon "Ondoy" (2009) and Habagat (2012)

－Inundation depth

Ondoy



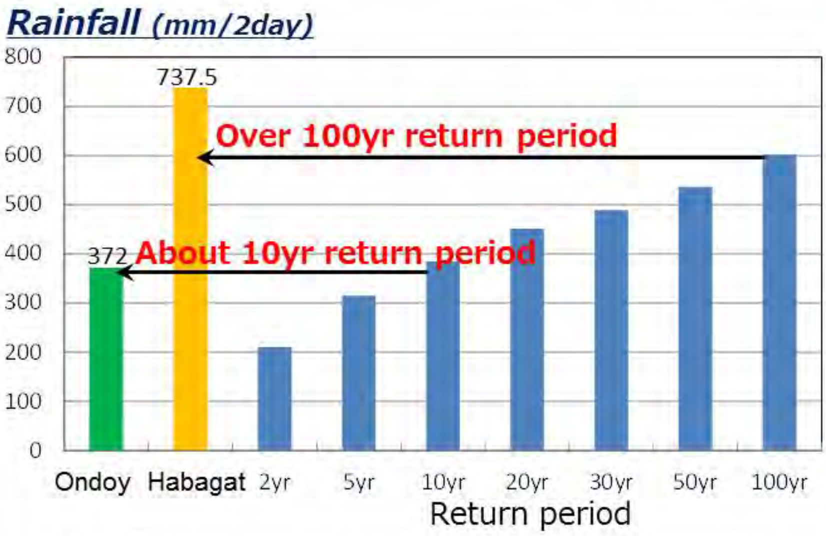
Habagat



5

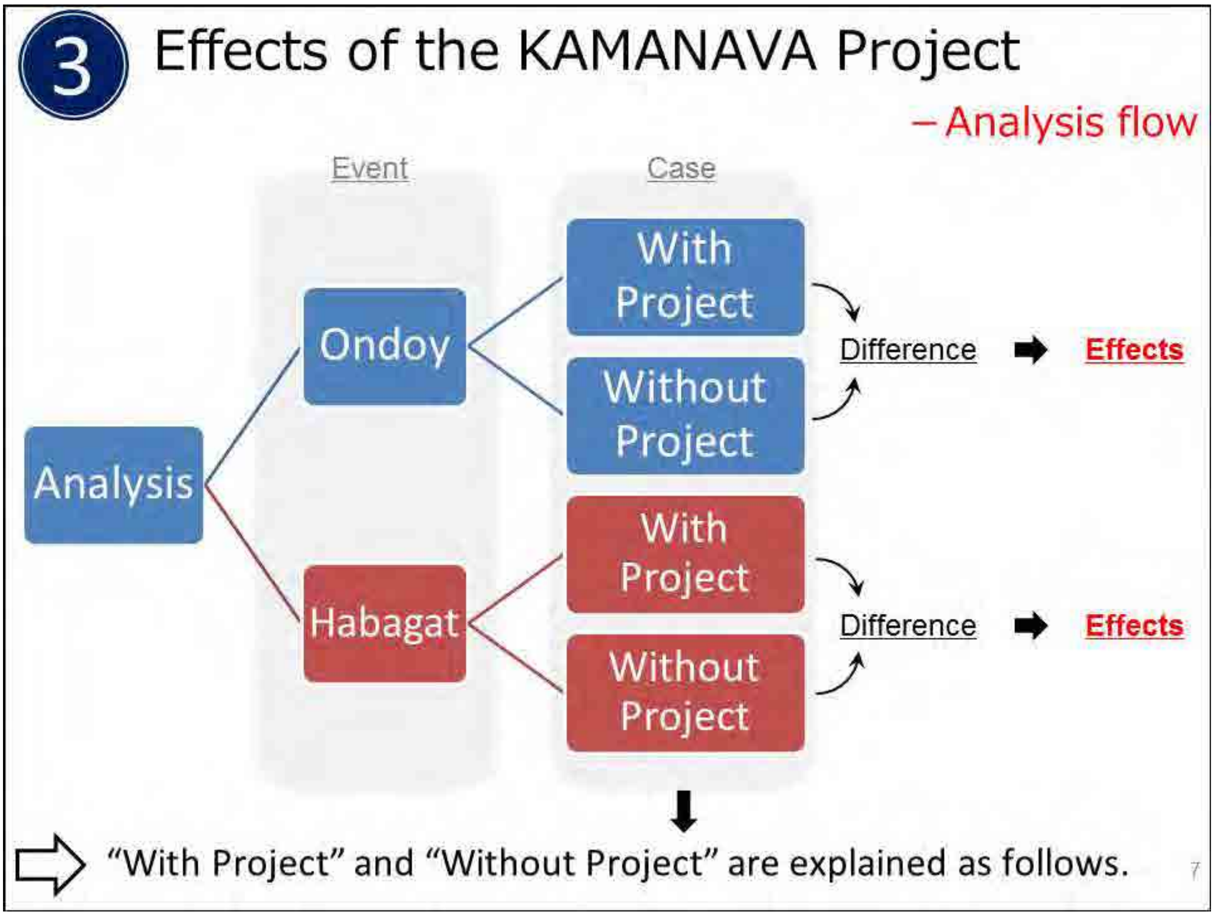
2 Reasons for the occurrence of floods during Ondoy/Habagat

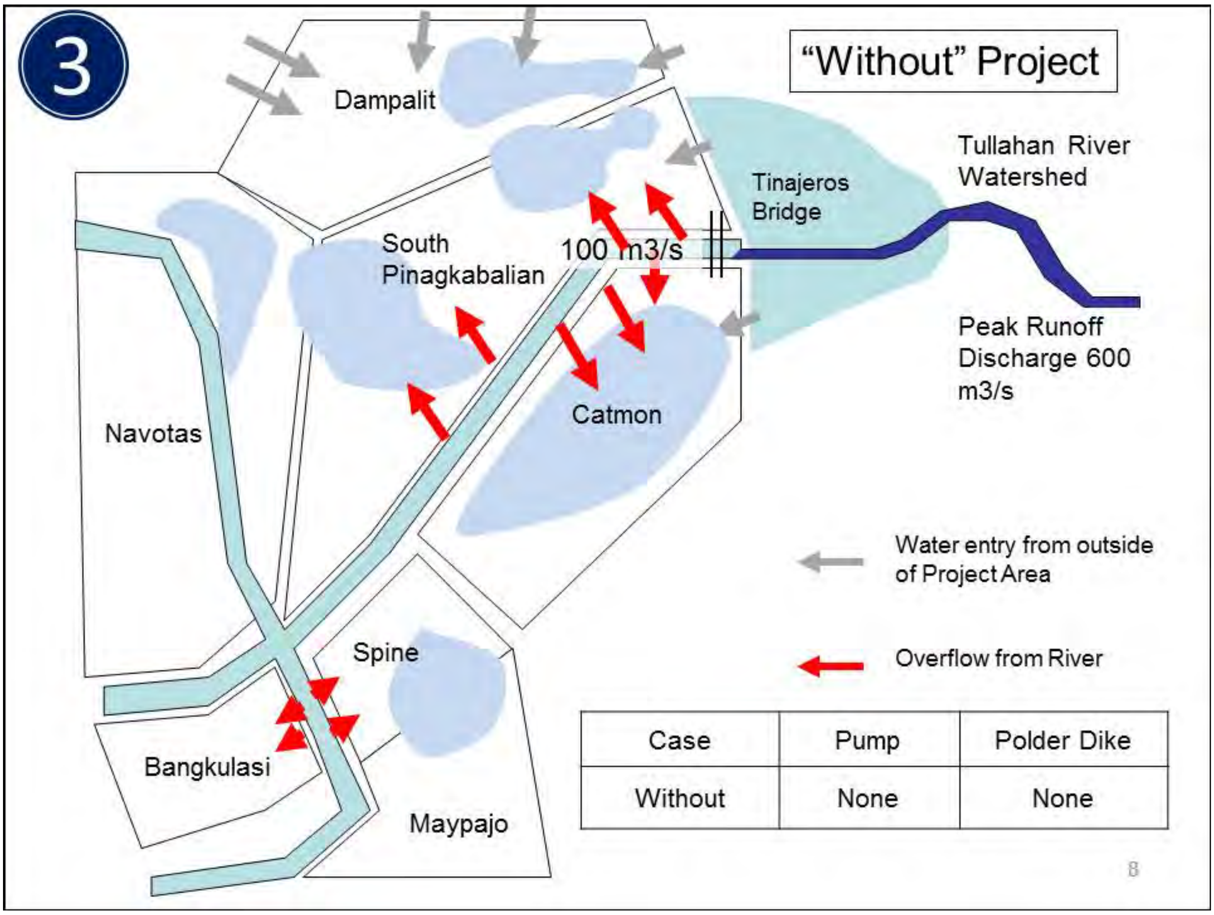
－Rainfall and Tide



- ◆ The rain and high tide were strong during Ondoy while way extreme during Habagat.
- ◆ These extreme conditions caused serious flooding in KAMANAVA area.

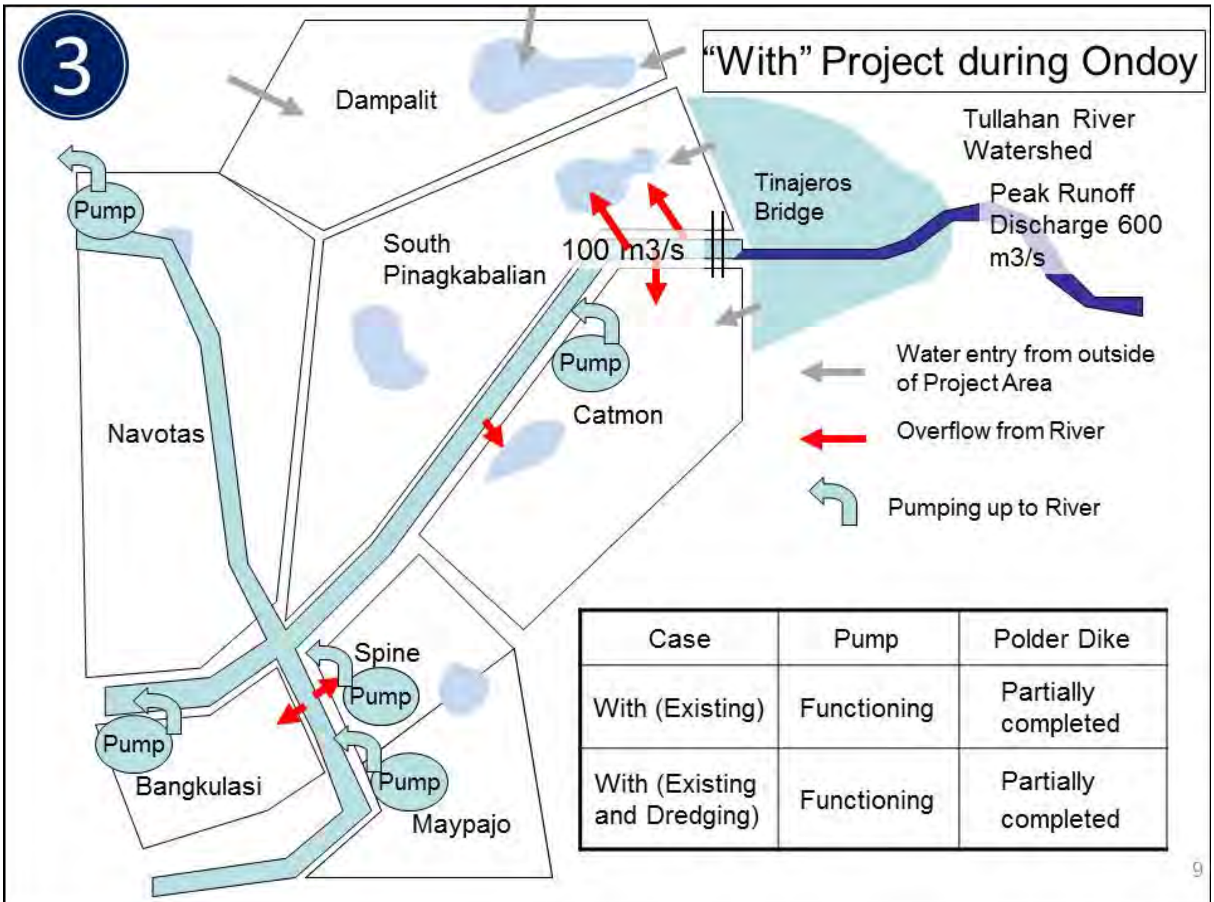
6


3
Effects of the KAMANAVA Project
– Analysis flow
Event
Case
Analysis
Ondoy
Habagat
With Project
Without Project
With Project
Without Project
Difference
Effects
Difference
Effects
"With Project" and "Without Project" are explained as follows.
7


3
"Without" Project
Dampalit
Tinajeros Bridge
Tullahan River Watershed
South Pinagkabalian
100 m3/s
Peak Runoff Discharge 600 m3/s
Navotas
Catmon
Water entry from outside of Project Area
Overflow from River
Spine
Bangkulasi
Maypajo
Case | Pump | Polder Dike
Without | None | None
8

3

"With" Project during Ondoy



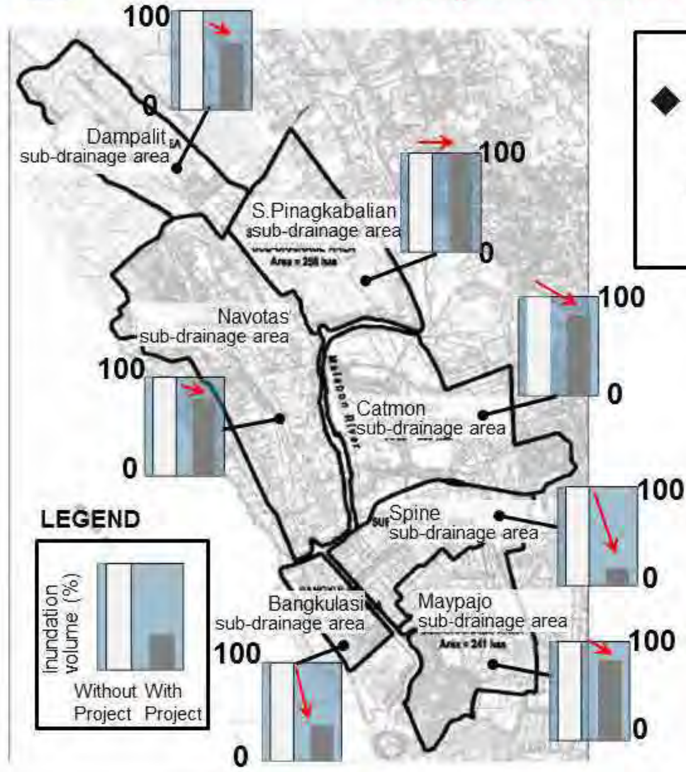
Case	Pump	Polder Dike
With (Existing)	Functioning	Partially completed
With (Existing and Dredging)	Functioning	Partially completed

9

3

Effects of the Project during Ondoy

Analysis of "With Project" and "Without Project"

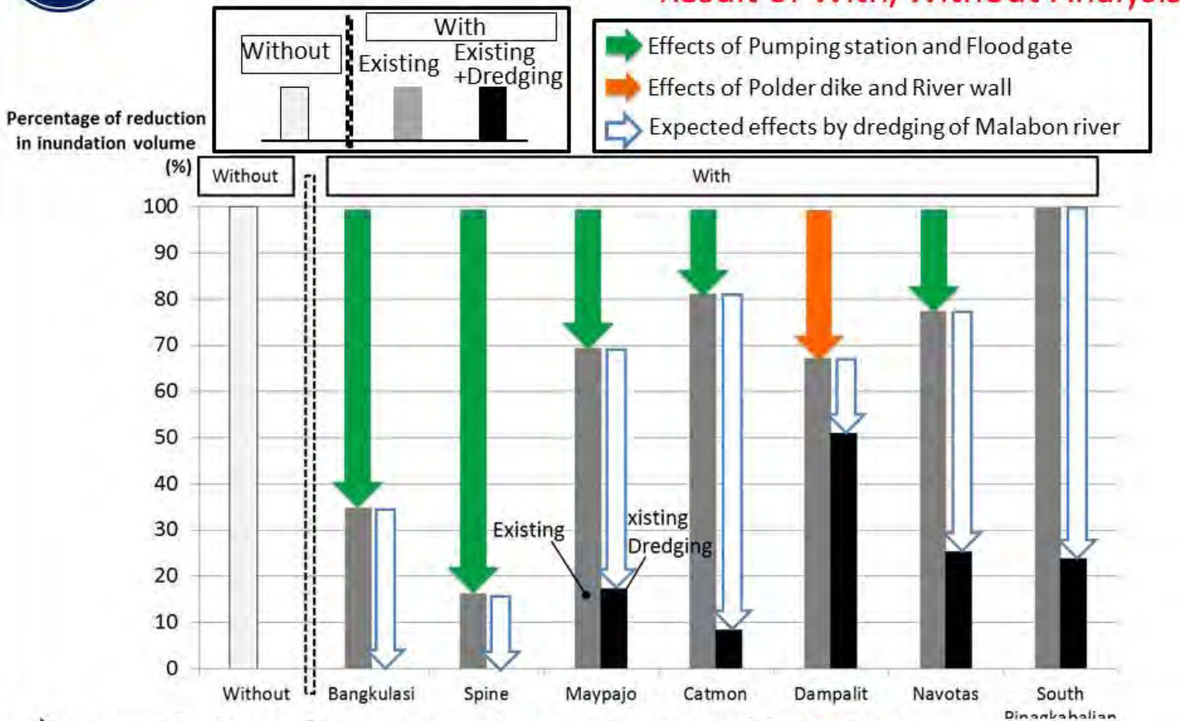


- Serious flood occurred but inundation reduced due to KAMANAVA Project

10

3 Effects of the Project during Ondoy

Result of With/Without Analysis



Inundation volume per unit area decreased by 26% on average.

