The Alternatives of Flood Mitigation in The Downstream Area of Mun River Basin

Dr.Phattaporn Mekpruksawong[1], Thana Suwattana[2] and Narong Meepayoong[3]

[1] Senior Civil Engineer, Office of Project Management, Royal Irrigation Department

(Samsen Road, Dusit, Bangkok 10300, Thailand)

[2] Chief of Project Planning Group I, Office of Project Management, Royal Irrigation Department

(Samsen Road, Dusit, Bangkok 10300, Thailand)

[3] Chief of Water Allocation Division, Regional Irrigation office VII, Royal Irrigation Department

(Ubol Ratchathani Province, Thailand)

ABSTRACT

Mun and Chi River basin cover an area 68 percent of the Northeastern part of Thailand. Chi River joins with Mun River at Amphoe Muang Ubol Ratchatani, then flow to Mae Kong River at the border of Thailand and the Republic of Laos. The downstream area of Mun Basin next to the joint between Chi River and Mun River is often flood. The causes of the flood are, (1) discharge capacity of Mun River is insufficient to carry the flood, (2) human activities decrease flow section area of Mun River, and (3) many large rapids along river bed obstruct the flow and leveling up water surface. This paper presents an application of HEC-RAS program for simulating flood condition when flood mitigation alternatives are implemented. The result found that flood depth is decreased for 4-196 cm and flood duration is decreased for 0-26 days depend on flood mitigation scheme.
Key Words: *Basin, Flood, HEC-RAS, Large rapids*

I. INTRODUCTION

The Mun River is the largest right bank tributary of Mekong International River. The basin area covers 119,000 km^2 or about 2/3 of the area of the Northeast Thailand. In an average year its contribution to the Mekong is approximately 25,000 MCM, which is equivalent to an average runoff of 210 mm or 800 m^3/s. Roughly a third of this comes from the Chi river, a left bank tributary that drains an area of 49,000 km^2. The Chi River joins the Mun River at Ubol Ratchathani province and flows eastward into the Mekong River. The junction point of these rivers just 25 kms. upstream of Ubol Ratchathani town. The natural complex rock forms as broad-crested weirs (large rapids) along the Mun River particularly since its confluence with the Mekong River to 40 Km upstream. The insufficient of discharge capacity at Ubol Ratchathani town, the large rapids in the river and the decreasing of flow section area by human activities cause flood in Ubol Ratchathani town particularly in 2000, 2001 and 2002. The Royal Irrigation Department (RID) was requested from the local administration to study flood mitigation in Ubol Ratchathani province focus on Ubol Ratchathani town (Fig. 1). The Alternatives of flood mitigation such as channel improvements, by pass channel, water storage area and combined method were proposed and analyzed its impact to reduced flood depth and duration at Ubol Ratchathani town.

