GOOD PRACTICES OF ENHANCEMENT EARLY WARNING SYSTEM FOR HIGH POPULATED CITIES – A CASE STUDY FOR JAKARTA FLOOD

Harkunti P. RAHAYU* and Seigo NASU*
Kochi University of Technology*

ABSTRACT**:** *Frequent occurrences of natural disaster with high impacts on urban area have become raising concerns in this decade. It is not only because of geodynamic and geographical position of Indonesia that made the country highly prone to many natural hazards, but also increased number of high populated cities and number of people living in cities outnumbered those in rural area. Among those urban-centered disasters, the most frequent with severe accumulated loss is hydro-meteorological disaster. Meanwhile, obtaining a flood free city is very costly; a certain level of acceptable risk should be taken. Without comprehensive strategies that politically, socially and economically accepted by stakeholders, the existence of any disaster risk reduction countermeasures is less effective to confront risk perception and attitude of people living in high populated urban flood prone area. To cope with this disaster situation, effective flood early warning should be one of optimum solutions in saving lives and belongings of the people at risk. However, existing systems established by city governments have failed to reduce number of loss of life.*

This paper attempts to discuss aforementioned issues based on the work conducted in Jakarta on the improvement of existing flood warning system becoming flood early warning system (FEWS). Both hardware (structure) and software (culture) components were developed and tested using end-to-end approach and multi-level stakeholder participatory, adapted from the development of Indonesian Tsunami Early Warning System (Ina-TEWS). To address underlying causes and dynamic pressures of existing vulnerability and capacity, an in-depth scientific and social judgment has been considered in problem identification and system development. The system developed was able to integrate 3 level of essential warning mechanism, i.e. monitoring and detecting potential flood; warning dissemination from Jakarta Provincial Government's crisis center to the last miles group; and community based warning response. Not only useful for the replication purposes; the best practices, success and hindrance factors of enhancement FEWS are reciprocally used to enhance the on-going study for restructuring the assessment indicator for establishment of culture component of Ina-TEWS at those high populated tsunami prone cities.

KEYWORDS: *Early Warning System, Effective DRR Intervention, Multi-level Stakeholder Participatory, Community Based Flood Warning and Response*

1. INTRODUCTION

Despite best endeavors of disaster risk reduction (DRR), the numbers of people affected and economic losses caused by natural disaster were still increasing over recent decade in Indonesia. Considering natural disaster risk as a function of natural hazards, vulnerability and ability to cope with disaster; currently more Indonesian cities are profoundly exposed to high risk. The hazard exposures compounded with escalated number and complexity of high populated cities has raised the

number of people at risk. As an impact of socio, political and economic changes in 1998, Indonesia entered the era of democratization and decentralization up to city/district level, which generated emerging of many new cities, euphoria of city development and over exploitation of its resources. Hence, massive unplanned urbanization cannot be avoided. By 2008, the number of Indonesian people living in the city outnumbers those living in rural area. Rapid growth of population in-migrants, if it has not been followed by sufficient development on infrastructures and lifelines, would have triggered various underlying causes and dynamic pressure of vulnerability factors resulted on the decrease of city's resiliency to cope with disaster.

At the beginning of 2010, there were 14 Indonesian cities listed among 600 world largest cities; among of these, Jakarta with its city population of 10.1 million and 24.1 million in metropolitan area is the only one also categorized as megacity. In 2020, Jakarta city population anticipated will be doubled, i.e. 20.77 millions. With 2.5% of average annual population growth rate, some of these largest cities have potentials to be new megacities and many more new high populated cities will be emerged (City Mayor Statistic, 2010). Thus, issues of natural disaster occurrence with high impacts on high populated cities, called urban-centered disaster, have alarmed careful attention.

Excluding Aceh Tsunami 2004, the most frequent urban-center disaster occurrence with severe accumulated loss is hydro-meteorological (hydromet) disaster, which has been also as global concern in drafting Hyogo Framework of Action 2005. The perennial, five-yearly and rob/tidal surge inundations, aggravated by dynamic pressure and underlying causes of vulnerability factors related with technological and socio-economic conditions, unplanned urbanization, development within high-risk zones and environmental degradation; have frequently caused many Indonesian cities collapsed due to its damages, loss of life and loss of business opportunity. Both national and local government's attempts for mainstreaming flood DRR into the development process have emphasized on the technical countermeasures to control flood through structural mitigation and other tangible countermeasures. In fact, obtaining a flood free city through extensive and intensive structural and non-structural mitigation is very costly; it needs strong government's commitment and funds for a short, mid and long term strategies. To bridge the time and cost gap, there is certain level of *acceptable risk* should be taken by these cities. However, the urban people risk perception and risk attitude was found to be indifferent and skeptical toward any implementation of DRR countermeasures, compare those living in rural area; since they have to take much higher socio-economic risk in their day-to-day life, beside the level of poverty has limited their abilities for protection.

Considering the trend and problem of *urban-center disaster risk* in Indonesia, the existence of *effective flood early warning system* as an optimum solution for this situation are challenged by the issues of *acceptable risk* and *urban people mindset*. Meanwhile, the hardware and software availability of the early warning system are further challenged by key issues of effectiveness, i.e. sufficient warning information, timely warning dissemination, ability to reach the last mile, and timely response by the people at risk. Thus, this paper attempts to address and discuss these critical issues in-depth based on the work conducted for DRR countermeasures intervention in the context of building integrated FEWS in Jakarta during 2008-2009, using the

end-to-end and multi-stakeholder participatory as adapted from the development of Ina-TEWS. The work was collaboration between ITB, Jakarta Provincial Government and some national agencies under the PROMISE scheme (Program for Hydro-meteorological Risk Mitigation for Secondary City in Asia) and sponsored by ADPC and USAID OFDA. With high complexity of Jakarta disaster risk profile, and the risk perception/attitude of megacity people; the model developed is expected to be easily replicated to other Indonesian high populated cities and other growing cities in Asian developing countries. Currently the best practices, success/hindrance factors and innovation elements of enhancement integrated FEWS in Jakarta are reciprocally used to enrich the development of assessment indicator for establishment of culture component of Ina-TEWS for high populated cities of tsunami prone areas.