It can be further decreased to 75% on average by Project with dredging.

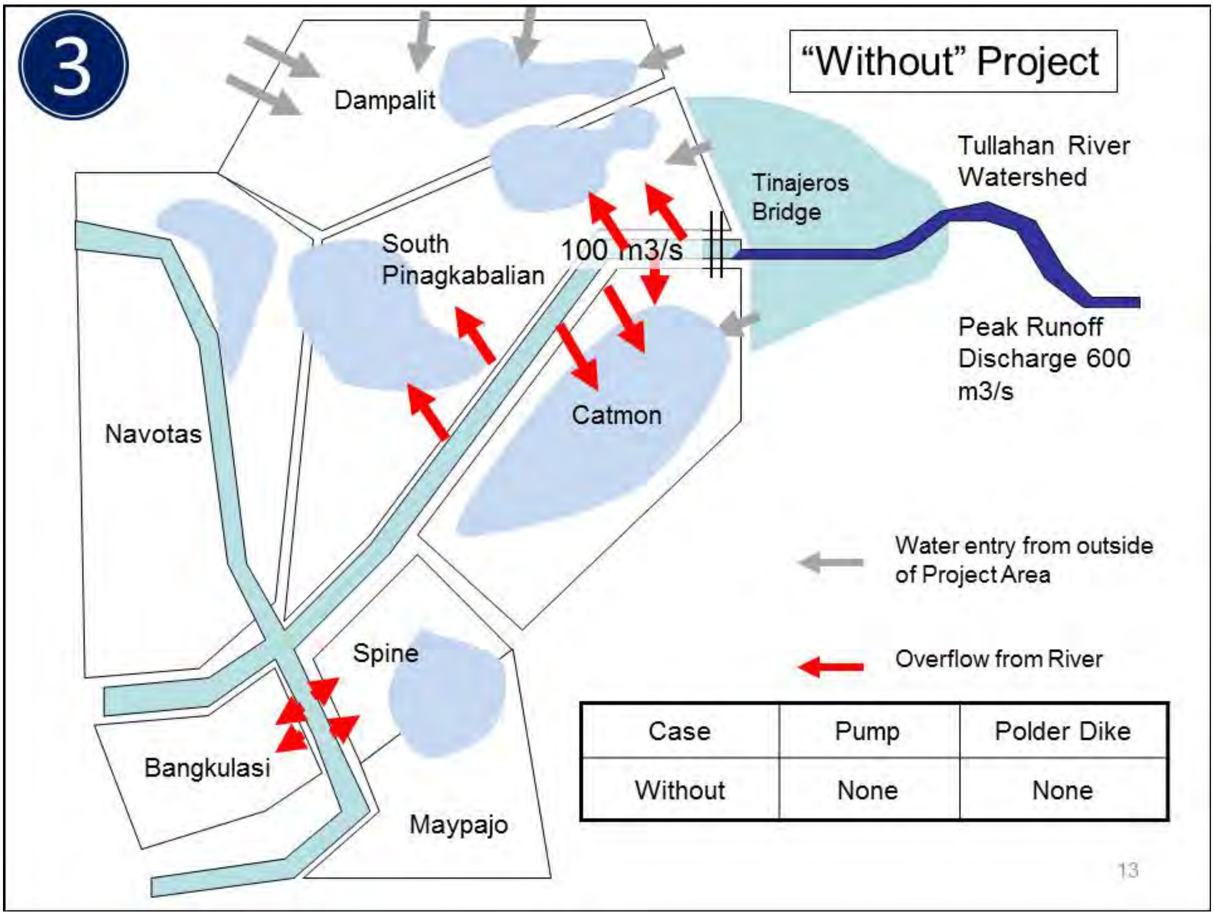
11

3 Effects of the Project during Ondoy

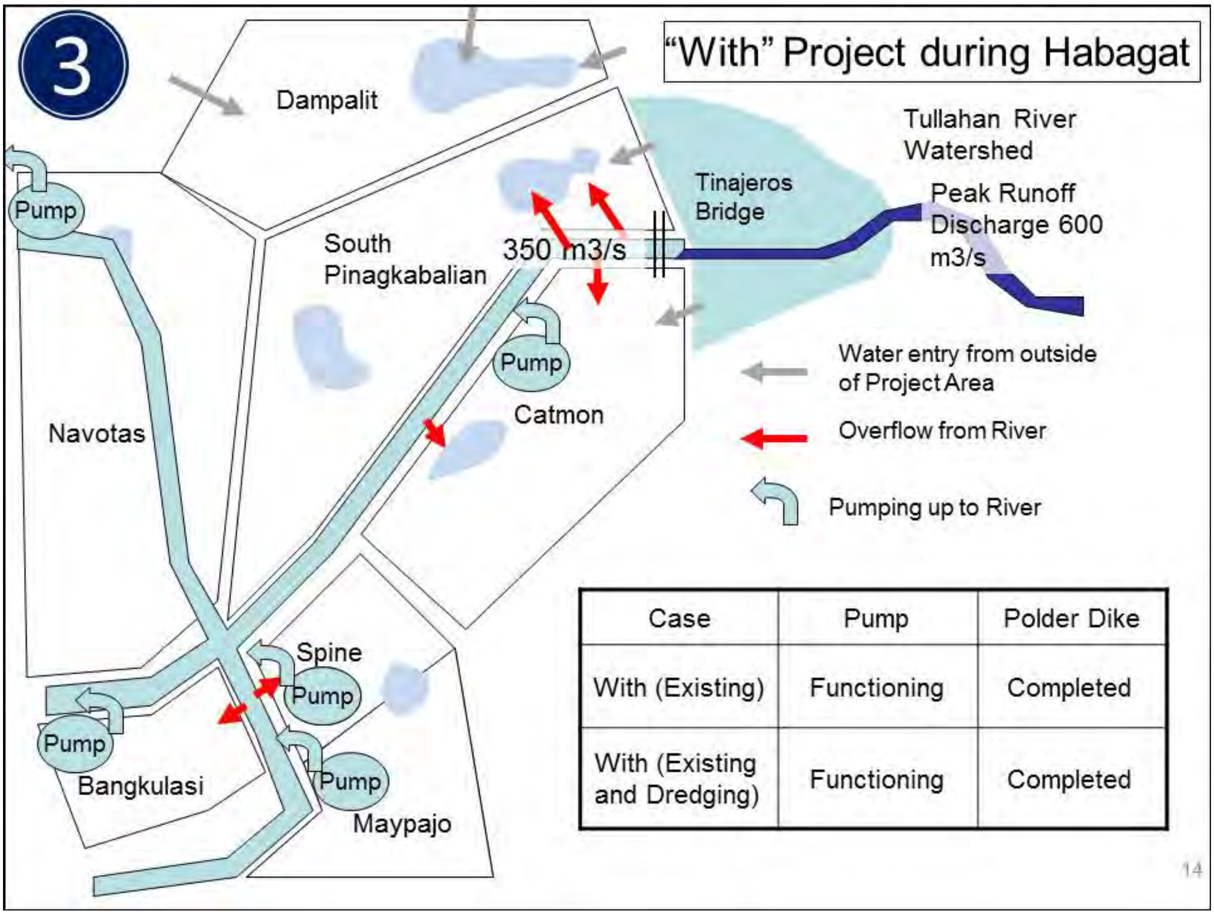
Findings from With/Without Analysis

1. If there were no Project, the average inundation volume would result to more than 1m depth, especially Dampalit, South Pinagkabalian and Catmon.
2. With the Project, the inundation volume in Project area decreased by 26% on average, mainly due to the pumps.
3. At the time of “Ondoy”, the channel capacity at upper reach of Malabon river is estimated to be 100 m^3/s only, so flood water had been overflowed into Catmon and South Pinagkabalian as well as Dampalit and caused inundation.
4. In Dampalit, the polder dike was not completed, so sea water entered in the Project area.
5. By dredging of Malabon river, the effects (reduction of inundation volume) would further be enhanced to 75% on average.

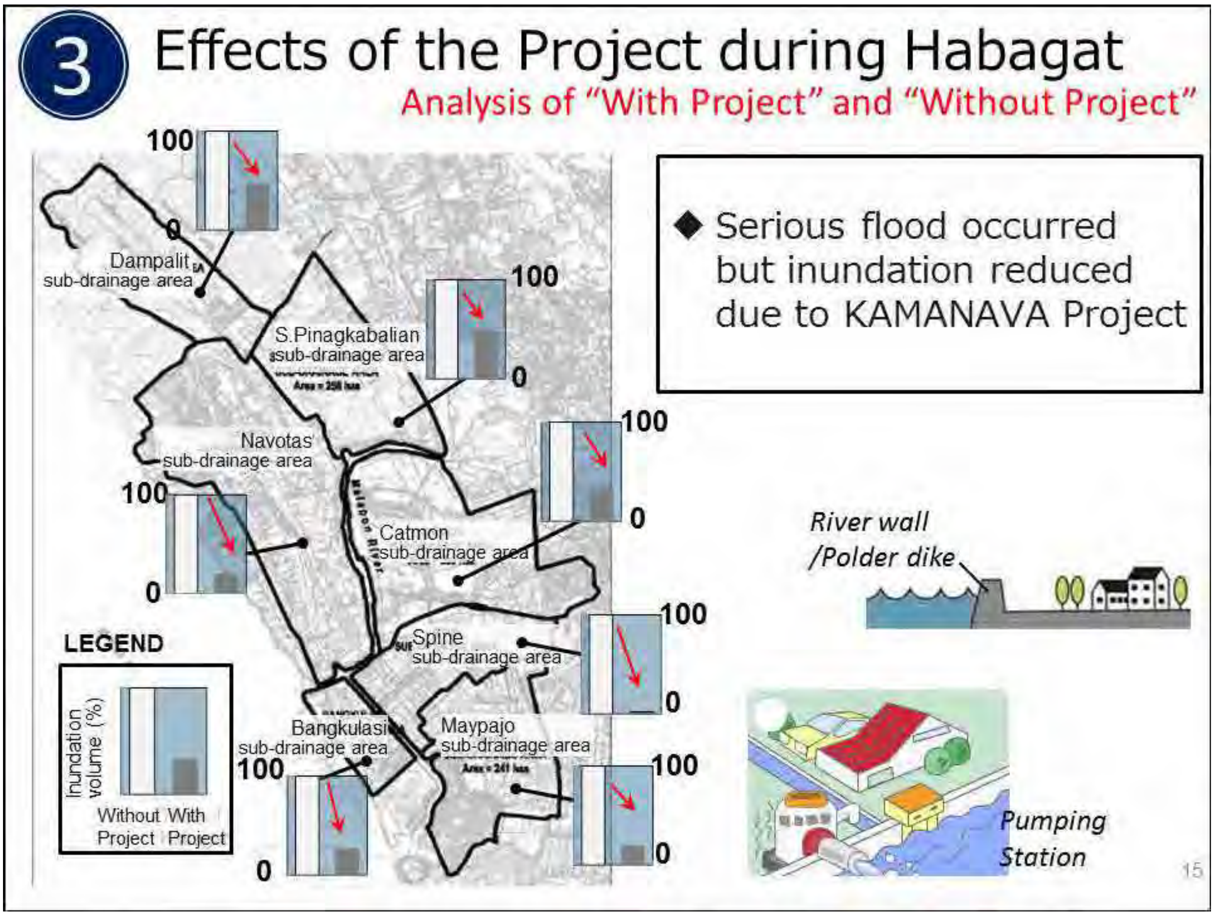
12

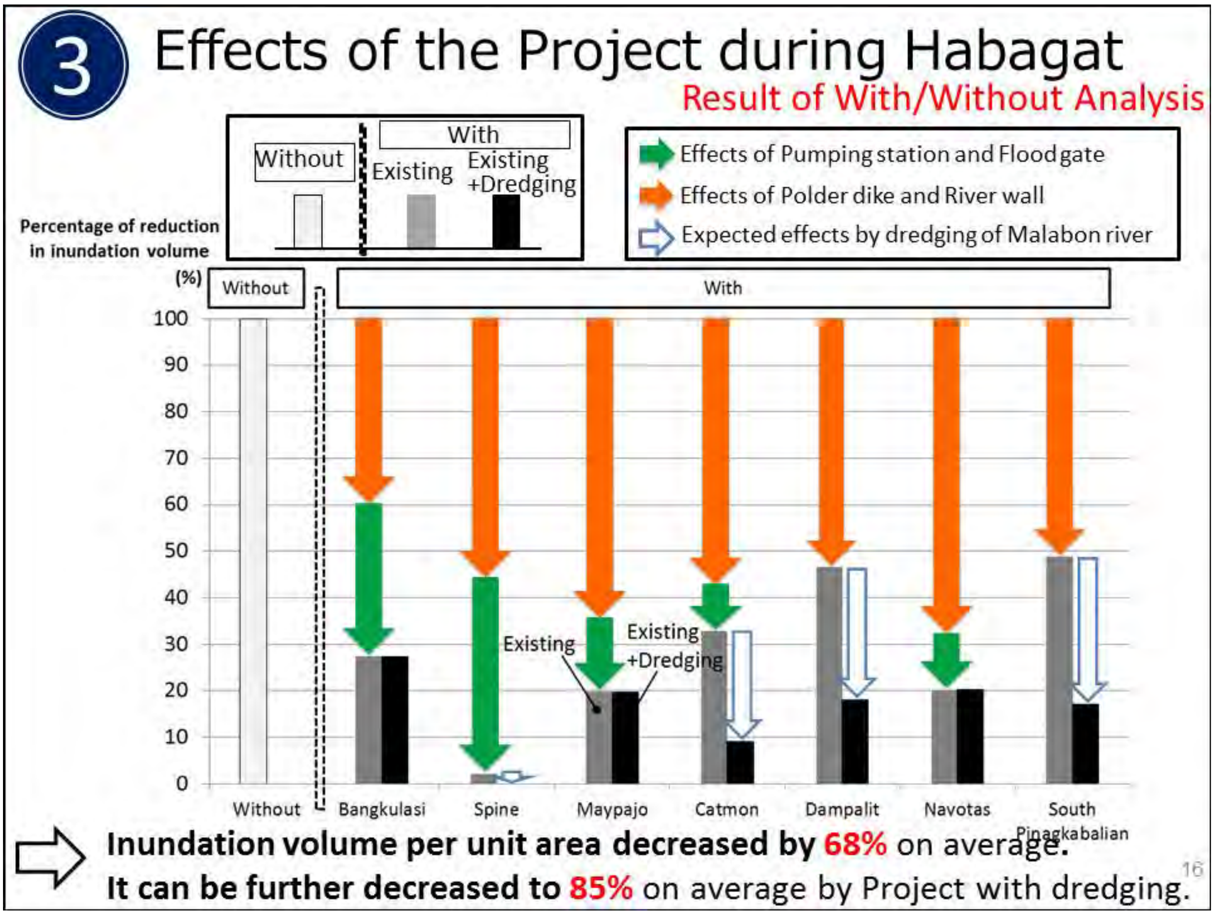


Case	Pump	Polder Dike
Without	None	None



Case	Pump	Polder Dike
With (Existing)	Functioning	Completed
With (Existing and Dredging)	Functioning	Completed


