The expert in **WATER ENVIRONMENTS**

CTCN CLIMATE TECHNOLOGY CENTRE & NETWORK DHI DRD

Hydrodynamic modelling for flood reduction and climate resilient infrastructure development pathways in Jakarta

Final Substantive Report

CTCN CLIMATE TECHNOLOGY CENTRE & NETWORK

Training and Workshop Report

May 2017

This report has been prepared under the DHI Business Management System certified by DNV to comply with ISO 9001 (Quality Management), ISO 14001 (Environmental Management), OHSAS 18001 (Health and Safety Management)

MANAGEMENT SYSTEM CERTIFICATION

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Hydrodynamic modelling for flood reduction and climate resilient infrastructure development pathways in Jakarta

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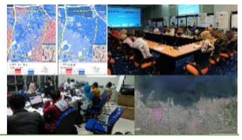

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LIST OF ABBREVIATION

1D	:	One dimensional
2D	:	Two dimensional
ADB	:	Asian Development Bank
BAPPEDA	:	Regional Agency for Development Planning
BAPPENAS	:	National Agency for Development Planning
BID	:	Basic Improvement District
BMA	:	Bangkok Metropolitan Administration
BMKG	:	National Bureau for Meteorology, Climatology, and Geophysics
BPBD	:	Regional Agency for Disaster Relief
BPPT	:	Agency for the Assessment and Application of Technology
BPS	:	Agency for Statistics
CC Factor	:	Climate Change Factor
CTCN	:	Climate Technology Centre & Network
DANIDA	:	The Danish International Development Agency
DEM	:	Digital Elevation Model
DISHIDROS	:	Hydrography and Oceanography Agency of Indonesia Navy
DKI	:	Special Area of Capital City
DPE	:	Regional Agency for Industry and Energy
DTA	:	Water Management Agency
FGD	:	Focus Group Discussion
FM	:	Flexible Mesh
GCM	:	Global Climate Model
GIS	:	Geographic Information System
GSW	:	Giant Sea Wall
HAII	:	Hydro and Agro Informatics Institute
JEDI	:	Jakarta Emergency Dredging Initiative
JICA	:	Japan International Cooperation Agency
JRC	:	Jakarta Research Council
KLHK	:	Ministry of Environment and Forestry
KOICA	:	Korea International Cooperation Agency
LiDAR	:	Light Detection and Ranging
MHHW	:	Mean Highest High Water
NCICD	:	National Capital Integrated Coastal Development
PUSAIR	:	Water Resource Research Centre of the Ministry of Public Works
RP	:	Return Period
RPJMD	:	Regional Medium-term Development Plan
RT	:	Neighbourhood unit
RW	:	Community unit
SIDA	:	Swedish International Development Cooperation Agency
SLR	:	Sea Level Rise
UNEP	:	United Nations Environment Programme

1 Introduction

Jakarta is increasingly threatened by flooding from a combination of land subsidence, rising sea levels particularly with relation to the spring tide cycle and higher river levels resulting from potentially increasing rainfall intensity and land use changes within the catchment areas. Strategies currently defined to address these threats include but not limited to creation of a Giant Sea Wall (GSW) to reduce the risk of flooding and coastal inundation.

The objectives of the Climate Technology Centre & Network (further called CTCN) technical assistance were (i) to better assess flood risks and hazards, and (ii) to design climate-resilient pathways to reduce the magnitude and scale of the impacts from this flooding. This assessment and strategy definition will help shape the design of climate resilient infrastructure projects including, but not limited to, the GSW. The outcomes were (a) a hydrodynamic flood model that can be used to evaluate a number of hard and soft engineering interventions to reduce the risk of flooding (b) a socio-cultural survey to examine inhabitants' perceptions of flooding, levels of acceptable risks and preferred adaptation options, (c) a series of technology transfer workshops to increase local capacity in high resolution hydrodynamic modelling and use of the model, (d) resultant policy and planning recommendations to reduce flood hazards, risk and vulnerability, and (e) a roadmap to sustain and expand the project using additional funding streams.

To meet the expected outcomes mentioned above, the technical assistance was divided into the following activities:

- Activity 1 – Flood Risk Assessment
    - Activity 1A – Model development
    - Activity 1B – Sociocultural Risk Assessment
    - Activity 1C – Technology Transfer
- Activity 2 – Formulate Policy Recommendations
- Activity 3 – Developing further funding streams
- Activity 4 – Knowledge sharing and South-South Cooperation

This substantive report presented the summary of all activities mentioned above. All the activities were done successfully during approximately one year technical assistance period.

1.1 Objectives

The objectives of this study were summarized in points as follow

- Activity 1A: To develop a high resolution hydrodynamic model for a study area in Jakarta that is capable of producing flood levels under differing climate and/or engineering scenarios.
- Activity 1B: To carry out a socio-cultural survey to capture the views of the local residents within the study area to the risks of flooding along with adaptation and mitigation options to alleviate these risks.
- Activity 1C: To enable local agencies to further develop the model to explore a wider range of scenarios.
- Activity 2: To allow local authorities to take the findings from the technical assistance into account when formulating plans to provide a sustainable future for the area.

- Activity 3: To initialise future funding opportunities to further expand the utilisation of the hydrodynamic model.
- Activity 4: To produce a report dealing with the lessons learned in the implementation of the hydrodynamic flood model and socio-cultural risk assessment in Jakarta.

1.2 Activities

The following section provides an overview of various activities that have been done under this study:

- Activity 1 – Flood Risk Assessment
    - Activity 1A – Model development
    - Activity 1B – Sociocultural Risk Assessment
    - Activity 1C – Technology Transfer
- Activity 2 – Formulate Policy Recommendations
- Activity 3 – Developing further funding streams
- Activity 4 – Knowledge sharing and South-South Cooperation

Activity 1 (Flood risk assessment) consisted of several activities, namely model development, sociocultural risk assessment, and technology transfer. The following tasks were carried out sequentially to meet the objectives of model development activity (Activity 1A): (1) Data gathering and pre-processing, (2) one-dimensional (further called as 1D) modelling, (3) two-dimensional (further called as 2D) modelling, (4) Coupling 1D and 2D modelling, (5) Production of Flood Maps, and (6) Analysis of flooding at the study area. For sociocultural risk assessment activity (Activity 1B), three level studies were conducted, namely macro study, meso study, and micro study. Furthermore, four series of the training were conducted as a series of technology transfer activity (Activity 1C). First training was held after the first workshop (July), second training was held in October 2016, the third training was held in December 2016, and the last training was held in March 2017. The participants came from Jakarta Research Council (JRC), Agency for the Assessment and Application of Technology (BPPT) and National Bureau for Meteorology, Climatology, and Geophysics (BMKG). Moreover, several workshops were held, included the expert meeting and stakeholder meeting.

Under Activity 2 (Formulate policy recommendations), several internal meetings as well as stakeholder and expert panel were conducted. The initial recommendation was done with expert panel along with the workshop in Activity 1C. After that workshop, several expert meetings were conducted internally to discuss and reformulate the recommendation. Then, those recommendations were presented to relevant policy makers and stakeholders on workshop to get some input. After the workshop on policy recommendation, the post-workshop meeting was held internally to discuss many inputs from the audiences and construct final recommendation on mitigation/adaptation options/technologies, alignment with a regulatory framework, strategic and institutional recommendations.

Activity 3 (Developing further funding streams) was done by creating the proposal for further funding stream as well as offering the proposal to international donor institution. A proposal of further study has been formulated through some internal meetings. Some potential funding institutions to further the study were listed. The institutions are DANIDA, Asian Development Bank (ADB), World Bank, and Korea International Cooperation Agency (KOICA). At this moment, some meetings were conducted to two institutions, namely World Bank and KOICA.

Activity 4 (Knowledge sharing and South-South Cooperation) were done by drawing on the experience arising from the aforementioned activities and conducting, as well as attending, the workshop that invites several countries representative.

The summary of those activities is presented in the sections below.

2 Summary of Activity 1 – Flood risk assessment

2.1 Activity 1A – Model development

The objective of Activity 1A (Model development) was to develop a high resolution hydrodynamic model for a pilot technical assistance area in Jakarta, shown in Figure 2.1, that is capable of producing flood levels under various climate and/or engineering scenarios. The following tasks were carried out sequentially to meet the objective of Activity 1A: (1) Data gathering and pre-processing, (2) 1D modelling, (3) 2D modelling, (4) Coupling 1D and 2D modelling, (5) Production of Flood Maps, and (6) Analysis of flooding at the study area. The area was chosen as one of the most flood-prone regions in Jakarta and is dominated by medium size commercial properties with additional medium-sized residential units, mainly to the north and south of the area.

Figure 2.1 (Left) The study area in northern part of DKI Jakarta shown in red polygon. (Right) Zoomed satellite image of the study area at the green circle. (Image source: Google Earth Pro)

Study location was showed in Figure 2.1. Even though the study area only included part of the total city drainage network and catchment of Jakarta, it was essential that the flood model should include those parts of the wider network that are hydraulically connected to it, e.g. the east-west flood canals. Therefore, a coarser model set up, with resolution of ~30m, was generated as a boundary condition to the study area flood model (high resolution of ~3m).

