Effects of Dike Heightening to Flood Behaviors in The Lower Chao Phraya River Basin

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INTRODUCTION

The Chao Phraya River Basin has area size around 160,000 km^2 which is approximately one-third of Thailand as shown in Fig. 1. The northern part of the basin is composed of both highland and flood plain, while the southern part of the area is only flood plain. The southern part or the Lower Chao Phraya River Basin frequently has floods in rainy seasons because of the combination of heavy rainfalls and high tides from the Gulf of Thailand.

In 1995, total inundation volume nearly exceeded 16 billion m^3 and around 11 billion m^3/s in the Lower River Basin. Because the capacity of the Chao Phraya River changes from 4,000 m^3/s at Chainat; the upper part, to 1,500 m^3/s at Ayutthaya; the central part, and 3,000 m^3/s at Bangkok; the southern part, the areas above Bangkok always have serious flood from water running overtop the dikes. Therefore, a possible alternative of flood mitigation is to heighten the dikes. However, although this measure is good for flood mitigation, it will change flood behaviors of river basin and downstream discharge.

The objective of this study is to clarify the dynamic behaviors of floods in the river channel and its basin and examine the effects of dike heightening onto the downstream discharge.

METHODS

The one-dimensional unsteady flow model was used in this study for analyzing hydrodynamics of the 1995 flood – the most severe flood in 25 years. The study area is the Lower Chao Phraya River Basin – from the Chao Phraya Dam in Chainat Province to Pakkred in Nonthaburi Province. The model is composed of four rivers and three canals with over a hundred cross sections. River basin with 4,500 km^2 is divided to 33 retention areas following irrigation projects and planning of road and dike as shown in Fig. 2.

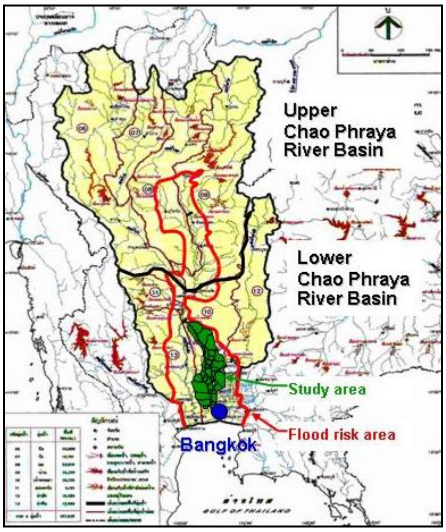

Fig. 1 The Chao Phraya River Basin

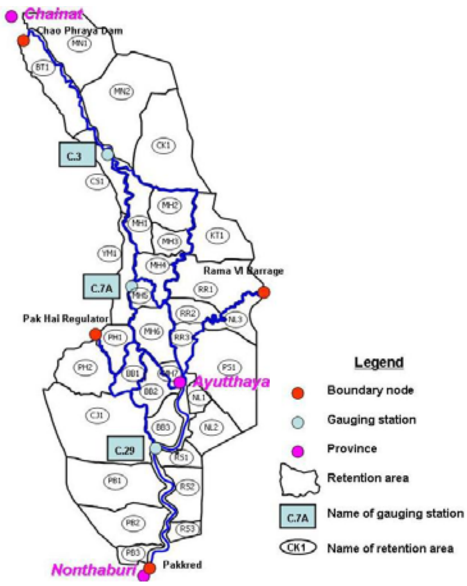

Fig. 2 Distribution of retention areas, boundary nodes and gauging stations

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Time-dependent river discharge is given as three upstream boundary conditions such as the Chao Phraya Dam on the Chao Phraya River, the Rama VI Barrage on the Pasak River and the Pak Hai Regulator on the Noi River. The main discharge is from the Chao Phraya Dam, which maximum discharge was about 4,500 m^3/s in the 1995 flood. While the maximum discharge of the Rama VI Barrage was about 1,000 m^3/s and discharge of the Pak Hai Regulator was nearly zero. Downstream condition is the time-dependent water level, where tide levels are also included. In this study, heightening the dike by 0.5 m and 0.8 m are examined. The water level and discharge of rivers and river basin compared with the present dike.