2. JAKARTA HYDROMET DISASTER RISK PROFILE

Jakarta, the capital of Indonesia, has suffered billions USD investment and opportunity loss during 2002, 2007 and 2008 floods, which inundated almost 60% of highly populated sub-districts and affected many Central Business Districts collapse and disturbed the airport activities due to inundated airport access road. Significant increases of inundated area coverage compared to flood volume were shown in certain districts of Jakarta, i.e. South and East districts see Figure 1 (Badri Kusuma et al, 2008).

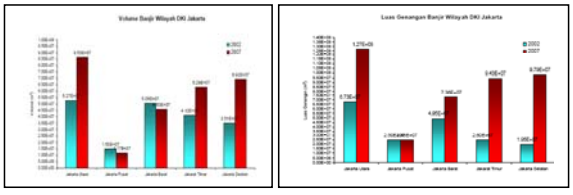

Figure 1 Distribution of 2002 and 2007 Jakarta Flood

These excessive rainfalls have not only inundated marginal area but also middle to upper class residential area, which has never been exposed to flood before. These have resulted on significant increase of death toll (from 32 to 48 people), displaced people (from 40,000 to 316,825 people), lifeline damages (from 132 to 2,104 electrical post, clean water disrupted, and central telephone down), and economical loss (from 6.7 T to 12 T Rupiahs) (sources: Kompas, 10 February 2007).

From hazard point of view and attributed physical vulnerability factors, as a *coastal megacity* Jakarta is located in the *exit point* of 13 rivers systems as part of 27 canal/drain/river systems with average altitude of 7 m above *mean sea level*, and 40% of low land area. With this limited rainfall retention capacity, the extreme monsoonal climate rainfall makes this region naturally very prone toward any type of floods due to excessive saturated overflow and flash flood. In some area, the inundation was aggravated by insufficient carrying capacity of the rivers and existing drainage canals, high rate of land-subsidence (40 - 60 cm), which is triggered by exploitation of water extraction and city weight (Abidin et al, 2001).

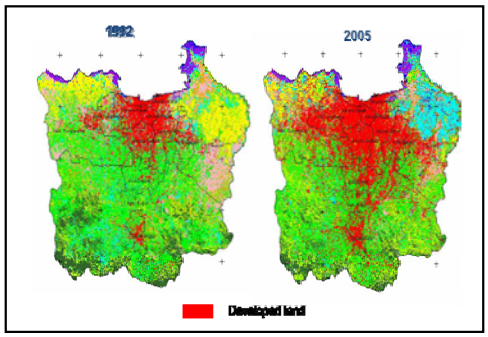

Figure 2 Progressive Land Developments (JPG)

The trend of extensive horizontal and vertical physical development has increased city weight, prevented ground absorption water and increased run-off that contributed to flash flooding, i.e. the construction of large number of private sector

world-class super blocks, shopping malls, and water front cities, as well as construction of government owned program on “one thousand tower for low income high rise apartment”. From the satellite image taken in 1992 and 2005, within 13 years the area developed of greater Jakarta was more than doubled, see also Figure 2.

3. UNDERLYING CAUSES AND DYNAMIC PRESSURE OF VULNERABILITY AND DRR COUNTERMEASURES

Beside hazards and correlated physical vulnerability factors, there are some underlying causes and dynamic pressures of vulnerability that related with socio-economic and technological conditions as well as failures on DRR countermeasures policy and development of Jakarta that attributed to the increase of flood risk. The push-pull factors of the Jakarta extensive development have attracted uncontrolled urbanization since late 1960s, with the peak of urbanization problem during the Indonesian economic booming 1980s to 1997. Without sufficient infrastructures and lifelines supports, these massive unplanned in-migrants might have affected various latent causes of vulnerability to flood; as also shown by progressive informal settlers with their illegal housing encroached many high risk zone area, i.e. river bank, along railway tracks, and harbors. With the highest population density of 30,000 people/km^2, and the average of 15,000 people/km^2, the vulnerability of related to demographic and socio conditions become critical issues.

Increased vulnerability due to dynamic pressure and underlying causes was shown by continued existence of new inundated area as an impact of uncontrolled urbanization, inconsistency development policy influenced by market and economic driven factors. The first case can be seen in the transformation of Tebet sub-district in South Jakarta as middle-class first real estate program built in 1970s recurrently inundated almost 60% of the area up to 6 m during the 1996, 2002 and 2007 floods, has been changed into a heterogenic community consisting of middle and low income with illegal inhabitants living in the river bank. However, floods do not strike the inhabitants of formal and informal settlements in the same way; people from the poor illegal areas are the most affected. Their behavior and coping strategies during the crisis are not due to a low perception of risk, but rather to some daily and non-hazard-related constraints which are not taken into account by the government (Textier, 2008). The second case is shown by Kelapa Gading sub-district development as example of investor driven real estate for high class of North Jakarta developed at the late 1990s during the economic booming, has been inundated up to 4 m in few weeks during 2002 Flood. Previously this area was a water retention pond for Jakarta. Further underlying causes can be shown by many *new* flood area located in the strategic points close to all CBDs, government offices, urban vital facilities such as school, hospital, market and other amenities; and easy access to lifelines, such as roads, electricity, telephone, and water supply networks.

From the preliminary study, as also summarized in Table 1, it was identified that the underlying causes influenced people preference to accept risk and refuse to be resettled to safer place were primarily based on the economic judgment and socio-economic condition. The transportation cost saving is worth as a trade off for taking the flood risk. This risk attitude is contradictory to their accurate perception of other risks they face in daily life; where the most important risk is not floods, but economic, social and political ones (Texier, 2008).

Table 1 Underlying Causes and Problem v. Increase Magnitude of Flood Risk in Jakarta