The flood model was simulated using 1D-2D coupled model. The flow in river and channel was modelled using the 1D model MIKE HYDRO River software, and the inundation area was captured in the 2D modelling program MIKE 21 Flow Model FM. The hydrodynamic interaction between the river and the flood areas was handled by the 1D and 2D coupling software MIKE FLOOD.

The Digital Elevation Model (DEM) was used to generate the cross-section, river network and catchment definition. The current DEM was based on the Light Detection and Ranging (LiDAR) data of that was generated in the year 2012 (~1.33m resolution), which was provided by the Water Management Agency (DTA) shown in Figure 2.2.The final DEM is a composite of LiDAR DEM and other DEM data, pre-processed to cover the entire major catchments flowing through Jakarta.

The land subsidence map for Jakarta used in generating past and future topographical conditions was obtained from Budiyono *et al.* (2016). From that data, a yearly subsidence rate was calculated and used to generate projected topographies for the years 2007, 2013, and 2025.

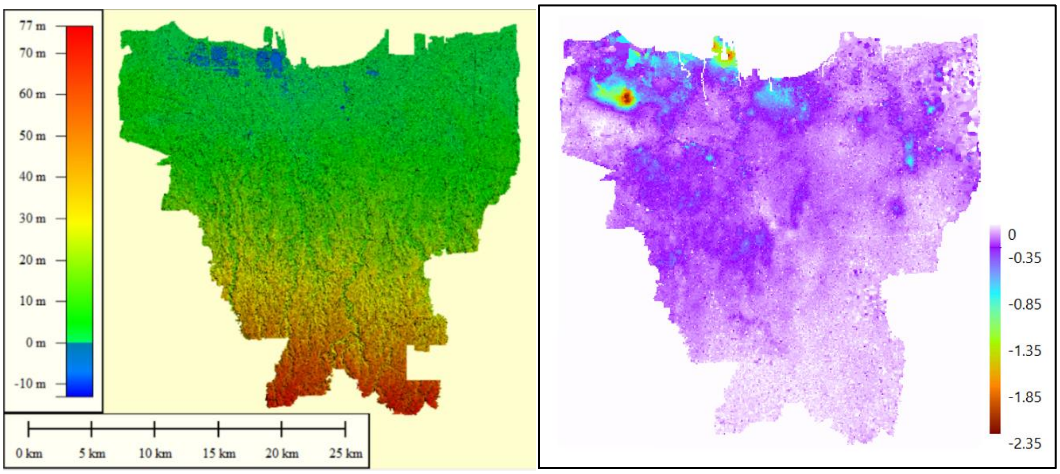

Figure 2.2 (Left) LiDAR DEM data of DKI Jakarta for year 2012. (Right) Land subsidence depths from 2012 to 2025 in meters to be used in generating past and future topographies. Source: Budiyono *et al.* (2016).

The rainfall data used were the actual rainfall data and designed storm data. Actual rainfall data provided by BMKG was used in simulations for 2007, 2012 and 2013 rainfall events. The designed storm data, derived from design storm generation as described in van der Sleen and Lopez (2013), has been used for climate change scenarios. Climate change factors are determined from literature, which calculated values obtained from Global Climate Model (GCMs) and Representative Concentration Pathways (RCPs) scaled down to Jakarta region. Upon discussion with JRC, DHI agreed to simulate worst-case climate change flooding scenarios to aid in policy-making decisions. The upper 75-percentile values were chosen as climate change factors for this study, as summarised in Table 2.1.

Table 2.1 Climate change factors from five GCMs and four RCPs. Modified from Budiyono *et al.* (2016).

	5 GCM Median	5 GCM Std	upper 68%	upper 95%	upper 75%
2030 RCP2.6	0.79	0.33	1.12	1.45	1.18
2030 RCP4.5	0.76	0.47	1.23	1.70	1.31
2030 RCP6.0	0.79	0.51	1.30	1.81	1.39
2030 RCP8.5	0.85	0.49	1.34	1.83	1.43
2030 RCP Average	0.80	0.45	1.25	1.70	1.33
	5 GCM Median	5 GCM Std	upper 68%	upper 95%	upper 75%
2050 RCP2.6	0.79	0.32	1.11	1.43	1.17
2050 RCP4.5	0.82	0.48	1.30	1.78	1.39
2050 RCP6.0	0.79	0.56	1.35	1.91	1.45
2050 RCP8.5	0.96	0.58	1.54	2.12	1.64
2050 RCP Average	0.84	0.49	1.33	1.81	1.41

Tidal data was used as a boundary data in MIKE HYDRO River and MIKE 21 Flow Model FM. The tidal data for 2007, 2012, and 2013 scenario was obtained from tidal prediction models from DHI, while tidal data for 2030 and 2050 was obtained by applying the sea level rise to the Mean Highest High Water (MHHW) level. Model values were extracted from the point in Jakarta Bay nearest to the study area. From Hydrography and Oceanography Agency of Indonesia Navy (DISHIDROS) tidal constituents, some statistical values for peak tide levels can be calculated such as the MHHW. Sea level rise values for 2030 and 2050 was calculated based on sea level rise estimation done by BAPPENAS (2010), summarized in Table 2.2.

Table 2.2 Projection of the average increase of sea level in Indonesian water (Source: Bappenas, 2010)

Period	Sea Level Rise Projection since 2000			Level of confidence
	Tide Gauge	Altimeter ADT	Model	
2030	24.0 cm ± 16.0 cm	16.5 cm ± 1.5 cm	22.5 ± 1.5 cm	Moderate
2050	40.0 cm ± 20.0 cm	27.5 cm ± 2.5 cm	37.5 ± 2.5 cm	Moderate
2080	64.0 cm ± 32.0 cm	44.0 cm ± 4.0 cm	60.0 ± 4.0 cm	High
2100	80.0 cm ± 40.0 cm	60.0 cm ± 5.0 cm	80.0 ± 5.0 cm	High

The scenario matrix in Table 2.3 was designed taking into account the available data and the modelling needs to meet the objectives and deliverables after discussion between DHI and JRC team. Models for 2007, 2012, and 2013 were built to simulate the notable recent flood events over the past decade. For climate change scenarios, 2030 and 2050 were selected.

Table 2.3 Scenario matrix

Scenario	Flood Event (Rainfall Input)	Tide (Peak Level)	Subsidence based from 2012 year – LiDAR DEM
1	01-02 Feb 2007 (31 Jan-05 Feb)	Actual tide (+0.500 m)	No Subsidence
2	01-02 Feb 2007 (31 Jan-05 Feb)	Actual tide (+0.500 m)	With negative subsidence (up to 2007)
3	16 Jan 2013 (15-19 Jan)	Actual tide (+0.276 m)	No Subsidence
4	16 Jan 2013 (15-19 Jan)	Actual tide (+0.276 m)	With positive subsidence (up to 2013)
5	21 Dec 2012 (20-24 Dec)	Actual tide (+0.286 m)	No Subsidence
6	2050 (50-year RP + 41% CC Factor)	MHHW + 0.375 SLR (+0.610 m)	No Subsidence

Scenario	Flood Event (Rainfall Input)	Tide (Peak Level)	Subsidence based from 2012 year – LiDAR DEM
7	2050 (50-year RP + 41% CC Factor)	MHHW + 0.375 SLR (+0.610 m)	With positive subsidence (up to 2025)
8	2030 (50-year RP + 33% CC Factor)	MHHW + 0.225 SLR (+0.460 m)	No Subsidence
9	2030 (50-year RP + 33% CC Factor)	MHHW + 0.225 SLR (+0.460 m)	With positive subsidence (up to 2025)

RP – Return Period

CC Factor – Climate Change Factor

MHHW – Mean Highest High Water

SLR – Sea Level Rise

Prior to scenario model simulated, flood models had to be calibrated and then validated based on observed data. However, there were no data available that can be used for calibration of the Jakarta flood model, which requires comprehensive data of observed rainfall, water level and discharge during flood events. Since the calibration process was not possible for this flood model, DHI validated the model performance using available information and previous research study in Budiyono *et al.* (2016). Comparisons of both 2007 and 2013 model results showed that MIKE model results had a good comparison with flood maps in the referenced paper.

In order to assess the flood risk in the study area, flood maps were generated for various flood scenarios as listed in the Scenario Matrix (Table 2.3). Flood maps were produced by extracting maximum flood depth from modelling results within the 4-5 days simulation period. Figure 2.3 shows a flood map for Scenario 9 as an example.

