Chao Phraya flooding in 2011

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1. Introduction

Chao Phraya river in Thai has 372km in length with 160000 km^2 of area and average flow rate of 833m^3/s, which is the biggest in Thailand with tributaries of Nan river and Ping river as shown in Figure 1. Its annual average runoff ratio is 0.4. In 2011, it started to rain more than the average year. In the beginning of September, near Nakhon Sawan in the middle watershed because of river water level increase at the left bank overflow started. Overflow water flowed southward and left the industry complex under water. In the beginning of November, the river water level decreased and flooding flow stopped at last before north Bangkok. Komori（2012）explained the main cause of this flooding is abnormal rain with 143% of the average rain season and 50 year probability. Other researchers pointed out a dam control problem, and the main cause is early storage in the dams for agricultural irrigation rather than flood control. Therefore, mainly two different opinions were presented so far. Here, the true causes were discussed from published hydrological data.

2. Method

Precipitation data was obtained from the home page of Thai Meteorological Department, TMD, which are observation data at 22 points in the watershed. Dam operation data were obtained from the home page of Electricity Generating Authority of Thailand, EGAT. River data were obtained from the home page of Royal Irrigation Department, RID. Other hydrological data were obtained from a series of reports Oki laboratory in Tokyo University (Oki *et al,* 2011) etc. The satellite data were ASTER/VNIR on November 17, 2011. Flooding simulation was referred from CHARM (2011).

From the observation data in 2011 at 22 stations of Thai Meteorological Department, watershed rainfall and each site rainfall were calculated with Thiesen polygons method. In the same way, the average year rainfall was also calculated.

Mainly hydrographs were calculated with the storage function method. But observation data were dominant for use rather than calculations.

3. Results

The watershed rainfall in 2011 was 133％ of averaged past 30 years. In logarithmic normal distribution for 21 years, the probability of rain season precipitation becomes 18.7 years.

In ordinal years, annual operation data of two dams, Bhumipol dam (Pin river) and Sirikitdam (Nan river) shows almost the similar patterns of operation for dams, however in 2011 the trend of increase was indicated from May and reached full capacity in October. And in 2010 the operation state was in very low water level, which suggests correspondence with storms prediction. The weather forecast of the Meteorological Department reported that rainy season starts on May 6, 12 days earlier because of La Niña effect. It estimated also the rainy season ends on October 21, the same as the ordinal year (TMD, 2010). Year 2011 was La Niña. Silikit dam has more precipitation and increase from June. On the other hand, both dams have accretion of sand at about one third of the total capacity, which affected the operation of dams and caused flooding as an element.

Figure 2 shows precipitation and hydrographs at Nakhon Sawa in the middle watershed (Oki *et al,* 2011). River flow

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Table 1 Flooding cause analysis ($10^8 m^3$)

Precipitation	Dam control	Dam sediment
115	163	67

Figure 1 Chao Phraya River watershed.

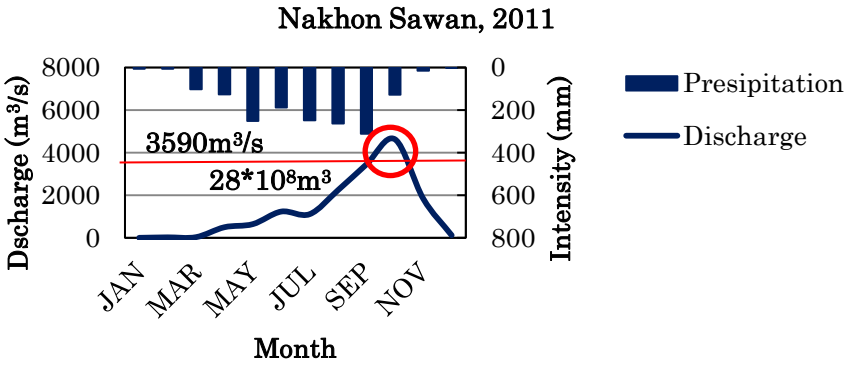

Figure 2 Precipitation and discharge at Nakhon Sawan in 2011.

capability at this point is 3590m^3/s, and overflow started on September 5 (Oki *et al*, 2011). Chao Phraya river flow capability becomes lower in downstream, which shows corresponding agricultural irrigation and urban use water in the watershed. Reversely in flooding, such flow changes overflow and causes flooding in Bangkok.

4. Discussion

In 2011, rainy season was predicted to be long term. Nevertheless, the storage of two dams started from early time. At Bhumipol dam, in August, the storage became 11 billionm^3, 80 % of full capacity. At Sirikit dam it became 7 billion m^3, 70 % of full capacity. In the peak of the rainy season, September at Bhumipol dam it became at almost full capacity. Then, if the ordinal operation were assumed, a hydrograph at Nakhon Sawan would become lower and overflow would decrease in downstream, at Ayutthaya overflow would occur with the amount of one tenth of the actual result. This shows that ponding became one tenth at industrial complex, which suggests low water level ponding.

In flood damage in 2011, flooding prediction was also a problem. Flooding flow into the central of Bangkok lost energy in November and finally the central escaped damage. However, the prediction simulation gave warning of 0.5 to 5 m ponding. It was because of lack of the boundary conditions. They are (1) drainage networks of urban area, (2) revetment structures and its drainage conditions, and (3) tide fluctuation. These conditions might not be included in the simulation. Next time these conditions should be assembled for more precise prediction.

5. Conclusions

(1) One of the causes was abnormal rainfall, but not so serious for long term prediction.

(2) In dam operation, even though long term rainfall season was predicted, the outflow during May and July was not enough, therefore, the operation did not function in the peak of the season, September, and this is the main cause of flooding. If the operation was the same as the ordinal years, the industrial complex at Ayutthaya could escape from flooding. Moreover, the amount of sedimentation in the lake became at one third of the full capacity and this is the third cause.

References

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