3
Effects of the Project during Habagat
Analysis of "With Project" and "Without Project"
Serious flood occurred but inundation reduced due to KAMANAVA Project
Dampalit sub-drainage area
S.Pinagkabalian sub-drainage area
Navotas sub-drainage area
Catmon sub-drainage area
Spine sub-drainage area
Bangkulasi sub-drainage area
Maypajo sub-drainage area
Malabon River
LEGEND
Inundation volume (%)
Without Project
With Project
River wall /Polder dike
Pumping Station
15


3
Effects of the Project during Habagat
Result of With/Without Analysis
Without
With
Existing
Existing +Dredging
Percentage of reduction in inundation volume
Effects of Pumping station and Flood gate
Effects of Polder dike and River wall
Expected effects by dredging of Malabon river
(%)
100
90
80
70
60
50
40
30
20
10
0
Without
Bangkulasi
Spine
Maypajo
Catmon
Dampalit
Navotas
South Pinagkabalian
Inundation volume per unit area decreased by 68% on average.
It can be further decreased to 85% on average by Project with dredging.
16

3 Effects of the Project during Habagat

Findings from With/Without Analysis

1. If there were no Project, the average inundation volume would result to more than 2m depth, especially Dampalit, South Pinagkabalian and Catmon would have deep inundation.
2. With the Project, the inundation volume in Project area decreased by 68% on average, especially Spine, Maypajo and Navotas.
3. At the time of Habagat, the channel capacity at upper reach of Malabon river is estimated to be 350 m^3/s which is still less than design capacity, so flood water had been overflowed into Catmon and South Pinagkabalian as well as Dampalit and caused inundation. But with the Project, the inundation volume was decreased by 50% or more in all areas.
4. In Dampalit, the polder dike was completed, so no sea water entered in the Project area and only a very few polder dike sections allowed inflow.
5. By dredging of Malabon river, the effects (reduction of inundation volume) would be further enhanced to 85% on average. However, the overflow of Malabon and Marala rivers due to high tide resulted into remaining inland inundation condition in Bangkulasi and Maypajo.

17

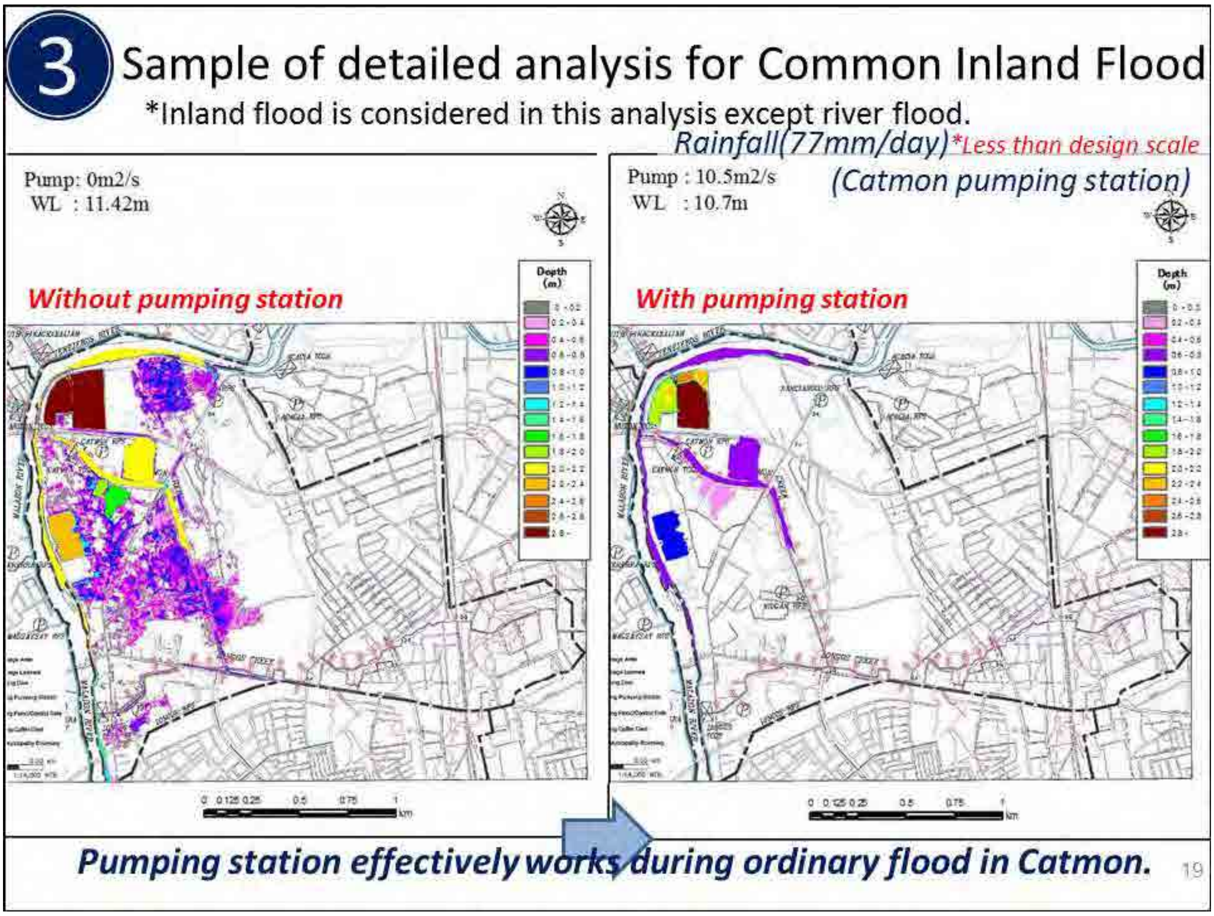
3 Effects of the KAMANAVA Project

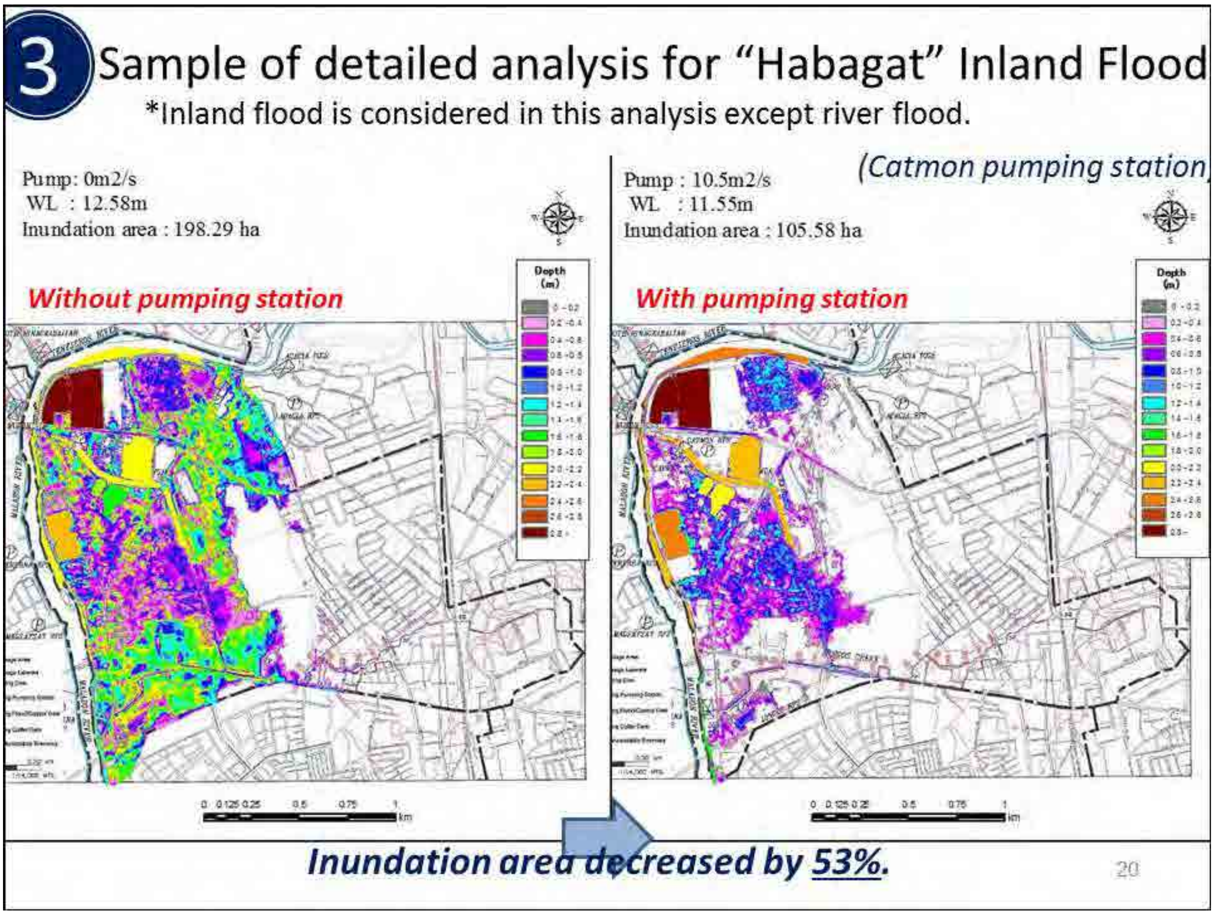
Conclusion

		2009 typhoon "Ondoy"	2012 Monsoon (Habagat)
Condition	Rainfall	About 10year return period	Over 100year return period
	Tide	Over design level	Way beyond design level
	Summary	**Under extreme condition**	**Under very extreme condition**
Effectiveness (Existing)	Inundation volume	26% decrease on average	68% decrease on average
	Summary	**Certain effects were realized** *Project was not completed yet.	**Significant effects were realized**
Effectiveness (Existing and Dredging)	Inundation volume	75% decrease on average	85% decrease on average
	Summary	Enhancement and strengthening of facilities are needed for extreme flood condition as proposed by this Study.	

- During Ondoy and Habagat, because of heavy rain and high tide, serious flood occurred, but KAMANAVA Project contributed to reduction of inundation volume for both flood events.
- To enjoy the full effects of the Project and minimize future floods, dredging is considered the most viable measure.

18


3
Sample of detailed analysis for Common Inland Flood
*Inland flood is considered in this analysis except river flood.
Rainfall(77mm/day)*Less than design scale
Pump: 0m2/s
WL : 11.42m
Without pumping station
Pump : 10.5m2/s
WL : 10.7m
(Catmon pumping station)
With pumping station
Depth (m)
Pumping station effectively works during ordinary flood in Catmon.
19


3
Sample of detailed analysis for "Habagat" Inland Flood
*Inland flood is considered in this analysis except river flood.
Pump: 0m2/s
WL : 12.58m
Inundation area : 198.29 ha
Without pumping station
(Catmon pumping station)
Pump : 10.5m2/s
WL : 11.55m
Inundation area : 105.58 ha
With pumping station
Depth (m)
Inundation area decreased by 53%.
20

4 Recommendations to achieve intended benefits/impact of the Project(1/2)

Actions , Initiatives of DPWH		in charge		Status in 2014
		DPWH	LGU	
Coordinate	Periodical meeting with all concerned agencies for exchange of information on the Project			
Implement	Coordinate in the planning, design and implementation of structure measures such as river wall construction			
Implement	Raising of Lambingan bridge crossing Malabon river			Ongoing
Implement	Raising of Bangkulasi, Tonsuya, Tinajeros bridges crossing Malabon river			Planned
Implement	Dredging of the navigation route in Navotas river			
Implement	River bed dredging of Malabon river from Tinajeros bridge down to its junction with Navotas river			
Implement	Upgrading of the Polder Dike to Road dike			
Confirm	Confirm future land use plan in Malabon city, especially in Barangay Dampalit			
Implement	Construction of Dampalit and S.Pinagkabalian Pumping stations			

Structural measure   Non-Structural measure

21

4 Recommendations to achieve intended benefits/impact of the Project(2/2)

Actions , Initiatives of DPWH		in charge		Status in 2014
		DPWH	LGU	
Manage	Implement solid waste management in wider area covering the upstream areas.			
Implement	Improvement of secondary/tertiary drainage channels			
Maintain	Existing drainage channels (dredging)			
Monitor	Flood situation and operation of LGU's small pumping stations and gates			
Implement	Tide measurement at Bangkulasi Pumping station and North Navotas Navigation Gate			Ongoing

Structural measure   Non-Structural measure

22

5 Recommendations to further enhance benefits/impact (1/2)

Actions , Promoting of DPWH		in charge DPWH	in charge LGU	Status in 2014
Implement	River wall raising/ strengthening along Malabon and Marala river			Ongoing
Implement	River improvement works from Tinajeros bridge to Macarthur Highway along the Tinajeros-Tullahan River			Ongoing
Implement	Construction of Navotas coastal dike			Ongoing
Study/Design	Measures for retention of rainwater on site			
Formalizing/ upgrading	Upgrading of Longos Relief Pumping Station and expansion for Bangkulasi Pumping Station			

Structural measure   Non-Structural measure

23

5 Recommendations to further enhance benefits/impact (2/2)

Actions , Promoting of DPWH		in charge DPWH	in charge LGU	Status in 2014
Implement	Capacity building for operators of floodgate and pumping stations			Ongoing
Implement	Monitor discharge measurement at Tinajeros River and Malabon River			
Implement	Monitor rainfall measurement at North Navotas Navigation Gate, Pinagkabalian Floodgate, Muzon Floodgate, Catmon Pumping station, Spine, Maypajo, Bangkulasi Pumping station.			
Implement	Control/regulation of land use in and around retarding ponds			
Implement	Enhancement of flood-fighting activities (ex. Storing of Sand bag at Polder dike)			
Implement	Dissemination of Information on the Project to Barangay			

Structural measure   Non-Structural measure

24

Discussion ~Confirmation of precondition (undertaking)

DPWH

- Raising the bridges

Bridge Name	Current Status
Bangkulasi	In 2014 to be raised by DPWH-NCR
Tonsuya	In 2014 to be raised by DPWH-NCR
Lambingan	Raising ongoing by DPWH-NCR
Tinajeros	In 2014 to be raised by DPWH-NCR

- Dredging of Malabon river ➡ Main factors are shown in next page.

LGUs

- Tributary drainage system in the Project Area
  ➡ The problem is lack of fund.
- Solid Waste Management
  ➡ LGUs recognize the necessity for wide collaboration among LGUs (Quezon city, Valenzuela, Caloocan).
- Dredging of Navotas river
  ➡ To be discussed in Today's Open Forum.

25

Discussion ~Confirmation of precondition

On Dredging of Malabon River

- The necessity of the dredging of Malabon riverbed to accommodate the flood discharge for 30 years return period has been recognized since JICA Study in 1990.
- Therefore, while the dredging of the Malabon riverbed has not been included in the scope of work of KAMANAVA Project, it was already agreed that it is an important precondition to achieve the full effects of the Project.