Problem	Underlying Causes	Indicators	Remark
Increased magnitude of Jakarta Flood from years to years	1. Flood Hazard	Extreme rainfall intensity	
	2. Collateral Hazards	a. 40% low land area below m.s.l.	
		b. Average altitude of 7 m above m.s.l.	
		c. Polder	existence of flood plain area enclosed by dyke
		d. Low carrying capacity of existing river, drainage and canal	encroached illegal housing in the river bank, debris clogging
	3. Socio-political Factors	a. uncontrolled growth of urban areas → prevented water from infiltrating during floods	• urbanization progressively waterproofed the surface
		b. uncontrolled growth of upstream areas → causing a huge reduction in the forested area	• villas (secondary residences) of Jakarta upper classes • government and/or community owned tea plantation on the main slopes of volcanoes
		c. urban development promotion→ causing: • waterproofed downstream area • progressively replacing traditional neighborhoods (kampongs) • reducing vegetated areas	• 1960s: construction of high buildings • 1990s: large shopping centers and upper class high rise residences • 2000s superblocks and 1000 tower of low cost high rise apartments
		d. urban housing policy: private sector role in building new high rise apartment without sufficient governmental control	• causing massive increase of illegal housing from construction workers and supported informal sectors
		e. Push-pull factors of Jakarta development → massive urbanization	• In-migrants from rural provinces forced to settle in remaining vacant and marginal area (river banks, along railway or near seashore)
	4. Socio-economic Factors of Illegal Inhabitants	a. illegal settlements	• Housing progressively encroaches on the natural flood expansion area of the rivers • contribute to increase flooding hazards by their settlement (as blamed by government)
		b. poor behavior	• contribute to poor drainage of by throwing domestic waste directly into the river.
Vulnerability of community at Risk	1. Socio-economic Factors	a. refuse to evacuate	• Protect the belongings: no bank system and insurance used
		b. Refuse to be restructured or resettled	• Close to works places
	2. Physical Factors	a. living in the most affected districts and within flooded areas near the rivers	• the main victims to floods • death cases due to: hypothermia, drowning, or electrocution • hundreds of informal settlers's non-permanent houses built on the riverbank were: o washed out by flood onslaughts o thousands more destroyed or heavily damaged
		b. very high density of population	• Average 15,000 people per km2 • Highest density 30,000 people per km2 in 3 sub-districts
		c. narrow road network	• complicate evacuation operations
		d. single story dwellings	• large proportion of the dwellings do not have a second floor, so that many of the people who did not evacuate had to clamber onto their roofs for safety.
	3. Sanitation and health	a. illegal inhabitants limitation to lifelines and utility lines	• No clean water network • Using electric pumping for water with low water quality
Coping Capacity	Coping Strategy of illegal inhabitant	a. flood-affected people have to cope with harsh daily conditions which increase their vulnerability during flood occurrences	• using electric water pumping since no water supply network with low water quality • during the flood the electricity cut off to avoid electrocution
		b. flood victims had to cope with poor hygienic conditions both during floods and rehabilitation phase.	• using muddy floodwater washed them-selves and cleaned their dishes • seldom washed their hands before eating
		c. ability living with stagnant water	• poor hygienic conditions made flood victims vulnerable to dengue and water-borne diseases

According to BPS statistical data, about 35 percent of employed Jakarta people have temporary jobs, after the Asian economic crisis at the late 1990s, with higher rate in informal sectors. This condition has triggered many home industries existed in the mix-community area, with low use of banking systems of saving and insurance. Securing the property and belongings is more important than evacuation for flood. Other underlying causes found in the preliminary survey from this area show that their reluctance to evacuate at the first place was because there is no proper and trustable early warning available; their reluctance to do the countermeasure was due to their time limit for other things than working for earning money (Rahayu, 2009). These underlying causes of vulnerability factors identified in the field have been oversight and over simplified in the Jakarta's grand design of flood disaster management.

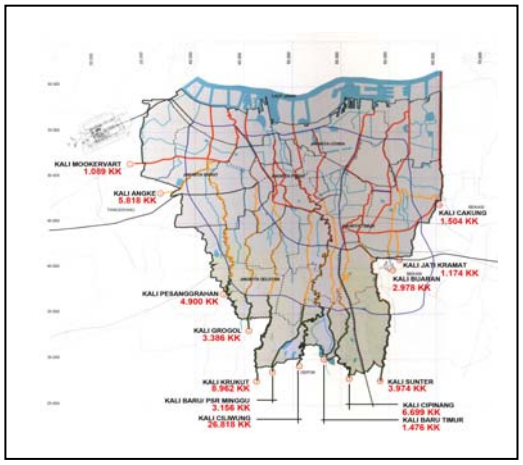

Figure 3 Numbers of Households at Risk (Sources: JPG)

With high number of 72,000 households at risk living in the 13 river banks, see also Figure 3 the distribution of households living in river banks, the mechanism of existing Jakarta Flood Early Warning System has failed not only because of unable to reach the last mile group who are very prone toward any flood but also less-experienced in warning criteria and no scientific based approach. Among these 13 rivers, the highest populated by people at risk is the Ciliwung river, with almost 40% of these people at risk, i.e. 26,850 households, living in its flood prone area. The study has been exercised for the Ciliwung River with the pilot study area in Kelurahan Kebon Baru and Kelurahan Bukit Duri of Tebet Sub-District; see also Figure 8 for the locations of CBDRR Interventions.

The existing criteria for warning at the Jakarta Provincial Government prior to the study has emphasized on the level of government preparedness, not for warning purposes, as shown by the readiness status chart in Figure 4 in the next page. Each level of readiness was correlated with the water level monitored at the water gates of some critical rivers among 13 rivers that having potential for flooding, e.g. Katulampa, Depok and Manggarai for Ciliwung River as shown Figure 5 in the next page.

The current high information technology and communication system at the crisis center built in 2005 under the same development scheme of Ina-TEWS has been used only for the emergency response purposes rather than designated purposes of early warning. It was functioned as government official emergency response, readiness to respond for large scale flood occurrences, or monitoring the damage for small scale flood through its CCTV networks. The existing flood warning mechanism still manually relies on monitoring the water level at those water gates where the travel time was defined deterministically. This system has not been functioned as early warning but rather as warning for the case where the flood has occurred in the upstream. From the view point of capacity of government officials, the crisis center has not been fully functioning as the hub for warning dissemination for the city. Many stakeholders assigned in the system have not been fully aware of

their functions in Disaster Management Agency at the province and municipality levels (Satkorlak PB and Satlak PB), a lot of misconducts in the operation and overlapped functions. Therefore the community at risk has never received the right warning in the right time. Other factors found that due to long bureaucracy for warning dissemination; for example the existing of 6 hours actual Ciliwung flood travel time from the Katulampa water gate monitoring system to the city flood prone area in south Jakarta has never been sufficient.