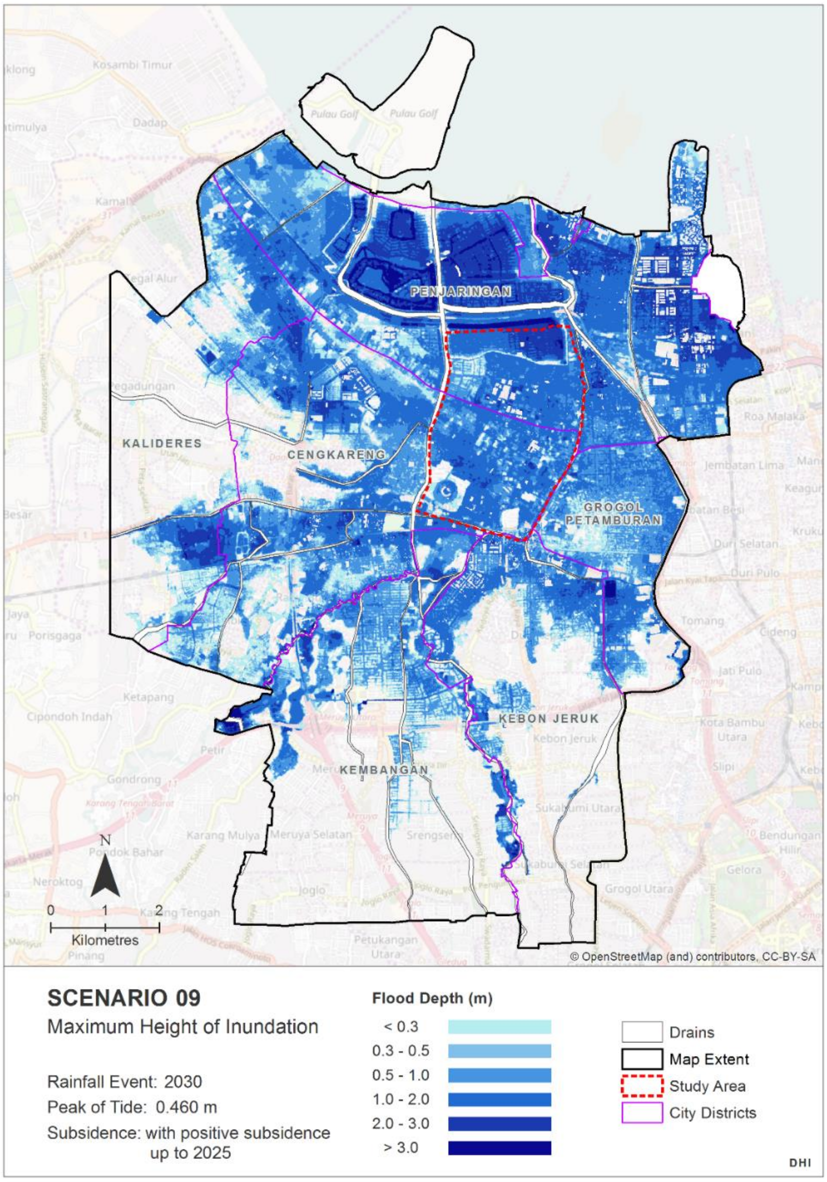

Figure 2.3 Flood map for Scenario 9.

To investigate the land subsidence effect toward flooding in the study area, flood maps from scenarios without land subsidence, i.e. using the base DEM, were compared to scenarios where land subsidence is applied. The comparison was done by plotting the inundation depth differences, for example between Scenarios 9 and 8 for 2030 shown in Figure 2.4a. One can see that the flood was worsened almost entirely in the study area (in Pantai Indah Kapuk polder, Kapuk Muara polder, and Kapuk Poglar polder).

In order to evaluate the effects of climate change towards flooding in the study area, various maps of flood depth differences were generated. Figure 2.4b shows the flood depths difference between 2030 and 2007 (Scenarios 8 and 1). The rainfall event in 2007 were calculated to have a frequency of 50-year return period (Budiyono *et al.*, 2016), which is the same frequency as in 2030 with calculated climate change factor of +1.33. Therefore, increased the rainfall intensities due to climate change alone is enough to increase the inundation depths at the study area. Among the three polders that are located in the study area, Pantai Indah Kapuk polder has the highest sensitivity from the effects of climate change.

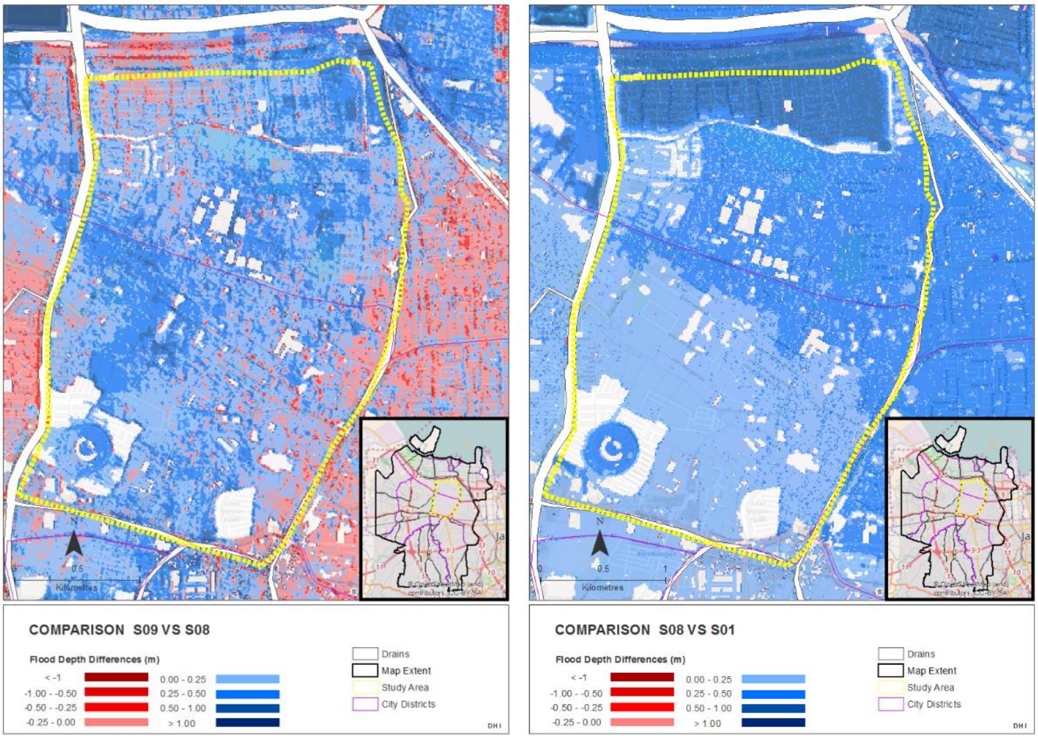

Figure 2.4 (a) Flood depth differences in the study area between with-subsidence scenario and without-subsidence scenarios for year 2030. (b) Flood depth differences in the study area between 2007 and climate change scenarios 2030.

To identify the critical areas where flood mitigation should be prioritised, DHI used the dynamic flood maps that can show the progression of flooding within the 4-5 day simulation period. It was observed that flood start to occur: in the north part of Pantai Indah Kapuk polder (Penjaringan district), Pluit polder, west part of Penjaringan district, Teluk Gong polder (Grogol Petamburan district), and around Angke river. A plot of the 1D results shows that flooding occurs when the water level overtops the cope levels of the river bank, particularly at shallow parts of Mookervart river and Angke river. One of the sets of dynamic flood maps is shown in Figure 2.5 for Scenario 9.

