URBAN FLOOD IN THE PHILIPPINES: AN OVERVIEW OF THE FLOOD MANAGEMENT IN METRO MANILA SUB-BASINS DURING AND AFTER THE EXPERIENCE WITH TS KETSANA

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Introduction

As the global effects of climate change contribute to the continued increase in the frequency of extreme rainfall and sea elevation rise (Lehner et. al., 2006), many communities in different parts of the world will become more susceptible to extreme floods, particularly those in the low-lying coastal areas. In East Asia, developing countries, such as Vietnam, Philippines (Figure 1), and Indonesia, are more susceptible and vulnerable to these anticipated flooding events (Yusuf et al. 2010). Metro Manila (Figure 1), a coastal mega-city and center of economy in the Philippines, is considered to be the most vulnerable region in the country (Yusuf et al., 2010), which has a population of 11.5 million and a total land area of 638 km^2. In 2009, tropical storm (TS) Ketsana devastated the highly urbanized region, leaving behind some 4.9 million affected residents, claimed more than 460 lives and caused around $25 million worth of damages to infrastructures and agriculture (Rabonza 2010). In light of the country's struggling economy and ever-increasing population, such incident compels for the reassessment of existing flood management schemes relative to the anticipated effects of climate change, which includes the re-examination of non-structural flood mitigation measures, such as flood forecasting and disaster preparedness and response; investigation on the effects of extreme flooding events to land use and water resources; impact assessment of extreme floods to the urban ecological environment; and performance evaluation of existing flood control structures, all as part of an integrated water resources management program.

Metro Manila sub-basins and flood control systems

Seventeen municipalities of Metro Manila occupy 10 highly urbanized sub-basins, where 5 of the sub-basins extend to the adjacent provinces: Bulacan, Rizal, Laguna and Cavite (Figure 1). According to the document published online in 2010 by the Metropolitan Manila Development Authority (MMDA), the government office currently in-charge of the region's flood management programs, Metro Manila drainage system consists of 580 km of open waterways, around 900 km of drainage laterals and 59 km of drainage mains and interceptors. About thirty percent of the open waterways have limited access due to the presence of illegally-built structures. Metro Manila has perennially been experiencing floods since time immemorial, but drainage improvements and construction of flood control structures have only intensified from 1974. Flood has continued to spread in the region parallel to its rapid urban development. The progressive spread of flood-prone areas in Metro Manila from the 1950's to 1990's is shown in Figure 2. (Nantes 2003).

At the south-east part of Metro Manila is a floodway facility (Figure 1) that has a weir control station and several flood control gate structures, which diverts some of the excess water coming from a major river in Marikina City, and using Laguna de Bay (lake) as a storage basin. Near the floodway is a hydraulic control structure with flood gates and navigational locks. This was built to prevent the backflow of saline water passing through a river in Pasig City towards the lake. The floodway and the hydraulic control structure are the physical components of a telemeterized control system known as the Effective Flood Control Operation System (EFCOS).

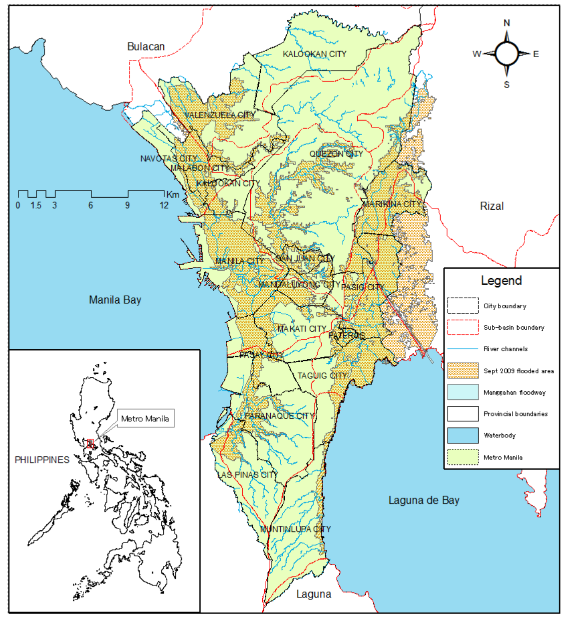

Figure 1. Location map of Metro Manila and its urban sub-basins

The EFCOS, which was completed in 1993, serves as a flood warning and flood control system in the core area of Metro Manila (i.e. Pasig-Marikina sub-basins). This system monitors and utilizes real-time hydraulic and hydrologic information such as rainfall intensity (measured at strategic locations) and water levels in the channels within the Marikina and Pasig sub-basins to predict the incoming floodwaters (Gatan 2010). The EFCOS however was not fully utilized during the onslaught of TS Ketsana due to operational issues that requires rehabilitation.