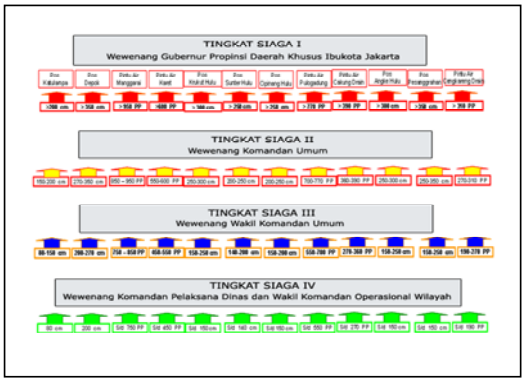

Figure 4 Level of Preparedness (Sources: JPG, 2008)

The existing system was unable to reach the last mile, due to the limitation of hardware and software, urban people risk perception/attitude influenced by the nature of flood as recurrent phenomena, socio and economic conditions and many other factors. On the other hand, even though there have been NGOs activities in the community, there was no such scientific based approach for community preparedness and no standard operating procedure for evacuation committed in the community level. The emergency evacuation system has not yet been systematically established. There is no scientific based strategic guideline available for determining the flood evacuation route, evacuation center and minimum requirement for equipment to be prepared at the community level. Example of wrong-doer during the 2007 flood was the communities designated evacuation centers was firstly stricken by flood; without good knowledge the community only decided based on the criteria of higher and available ground, where the river embankment is the highest place among their dwellings. This mistake has caused such damages and loss of life.

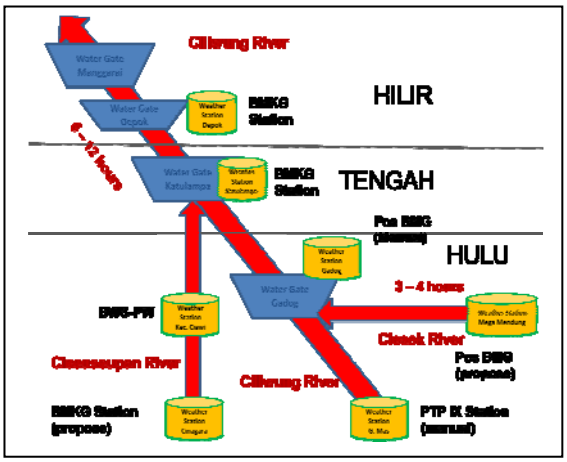

Figure 5 Water Gate Monitoring System

Other critical factors found in the field were that no data sharing of the same object among national and provincial government institution, for example national public works BBWS-PW has installed telemetry networks that automatically recorded the water level at those water gates also used by *JPG's Public Works Department*. This kind of *communication and coordination gap* were partly caused by the existence of national policy for the distribution of responsibility and authority for river flood management between national and city government in, see Figure 6 in the next page. In practice, this policy has been understood that the national government only responsible to ensure the river flood must below the river capacity by using intensive structural mitigation discussed above. While local/provincial government is only responsible for inundation using countermeasures intervention such as dyke and canal construction and controlling the city development as discussed above. The problem from this policy will exist if the priority

of national government is not in lined with the priory of local and provincial government in flood management.

Figure 6 Responsibilities Sharing of River Flood Management (Source: JPG)

These gap, underlying causes and dynamic pressure of vulnerability factors identified were used to design the improvement of hardware and software part of the improved flood early warning system to meet the criteria of effective early warning and to attempt to solve the flood problem in Jakarta.

4. IMPROVEMENT OF FLOOD EARLY WARNING SYSTEM

To challenge problem of urban-centered disaster, failure countermeasures and oversight underlying causes of vulnerability factors presented in section 2 and 3, the study conducted aims to support *Jakarta Provincial Government* to reduce flood disaster risk by developing an *Integrated Flood Early Warning System* for Jakarta. The effort was to improve existing Jakarta FEWS by integrating the existing FEWS with some aspects: (1) monitoring and detecting flood potential by both national and JPG designated agencies, (2) dissemination of warnings by Jakarta Crisis Center, (3) interface agencies supports for warning dissemination, and (4) community based FEWS. The focus of *Flood Early Warning System* improvement as following criteria:

- To allow sufficient time for people at risk to respond by packing the valuable belongings and evacuation
- To be able to disseminate the warning in time
- To be able to reach the last miles
- To be responded by the people

To meet the first three criteria, the improvement carried out on the hardware/***structure*** part; while the development of software/***culture*** part was for criteria 3 and 4. To meet first criteria of providing sufficient time for flood early warning, new system was developed to integrate the existing system with national system for ***detecting, monitoring and disseminating*** *a warning of potential extreme weather*, which is under authority of National Government Bureau for Meteorology, Climatology and Geophysics (BMKG). This integration aims for alerting the Jakarta Crisis Center 24/7 officers on duty and the people at risk that within 36 hours, there will be potential flood due to heavy rainfall at the upstream and catchment area for anticipating *flash flood*; and/or potential flood due to heavy local rainfall at certain flood prone area for anticipating *creeping flood*. This warning is updated by BMKG in hourly basis, ranging from 6 hours down to hourly depending on the criticality of situation. For second and third criteria, the existing Jakarta FEWS and performance of multi-level stakeholders involved in disaster management and emergency response were reviewed and redesigned to avoid missing link and redundant/overlapping functions. The third and fourth criteria were enhanced by integrating the Jakarta FEWS with the ***culture*** system, i.e. the *community based flood warning mechanism* to be developed in compliance with the ***structure*** system. As also adapted from the best practices of the development of the grand scenario of Ina-TEWS, the end-to-end and multi-stakeholder participatory approach was used in the process development of the

structure and culture part of the system, this included to accommodate the participatory of interface agency to ensure for meeting the second and third criteria through multicast warning information to be received by the last miles group using these agencies existing networks (Rahayu, 2008). The role of National Disaster Management Agency (BNPB) in the system as Interface Agency is expected to be very influential to attract participatory of other stakeholders to participate in disseminating this warning. The overall scheme of *Jakarta Integrated Flood Early Warning System* developed can be seen in Figure 6 below.