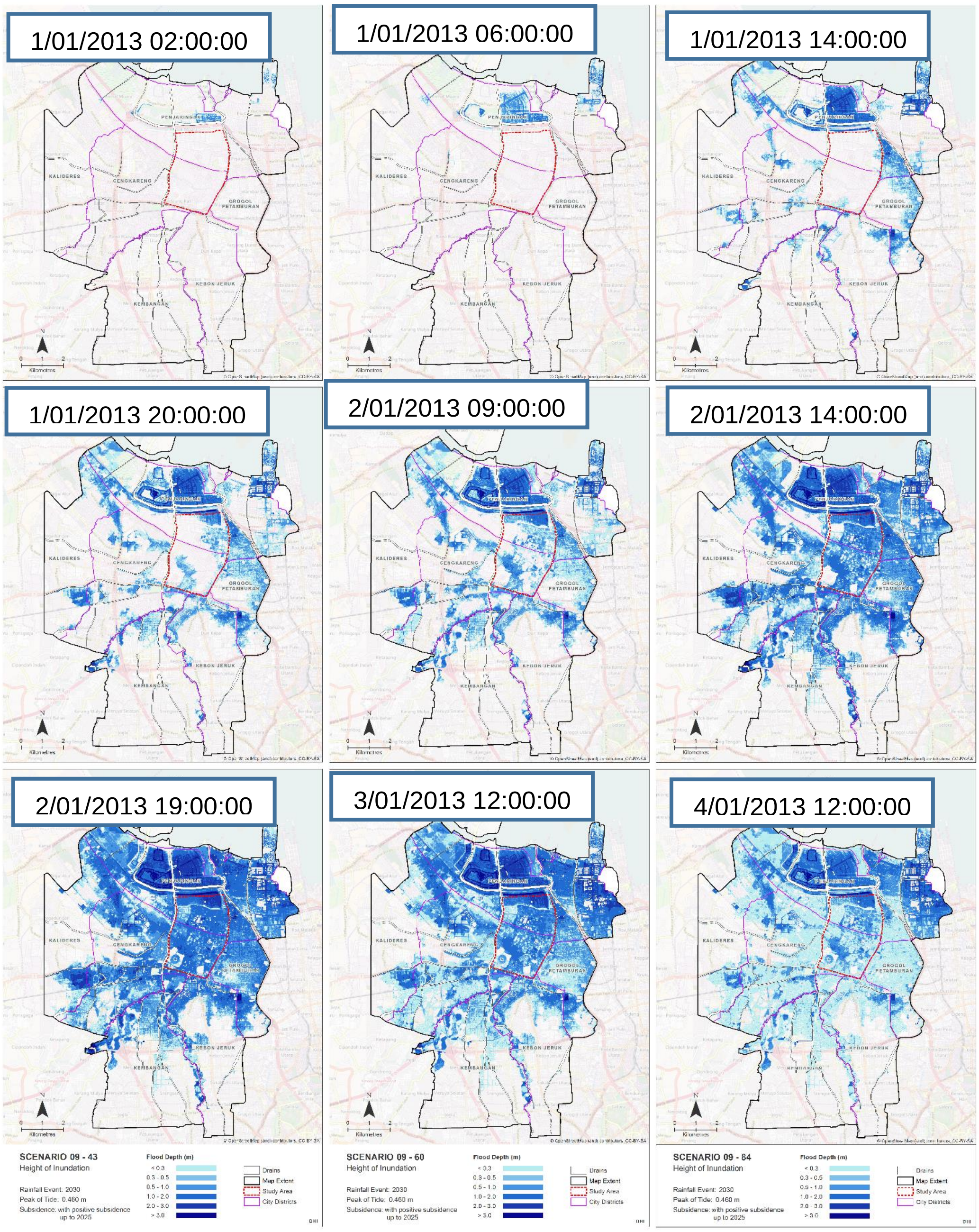

Figure 2.5 Dynamic flood maps from Scenario 9 model result. For 2030, the simulation period is not indicative of actual flood event, since rainfall/tide are derived from calculations

Test simulations were generated to further analyse the effects of tide in coastal flooding. DHI simulated two scenarios of 2030 tidal input without rainfall, i.e. no subsidence and with positive subsidence until 2025. Results in Figure 2.6 show that tide causes flooding in the projected subsidence in 2025, but not in ‘no subsidence’ scenario (i.e. 2012 ground levels). The flood caused by the tide was not reached the study area since the spreading of the flood only occurred in some part of Penjaringan district, especially in Pluit polder. It shows that tide caused flooding but only when land subsidence was applied. Therefore, the flooding was mostly sensitive to the increase of rainfall/rainfall intensity.

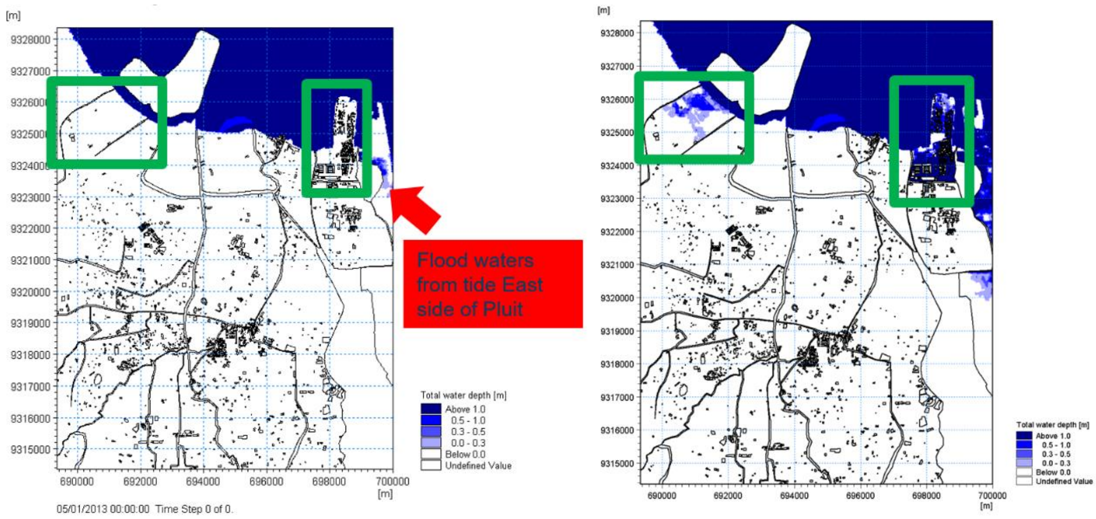

Figure 2.6 Model results with only 2030 tidal input. (Left) Without subsidence – 2012 DEM, and (right) with subsidence – until 2025.

The Blue Green Jakarta was the winning proposal in the Green Metropolis Jakarta 2050 competition. The retention pond included in Blue Green Jakarta was planned to be located in Kapuk Polder system (study area), because this area is continuously flooded, notably in 2007 and 2013. The area is also affected by land subsidence. This retention pond is a proposed measure in reducing the flood by diverting the flood into the pond. The retention pond is designed to help prevent the 50-year return period flood. Therefore, to estimate the capacity of retention pond, DHI's flood model results from Scenario 2 (2007 flood event with subsidence) were used. Furthermore, model results from Scenario 9 (2030 with subsidence) were also used for the pond capacity estimation as a mitigation of future flooding from climate change and subsidence in 2030, summarised in Table 2.4. This capacity estimation for 2030 (~11M m^3) is well within the estimation of Pond Capacity (10 – 15M m^3) described in the Blue Green Jakarta proposal.

Table 2.4 Estimation of the retention pond capacity

Year	Mean Flood Depth (m)	Pond Volume (m^3)	Depth in 200 ha Pond (m)
2007	0.84	7,463,854.30	3.73
2030	1.24	11,028,313.31	5.51

From the above results and analysis, the following conclusions can be made:

- The current flood model setup generates reasonable flood maps consistent with increasing rainfall, tide and subsidence.
- Current flood maps are validated with other models and surveys on 2007 (~50-year return period) and 2013 (~25-year return period) flood events.
- Flood is caused more by increased rainfall rather than tide and projected sea level rise.
- Land subsidence significantly worsens the flooding, similar to the findings of previous studies.
- Further analysis of tidal influence show that coastal flooding from tides is observed only in future land subsidence scenarios (2025 projected ground levels).
- If a worst-case climate change scenario is taken into account, i.e. increased rainfall, the study area is almost fully inundated compared to 2007 flood event (one of worst flood occurred).

- The hydrodynamic model also provides the "weak points" where flood starts to overflow. This will help to mitigate the flood with different options for the relevant authorities in Jakarta.

2.2 Activity 1B – Sociocultural Risk Assessment

As part of the main activity, the sociocultural risk assessment activity focused on a high resolution study of social, economic and cultural characteristics of communities in flood prone areas. This study analysed several issues i.e., socio-economic conditions and demographics of the communities, public perception of the risk of flooding, how social and economic characteristics in society affects the perception, vulnerability, resilience social, potential losses (flood exposure), the level of acceptable risk, mitigation and adaptation choices, the willingness to be relocated to support mitigation and adaptation efforts of the government. This study is expected to provide useful inputs into policy recommendations and to reduce flood risk in Jakarta

This assessment was conducted in two districts i.e., *Cengkareng* District in West Jakarta Municipality and *Penjaringan* District in North Jakarta municipality. In each district, the study focussed on two sub-districts (*kelurahan*). For *Cengkareng* disctric, *Kapuk* and *Kedaung Kali Angke* sub-districts were choosen, while for *Penjaringan* district, *Kapuk Muara* and *Pejagalan* sub-districts were choosen. These sub-districts were selected because they are the most flood-prone areas in west and north Jakarta due to overflow three rivers i.e., *Cengkareng* Drain, *Angke* Drain River, and *Apuran* River. Furthermore, they are threatened by sea level rise of Java Sea, which is located in the northern part of this area. The four sub-districts have total area 21.73 km^2, but only focussed on the most flood prone about 6.91 km^2 (further called as "the pilot area"). Table 2.5 displays the demographic characteristics of the four sub-districts and Figure 2.7 shows the map of those areas.