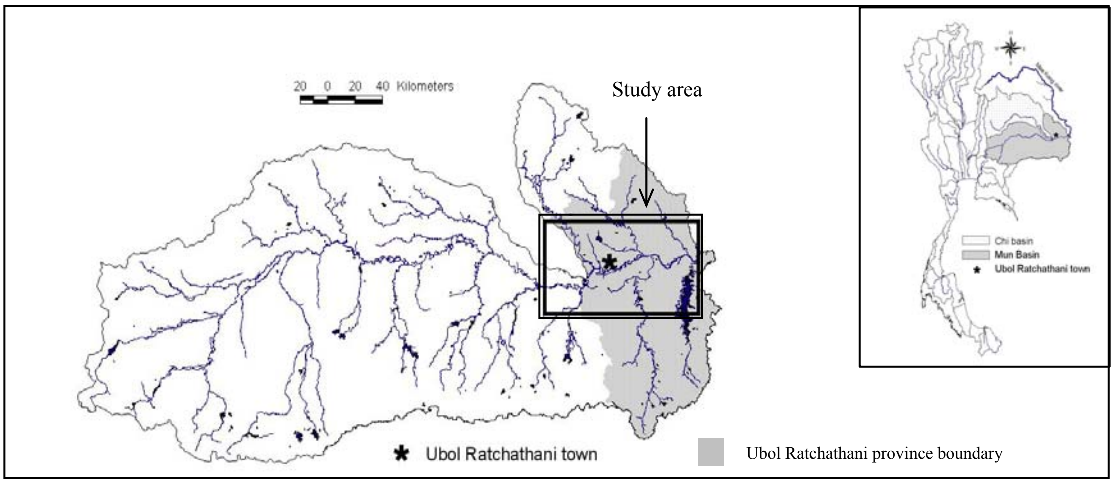

Figure 1: The Mun River basin and study area.

II. THE STUDY AREA

Ubol Ratchathani province is 630 Km away from Bangkok and cover an area of 16,112 Km^2. The general topography is relatively flat and gently inclines to the East. The land form is mainly floodplain with hilly plateau and mountains in various rocks in the East. The climate is strongly seasonal with respect to rainfall. It is governed by the South-West monsoon from the Indian Ocean (April to October) and the North-West monsoon from China (November to April). An average temperature is 26.9^{O}C, relative humidity is 73%. An annual pan evaporation and rainfall is 1,853 mm and 1,581 mm respectively (Fig.2 shown their monthly distribution). Typically, more than 80 % of annual rainfall occurs during May-September. There are two existing large multipurpose water resources projects named Pakmun and Sirinthorn Dam. Both of them are downstream of Ubol Ratchatani town and operated by Electricity Generating Authority of Thailand (EGAT). This study area covers the downstream area of Mun River basin (from the junction of Mun and Chi River to Mekong River) and focus on Ubol Ratchathani town. RID survey the cross sectional 181 and 94 sections in Mun and Chi River respectively. The flood sign elevation of section also record if it is evident in order to use for calibrate the parameter of model.

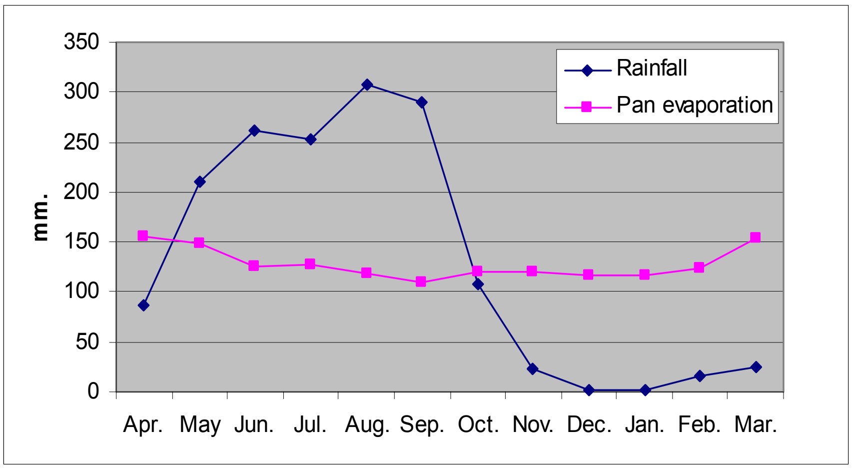

Figure 2: The monthly distribution of rainfall and pan evaporation.

III. HYDROLOGICAL CONDITION

The average river bank at Ubol Ratchathani town is +112 m.msl (meter above mean sea level) which approximated to 2,400 cms discharge. The observed water level and discharge of Mun River at station M.7 since 1950 to 2003 was shown in Fig. 3 and Fig. 4. We can see that the maximum discharge flow to Ubol Ratchathani town often over its capacity (about 2 or 3 years interval). From this data set, its probability distribution was analyzed by GUMBEL method as shown result in Table 1. The longitudinal profile of Mun River[1] in Fig. 5 could estimate the slope of river bed for an approximately 1:30,000 from the origin to Amphoe Rasi Salai and gradually forms gentle slope until the joint with Chi River. The large rapids since downstream of Amphoe Phiboon Mungsahan causes river bed undulant and obstruct the flood flow. It can concluded that flood in the downstream area of Mun River basin caused by

1) Insufficient discharge capacity of Mun River to carry flood.
2) The large rapids cause back water effect to the upstream and reduce the drainage efficiency of river channel.
3) The flood flow section of Mun river is decreased by human activities such as construction of house or road in flood way.