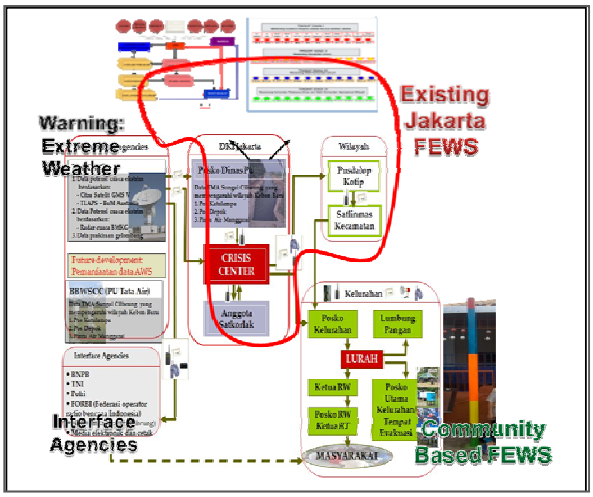

Figure 6 Development Schemes of Integrated FEWS

The ***structure*** component consists of the activities of detecting, monitoring, analyzing and disseminating of two potential hazards, i.e. extreme weather and flood, to JPG's Crisis Center; this include the mechanism conducted by BMKG and The JPG's Department of Public Works. The ***culture*** component includes the activities of JPG's Crisis Center in conveying the warning down to the lowest administrative level, i.e. Kelurahan (Village or sub-sub-district), and the order of evacuation issued by Lurah (official head of village) to community cluster then neighborhood levels, then followed by the respond of communities and neighborhood to the order of evacuation using the Flood Reference, a ***CBDRR Flood Warning*** developed under the study.

The main goal of this development is to support the Jakarta Provincial Government in enhancing disaster risk reduction countermeasures effectively by improving the existing flood early warning system for local flood as well as flash flood, which is able to allow more response time for the community at flood prone area. The mechanism of process development for both ***structure*** and ***culture*** component of the new system is described in detail in the next sections, including the best practice and lesson learned identified from the development of the system.

5. DRR COUNTERMEASURES INTERVENTION

The implementation scheme of mainstreaming DRR countermeasures into the development process of improving the Jakarta FEWS was conducted using scientific based *end-to-end* approach and *multi-level-stakeholders* participatory; as adapted from the process development and testing mechanism of Indonesian TEWS (Rahayu et al, 2008). Even though flood and tsunami are two different natural hazard phenomena, but the stakeholders involved at the government and community level are the same from the view point of disaster management and response; thus the lesson learned from using the end-to-end approach in Indonesian Tsunami Early Warning System is scientifically sound to be *adapted* with some modification on the level of responsibilities based on the existing legal framework on disaster management, i.e. Disaster Management Law no 24/2007 and Jakarta Local Regulation in Disaster Management. To compare, the mechanism of tsunami warning system and flood early warning system developed under the study, the lowest

responsibility to issue order for evacuation to community is different. Tsunami is wide impact phenomena, thus the lowest authority to issues the order for evacuation is the head of the city/districts, i.e. Mayor, or Governor for special Province such as Jakarta or Yogyakarta. Meanwhile, flood phenomena stricken more often and only at those flood prone areas, thus under this study the head of Village as the lowest government administration is encouraged to have mandate to issue the order for evacuation as well as the disaster manager at the village level. However for the emergency response purposes, the Mayor/Governor will take the responsibility for big flood, such as 2002, 2007 and 2008 Jakarta Flood. This mechanism is expected to make the effectiveness in disaster management, especially for flood. However, during the process development the compatibility of existing hardware system as part of ***structure component*** and readiness of software parts as part of ***culture component*** becomes critical issues.

To overcome these issues, some necessary disaster risk reduction countermeasures can be described in 6 main short term objectives as follows:

a. To develop hardware system (structure component) of integrated FEWS for Jakarta, through synergizing the capacity of BMKG and JPG's Public Works in detecting, monitoring, analyzing and disseminating the warning of potential hazards, with the capacity of interface agency and JPG's Crisis Center.
b. To develop culture component through a series DRR activities as follows:
    i. To empower JPG crisis center as the Emergency Operation Center (EOC) of Disaster Coordinating Unit at the Province (Satkorlak) and the unit at local level (Satlak) to be able to receive and to disseminate the early warning effectively in timely manner;
    ii. To increase capacities of the existing resources of Jakarta FEWS;
    iii. To empower community active participation in flood disaster risk reduction countermeasures activities;
    iv. To create and increase community preparedness in responding the flood early warning in proactive and timely manner;
    v. To bridge the gap identified in previous sections.

These short term objectives were defined further into the implementation scheme of disaster reduction countermeasures as shown in Figure 7 below. All the activities for implementing disaster risk reduction countermeasure were clustered in 4 main components of activities, i.e. hazard, vulnerability and risk assessment; mitigation and preparedness; training and public awareness; and mainstreaming disaster risk reduction in city governance.

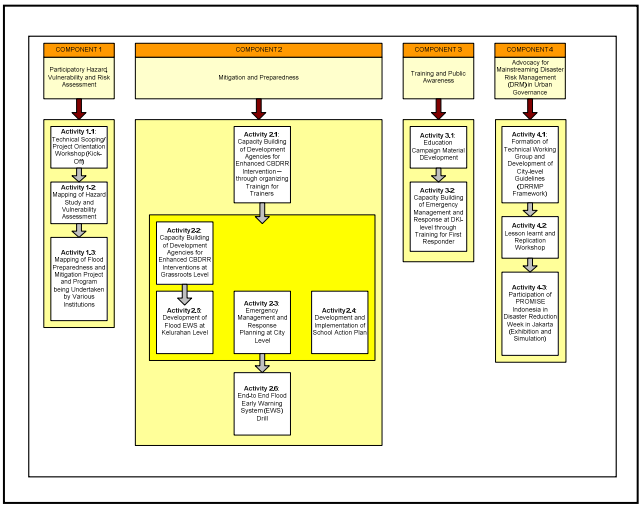

Figure 7 DRR Interventions for Enhancing the Integrated FEWS for Jakarta

Global and in-depth disaster risk assessments were conducted under the first component; where the global assessment aimed for identifying potential hydro-meteorological hazards, collateral hazards, and underlying causes and dynamic pressure of vulnerability factors, by mapping existing

hydro-meteorological hazard exposure and disaster risk reduction initiatives implemented by various institutions. Scientific based in-depth risk assessment was conducted at the selected pilot study area, using Duflow for flood inundation modeling, which was integrated with vulnerability and capacity assessment using GIS. The risk map developed is used by the study as well as the JPG and community of the area for more accurately knowing the level of disaster risk and the priority of countermeasure intervention needed, prior the intervention; then it can be used to identify effectiveness of the intervention by comparing the prior and post intervention risk maps (Rahayu 2008).

The implementation of disaster risk reduction countermeasures for obtaining the integrated flood early warning system covered in component two, consisted of capacity building of stakeholders involved at both provincial and sub-sub-district level; development of hardware system which included full participatory of Jakarta Provincial Government and national stakeholders including the interface agencies; development of software system which included development community and school based disaster risk assessment through town watching, action planning, flood references and some activities related to increase community preparedness; and end-to-end simulation to test the system developed and identifying the missing link.

