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# DEVELOPMENT OF THE FLOOD RISK MANAGEMENT BY GEOGRAPHIC INFORMATION SYSTEM FOR MIDSTREAM OF CHAO PHRAYA RIVER BASIN

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論　文　名　　：DEVELOPMENT OF THE FLOOD RISK MANAGEMENT BY GEOGRAPHIC INFORMATION SYSTEM FOR MIDSTREAM OF CHAO PHRAYA RIVER BASIN
（GIS を用いたチャオプラヤ川中流域における洪水リスク管理に関する研究）

区　　分　　：甲

## 論　文　内　容　の　要　旨

Thailand had largest scale of flood event in year 2011. The main reasons were due to 143% of rainfall volume more than average in the past twenty years and five typhoons attacked since June in the same year. It was estimated the total damages and losses from 2011 Thailand floods were amounted to USD 46.5 billion (The Ministry of Finance, 2012). The main objective of this research is to analyze flood condition at midstream of Chao Phraya River Basin to understand if controlling flooding in midstream would able to mitigate downstream flooding. Midstream is an even and flat area. It is the location whereby confluence of Nan River and Yom River, and confluence of Nan River and Ping River occurred. Since it is an area that has confluence of the rivers and surrounded by higher elevations, it is prone to high risk area to be flooded. Furthermore, most of the freshwater swamp forests in midstream had been removed entirely and changed into a plain for rice paddies, urban areas and industrial estates. These might accelerate seriousness of the flood in Bangkok. This research applied two methodologies, which are GIS technologies and Hydrodynamic Simulation Model to estimate flood inundation depth and flood inundated volume occurred. Results were validated with field measured flood marks and streamflow data from Royal Irrigation Department (RID). Furthermore, the land use changes were discussed to learn if it affected flood impact to downstream. In order to propose suitable flood countermeasures, flood control scenarios were simulated for three rivers to study if controlling flooding in midstream would able to ease flood condition in downstream. Subsequently, simulated flood control scenarios were used to understand its effect in minimizing loss estimation of paddy field.

In Chapter 1, the background, problem statements, research objectives, and research scope were explained. Literature reviews were summarized in Chapter 2 and it helped to understand there were many studies focused on downstream of Chao Phraya River Basin as it brought huge damages in this area. However, it is important to study on midstream to understand the causes of flood occurance and impact to downstream. In addition, there was lack of studies focused on land use changes to understand if it affected flood condition.

A post-analysis on 2011 Thailand flood event was done using streamflow data obtained from RID and it was clarified in Chapter 3. Streamflow data of observation stations in midstream of Chao Phraya River Basin were compared. It showed flood peak period happened from September 21 to October 30, 2011. Total flood inundated volume of 1,300 million $m^3$ exceeding the harmless streamflow limit, which was 4,000 $m^3/s$, at

observation station near to starting of Chao Phraya River (Obs. C2). Research group conducted field survey on flood marks and interview with residents from September 27 to 30, 2012. There were eight measured flood marks used for data validation. Besides, interview results showed flood did not bring serious impact to residents in midstream as they built high-floored houses. The calculations of flood inundation depth and flood inundated volume using GIS also explained. Results showed possibilities to prevent the excessive streamflow capacity and the flooding damage in downstream if flood inundated volume of 0.7 billion $m^3$ were controlled in midstream (upper and middle reaches).

MIKE FLOOD, which able to simulate flood condition were used to simulate 2011 Thai flood generation and discussed in Chapter 4. Parameters of rainfall, cross sections, streamflow, and bathymetry were prepared using GIS. Validation with flood marks surveyed showed good agreement. The flood distribution on October 15 also similar with flood extent of RID. The result was then compared with GIS calculated results. Subsequently, the relationship between land use and flood condition was analyzed. The Root-Mean-Square Error on flood inundation depth for GIS result and simulated result were 2.22 and 1.66 respectively. The Relative Root Mean-Squared Error for streamflow at Obs. C2 was less than 1.4. There were some error propagation effects between observed and simulated results caused by limitation of data and variable parameters such as various artificial structures, micro topography, variables of rainfall volume, lacking of cross sections along rivers, which have possibilities to affect the dynamics of flood wave, particularly when the flood depth became low. Evaluation between GIS calculated result and simulated results showed MIKE FLOOD could simulate the past event and estimate the future flood for risk reduction.

Flood control at midstream of Chao Phraya River Basin was demonstrated in Chapter 5, particularly on Nan River, Yom River and Ping River. Initially, nine cases were simulated and compared to understand its effect of flood control in the consideration of streamflow and flood distribution coverage. Evaluation on nine cases showed controlling at one river only was insufficient. Ultimately, two kinds of flood control cases were recommended. Case 4a controlled the streamflow at upper reaches of Nan River (20%) and Yom River (20%), which able to reduce 60% of streamflow that over harmless streamflow limit. Case 4b controlled streamflow at upper reaches of Ping River (10%), Nan River (20%) and Yom River (20%), it helped to minimize nearly 80% of streamflow that over harmless streamflow limit.

Details on analyzing losses in paddy field by using GIS were explained in Chapter 6. Based on calculated result, losses in study area showed nearly 25% of total losses in 26 provinces. Furthermore, Case 4b could minimize about 5% of total loss and reduced nearly 30% of flood extent on rice field. This is compatible with work plan for Management of Major Water Reservoirs as RID recommended to implement “Target Rule”, which is target storage volume for water use and upper limit for flood control to improve operation efficiency of existing dams at upper reaches of Ping River and Nan River. Asian Development Bank also suggested building on structural measures on upper reach of Yom River.

Lastly, Chapter 7 evaluated the findings of the study, discussed and summarized on the results of analysis. It also provided some recommendations for further research.