Table 2.5 Demographic characteristic of the study area in 2015

District	Sub District	Area (km^2)	Neighbour-hood (unit)	Household (unit)	Population (people)	Sex ratio
Cengkareng	*Kapuk*	5.63	16	48,034	148,197	104.81
	Kedaung Kaliangke	2.81	8	12,036	36,246	106.34
Penjaringan	*Kapuk Muara*	10.06	10	11,907	36.578	104.14
	Pejagalan	3.23	18	29,109	88,224	102.29

Source: Statistics of West Jakarta (2016a), Statistics of North Jakarta (2016b)

Figure 2.7 The map of assessment area

In order to obtain comprehensive information, this assessment was conducted in three levels. The first level, called as a macro study, aimed to show an overview of economic and demographic characteristics of the study area as well as consequences of flooding in recent years. The second level, called the meso study, aimed to obtain information on social, economic, and cultural based on perspectives of community representatives. The third level, called the micro study, aimed to obtain more detailed information related to the characteristics of the economic, social, and cultural of communities in the study area. Furthermore the micro study obtained other information i.e., perceptions on flood risk, vulnerability assessment, resilience social, potential damage (flood exposure), the level of acceptable risk, mitigation and adaptation choices, and the willingness to be relocated to support mitigation and adaptation efforts of the government. The framework of this study is illustrated in Figure 2.8 below.

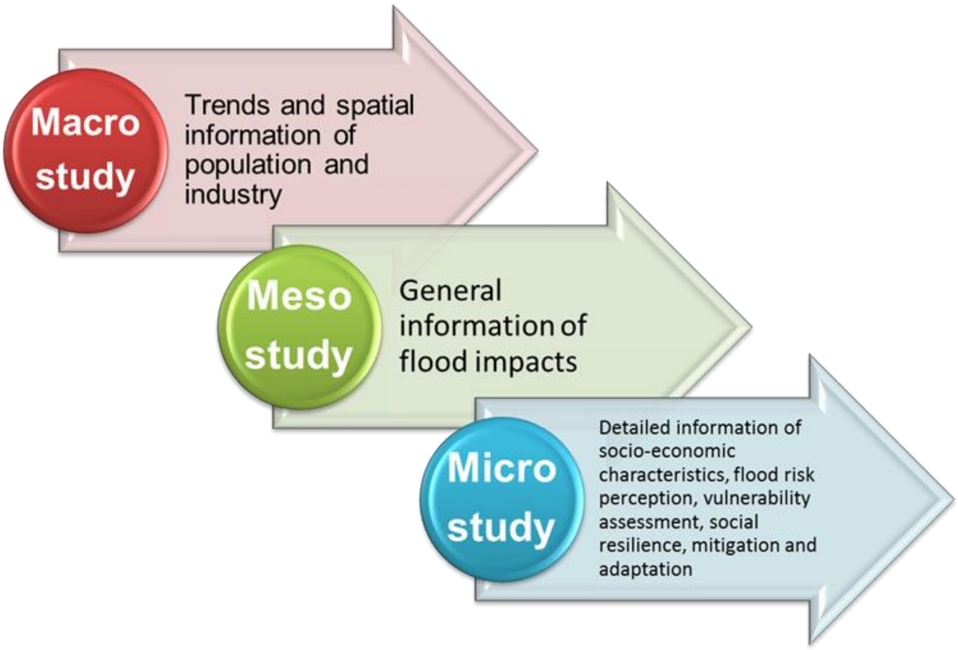

Figure 2.8 Assessment framework

The macro study was conducted by analysing the trends of population and business unit distribution in the study area based on data from BPS Jakarta, DPE Jakarta, and BPBD Jakarta. Data from various agencies was analysed to see the trends of population and distribution of industry from 1995 to 2015. DHI also displayed such information in several maps.

The meso study employed three focus group discussions (FGDs) i.e., (1) FGD with community representatives of *Cengkareng* District, (2) FGD with representatives of *Penjaringan* District, and (3) FGD with representatives from industries located in study area. The representatives from each district consisted of local government representatives e.g., head of district, head of sub-districts, and head of communities. The aim of the first and second FGDs was to inform the participants about the objective of the current study and to obtain general information about socio, economics, and cultural aspects of society in the study area, which was useful as inputs to prepare the questionnaire of household survey in the micro study. The *Cengkareng* FGD was conducted on 23 January 2017 and was attended by 23 participants. The *Penjaringan* FGD was conducted on 24 January 2017 and was attended by 15 participants.

Activities in these FGDs were divided into four sessions. In the first session, participants described the negative impacts of flood to their households. In the second session, participants gave detailed explanations on the locations that are always being flooded, public and private flood mitigations that already been conducted, and their expectation on future public mitigation. In the third session, participants were asked to give their opinions on three types of mitigation i.e., construction of a lake as storage, relocation of some warehousing area to outside Jakarta, and relocation of people who live in the flood prone areas to vertical houses. In the fourth session, participants were asked to sit based on their sub-districts and to give their preferences on eight social resilience indicators, by giving a score 0 to 4 indicating extremely do not agree to extremely agree. Here the assumption was that the average scores from all indicators indicate the level of social resilience. Therefore, the higher scores means the better social resilience level.

FGD with industry representatives was conducted on 27 February 2017 and was attended by 15 participants from DPE, Jakarta research council, and industries located in the study area. Discussion was conducted in two sessions; first, the discussion focused on how flood have affected industry and what kind of mitigation that have been conducted by industries, and second, the responses of industries regarding relocation of industry to support flood adaptation were discussed.

The micro study was conducted through household survey. Sampling frame of the survey is all households affected by floods in pilot area. Respondents were selected by using multistage random sampling, in which respondents were selected through three steps. First, the study selected the affected community units (RW) in each sub-district. Second, the study selected affected neighbourhood units (RT) within selected RWs. Finally, the households respondents within the selected RTs were chosen. In total, survey reached 16 RWs, 135 RTs, and 342 households. The survey questionnaire included 50 questions, which are divided into eight topics i.e., socio-economics characteristics of households, perception on flood risk, vulnerability assessment, social resilience, flood exposure, choices on mitigation and adaptation, and preference on relocation.

Data were analysed by using both qualitative and quantitative methods. The qualitative method was used to describe the results in meso study. The quantitative methods were employed to develop trends in macro study and to analyse results from survey. Furthermore, *ArcGIS* software was employed in macro study to present the spatial information of population and industrial growths in study area.

The result of this activity showed that the study area was prone to flood as it was located in unfavourable location due to overflow of three rivers, increasing sea level rise, and land subsidence. People lived in a high densely populated area, in which most of them had a low income, low education, and worked in informal sector. People were used to live with flood and their perception on flood risk was low. One of reasons might be because flood magnitude in terms of flood depth and flood duration in study area decreased during the last five years. They were more worried about the consequences of future flood than the probability of future flood. Furthermore, migrant households tend to have a higher risk perception than local households, and also households which experienced a higher flood depth during the last year tend to have a higher risk perception than others.

The results show that potential damage per house was found in Kapuk Muara, but for the highest aggregate potential damage were happened in *Kapuk* (see Table 2.6), because it had the highest number of affected houses. Social resilience of the people was high and it relied on sense of community, trust, and collective efficacy.

Table 2.6 Aggregate potential flood damage in each sub-district (Million USD)

Flood depth Outside house (cm)	**Potential damage (Million USD)**			
	Kapuk	***Kedaung Kali Angke***	***Kapuk Muara***	***Pejagalan***
30	3.64	1.22	0.54	0.24
50	8.51	3.00	1.16	0.75
75	12.37	4.41	1.64	1.15
100	15.12	5.41	1.98	1.44
125	17.24	6.19	2.25	1.66
150	18.98	6.82	2.47	1.84
200	21.72	7.82	2.81	2.13

Various type of private and public mitigation flood measures were established. Most of households combined two or more mitigation measures. However maintaining local drainage system and improving pumping facilities were still requested by households to minimize the future damage. Regarding to adaptation choices, there was no clear indication of the most prefered adaptation, but respondents likely prefered relocation of warehouses than constructing a lake. Moreover, most of households were resistant to the idea of relocation to vertical houses, because they assumed such relocation will lower their welfare by loosing their job or increasing monthly enpenditures. Only households who were staying in a rent house and experienced with more flood events and a higher depth were willing to be relocated.

Besides housing, the study area was also dominated by small-medium-sized industries. Such industries were dominated by food industry, machinery installation and tools, as well as metal goods except machinery. Meanwhile, the number of large-sized industries decreased significatly within 15 years. Some industries left the pilot area with the following reasons i.e., avoiding flood losses, following 7 zonation regulation from Jakarta government, and expanding their business to cheaper-input-prices areas.

2.3 Activity 1C – Technology Transfer

The technology transfer were done by conducting workshops, FGDs and trainings. The workshop and FGD mostly aimed to understand the progress of Technical Assistance as well as to discuss the progress of the tasks. The participants of this technology transfer activities were DHI, JRC, BPPT, and other related institutions/agencies. Training materials from the four training session consisted of theory, module, and study case of MIKE HYDRO River, MIKE 21 Flow Model FM, and MIKE FLOOD. In addition, the training material also included the material about pre-processing before modelling was done.