To raise public awareness and increasing the preparedness, a series of activities conducted under component 3 for the targeted area and other potential replication area, i.e. a series of education material development were prepared, as well as increasing the capacity of first responder team through skill training. Component four aims for bridging the identified gap, through establishment of technical working group team. A series of technical working group meeting and focus group discussion conducted to be solved the problem faced during process development. The integrated system for flood early warning was expected to boost, which was the interest of the government to mainstream the countermeasures intervention as part of mainstreaming the disaster risk reduction into urban governance, i.e. drafting the framework of DRRMP, review the existing of disaster management agency in province level to municipality level as part of transition period to new format of disaster management organization (DMO) as endorsed by the President decree and Indonesian Disaster Management Law (UURI no 24, 2007). Other critical disaster risk reduction activities used to enhance the effectiveness of the system developed were conducting a series of table top exercise prior the full scale simulation to test the flood early warning system SOP developed at both the provincial and community level.

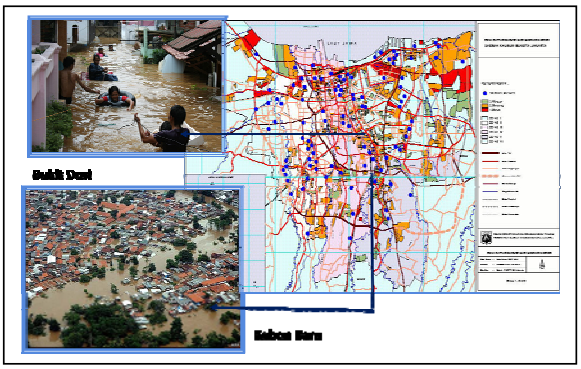

Figure 8 Locations of CBDRR Interventions

Rationale for the selection of case study location was based on the number of people at risk living in Ciliwung riverbank with about 40% of total number of 72,000 households at risk living in the river banks, see also Figure 3. For this study, the mechanism of Ciliwung flood early warning with selected pilot study area for community of Kelurahan Kebon Baru and Kelurahan Bukit Duri of Tebet sub-districts will

used as the case study in improving the whole JPG FEWS. These two villages are the best case to model the lowest government administrative with typical heterogenic urban socio and economic condition with complexity of megacity risk exposure as has been previously discussed. The location of case study area can be seen in Figure 8 below.

6. DISCUSSIONS

Some significant DRR countermeasures conducted that enable the study in achieving the effectiveness of DRR countermeasures implementation can be summarized as follows:

Established Technical Working Group (TWG)

The TWG was a group of experts and officials from focal institutions in disaster risk management from National, Regional and Local levels of Jakarta Provincial Government and ITB, established at the beginning of the study aiming for supporting process development and solving obstacle in the field. The role of TWG later became the think tank of the study, through a numbers of meetings.

- To identify problem and formulate most effective and efficient way in reducing flood disaster risk for Jakarta;
- To select case study area for implementing community based disaster risk reduction initiatives (CBDRR) countermeasures among 4 potential locations obtained from preliminary survey and study;
- To draft standard operating procedures (SOP) of Jakarta Integrated FEWS
- To discuss other matters related with integrating DRR countermeasures into urban governance, i.e. role of crisis center, disaster reduction master plan, new form of disaster management organization.

Focus Group Discussion (FGD)

During the study, a series of FGD meetings were conducted for socializing the progress results and obtaining opinion/feedbacks. The forum has also been used to bridge the gap between the government officials, community representatives, NGOs and other stakeholders. Such progress results that have been discussed were: Scientific based in-depth risk mapping at the sub-sub-district level, draft SOP of Integrated Flood Early Warning System for Jakarta, and Conceptual Paper on Disaster Risk reduction Master Plan.

Training for Trainer (TOT) on FEWS and First Responder

TOT on FEWS with mix-participants consisted of government officers, NGOs, CBOs, case study community representatives and school teachers, and representatives of surrounding municipalities of West Java and Banten Provinces, was conducted to increase knowledge and capacity of participants in flood early warning system as well as creating the same platform of understanding and perception toward DRR initiatives for flood and FEWS. Meanwhile, TOT on First Responder was conducted to enhance capacity of local community in emergency response through increasing skills in water safety and water rescue, camp management including field kitchen management and health aspect at post disaster.

Capacity building activities for creating community preparedness to respond FEWS

A series of flood DRR activities was conducted in 6 flood prone cluster of communities (RW) of Kelurahan Kebon Baru, i.e. TOT for increasing the capacity and knowledge of community on disaster risk reduction countermeasures; and town watching to create better understanding among

community toward the exposure of their neighborhood to flood risk through identifying hazard exposure, collateral hazards, vulnerability and capacity to prepare disaster risk map and route of evacuation for anticipating future flood. Action planning conducted at the RW level, covering the 3 stages of action for short-term, mid-term and long-term of prior countermeasures reducing and responding the flood risk. SOP of community based FEWS was prepared by participatory of community stakeholders, which was then followed by some Table Top Exercises at both village level and community level to test the draft of SOP in order to have simple and effective line of warning dissemination and coordination.

Capacity building for increasing readiness of Crisis Center's 24/7 officer on duty and other stakeholder institutions engaged with FEWS

A series of capacity building activities were conducted to increase the readiness of 24/7 officer on duty of JPG's crisis center, through the development of SOP for integrated FEWS, table top exercise at provincial level, communication and coordination exercise from provincial level to village level, then full scale end-to-end FEWS simulation.

Full scale end-to-end simulation for Integrated Flood Early Warning System

The objective of simulation conducted on February 1, 2009 was to test the 3 main components of Integrated FEWS of Jakarta. They were: (a) System and mechanism of FEW; (b) Readiness of 24/7 officer on duties at multi-level: Meteorology Center of BMKG, Jakarta Crisis Center, Posko DPU-DKI, Posdukes DinKes, Posko DinSos, EOC at Jakarta Selatan City, EOC sub-district of Tebet, up to sub-sub-district level called Posko Kelurahan; and (c) Preparedness of community in responding warning and other disaster management activities needed to anticipate future flood. These were shown by activities of monitoring and disseminating potential flood using Flood Reference deployed about two for each RW prone to flood. This was followed by evacuation conducted in timely and orderly manner; and some emergency response activities, such as water safety and water rescue, triage by medical first responder, activities in camp refugee, building shelter, public kitchen, trauma relief etc. The half day simulation was inaugurated by the Governor of Jakarta and participated by 200 officials of implementing agencies related with disaster management and planning of Jakarta Provincial Government, South Jakarta Municipalities, Tebet Sub-district, BNPB, NGOs, CBOs and 500 community of Kelurahan Kebon Baru.