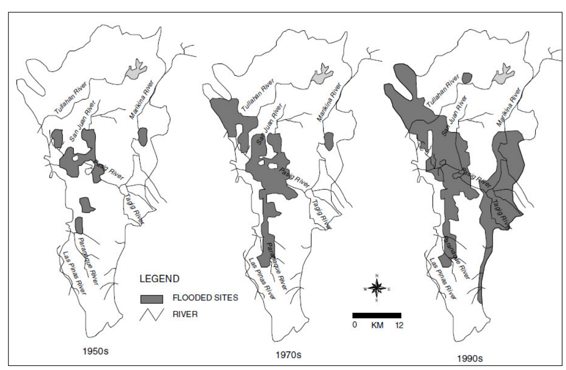

Figure 2. Frequently flooded sites in Metro Manila during the 1950's, 1970's and 1990's (Source: Nantes 2003)

At the north-west part of Metro Manila, improvements on the capacity of drainage channels were being made, which involves dredging and river widening. River training works; construction of polder dikes, flood control gate structures, and pump stations were installed to cater to the frequently flooded areas of Valenzuela, Navotas, Kalookan and Malabon cities (Gatan 2010). However, despite the existing flood mitigating measures, a large extent of Metro Manila was still submerged (Figure 1) and significant numbers of lives, properties and livelihoods were lost when TS Ketsana made its landfall on September 26, 2009. This clearly indicates the insufficiency of the current structural flood mitigation measures and emergency response procedures.

Situation during the storm

At the height of the heavy downpour of TS Ketsana, the water level of Laguna de Bay reached a maximum of 14 m (in reference to the Manila Bay datum of 0.0 m) due to flood diversions coming from the floodway as well as inflows being received by the lake from other tributaries. The lakeshore towns that are situated in the floodplains were inundated. Villages at the banks and flood plains of Marikina's major channels were either submerged or swept away by the onrushing flood. In some elevated communities, flashfloods and inundations have occurred due to the inefficient performance of storm drains and cases of dam breaks. Since some structural flood mitigation measures in the Pasig and Marikina areas were not yet complete at the time of the storm, the drainage systems were immediately overwhelmed by the 500-year return flood event. There were cases of landslides due to erosion and debris flows at the steep areas, where several urban poor reside. A large part of the west and northwest parts of Metro Manila were also submerged (Gatan 2010).

Causes of flood during the storm

Several factors were brought up as reasons for the calamity. Major factors include the downpour of 455 mm within the span of 24 hours (100 years return period), which surpassed the design rainfall return period of the existing flood control structures (10 – 30 years return period); the peak flow (>5,000 m^3/s) that greatly exceeded the usual capacity of the river channels in Pasig (500 m^3) and Marikina (900 m^3) including the 30-year design flow capacity of 2,900 m^3/s for the flood control structures within the same drainage area; the high rate of urban development that decreased the percolation and infiltration rate, consequently increasing the surface run-off coefficient and further aggravated by forest denudation; the inappropriate designation of land use, which positioned some commercial establishments and residential communities within the flood prone areas; Some clogged drainage systems due to the presence of floating and silted anthropogenic wastes; the encroachment of informal settlements along the river banks, reducing the flow capacity of the river channels; some small drainage and waterways were blocked due to the encroachment of privately owned structures, such as roads and buildings; and the occurrence of flood in the coastal areas due to storm surges exacerbated by the increasing tide elevation. (Gatan 2009; Liongson 2010)

Flood warnings, preparedness and response

The real-time flood warning system of EFCOS was not operational during the storm, which left the downstream communities without a clue on the magnitude of the incoming torrent. The lack of community-based flood response procedures left many residents stranded in the streets and inside of their own houses. The insufficiency of information on the man-made and natural drainage systems may have also contributed to the absence of community flood hazard maps and effective flood warning systems. The insufficient hydraulic and hydrologic monitoring/ gauging facilities added to the inefficiency of the early warning systems.

Immediate actions after the storm

Because of the incident, MMDA initiated the following non-structural measures: formation of a flood response command center and deployment of trained composite teams equipped with flood and rescue equipment; coordination of the emergency response group with the local government offices of the affected areas; re-launching of existing solid waste management policies, such as the "Anti-littering Law"; a push for clean-up drives within the flood-prone areas with clogged drainage channels; and formation of community-based alliances, which will be in-charge of the flood mitigation activities in their respective zones.

Future flood mitigating measures

Proposed measures to improve the flood management in Metro Manila include the installation of additional pump stations; dredging and widening of rivers and other drainage canals; relocation of informal settlements and removal of encroached structures in the open drainage channels; construction of road dikes along the perimeter of Laguna Lake; dam construction at the Marikina river; construction of bypass channel to augment the existing floodway in the south-east portion of Metro Manila (Gatan 2010).

Conclusion

As expressed in this overview, the solutions to the problems of urban flood management in Metro Manila must take into consideration the existing flood mitigation systems and the capacity to provide the needed resources to address the vital elements, such as enhanced early warning systems and improved structural flood mitigation measures. The review also shows that it is imperative for a coastal megacity, especially in a developing country, to prepare for similar extreme weather conditions as brought by the effects of climate change. Informed and effective approaches are needed, thus, further research may be performed based on the country's experiences with TS Ketsana..

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