26

Discussion ~Common issues among LGUs

The following 2 issues are regarded as transboundary/common issues between Navotas and Malabon cities.

1. North Navotas Navigation Gate Operation
2. Land use development and KAMANAVA Project

27

Discussion

1. North Navotas Navigation Gate Operation

LGU	Conflict of Interests in terms of gate closure elevation
Navotas	Due to the shallow water depth at EL.10.5m and livelihood of the residents, Navotas prefers higher gate closure elevation such as EL.11.5m.
Malabon	Due to many low elevation areas in the city, Malabon prefers lower gate closure elevation such as 10.5m as per Design.

Area below EL.10.5m

Area below EL.11.0m

Area below EL.11.5m

28

Discussion

1. North Navotas Navigation Gate Operation

- In Malabon, during high tide, the reverse flow from river to inland areas thru drainage channel causes inundation. So the gate closure level should be lower than the present EL.11.0m to avoid such situation. According to Malabon City, the gate closure level should be 10.5m as per design.
- One of the solutions discussed was dredging of Navotas river to lower the riverbed so that the ships can still pass through with the closure level at 10.5m.
- Another consideration in the gate closure level of is the livelihood of fisher folks (e.g. longer closure time of the gate will shorten the access time)

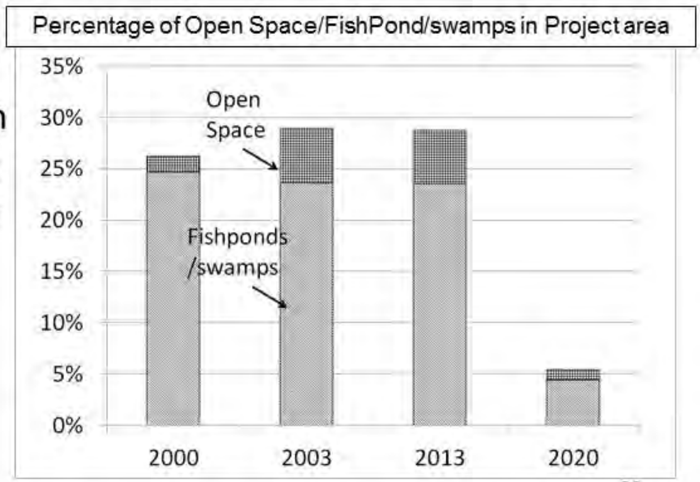
29

Discussion ~Common issues among LGUs

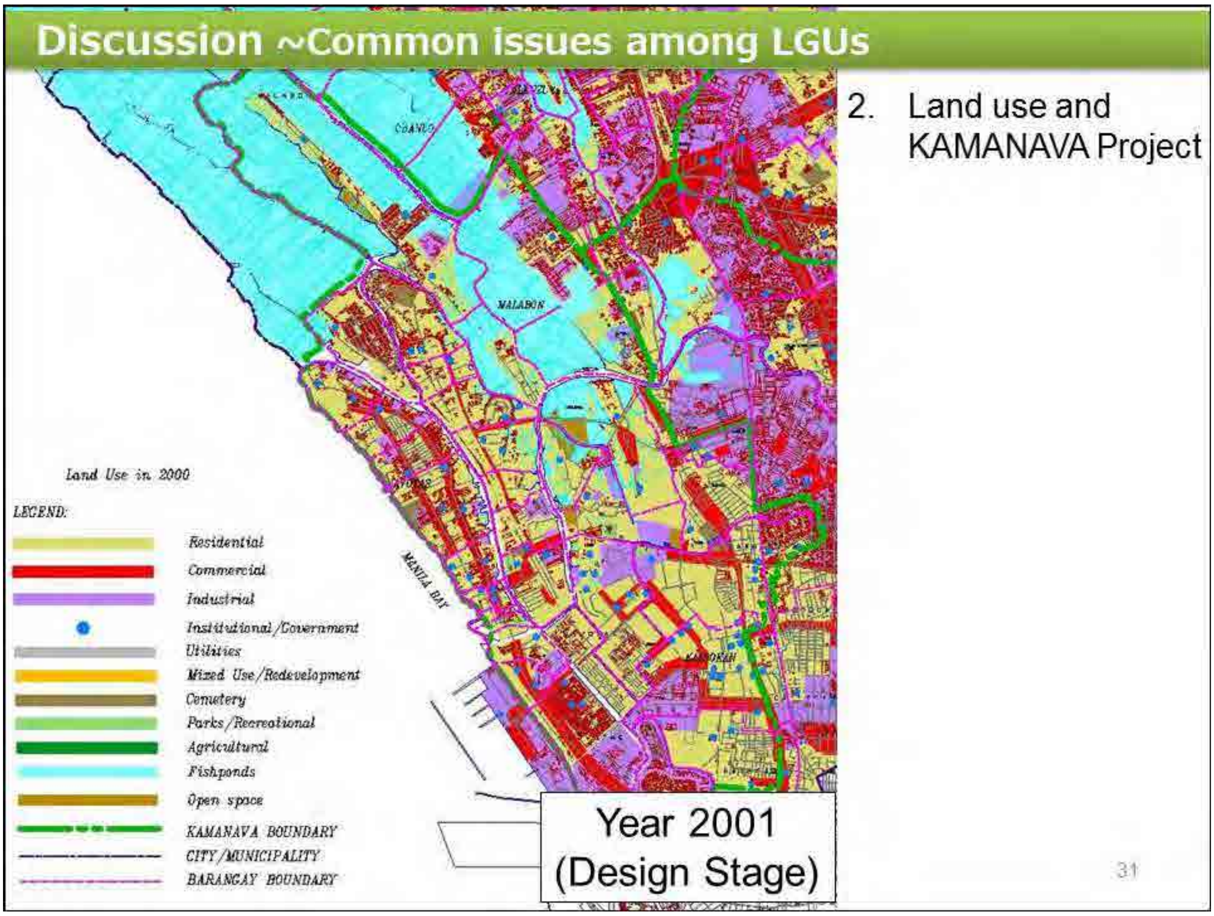
2. Land use and KAMANAVA Project

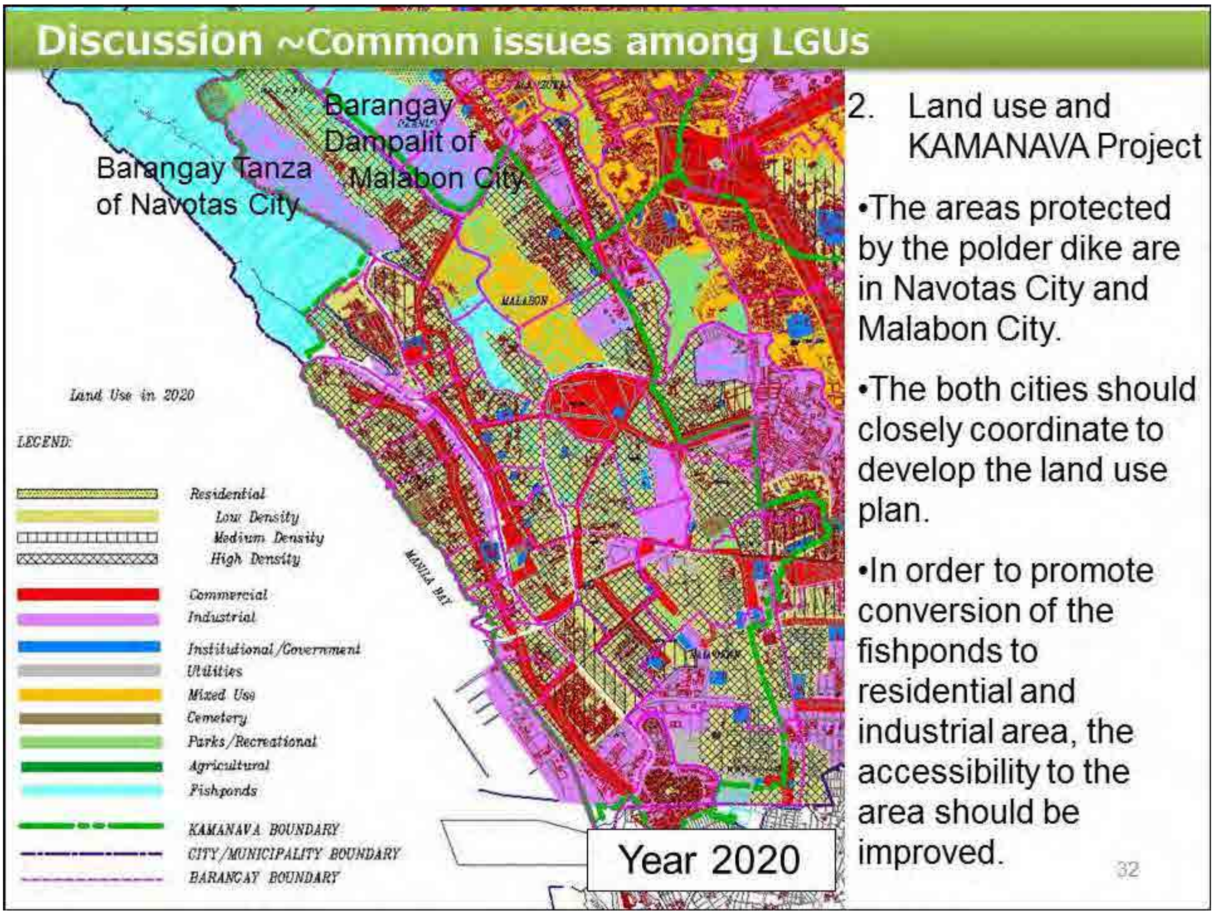
- The KAMANAVA Project assumed the open space and fishpond/swamps would decrease to 5 % in 2020.
- As of 2013 the percentage of open space and fishpond/swamps in the Project area has not decreased since 2003.

- Implementation of Dampalit Pumping Station was deferred considering the actual land use of the area.



30


Discussion ~Common issues among LGUs
2. Land use and KAMANAVA Project
MALABON
MANILA BAY
Land Use in 2000
LEGEND:
Residential
Commercial
Industrial
Institutional/Government
Utilities
Mixed Use/Redevelopment
Cemetery
Parks/Recreational
Agricultural
Fishponds
Open space
KAMANAVA BOUNDARY
CITY/MUNICIPALITY
BARANGAY BOUNDARY
Year 2001
(Design Stage)
31


Discussion ~Common issues among LGUs
2. Land use and KAMANAVA Project
•The areas protected by the polder dike are in Navotas City and Malabon City.
•The both cities should closely coordinate to develop the land use plan.
•In order to promote conversion of the fishponds to residential and industrial area, the accessibility to the area should be improved.
Barangay Tanza of Navotas City
Barangay Dampalit of Malabon City
MALABON
MANILA BAY
Land Use in 2020
LEGEND:
Residential
Low Density
Medium Density
High Density
Commercial
Industrial
Institutional/Government
Utilities
Mixed Use
Cemetery
Parks/Recreational
Agricultural
Fishponds
KAMANAVA BOUNDARY
CITY/MUNICIPALITY BOUNDARY
BARANGAY BOUNDARY
Year 2020
32

Annex 3.2:
Presentation material for Workshop on Public Information of KAMANAVA Project for Residents of Malabon/ Navotas city (English version)

Workshop on Public Information of KAMANAVA Project For Residents of Malabon/ Navotas city