The good practices and effectiveness of disaster risk reduction countermeasure intervention on both hardware system and software can be measured qualitatively using comparison analysis based on several criteria below (Summary of the discussion are presented in Table 2 and Table 3):

a) *Who was involved?*
b) *Who and how many people were targeted?*
c) *What has been its impact?*
d) *What have been the key success/failure factors of these initiatives?*
e) *What are the innovative elements?*
f) *What has been the local government contribution to reducing disaster risk and vulnerabilities?*
g) *Why is this good practice?*

Table 2 Institutions officially engaged before and after the improvement of Jakarta FEWS

No	Multi-Level Stakeholder	Before	After
A	**Number of institutions officially engaged for Jakarta Flood Early Warning System**		
1	National		a. Meteorology, Climate and Geophysics National Agency b. National Agency for Disaster Management c. Directorate for Monitoring Cisadane and Ciliwung Rivers, Ministry of Public Works
2	Jakarta Provincial Government	a. Governor b. Regional Secretary c. JPG Crisis Center d. Civil Defense Department e. Department of Fire and Disaster Management f. Public Work Department g. Health Department h. Social Department	i. Governor j. Regional Secretary k. JPG Crisis Center Regional Planning Board a. Civil Defense Department b. Department of Fire and Disaster Management c. Public Work Department d. Health Department e. Social Department f. Department of Community Empowerment l. Red Cross Jakarta Chapter (Government Owned NGO-GONGO)
3	South Jakarta District	a. Mayor of South Jakarta District b. Secretary to the City c. South Jakarta Crisis Center d. Civil Defense Department e. Department of Fire and Disaster Management	a. Mayor of South Jakarta District b. Secretary to the City c. South Jakarta District Crisis Center d. Civil Defense Department e. Department of Fire and Disaster Management
4	Tebet Sub-Districts	a. Head of Sub-district b. Coordination Post of Sub-District & Civil Defense	a. Head of Sub-district b. Coordination Post of Sub-district & Civil Defense c. Red Cross – Tebet Branch
5	Kebon Baru Sub-sub-district	a. Head of Sub-sub-district (Village) b. Village Post of Coordination & Civil Defense	a. Head of Sub-sub-district (Village) b. Village Post of Coordination & Civil Defense c. Village Council
B	**Number of Community/Organization from Case Study location engaged for Jakarta Flood Early Warning System**		
1	Community		a. Head of Neighborhood Cluster (6) b. Post of Coordination at Cluster level (6) c. Head of neighborhood (60) d. Village logistic e. Field kitchen
2	Non-Government Organization		a. Indonesian Red Cross at village level
3	Community Based Organization		a. Air One – Community Water Rescue Team b. Yayasan Empati Sesama

Table 3 Who and how many people were targeted?

No	Targeted Group	
1	Government officials and stakeholders	• 20 active TWG members who are the officials of JPG, GONGO, BMKG, BNPB and ITB • 25 persons on duties 24/7 at Jakarta Crisis Center. • 4 persons on duties 24/7 at EOC of Satlak Jakarta Selatan • 4 person on duties 24/7 at EOC of Satlinmas Tebet • 4 person on duties 24/7 at Posko Kelurahan Kebob Baru
2	Community level	The development of SOP of Community FEWS at Kelurahan Kebon Baru is expected to protect 50% population living in flood prone area, i.e. **15,675** People. Kelurahan Kebon Baru consists of 14 RW (Rukun Warga) – the cluster of neighborhood; where each RW consisting approximately 10 RT – the neighborhood that consists of around 60 to 100 households
		The development of Community Action Plan for 6 RW that are prone to flood has able to increase the community preparedness and resiliency in anticipating future flood
		The development of Flood Reference at RW level is expected to create the community readiness to timely response the flood warning mechanism established and agreed by them.
		In total the number of targeted community is bigger than the registered one. The registered Population are shown as following table. The unregistered people are related with the ownership status of Jakarta ID. In some RW, i.e. RW 10, the illegal inhabitants mostly working in informal sector, i.e. street hawkers, live in squatter area.

		<table><tr><th>No</th><th>Name of Flood Prone Communities (RW)</th><th>Population</th></tr><tr><td>1</td><td>RW 1 (10 RT)</td><td>2,675</td></tr><tr><td>2</td><td>RW 2 (10 RT)</td><td>2,447</td></tr><tr><td>3</td><td>RW 4 (10 RT)</td><td>2,669</td></tr><tr><td>4</td><td>RW 8 (10 RT)</td><td>2,652</td></tr><tr><td>5</td><td>RW 9 (10 RT)</td><td>2,539</td></tr><tr><td>6</td><td>RW 10 (10 RT)</td><td>2,693</td></tr><tr><td></td><td>Total Population at Risk</td><td>15,675 (43% of Population)</td></tr><tr><td></td><td>Total Population of Kelurahan (14 RWs)</td><td>36,496</td></tr></table>
	During simulation	500 communities of Kelurahan Kebon Baru, 100 officials of Jakarta Provincial Government and Jakarta Selatan City Government, National Institutions, NGOs and CBOs.

Table 3 What is the Impacts, Success Factors and Innovative Elements?