2.3.1 Workshop and First MIKE HYDRO River Training

The first series of the workshop and training were conducted in three days (27-29 July 2016). Three activities were included in this series, i.e. (1) pre-workshop (a coordination / preparation meeting for workshop activity), (2) workshop and FGD, and (3) the first MIKE HYDRO River training.

The pre-workshop meeting was actually a coordination / preparation meeting for workshop activity on the next day. It was held at DHI Indonesia and was attended by DHI staff and some representatives from JRC. During the pre-workshop meeting, the participants agreed that one of the questions expected to be answered through this technical assistance was how big is the impact to the study area in terms of engineering, social and economy aspects if the Blue Green Metropolis Jakarta city concept is applied in this area, as shown in Figure 2.9. In this meeting, it also was cleared that the hydrodynamics modelling will be conducted by DHI, and there will be a transfer knowledge activity from DHI (regarding the hydrodynamic modelling) to the JRC.

Figure 2.9 Blue-Green Metropolis Jakarta (Sopaheluwakan, 2017)

In the second day (Thursday July 28, 2016), workshop and FGD as series of Technical Assistance activities were held in Dinas Perumahan dan Gedung Pemda Provinsi Jakarta. The problem statement and the goal of this technical assistance were formulated by the experts that were involved in this technical assistance. The workshop was opened by Dr. Ir. Tusy A. Adibroto, M.Si. as representative from JRC. The workshop consisted of (1) keynote speech from Ir. Tri Rachmat Djunarso, MM. as representative of Regional Agency for Development Planning (BAPPEDA) Jakarta, (2) presentation sessions from Prof. Jan and Dr. Suresh, and (3) FGD. He explained about alternative plans to develop Jakarta. He also explained about the background and the regulation of Jakarta reclamation. In presentation session, Prof. Jan gave an overview of this technical assistance, while Dr. Suresh presented the hydrodynamic modelling for flood including the importance of modelling as baseline for decision makers.

In this workshop, FGD was conducted to clarify the technical execution of this technical assistance. The FGD session was divided into two groups, the first group covered the hydrodynamics modelling and the second represented the socio-economic vulnerability group. The moderator of first group was Mr. Yus from JRC and Pini Wijayanti M.Sc from Bogor Agricultural Institute (IPB) for the second group. The FGD from the hydrodynamic modelling group came up with a list of important data needed to conduct the hydrodynamics modelling activities, as well as the availability of the data and potential data sources. These data were mostly scattered in several work units of DKI Jakarta and national institutions. The FGD from socio-economic group concluded that the proposed location was representative enough, but needed more care for applying sampling in the survey. It was decided that the survey should use stratified sampling, and that some weighting in economic impact study for each district was needed

In the third day, the first MIKE HYDRO River training was held as the first stage of technology transfer under this technical assistance. DHI conducted a demo how to conduct hydrodynamics modelling for flood using MIKE HYDRO River, successor of MIKE 11 software. The activity lasted for two hours, and then followed by informal discussion between DHI and JRC representatives.

2.3.2 Second Training (MIKE FLOOD)

The second training was conducted on 11-12 Oct 2016 at BPPT Office – Serpong. The training topic consisted of MIKE HYDRO River tutorial and exercise as well as a brief explanation and demo of MIKE 21 Flow Model FM and MIKE FLOOD. The participants of the training came from BPPT and BMKG. The training itself was carried by Dr. Suresh. In this training, the participants were asked to do some exercises, i.e.: (1) re-do the simulation using the material that was given and (2) build MIKE HYDRO River model in Salmon River. The purpose of this exercise was to make the participants understand more about MIKE HYDRO River

2.3.3 Workshop and Third Training (MIKE HYDRO River)

The third training and workshop activity was aimed to follow up the technology transfer activity under this technical assistance. This activity was held for five days (5-9 December 2016). The training and workshop was carried by Dr. Suresh as senior water resource engineer and supported by Ms. Fritzi Anne G. Gironella, both from DHI Singapore. This activity also was supported by Ms. Maraya Syifa Widyastuti and Ms. Meirita Ramdhani from DHI Indonesia.

Technical details using real data gathered for the Jakarta River modelling were explained in the first day of training. Technical discussion on developing high resolution 1D model, including surface runoff from rainfall data, was presented on the second day of training. Ms. Fritzi and Dr. Suresh gave a demo on how to simulate the Rainfall Runoff model and the 1D river model, as well as how to do visualization and analyses of the results from those models. On the third day, model scenario and task allocation between DHI and JRC in doing the model setup were discussed. At that time the scenario matrix designed was still pending to be finalised, namely: to choose either or both 2012 and 2003 rainfall event depending on rainfall data provided; and whether to include 2050 climate change scenario. Hence the number of scenarios will be between scenario six and nine.

On the fourth day, the training material provided was about adding basic structures. The training and workshop on the last day was dedicated for an exercise to finalize the model setup and the discussion about follow-up action for December 2016.

2.3.4 The Fourth Training and Workshop (MIKE 21 Flow Model FM, MIKE FLOOD)

The fourth training and workshop were conducted to train the participants about MIKE 21 Flow Model FM and MIKE FLOOD, as well as to get some input/advise from JRC for updating the initial model. This activity was held for two days (13-14 March 2017) at Gedung Teknologi 3, BPPT, Serpong.

The first day fully consisted of MIKE 21 Flow Model FM and MIKE FLOOD training. The trainer for this training was Ms. Fritzi and was assisted by Ms. Mei and Ms. Syifa from DHI. The training was attended by ten participants that came from BPPT/JRC and BMKG

The second day was dedicated to discussion. The discussion topics were about: (1) input data and scenario matrix that was used in the current model, (2) overview of 1D and 2D model result, (3) field survey result conducted by JRC, and (4) flood protection analysis and other future scenarios. In this discussion session Dr. Suresh also joined the discussion for about one hour via Skype.

It was the last training from all the training series conducted by DHI in this technical assistance. The overall feedback from the participants were satisfactory especially about the training materials provided. The participant also shared how the training could be improved in other aspects such as the licensing and usage of the MIKE software, dedicated laptops for the training and installation of the MIKE software prior to the session, training venue, and for some, the complexity of the training material especially those not familiar with flood modelling. Despite of technical feedback regarding the training implementation, the training itself successfully triggered the participant to try learning and building their own model. At the end of the training, the participant were successful in developing a demo model on their own and some of the participant are still in contact with DHI team to check and discuss their model.

2.3.5 The Final Workshop (Expert and Stakeholder Meeting)

The final workshop was held in two days (20-21 April 2017). Three activities were included in this series, i.e.: (1) Expert meeting, (2) Stakeholder meeting, and (3) Internal discussion with the CTCN.

The expert meeting was held at 20 April and was opened by Dr. Tusy. This activity consisted of several presentation sessions and discussion session. The first presentation was about model approach and initial model result presented by Dr. Suresh. The second presentation was presented by Prof. Jan. He explained the global concept of this technical assistance. The next presentation was done by Mr. Yus in which he presented the approach and the results from the socio-economic survey. The last presentation was presented by Dr. Tusy about the summary from hydrodynamic and socio economic studies as input for policy recommendation formulation. She explained that the policy recommendation should include the approach from hydrodynamic modelling result (2) socio-economic study result, and (3) improving previous regulation. In the end of the expert meeting, it was summarized by Prof Jan and closed by Dr. Budy by stating a short conclusion as follow:

- Land subsidence monitoring has been started.
- Based on the fact that some institutions were currently undertaking research which are in line with this technical assistance, it would be appreciated if in the future there will be some kind of public disclosure about what has been delivered by the joint team, so that there will be discussion and brainstorming in the same (government) level.
- The land subsidence problem which was caused by ground water extraction, can be solved using clever ways for example by surface water based urban renewal
- Emphasising the importance of data availability to improve the modelling result and also for model calibration and verification.
- This technical assistance was a good contribution from CTCN for better Jakarta condition (regardless of the existence of NCICD or not) and the result of this

technical assistance is applicable to every governor who will lead the city in the next five years

The second day of workshop was a stakeholder meeting that was attended by more than 50 people. This activity was held in BAPPEDA Jakarta office at 21 April 2017. The activity was opened by Ir. Tuty Kusumawati, MM. as Head of BAPPEDA Jakarta. She hoped that the result of this technical assistance could be used as additional data and information for Regional Medium-term Development Plan (RPJMD) 2018-2020. After opening remarks from Ir. Tuty, the workshop continued with the keynote from Mr. Gunawan as representative from KLHK.

The workshop continued with several presentations: (1) presentation about initial result of Jakarta flood modelling by Dr. Suresh and Dr. Budy, (2) presentation about socio-cultural risk assessment by Mr. Yus, (3) presentation about the overview on hydrodynamic modelling and social economic changes in Kapuk Polder system by Prof. Jan.