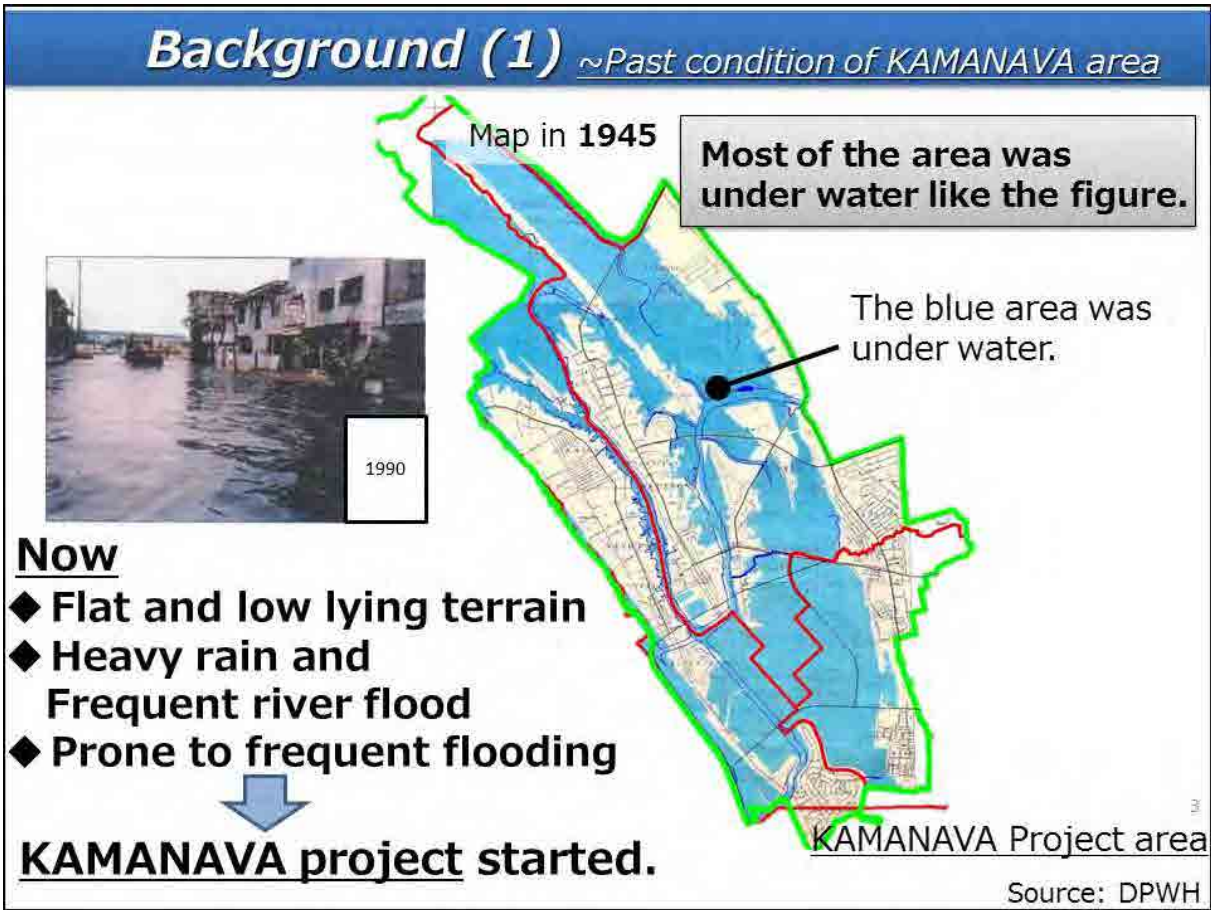
DPWH

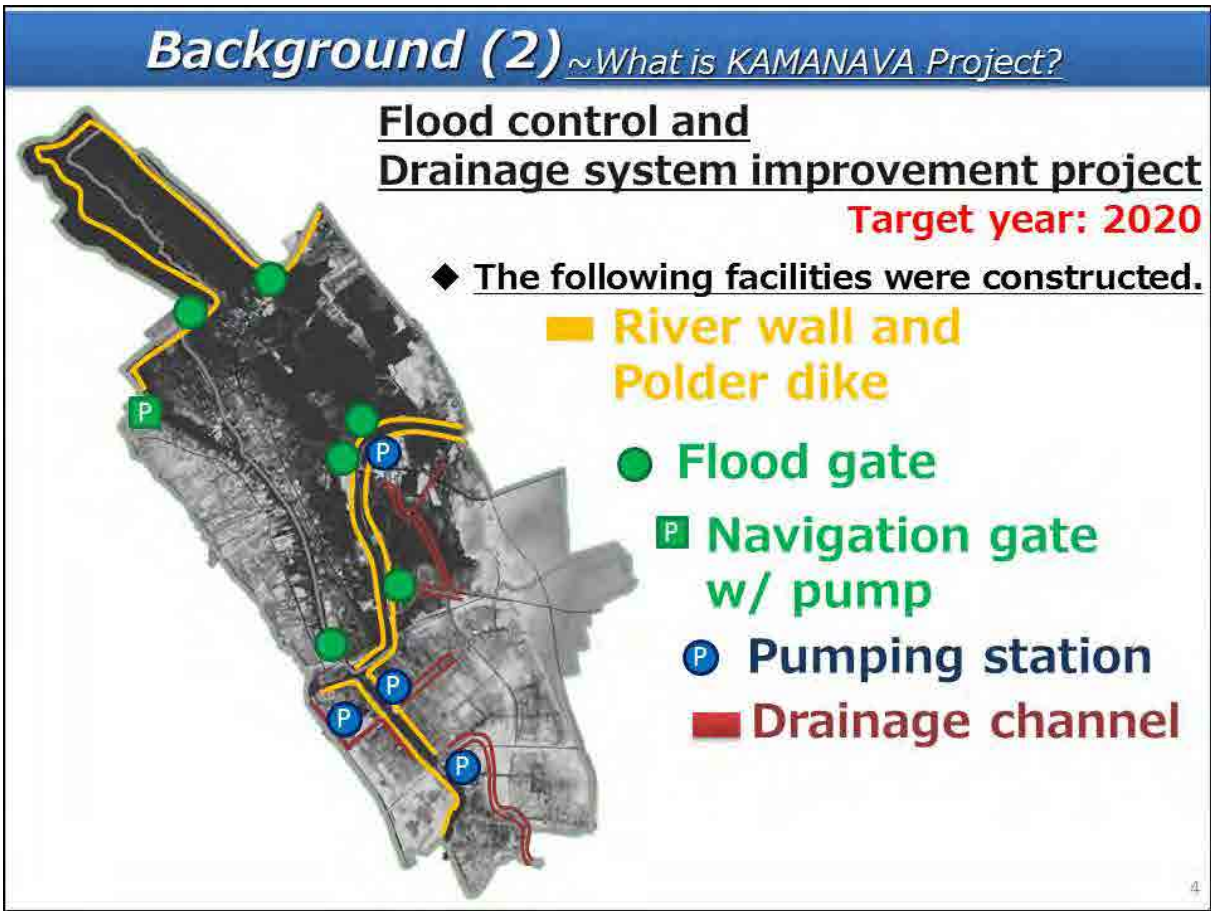
Contents of This Session

9:45 – 10:15

- Background
- Objectives of this workshop
- Recent floods and Future of KAMANAVA Project (1 2 3)
- Conclusion

2


Background (1) ~Past condition of KAMANAVA area
Map in 1945
Most of the area was under water like the figure.
The blue area was under water.
1990
Now
◆ Flat and low lying terrain
◆ Heavy rain and Frequent river flood
◆ Prone to frequent flooding
KAMANAVA project started.
KAMANAVA Project area
Source: DPWH
3


Background (2) ~What is KAMANAVA Project?
Flood control and Drainage system improvement project
Target year: 2020
◆ The following facilities were constructed.
River wall and Polder dike
Flood gate
Navigation gate w/ pump
Pumping station
Drainage channel
4

Background (3)

~However, the flood at Ondoy and Habagat happened.

- *Why did such serious floods happen?*
- *What was improved by KAMANAVA Project?*

This Study was started.

5

Objectives of today's workshop

For confirmation of actual conditions objectively

the followings were done in the Study

- **Review of KAMANAVA Project's progress**
- **Flood mark survey**
- **Inundation condition survey**
- **Social survey and holding of Workshops**
- **Land use survey**
- **River cross-section survey**
- **Consultation of LGUs**

Today's workshop is held

to share information of KAMANAVA Project and

to exchange the idea for improving current situation.

6

Recent floods and Future of KAMANAVA Project

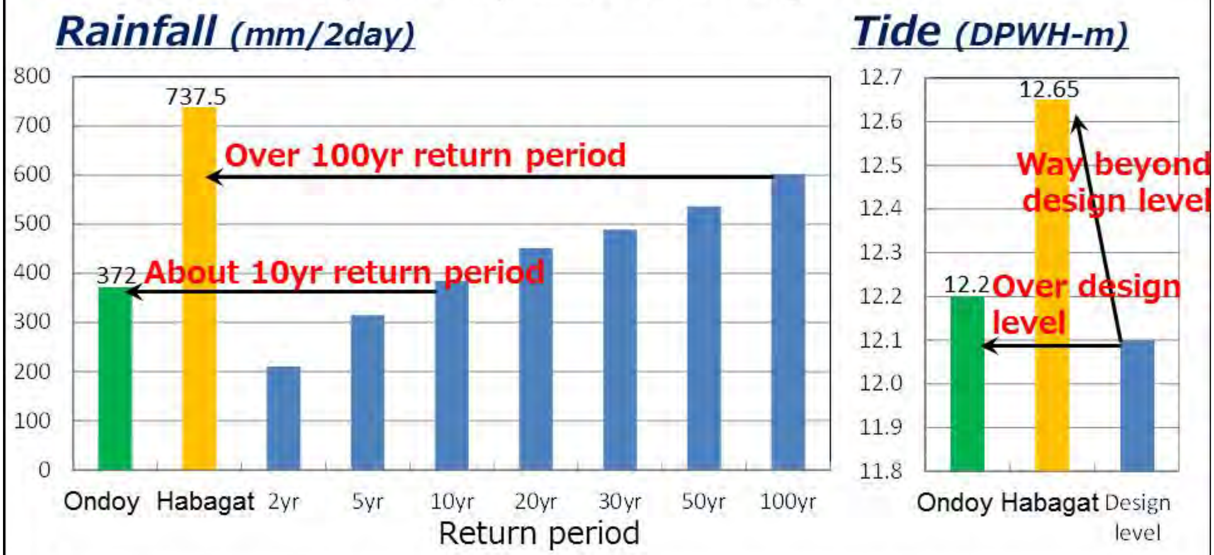
1. During Ondoy and Habagat, severe floods were caused by heavy rain and high tide.

2. Despite the serious floods, KAMANAVA Project had certain effects.

3. To enhance the effects and prevent future flood, cooperation with DPWH, LGU and community is necessary.

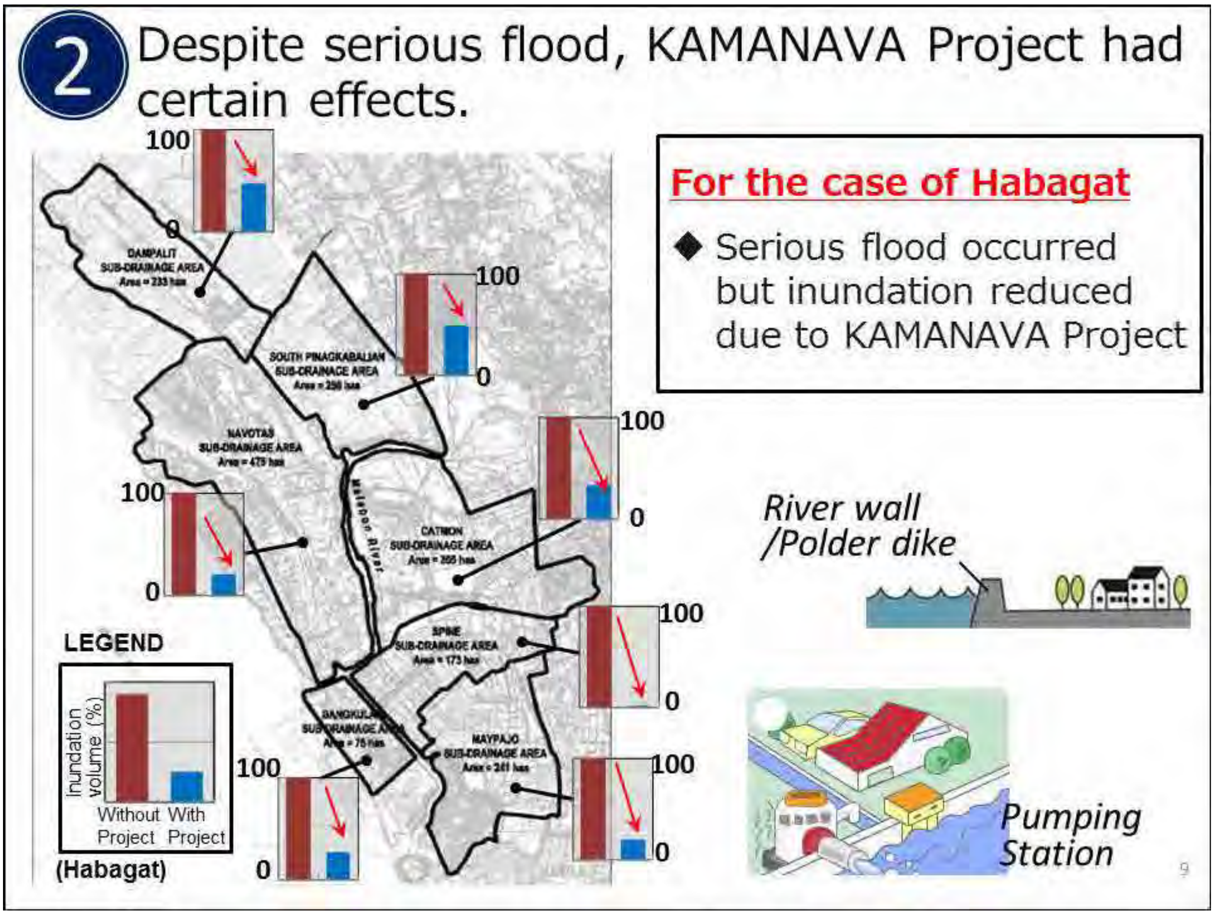
7

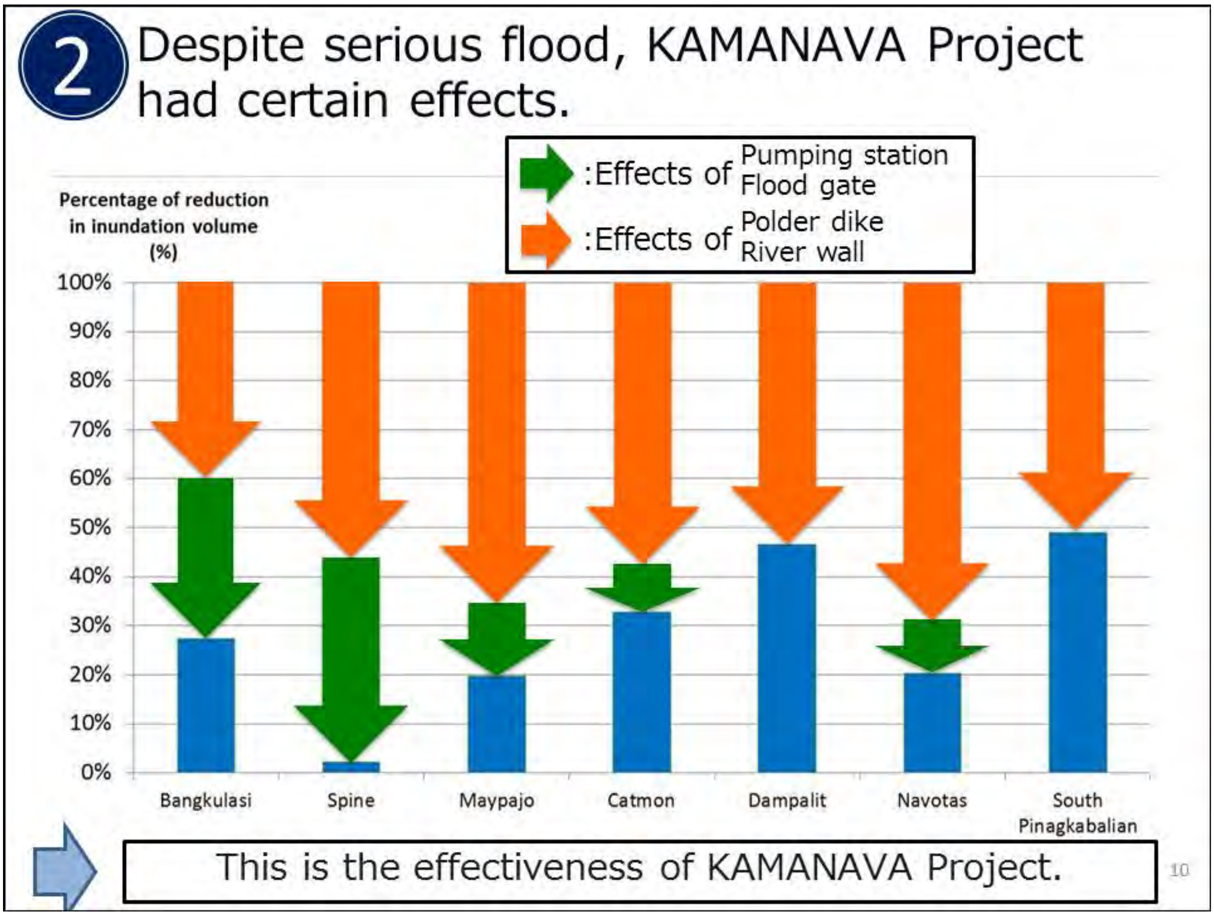
1. During Ondoy and Habagat, severe floods were caused by heavy rain and high tide.

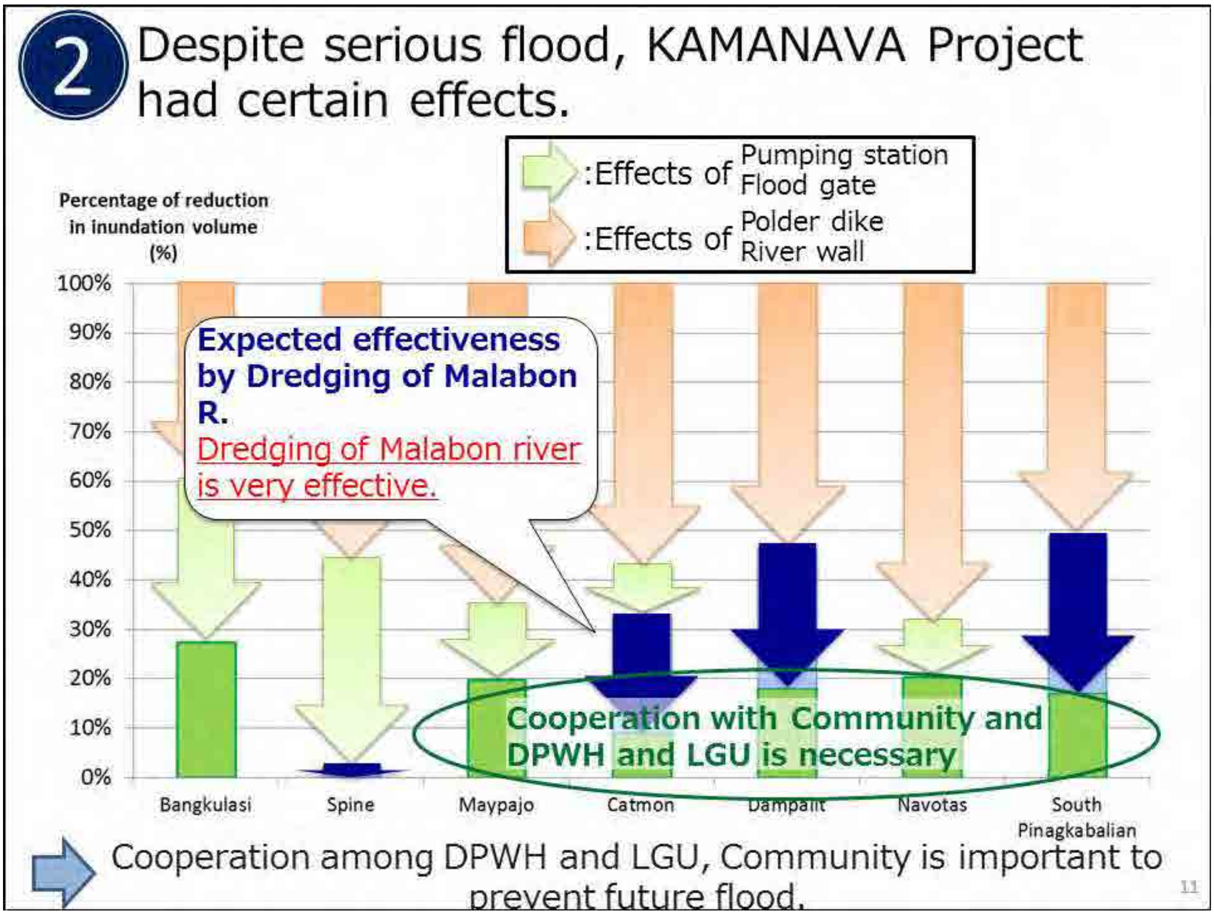


- The rain and high tide were strong during Ondoy while way extreme during Habagat.
- These extreme conditions caused serious flooding in KAMANAVA area.