Impacts	Success factors	Innovative Element
Through the development of Integrated FEWS for DKI Jakarta : a) The system is able to accommodate the warning of extreme local precipitation for local flood and the warning of extreme rainfall at the upstream for the flash flood in Jakarta. b) The system is able to allow longer and sufficient response time for community at flood prone area along the river bank by disseminating the warning of potential extreme weather at 36 hours prior the occurrence of extreme rainfall as well as its updating weather information from radar in hourly basis. The response time is sufficiently needed for packing valuable belongings and evacuation to the safe place. c) The Table Top Exercise and Integrated FEWS Simulation have created the readiness of the institutions and officer on duties for monitoring, detecting and disseminating the warning to become more coordinative and responsive in anticipating the flood disaster through FEWS, with clear role and responsibilities. d) The community preparedness activities which included TOT, Participatory Town Watching, Action Planning, and Training for First Responder have created the communities of the case study area increased their preparedness and resiliency to cope for flood disaster at the stage of before, during and after the flood disaster. e) The establishment of Flood Reference as Flood Warning Mechanism at community for RW Level has helped the community to be ready to pack and evacuate with timely and orderly manner. f) The establishment of Community FEWS SOP, i.e. starting from Kelurahan down to RW level then to community, has created the readiness of the whole community's stakeholders to become more coordinative and responsive in anticipating the flood disaster through FEWS, with clear role and responsibilities in anticipating and coping with the flood disaster at the stage of before, during and after. g) The Table Top Exercise and Integrated FEWS Simulation at community level have created the preparedness of the communities of the case study area, i.e. Kelurahan Kebon Baru (Sub-Sub-District level), to become more coordinative and responsive toward the flood warning. Beside it has created strong partnership and sense of ownership toward their Community FEWS. h) The attendance of The Governor of Jakarta to inaugurate the simulation of Integrated FEWS inaugurated has created moral support at the community level and strong partnership between the community and the JPG as well as with City Governments. i) The Integrated FEWS for DKI Jakarta developed under this project activities could be used as FEWS model for other municipality of DKI Jakarta as well as other cities that have the same typology.	a) Good vision and similar perception among multi-level-stakeholder involved in improving the Integrated FEWS. b) Active participation from each multi-level-stakeholder in playing their roles and responsibility. c) The existence of TWG consisting of experts from prominent institutions described in section 5 above has enriched the angle during the development process of Integrated FEWS for Jakarta. d) The existence of FGD attended by multi-level-stakeholders has able to bridge the gap between the governments and community perception regarding the flood disaster risk reduction initiatives. e) Active participation of community at Kelurahan Level and RW level in a series of community based disaster risk reduction activities, such as TOT, Town Watching, Community Action Planning, Flood Referencing, Training for First Responder and Integrated FEWS simulation. f) A mix 0f multi-level TOT has been able to level up the perception of both community and government officials toward DRR initiatives as well as the important of FEWS.	a) Integrated FEWS mechanism for DKI Jakarta which is able to address longer response time than the existing one and to address the warning for both flash flood due to extreme rainfall at the upstream as well as the flood due to saturated overflow caused by local extreme rainfall. b) Collaboration among multi-level-stakeholders in developing the Integrated FEWS for Jakarta. c) Flood Reference as community based flood early warning mechanism used a set of 5 unique colors in describing level of emergency response is very suitable for urban communities who are prone to similar type of flood. d) FGD attended by multi-level-stakeholders and a multi-level TOT has bridged the gap between the government and the communities.

7. CONCLUSION

The study conducted in enhancing the early warning system for flood is a kind of the first attempt in solving the flood problem comprehensively for Indonesian high populated city, by integrating flood warning with early warning for potential hazards and community based warning response. The good practices obtained from this study in mainstreaming disaster risk reduction into urban governance, in the context of enhancing effective flood early warning system for Jakarta, are expected to be worthwhile findings to fill the gap existed among the government, community and stakeholders in dealing with the acceptable risk of urban-centered disaster, not only for flood but also adaptable for other type of urban-centered disasters such as domestic fire or technological failures. The end-to-end and multi-stakeholder participatory approaches used for process development has benefit the stakeholders in having a comprehensive investigation of the hazard exposures and the latent/underlying causes of vulnerability and capacity to measure the risk level and defining the proper countermeasures needed. Beside, the use of scientific based risk mapping is not only needed and convinced the government but also the community in determining and prioritizing the countermeasures for reducing the disaster risk.

As it has been described that the trend of urban-centered disaster and increased number of high populated cities in Indonesia become global, regional and local concerns, the model developed is expected to be replicated to other growing cities in Indonesia as well as Asian developing countries. The replication of the model developed at the provincial level has been shown by the JPG in having the replication conducted in other flood prone sub districts and conducting the en-to-end simulation as annual activities for every October, as part of the JPG agenda of Jakarta Disaster Reduction Week as part of global participation to ISDR and Hyogo Framework of Action commitment. A year after the study completed, JPG has conducted the full scale simulation not covering the Kebon Baru and Bukit Duri as our case study, but also other sub-districts. The model of integrated flood early warning system has become the legacy of Jakarta attempts in reducing the flood disaster together with community. From the global perspective, some international and national focal organizations have been interested to learn directly at the field to adopt the model to other cities.

Last but not least, the important of conducting this study by adapting the approach of Indonesian Tsunami Early Warning System is reciprocally used to enrich the current work in the development of assessment indicator for the implementation of Culture Component of Indonesian tsunami Early Warning System at those high populated tsunami prone areas in Indonesia.

REFERENCES

1. Abidin, et al, 2001, “Land subsidence of Jakarta (Indonesia) and its geodetic monitoring system”, *Natural Hazard*, Vol. 23, pp. 365-87
2. Badri Kusuma, et al, 2008. “Mathematical modeling on the effectiveness of reservoir development to flood control capacity of Central Jakarta”, *Civil Engineering Department Journal*, Civil Engineering Department, Institute Technology of Bandung
3. Bowo, F. 2008, Presentation of Governor of Jakarta to the President in January 2008
4. City Mayor Statistic Web, URL: http://www.citymayors.com/statistics/largest-cities-population-125.html (last date accessed: 20 February 2010).

5. Florian Steinberg, 2007, Jakarta: Environmental problems and sustainability, *Habitat International* 31, p 354–365, Elsevier
6. JBIC, 2007, Reports on Pilot Study for Project Formation for Integrated Urban Disaster Management Project in Jakarta Metropolitan Area.
7. Rahayu, H., 2009. Final Report of PROMISE (Program for Hydrometeorology Risk Mitigation for Secondary Cities in Asia), Center for Disaster Mitigation, Institute Technology of Bandung
8. Rahayu, et al, 2008, National Guideline for the Implementation of Tsunami Drill for City and Regency of Indonesia, Publication of Ministry of Research and Technology, Indonesia
9. Rahayu, H., 2003. "Indonesia experience", in Shaw, R. and Okazaki, K. (Eds). Sustainability in Grass-Roots Initiatives: Focus on Community Based Disaster Management, *United Nations Centre for Regional Development-Disaster Management Planning*, Kobe, pp. 50-7.
10. Texier, P. 2008. Floods in Jakarta: when the extreme reveals daily structural constraints and mismanagement, *Disaster Prevention and Management* Vol. 17 No. 3, 2008, pp. 358-372