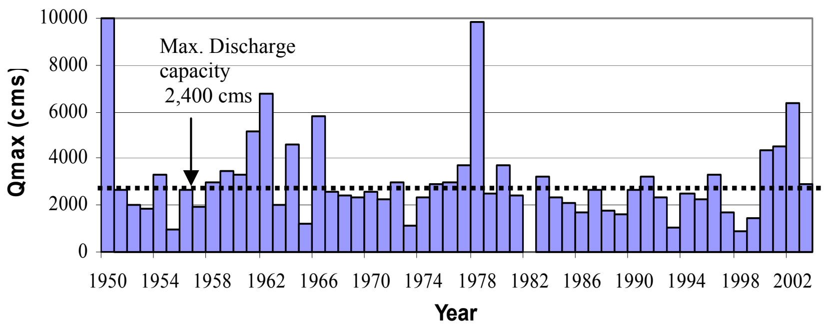

Figure 3: The historical data of maximum annual discharge at station M.7

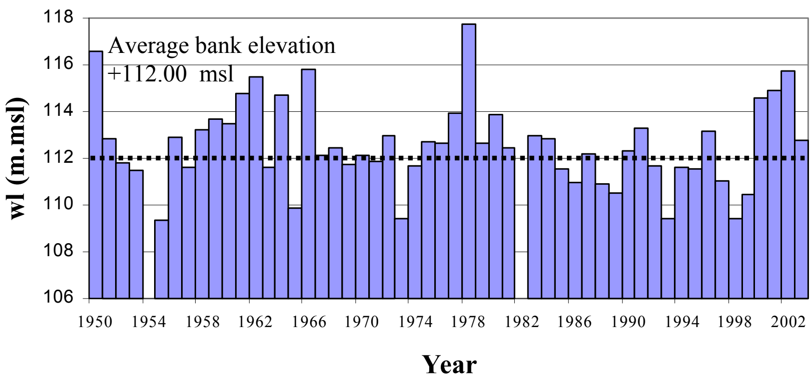

Figure 4: The historical data of maximum annual water level at M.7

TABLE 1: The maximum annual discharge and return period at station M.7.

Return Period (years)	1	2	5	10	20	25	50
Qmax (cms)	99	2,669	4,100	5,048	5,958	6,246	7,135