After the presentations ended, Dr. Tusy (representative from JRC) opened the discussion session. The participants were actively involved in discussion. After discussion session, the workshop was closed by Mr Jukka Uosukainen (CTCN director) and Mr. Afan (BAPPEDA representative). Mr Jukka Uosukainen hoped that this technical assistance result can give tools and methods that will help to make policy brief. This technical assistance also expected to help upscaling the lesson learned, because technical study should be continued with action. In the closing remarks, Mr. Afan emphasized that the community relocation should be avoided, and use the word “settlement reorganization” instead. Mr. Afan hoped that this technical assistance can produce some recommendation that will be in line with the vision of the newly elected governor. The job program of the newly elected governor could be found in the website: jakartamajubersama.com.

The last activity in the workshop was internal discussion with CTCN representative. This activity was held after the stakeholder meeting. The internal discussion was attended by various parties, i.e.: CTCN, JRC, DHI, BPPT, KLHK, and BMKG. The discussion was started by Mr Jukka Uosukainen’s explanation about the latest issue from CTCN. At the end of the discussion, Prof. Jan concluded that:

- The activity received good responses from Jakarta government, and they expect that the result can be used for policy recommendation
- At that time, the team still have to finish some task, and there were two following activities, namely policy recommendation and upscaling the application
- Need to socialize the result with other country.
- License issue will be discussed and will be follow up through the next discussion by CTCN, JRC, and DHI
- Regarding NCICD, this technical assistance could be integrated to that study
- Upscaling the application could be started in Jakarta, and similar places.

3 Summary of Activity 2 – Policy Recommendation Formulation

The initial recommendation formulation was done through expert panel along with the workshop in Activity 1C. In that workshop, after several presentations about the overview of this technical assistance and the result of activity 1 (flood risk assessment), Dr. Tusy presented the summary from hydrodynamic and socio economic studies as input for policy recommendation formulation. This workshop delivered three main points of the recommendation approach which needs to be included for the policy recommendation, i.e.:

1. From hydrodynamic modelling result policy recommendation needs to cover:
    a. Policy regarding polder management
    b. Retention ponds location and its pump system
    c. Land subsidence that related to drinking water service
2. From socio-economic study result policy recommendation needs to cover:
    a. Socialization to community, related to area environment improvement planning.
    b. Regulation or technical policy developed by the government should be started by involving the community, this is related with the tendency of rejection action regarding long-term adaptation.
3. Recommendation for improving previous regulation:
    c. The regulation for absorption well (this is related to the water runoff constant)
    d. Operational polder system of 66 polder (macro management) needs to follow province government planning.

Following the presentations, the participants were separated into two groups to discuss hydrology and flood infrastructure aspects (Group 1) and socio-economic aspects (Group 2).

Group 1 concluded:

- Flood risk map must be produced as basis for decision support system
- Need to harmonize existing regulations affecting polder system
- Coordination between local and central government must be strengthened
- Public-private partnership was required to tackle flood issues in Jakarta

Group 2 concluded:

- The statement “resilience is an opportunity” could be translated to the action level (not only physics, but also social, environment, and take into consideration climate change effect)
- The outcome and recommendation should be included to the RPJMD of Jakarta
- Need to examine different scenarios (physical, social, economy, and environment) in the targeted location. These could include:
    - Business as usual scenario
    - Survival scenario
    - Transformative scenario

- Jakarta had experience with relocation of communities. It was recommended that:
    - Relocation should take into account household level
    - Relocation need to take into consideration micro economic activities in a relocated area
    - Livelihood design for the communities
    - Coordination and collaboration among the stakeholders
    - Preparation and socialization to the community about further plan was required

In the end of group 2 discussion, there was also a suggestion that the recommendations resulting from this technical assistance should consider and adjust with the vision, missions, and programs of the newly elected governor of Jakarta.

With relation to the workshop, one of the invited experts gave her input by email on relocating the community in the targeted area to the higher rise settlement. To revitalize the targeted area for creating blue-green metropolis, many preparations were required for the affected community by taking into consideration that should be done as follow:

- Relocation could use participatory approach and the term of "settlement organization" could be used instead of "relocation" due to the reluctance of the community with the issues of relocation
- The requirement of higher rise settlement for the affected community. To implement this recommendation, socialization or improving community's awareness, identification of the potential tenant's characters, and coordination among the stakeholders are required. The community should be invited from the beginning of the process. They also needed to change their habits or cultures to the higher rise housing / vertical housing.
- A study about moving pattern of the community regarding their economic activity was needed to decide the optimum location in community relocation
- After relocation process, activity to strengthen the community's economy and determine Basic Improvement District (BID) area was required to empower the affected community.
- Coordination among the stakeholders could be done by creating a forum or consortium to coordinate each unit in the government of Jakarta. This forum is a cooperation place since preparation step until collaboration funding system. With this forum, the implementation process of the big concept of revitalization could be controlled.

Beside the input from the workshop, the result from activity 1 (flood risk assessment) also contributed in policy recommendation formulation. The overall long-term adaptation recommendation from the modelling in the pilot area is to adopt a hydrological and open space approach to revitalize Jakarta as a blue green metropolis, taking into account environmental, economic and social concerns. The solution implies: (1) development of a hydrologic solution/infrastructure based on retention ponds, (2) resettling in higher rise buildings thus allowing population to stay in local area, and (3) infrastructure to adhere to the concept of blue-green metropolis.

From overall hydrodynamic study, amendments should be made to existing regulation:

1. Building codes should be adjusted for the flood recurrence for example with respect to location of electrical system (first floor). Places of worship should be designed as refuge centers in cases of flood, possibly adding an additional floor 3 meter above ground.
2. The condition/quality of polder embankments should be supervised systematically.
3. Retention pond and pumping systems need to be reconsidered and regulated based on hydrodynamic modelling.
4. Flood preparedness needs to be strengthened (broadcasting, evacuation procedures, education/awareness/capacity building) also taking into account recurrence events exceeding 100 years.

From socio-economic risk assessment, some requirements were identified for the policy recommendation if a blue-green metropolis was implemented. A blue-green metropolis approach encompassing distributed retention ponds would change the population distribution pattern and relocation of people into higher rise settlements was required. This implies:

1. Provision of alternative higher rise housing for relocated people. Preparatory recommendations are:
    - Increase awareness among local communities on flood mitigation and adaptation. Such awareness raising will benefit from the involvement of key-persons from the community (leaders). Community awareness raising should be initiated as early as possible and continued throughout the transformation process.
    - Ensure that the design of new residence takes into consideration the culture and needs of the relocated population. Requires in depth understanding of their current situation.
    - Address the implications of economic activities (household livelihoods) related to transport to minimise burden on relocated population.
    - Establish strong coordination between stakeholders in the transformation/ relocation process (including Public works, Office of Water Management, Office of Housing and Building and down to community levels). A coordination platform/arrangement should be established to manage and monitor the transformation process.

2. Improving the community economy. Preparatory recommendations are:
    - Capacity building of the relocated community targeting household economy adjustments/improvements (develop alternatives to prior economy consistent with new settlement).

Policy considerations have been consolidated into concrete action outlines. Each of the needs and opportunities as discussed above were presented into action brief in term of proposal (Table 3.1). A proposal to further assessment and implementation of pilot project for Integrated Polder Management of Flooding in Jakarta has been submitted to KOICA (Appendix 1).

Table 3.1 Action brief template

Background:	Provide a very brief description of what has led to the identification of this action	
Title:	The title of the actions	
Action Reference:	Unique identifier for action database and other references.	
Justification:	Provide statements justifying that this action should be considered for funding.	
Objective:	Establish what the action if implemented is expected to achieve.	
Expected outputs:	Identify key outputs required to fulfil the objective.	
Activities:	List key activities that have to take place to produce the outputs.	
Assumptions:	State what assumptions concerning conditions outside the control of the action that must be met.	
Risks:	Identify risks that the source of funding and the responsible for the action should be aware of and try to mitigate.	
Means of implementation:	Logistics, technical, scientific	Outline expectations for logistic requirements, technical and scientific environment.
	Human Resources	Outline expectations on human resources engagement
Budget estimate:	Provide an assessment of budget requirements in very broad terms as detailed assessments can only be made in project appraisal and detailed design. The budget requirements may assess both project preparation (appraisal and design) and project implementation dimensions	
Source of funding:	Identify potential funding sources, including government, development partners, private sector, etc. or combination thereof if applicable. The identification should to the extent possible be aligned with strategies and plans of the funding sources.	
Responsible for the action:	Identify which institutions would be responsible for implementing the action, government and or non-government. One institution should be overall responsible but contributing institutions should as applicable also be identified.	
Beneficiary from the action:	Make qualitative assessment of beneficiary(ies). Quantitative assessment of beneficiary(ies) can at best be made in very broad terms until appraisal.	
Schedule:	Indicate a time schedule for the implementation of the action.	
Links to other actions:	Identify and explain linkages to other actions	
Performance indicators:	Identify verifiable performance indicators that can be used to monitor the implementation of the action.	
Comments:	Provide any comments that are considered useful for the considerations by funding sources and institutions responsible for the action.	