SIMULATION RESULTS

The data of the 1995 severe flood were used as reference in the simulation. In the present condition of the dike, the simulation showed the flooding would begin on September 5; the river water overflows into MH6 retention area, which is the neighbor of Ayutthaya. Then, the flood spills over the inner dike into the neighbor retention areas. On October 20, the inundation spreads into the whole area.

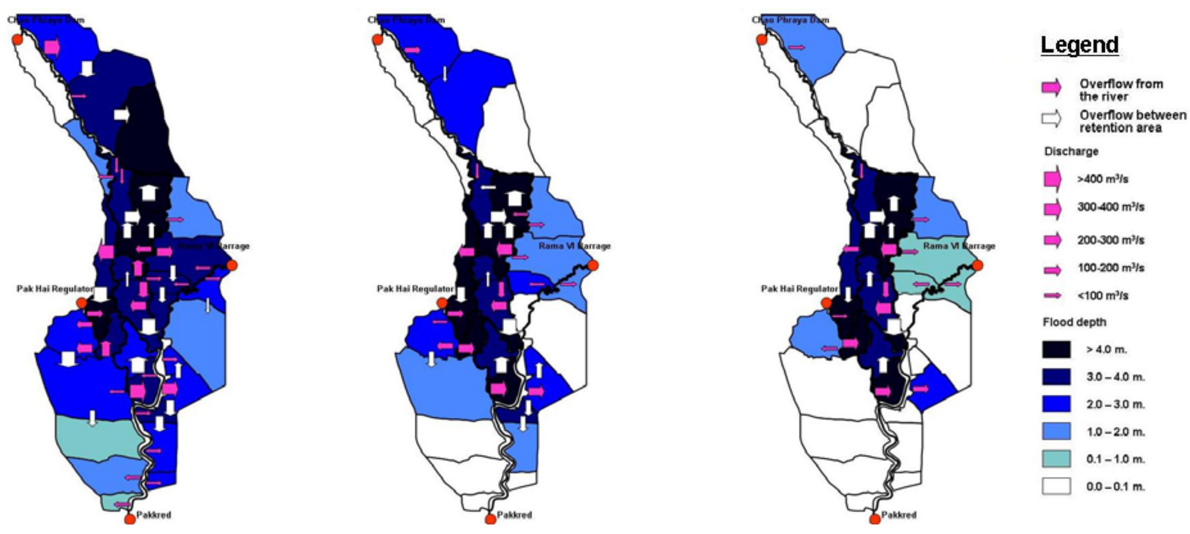
The simulation results of dike heightened by 0.5 m and 0.8 m showed the first flood would begin in the MH6 as well, but the starting time is delayed to September 10 for raising the dike by 0.5 m and September 20 for raising the dike by 0.8 m. However, the flood reaches the maximum depth in the same period, which is between October 20 and November 1.

Besides, the flood flow rate over the dikes was decreased by the dike heightening as shown in Fig. 3. For example, in the upper area MN1, discharge was decreased from 400 m^3/s in the present dike to 200 m^3/s in heightening dike by 0.5 m and 100 m^3/s in heightening dike by 0.8 m. Therefore, inundation areas and inundation volume would be decreased. From the rough calculation, inundation volumes of present dike condition, 0.5 m and 0.8 m. dike raising are 4,200 million m^3, 2,800 million m^3 and 2,000 million m^3, respectively.

CONCLUSIONS

Dike heightening is a straight measure for flood mitigation. Therefore, the number of inundation areas and the inundation depth in retention areas is drastically reduced. However, the flood around Ayutthaya areas is still deep because there are effects from many rivers flowing through the area. Besides, heightening dike makes retention areas deeper when river water flows over the dike to the retention areas, which makes inundation depth deeper.

However, the main disadvantage is the increase of downstream discharges. The experimental results showed that downstream discharges were about 4,300 m^3/s and 4,500 m^3/s for 0.5 m and 0.8 m dike heightening, respectively. Since, all river water flows to Bangkok but the capacity of the Chao Phraya River at Bangkok is approximately 3,600 m^3/s; therefore, flood will occur in Bangkok area with high possibility. Therefore, flood management in the retention areas must be examined very carefully in order to decrease inundation areas and downstream discharges.



(a) Present dike condition (b) Heightening dike by 0.5 m (c) Heightening dike by 0.8 m

Fig. 3 Comparisons of simulated maximum flood depths in retention areas and movements of the 1995 flooding water on the present dike condition and the two alternatives