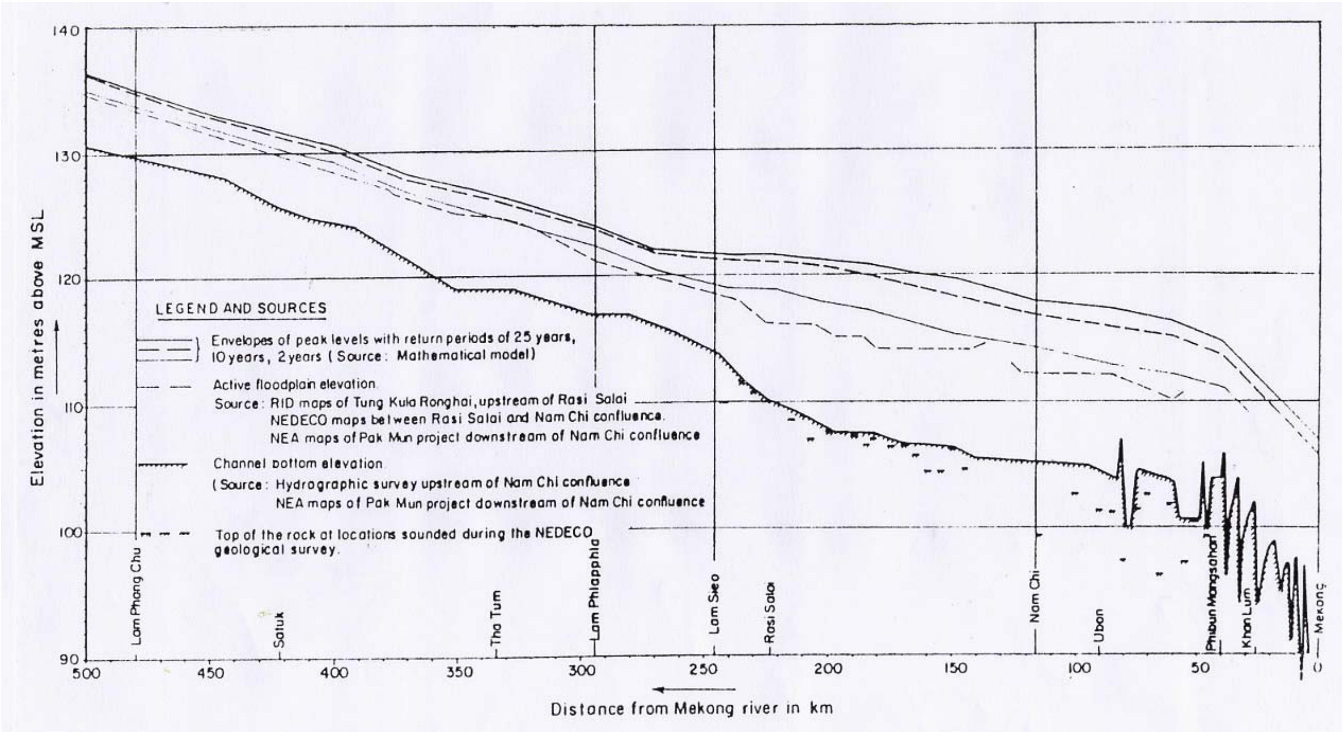

Figure 5: The Longitudinal profile of Mun River.

IV.THE ALTERNATIVES OF FLOOD MITIGATION AND SIMULATION

The alternatives of flood mitigation scheme are purposed in order to reduce or delay flood before it reach to Ubol Ratchthani town as shown in Fig. 6

1) Construct the by pass channel on the upstream of Ubol Ratchathani town in order to reduced flood which flow to Ubol Ratchathani town[2]. The designed discharge is 500 cms. and channel length is approximately 90 km.[2]
2) Construct the by pass channel on the downstream of Amphoe Phiboon Mungsahan in order to reduce flood which flow to large rapids and backwater effect[2]. The designed discharge is 500 cms. and channel length about 22 km.
3) Combine alternatives[2] 1) and 2)
4) Improve the channel hydraulic property by adjusting steeper bed slope from downstream of Ubol Ratchathani town to Pakmun dam[2] to 1:10,000. Although it is very scarce to occur because all large rapids will be cleared out from channel but the result from simulation can show that the large rapid influence to flood condition.

5) Improve channel hydraulic property by adjusting steeper bed slope from Ubol Ratchathani town to Amphoe Phiboon Mungsahan to 1:10,000[3]. All large rapid is remained for this alternative.
6) Construct storage area to keep water from the flood by digging storage area then, fill up the dike around storage area and construct 2 control gates[3]. The maximum storage volume is 47 MCM. at level +116 m.msl.
7) Combine alternatives[3] 5) and 6)