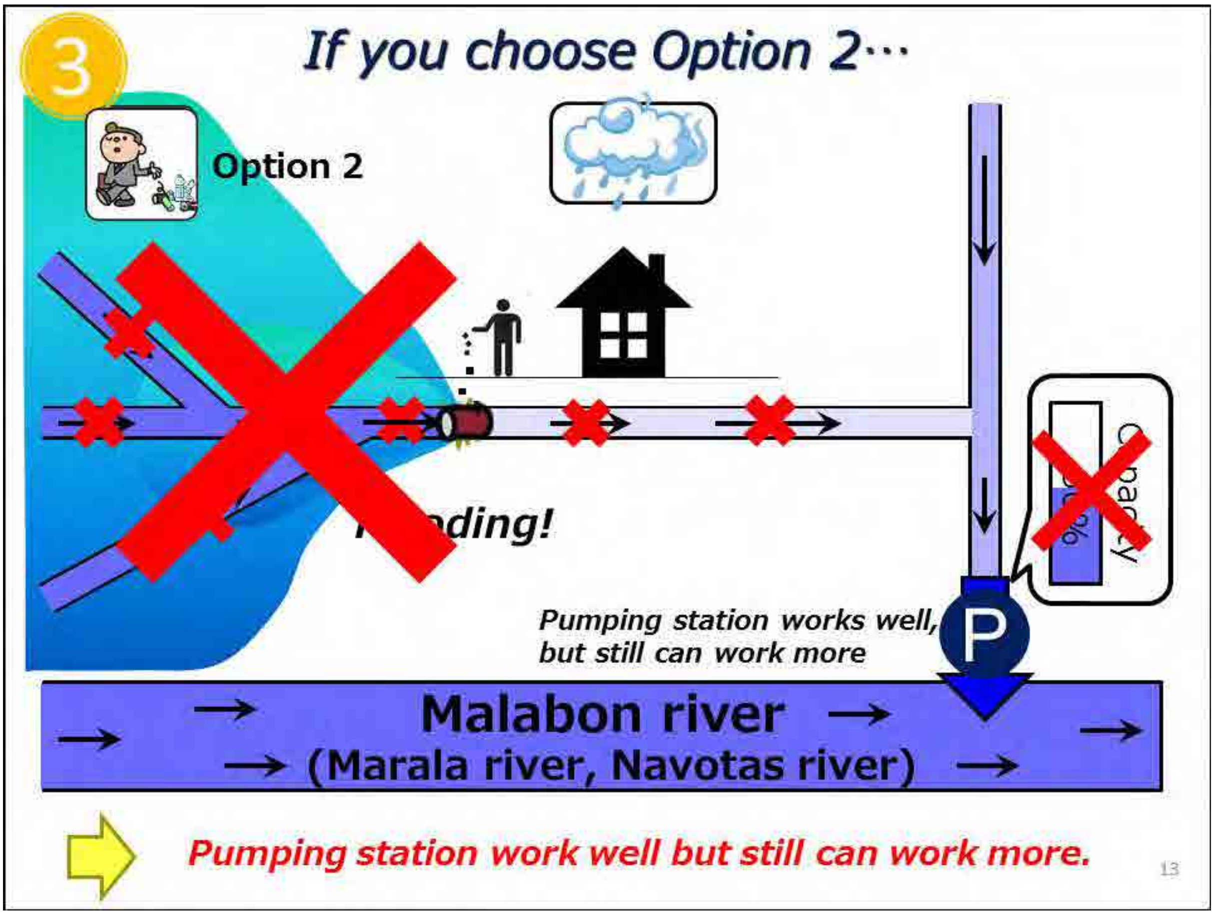
8

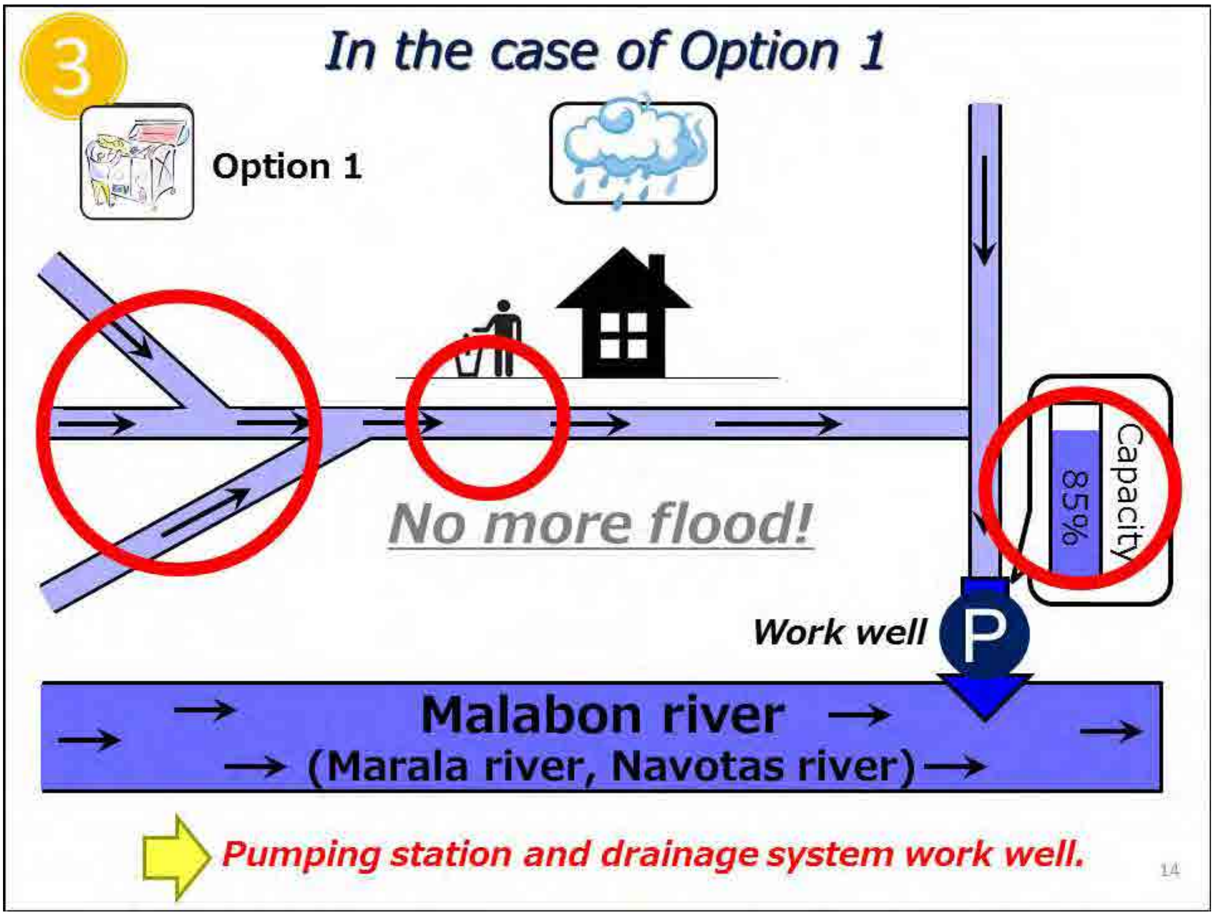

2
Despite serious flood, KAMANAVA Project had certain effects.
For the case of Habagat
◆ Serious flood occurred but inundation reduced due to KAMANAVA Project
River wall /Polder dike
Pumping Station
LEGEND
Inundation volume (%)
Without Project
With Project
(Habagat)
100
0
9


2
Despite serious flood, KAMANAVA Project had certain effects.
:Effects of Pumping station Flood gate
:Effects of Polder dike River wall
Percentage of reduction in inundation volume (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Bangkulasi
Spine
Maypajo
Catmon
Dampalit
Navotas
South Pinagkabalian
This is the effectiveness of KAMANAVA Project.
10

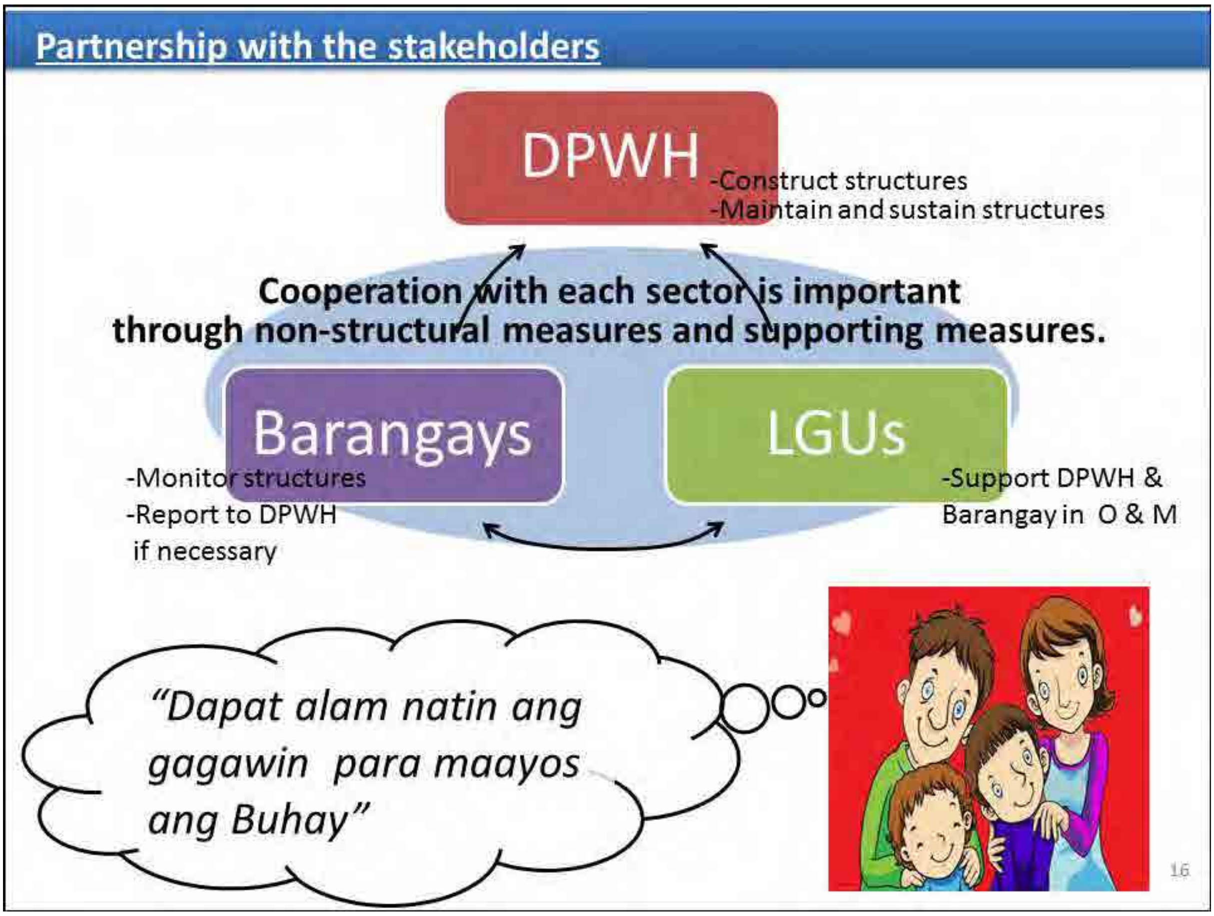

2
Despite serious flood, KAMANAVA Project had certain effects.
:Effects of Pumping station Flood gate
:Effects of Polder dike River wall
Percentage of reduction in inundation volume (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Expected effectiveness by Dredging of Malabon R.
Dredging of Malabon river is very effective.
Cooperation with Community and DPWH and LGU is necessary
Bangkulasi
Spine
Maypajo
Catmon
Dampalit
Navotas
South Pinagkabalian
Cooperation among DPWH and LGU, Community is important to prevent future flood.
11


3
To enhance the effects and prevent future flood, cooperation with DPWH, LGU and community is necessary.
One of the cooperative activities:
Solid Waste Management at LGU/community level
Case Study
Option 1
Option 2
Throw away trash in a garbage can
Throw away trash in the river/ channel
12


3
If you choose Option 2…
Option 2
ding!
Capacity
Pumping station works well,
but still can work more
P
Malabon river
(Marala river, Navotas river)
Pumping station work well but still can work more.
13


3
In the case of Option 1
Option 1
No more flood!
Capacity
85%
Work well
P
Malabon river
(Marala river, Navotas river)
Pumping station and drainage system work well.
14


Future of KAMANAVA Project
1
During Ondoy and Habagat, severe floods were caused by heavy rain and high tide.
Additional measures are in progress by DPWH and LGUs.
2
Serious flood happened, but KAMANAVA Project had certain effects.
Proper operation and maintenance are continuously needed.
3
To enhance the effects and prevent future flood, cooperation with DPWH, LGU and community is necessary.
Let's cooperate together to prevent future flood.
15


Partnership with the stakeholders
DPWH
-Construct structures
-Maintain and sustain structures
Cooperation with each sector is important
through non-structural measures and supporting measures.
Barangays
-Monitor structures
-Report to DPWH
if necessary
LGUs
-Support DPWH &
Barangay in O & M
"Dapat alam natin ang gagawin para maayos ang Buhay"
16

Methodology

Participants

The affected Barangays, City Engineers, City Planning and Development , City Health, City Social Work and Development , City PNP, DEP ED Superintendent, DPWH

1. *Above participants present their institutional mandates in relation to the Project implementation.*
2. *Review materials/ information from presentation*
3. *Discuss the Barangay situation as of now.*
4. *Using Manila Paper and colored pens, the Barangay illustrates in a drawing their vision of their Barangay 10 years from now.*
5. *Present their work in the plenary session.*
6. *Give other comments and observations*

17

Annex 3.3: Presentation material for Workshop on Public Information of KAMANAVA Project for Residents of Malabon/ Navotas city (Tagalog with English version)

Workshop
Sa Pagbibigay alam tungkol sa KAMANAVA Project para Sa mga naninirahan sa Malabon/ Navotas city