4 Summary of Activity 3 – Developing further funding stream

In developing further funding stream, several internal meetings were conducted to formulate a proposal of further study, as well as to identify some potential institutions that considered can fund the further study.

In an internal meeting at 12 July 2017, Dr. Tusy emphasized the background of activity 4 (Further funding stream) was CTCN commit to help the continuity of previous activities in order to implement the result to government's policy, but the funding source is not from CTCN (will be offered to other international and national donors).

In that meeting, Dr Tusy also emphasized that the future project should involve BPPT, since BPPT was the recipient of previous technology transfer. Therefore, the proposed further study from DHI/Mr. Suresh about *Ground Water Modelling* will be included in proposal along with others further study proposed by BPPT. BPPT had many topics to be offered for proposal content. One of the topic was study about sedimentation and water pollution as well as its management. Beside that, BPPT also offered Master Plan of study area for the proposal content. For continuity of activity 1B, BPPT suggest to include the study of economic transformation to increase the community economic condition in the new area.

At the end of internal meeting, Dr. Tusy concluded that the proposal title will be reformulated (to generalize the aspect). She said that the proposal will have one big title, and will covered the continuity of activity 1a and 1b.

From all the internal meetings, some international and local potential donors, have been listed. The institutions are DANIDA, ADB, World Bank, JICA (Japan *International Cooperation Agency*), KOICA, and SIDA (Swedish *International Development Cooperation Agency*). For local institution, KLHK and Ministry of Maritime Coordinator have been identified as potential donors. At this moment, some meetings were conducted to two institutions, namely World Bank and KOICA.

Meeting with World Bank has been conducted at 10 August 2017 in World Bank Office. The representatives from World Bank are Ina Binari Pranoto and Rambat Safwan. In that meeting Mr. Rambat explained about the current JEDI (Jakarta Emergency Dredging Initiative) project which was funded by the World Bank. JEDI was a small program which was funded by World Bank to revitalize the rivers, canals and reservoir in Jakarta to it main function. The JEDI project is also including river embankments revitalization.

Mr. Rambat also said that technical assistance was almost similar with PUSAIR project which was funded by World Bank, especially related to the water management project. But there are still some of the aspect that is not included in the current project between PUSAIR and World Bank such as the ground water modelling, and social economy impact analysis.

World Bank Indonesia explained that the joint collaboration model for grant or loans is always allocated to national project, with one main theme which can be covered several activities. Therefore, the funding of the project will be given through national institution such as BAPPENAS.

They said, the current proposal is related to the water resource management section which implementation has been started by PUSAIR. World Bank Indonesia informed that JRC could try to approach PUSAIR, because there were opportunity to use the remaining funds from previous project. The consequences was that this will add PUSAIR working load, where the proposed future project can be input as part of PUSAIR project.

Therefore, Prof. Jan (as representative of this technical assistance, from JRC) will contact Mr. William in PUSAIR. World bank Indonesia will help to forward the information to Mr.

Markus (urban division representative) related to future project (the continuation of this technical assistance). After discussion with the donors, the proposing team agreed that the proposal would be communicated with NDE Indonesia for further support, in the form of channeling or official endorsement to the CTCN consortium

The next meeting was a further funding stream meeting with KOICA. Meeting with KOICA were carried out several time at KOICA Indonesia office. KOICA Indonesia representative, Ms.Lee as a Deputy Director said that the funding proposal submission for year 2019 has been opened and the deadline would be at the end of August (2017). The funding scheme of KOICA was using HN-2 year. KOICA Indonesia priority program is covered E-government and IT, Infrastructure, Transportation, Water Management and Climate change. There will be a consultation with KOICA expert (regarding the proposal submission).

Following the first meeting with KOICA, a proposal for further funding stream activity were done based on KOICA template. The proposal entitled “Master Plan of Integrated Kapuk Polders Management System toward Adaptive and Resilient Jakarta”. This future project consisted of two main activities i.e. the hydrodynamic modelling and the socio-economic assessment. Integration of the two activities would support options of the master plan considering socio-economic growth, aesthetics, and urban resiliency. The output of proposed study were:

- Preliminary master plan based on hydrodynamic modeling of Kapuk polders.
- Socio-economic analysis based on new regional economic system approaches.
- Set of envisioning policies and infrastructure investment guidelines to achieve adaptive and resilient Jakarta, with particular attention to the on-going strategic initiatives (e.g. NCICD).

5 Summary of Activity 4 – Knowledge sharing and South-South Cooperation

Some meetings were held internally to discuss about lesson learned and good practice based on all the activities that were done previously.

From the hydrodynamics modelling activities, time allocation and data availability became the main concern especially in data collection process and model development. The data required is quite a lot and they were scattered in several institution. The process required a lot of direct contact and lobbying with government's institutions so that the process took longer time than the time allocation. Data processing and model calibration data also took longer time because the data available are not all in 'ready to use' state condition. Apart from these constraints, the hydrodynamic model that has been built was quite successful in representing flood conditions in 2007 and 2013 which was a representation of floods with return period of 50 and 20 year.

The constraints that occur in the hydrodynamic model development process that takes more time than its time allocation was also giving a significant impact on the next activity of socio economic impact assessment. Previously, socio-economic surveys were planned to be executed after hydrodynamic modelling activities were completed, but eventually it was done in parallel with model development. The basis of sample survey sampling was finally taken based on information from FGD activities. The timing of survey activities which coincided with governor election (PILKADA) was also a constraint in the implementation of surveys and FGDs. Apart from the constraints faced, the socio economic survey activity was successful in collecting detail household vulnerability data.

Transfer technology activities which ran in parallel with model development were completed, a series of training and workshops were implemented as a form of knowledge transfer from DHI as the technology holder to the BPPT/JRC as recipient. The technology transfer activity has increased the recipient capabilities to be able to duplicate and to build their own model. Unfortunately, this transfer technology activity was constrained by the license of software that expired when the technical assistance activity is completed.

Result of hydrodynamic modelling and socio economic survey which became the baseline for making policy recommendation. The biggest achievement of this activities was the policy recommendation that has been made will be included in the RPJMD 2018-2022.

South-south cooperation workshop was done 26 September 2017 at office building of Jakarta governor. The workshop was attended by CTCN representative (Ms. Karina Larsen and Mr. Viktor Presenti). The workshop was conducted to share the experience during this technical assistance as well as to show the result of this technical assistance and brief overview of the further study. A presentation for dissemination of Technical Assistance Result was presented also during UNEP Advisory Board Meeting in Copenhagen, Denmark in 29-30 August 2017.

As continuation of South-South Cooperation Workshop, DHI and JRC were invited to attend and present Technical Assistance Result and Lesson Learned to the Dissemination Workshop by UNEP/DHI at BMA (Bangkok) in 7 November 2017.

The lesson-learned from Indonesia entitled 'Hydrodynamic modelling for flood reduction and climate resilient infrastructure development pathways in Jakarta' has been presented at the Dissemination Workshop organised by CTCN, DHI Water & Environment and hosted by Bangkok Metropolitan Administration (BMA). The Bangkok's Technical Assistance was slightly more advance compared to technical assistance in Indonesia, while DHI provided the idea on strengthening Early Warning System for Flood. Mike

Operation (Mike Customized Software) for transforming data into operational Decision Support System, has been introduced.

Below are the summarized lessons learned from this activity:

- Bangkok flood control system including warning system and its underlying hydrodynamics model already existed in Jakarta. Hydrodynamics model in Bangkok metropolitan existed in detail 1D/2D model particularly with the drainage system, while in Jakarta the model started at small scale on three polders i.e. Pantai Indah Kapuk 8, Kapuk Muara, and Kapuk Poglar with total area 1,000 ha

- Jakarta hydrodynamics model relied on SRTM, ALOS and recently LiDAR images and big streams cross sections, while disregarding fine drainage measurements as was the case in Bangkok.

- Bangkok named the warning system as “Urban Flood Warning” with emphasis to the use of model for emergency response. This was understandable since Bangkok flood is mainly due to over-topping of Chao Phraya river. The Chao Phraya size is comparable to Mahakam for Samarinda, Indonesia rather than Ciliwung for Jakarta. The geography makes Ciliwung catchment narrow and steep. In terms of climate, Jakarta is close to mountainous area which makes the over-topping not as important as Bangkok. On the other hand, Jakarta named the system “Flood Early Warning System”, extending the traditional bamboo gong warning system. The system focuses on flood arrival and evacuation.

- Both cities currently saw polder systems as pumping system on the most inundated area. In this sense, Jakarta carried advancement as seen in “Polder System Plan 2030”. The plan halved Jakarta into 66 small polders to the north. Among the 66 polders, pumping systems existed on 43. However, the system did not include (or in an insufficient manner) retention lakes that could withstand higher return period of floods.

- While Bangkok focused on hazard, the technical assistance in focused on flood damage analysis employing the land use and stage-damage function found in previous studies. In Jakarta technical assistance, the quantified damage is the basis of decision system as described in our policy recommendation.