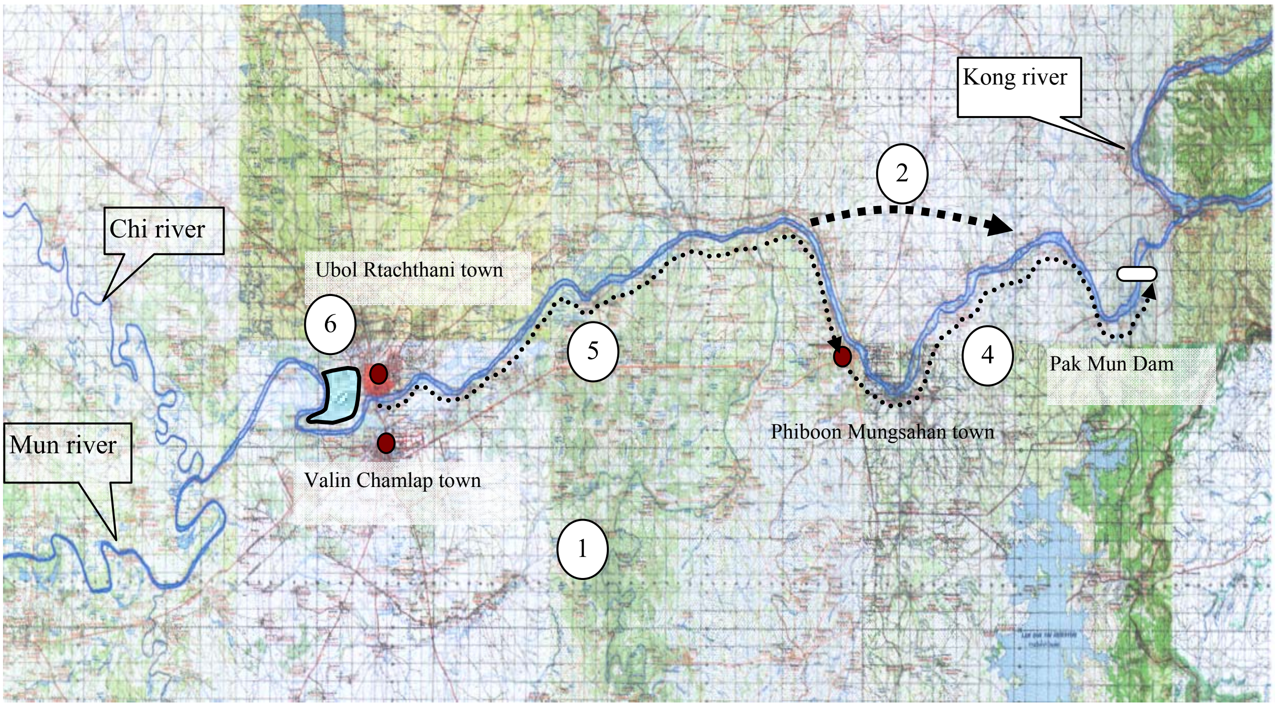

Figure 6: The outline of flood mitigation alternatives.

The HEC-RAS (Hydrologic Engineering Center, River Analysis System) hydrodynamic model is developed by U.S. Army corps of Engineers. It is an implicit finite different, one dimensional model for computation of unsteady flows in rivers. The model can describe subcritical as well as supercritical flow condition. It can also be used for the description of flow over hydraulic structures and structural operation. The simulation boundary starts from kilometer 94 th. and kilometer 70 th. upstream of the junction in Chi and Mun River respectively. The downstream boundary is Pak Mun Dam. Fig. 7 shows schematic diagram of river system in the simulation boundary. The simulation period are selected from annual maximum flood which covered 10 and 25 years return period that lined on year 2001 and 2002 respectively. The data which were used for simulation are;

- The discharge hydrograph of station M.7, E20A, M5 and out flow from Sirinthorn dam
- The stage hydrograph of station M.7 for calibration Manning coefficient , n of model
- The assumed Manning coefficient, n of channel and bank.
- The cross sectional data that cover 141 and 47 sections in Mun and Chi River respectively. The HEC-RAS program requires input cross section data starting

from downstream boundary to upstream boundary (called river station, RS). The total length of Mun River for simulation is 176 km.