DPWH

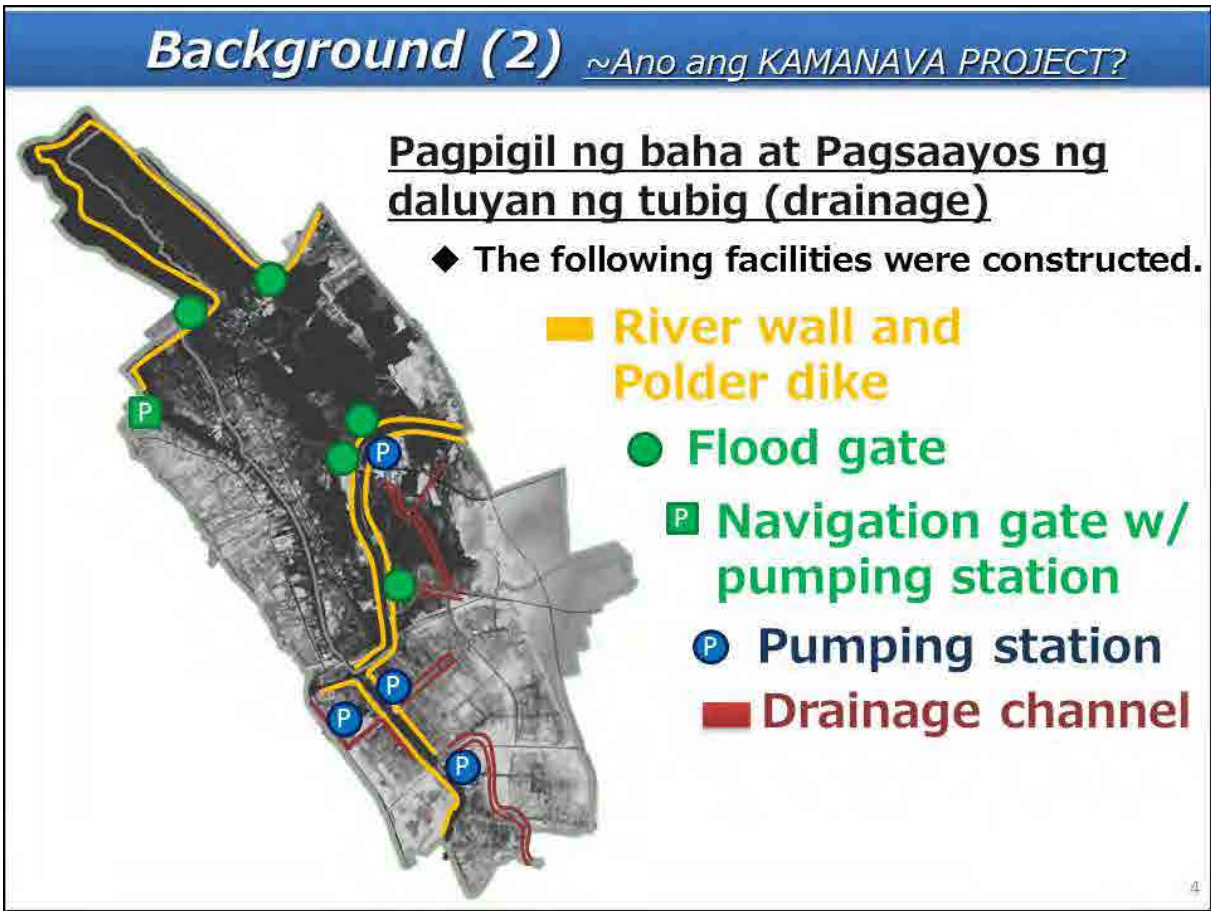
Ang paguusapan

9:45 – 10:15

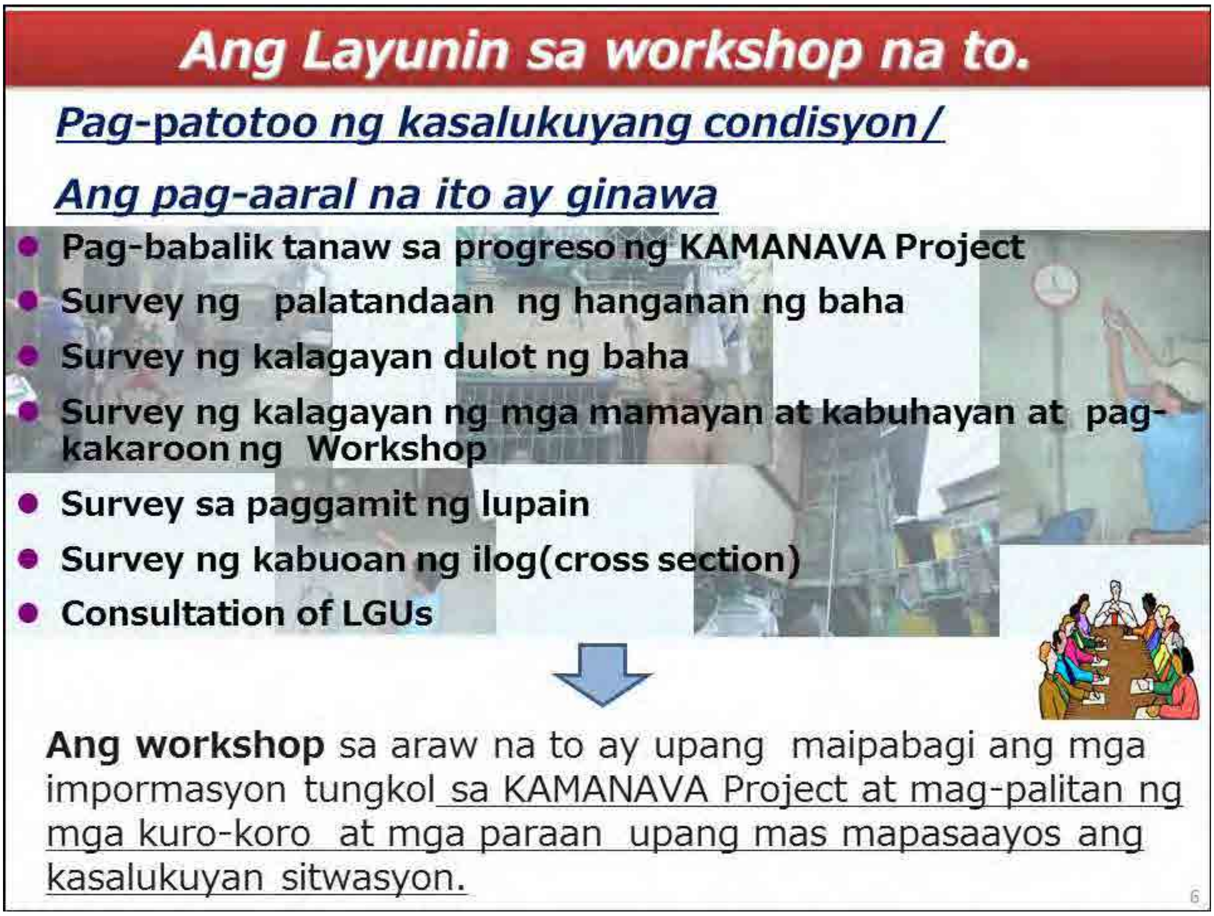
- Simulain
- Layunin ng workshop
- Ang kakadaan na mga Bagyo at Kinabukasan ng KAMANAVA Project (1) (2) (3)
- Konklusyon

2


Background (1)
~Ang KAMANAVA noon
Map in 1945
Lubog ang karamihan ng Lugar
The blue area was under water.
1990
Ngayon:
◆ Patag at mababa ang lupain
◆ Matinding ulan at laging ng umaapaw ang ilog
◆ Laging binabaha··· AT DAHIL NITO
Ang KAMANAVA project ay nagsimula.
KAMANAVA Project area
Source: DPWH
3


Background (2)
~Ano ang KAMANAVA PROJECT?
Pagpigil ng baha at Pagsaayos ng daluyan ng tubig (drainage)
◆ The following facilities were constructed.
River wall and Polder dike
Flood gate
Navigation gate w/ pumping station
Pumping station
Drainage channel
4


Background (3)
~Ngunit nangyari ang baha noong Ondoy at Habagat.
Bakit nangyari ang matinding pagbaha?
Ano ang nagawa ng KAMANAVA Project?
Ang Pag-aaral ay nagsimula
5


Ang Layunin sa workshop na to.
Pag-patotoo ng kasalukuyang condisyon/
Ang pag-aaral na ito ay ginawa
Pag-babalik tanaw sa progreso ng KAMANAVA Project
Survey ng palatandaan ng hanganan ng baha
Survey ng kalagayan dulot ng baha
Survey ng kalagayan ng mga mamayan at kabuhayan at pag-kakaroon ng Workshop
Survey sa paggamit ng lupain
Survey ng kabuoan ng ilog(cross section)
Consultation of LGUs
Ang workshop sa araw na to ay upang maipabagi ang mga impormasyon tungkol sa KAMANAVA Project at mag-palitan ng mga kuro-koro at mga paraan upang mas mapasaayos ang kasalukuyan sitwasyon.
6

Recent floods and Future of KAMANAVA Project

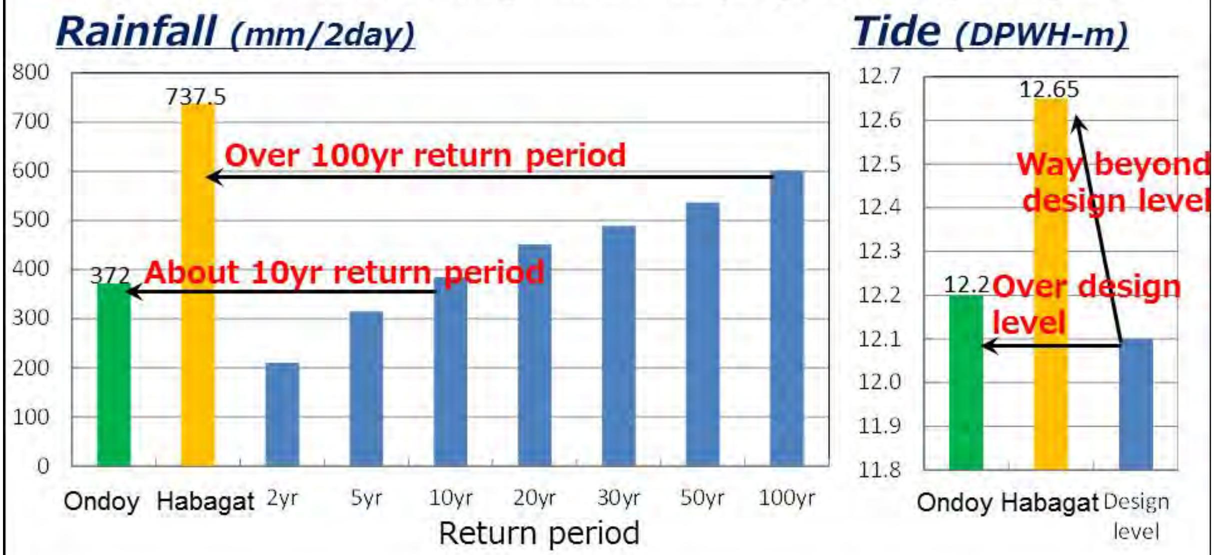
1. Sa Ondoy at Habagat. Ang sanhi ng pagbaha ay dahil sa matinding ulan at pagtaas ng dagat.

2. Kahit matindi ang pagbabaha, ang KAMANAVA Project ay may naitulong na ibsan ito.

3. Mapahusay ang pagiging epektibo at maiwasan ang mga darating pang baha, sa paki pagtulungan sa DPWH, LGU at ng Barangay.

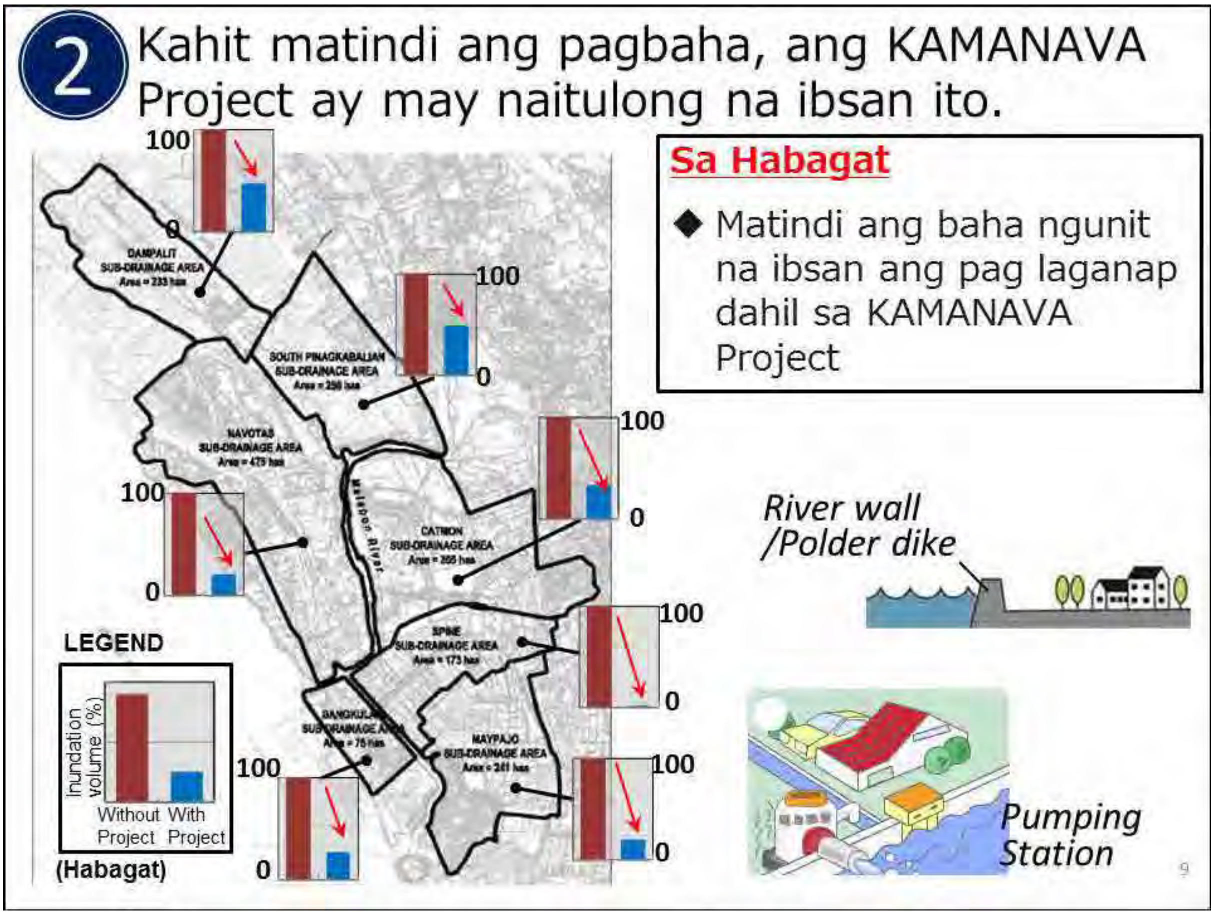
7

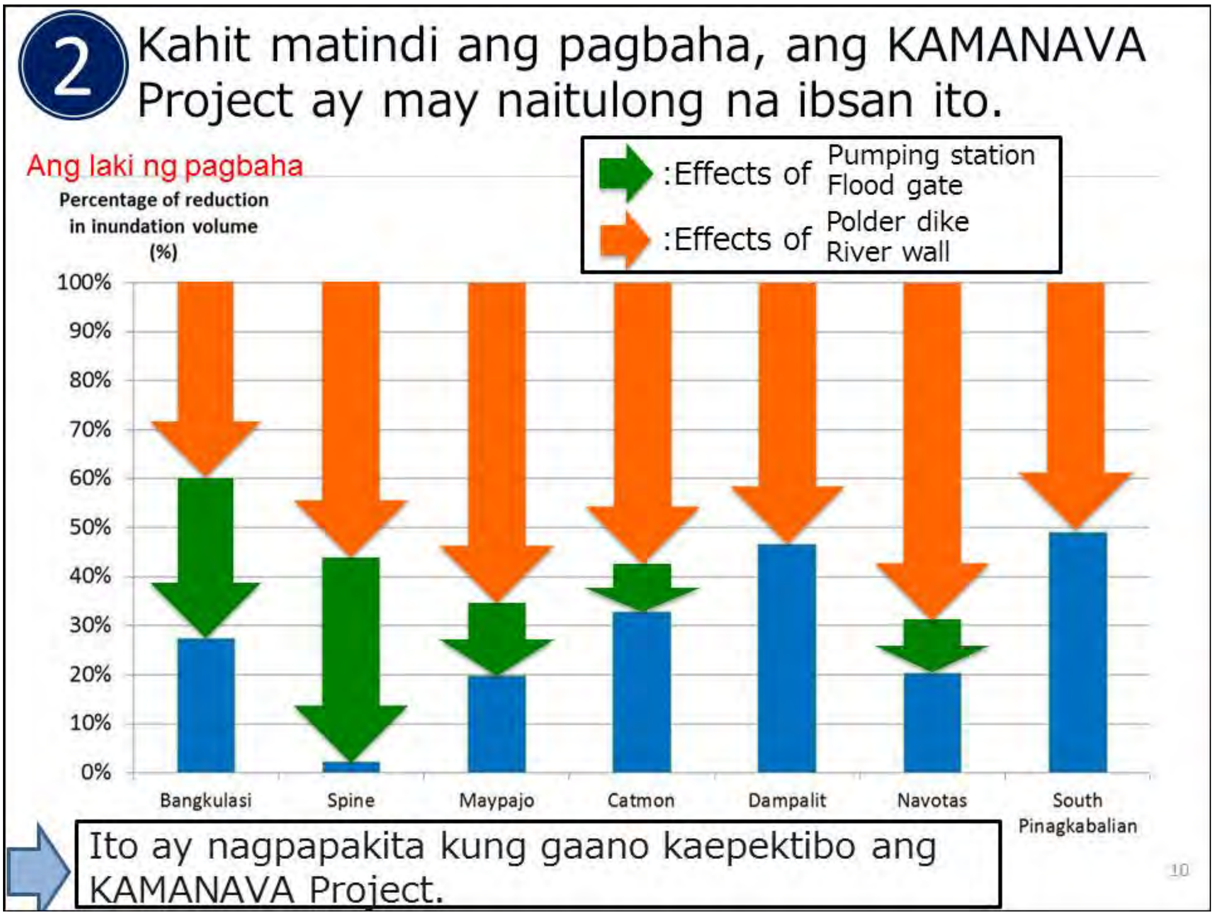
1. Sa Ondoy at Habagat. Ang sanhi ng pagbaha ay dahil sa matinding ulan at pagtaas ng dagat