- The flood sign elevation in the year 2002 that were record during survey cross section in order to use for calibration Manning coefficient, n of model.
- The stage hydrograph at Pak Mun dam for used as downstream boundary condition of model.

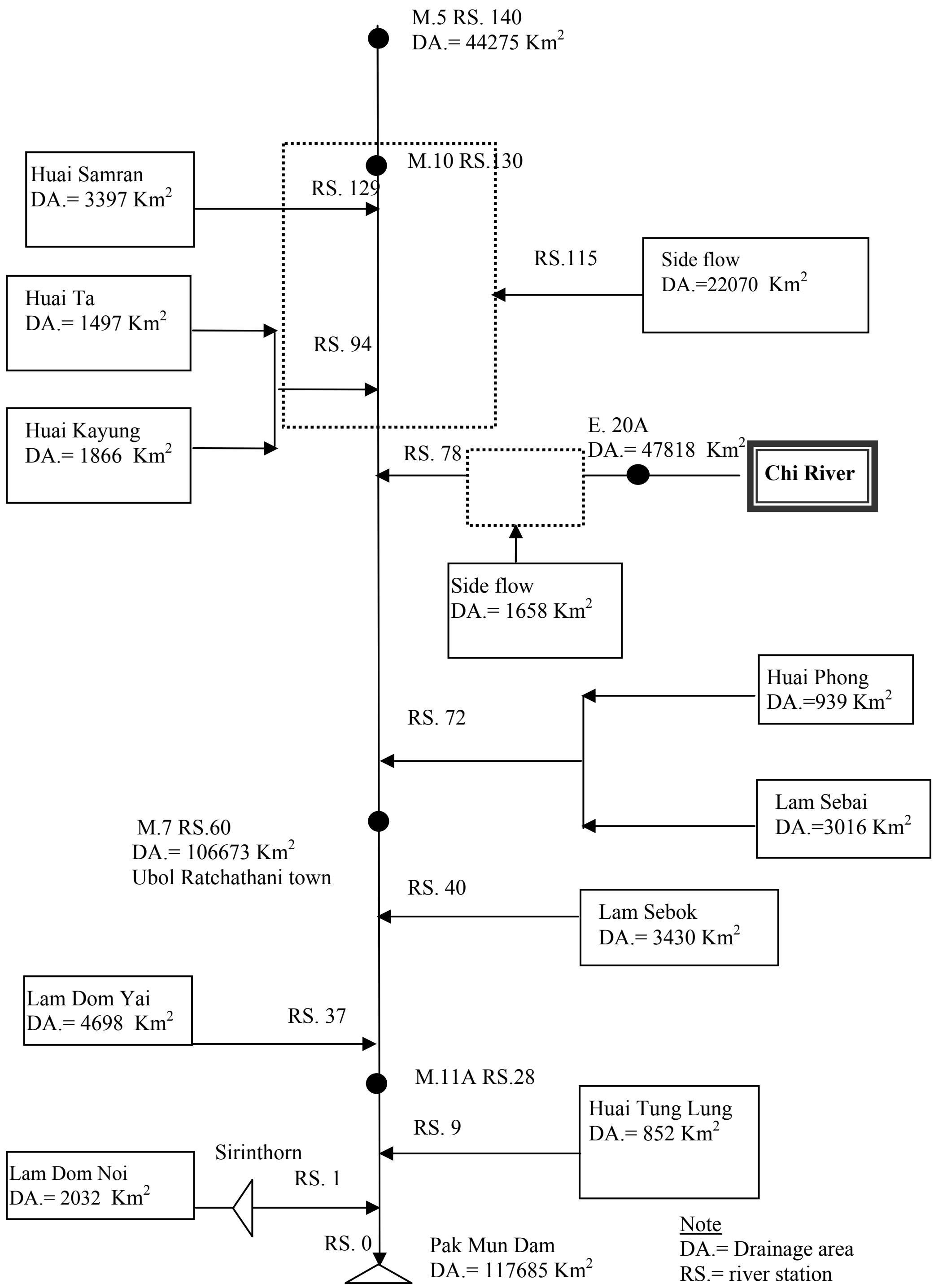

Figure. 7: Schematic diagram of simulation area

V. THE SIMULATION RESULTS

The model calibration is conducted by comparing simulated and observed water level at M.7. The result using Manning coefficient, n of channel ranged from 0.033 -0.045 and n of bank 