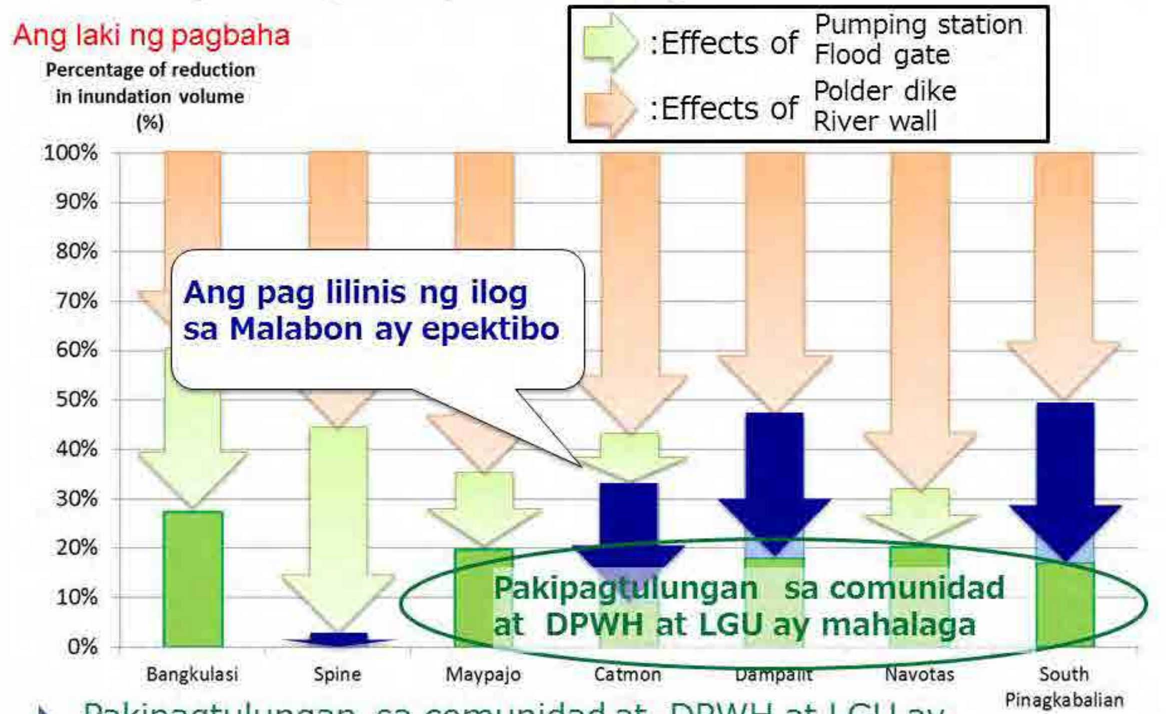
◆ Matindi ang ulan at taas ng dagat noong Habagat. At ganoon din noong panahon ng Ondoy na ngpabaha sa KAMANAVA.

8


2
Kahit matindi ang pagbaha, ang KAMANAVA Project ay may naitulong na ibsan ito.
Sa Habagat
◆ Matindi ang baha ngunit na ibsan ang pag laganap dahil sa KAMANAVA Project
River wall /Polder dike
Pumping Station
LEGEND
Inundation volume (%)
Without Project
With Project
(Habagat)
100
0
9


2
Kahit matindi ang pagbaha, ang KAMANAVA Project ay may naitulong na ibsan ito.
Ang laki ng pagbaha
Percentage of reduction in inundation volume (%)
:Effects of Pumping station Flood gate
:Effects of Polder dike River wall
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Bangkulasi
Spine
Maypajo
Catmon
Dampalit
Navotas
South Pinagkabalian
Ito ay nagpapakita kung gaano kaepektibo ang KAMANAVA Project.
10

2 Kahit matindi ang pagbaha, ang KAMANAVA Project ay may naitulong na ibsan ito.



Pakipagtulungan sa comunidad at DPWH at LGU ay mahalaga para maiwasan ang pagbaha

11

3 Mapahusay ang pagiging epektibo at maiwasan ang mga darating pang baha, sa paki pagtulungan sa DPWH, LGU at ng Barangay.

Ang pakipagtulongan ay mahalaga:
Solid Waste Management at LGU/community level

Case Study

Option 1

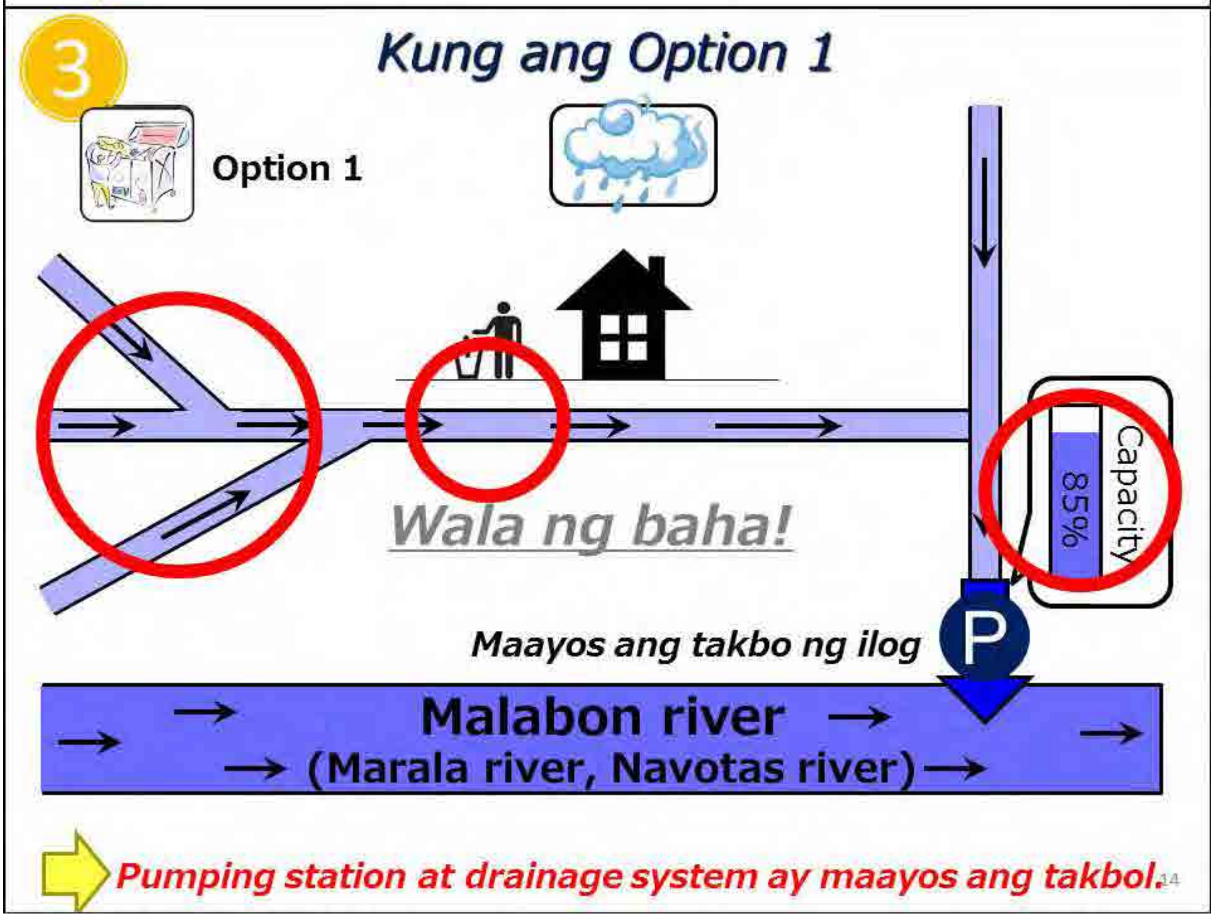
Pagtapon ng basura sa tamang lugar

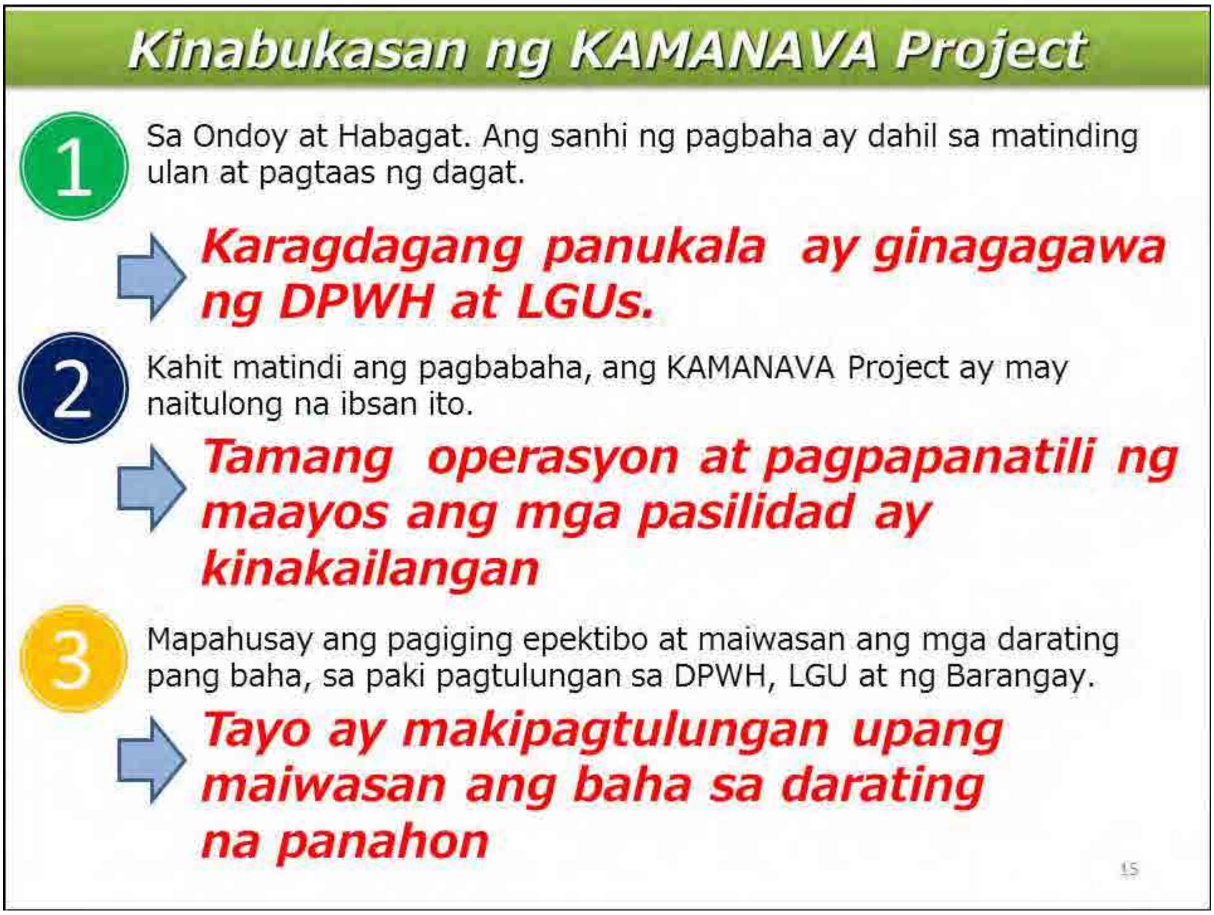
Option 2

Pagtapon ng basura sa ilog.

12


3
Kung pipiliin mo ang Option 2···
Option 2
ding!
Ang Pumping station ay gumagana ng maayos
Ngunit hindi kinakaya ang tindi ng tubig dumadaloy
P
Malabon river
(Marala river, Navotas river)
Pumping station work well but still can work more.
13


3
Kung ang Option 1
Option 1
Wala ng baha!
Capacity
85%
Maayos ang takbo ng ilog
P
Malabon river
(Marala river, Navotas river)
Pumping station at drainage system ay maayos ang takbol.
14


Kinabukasan ng KAMANAVA Project
1
Sa Ondoy at Habagat. Ang sanhi ng pagbaha ay dahil sa matinding ulan at pagtaas ng dagat.
Karagdagang panukala ay ginagagawa ng DPWH at LGUs.
2
Kahit matindi ang pagbabaha, ang KAMANAVA Project ay may naitulong na ibsan ito.
Tamang operasyon at pagpapanatili ng maayos ang mga pasilidad ay kinakailangan
3
Mapahusay ang pagiging epektibo at maiwasan ang mga darating pang baha, sa paki pagtulungan sa DPWH, LGU at ng Barangay.
Tayo ay makipagtulungan upang maiwasan ang baha sa darating na panahon
15


Partnership with the stakeholders
DPWH
-Construct structures
Kooperasyon sa lahat ng kababayan ay mahalaga
Sa pamamagitan ng mga paraan hindi istruktural
(swm, clean & green at impormasyon).
Barangays
LGUs
-Monitor structures
-Report to DPWH
if necessary
-Support DPWH &
Barangay in O & M
"Dapat alam natin ang gagawin para maayos ang Buhay"
16

Methodology

Participants

The affected Barangays, City Engineers, City Planning and Development , City Health, City Social Work and Development , City PNP, DEP ED Superintendent, DPWH

1. *Above participants present their institutional mandates in relation to the Project implementation.*
2. *I-review ang mga materyales ng informasyon galing sa pagpahayag.*
3. *Pagusapan ang sitwasyon ng Barangay sa ngayon .*
4. *Gamit ang Manila Paper at crayola, ipakita ng Barangay sa pamamagitan ng drawing ang bukas ng Barangay*
5. *Ipahayag ang kanilang drawing .*
6. *Give other comments and observations*

17

Maraming Salamat po!

Annex 4

Cartoon used to promote the community's understanding in Workshop