0.05 show good correspondence between simulated and observed water level as shows in Fig. 8-Fig. 9 and summarized in Table 2. The simulated water level in 2002 has good correspondence to flood sign too.

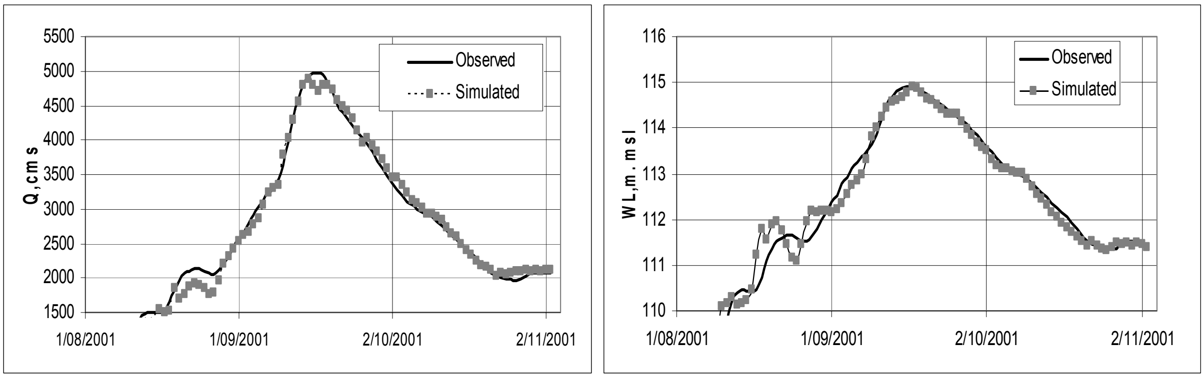

Figure 8: Comparison of observed and simulated discharge and water level at M.7 in 2001

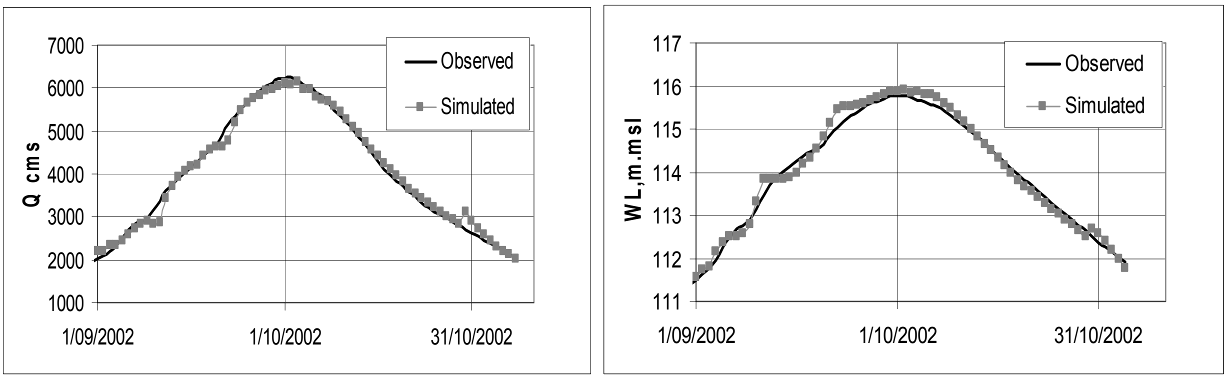

Figure 9: Comparison of observed and simulated discharge and water level at M.7 in 2002

Table 2: Summarize of calibration results

Year	Max. Discharge (cms)		Max. water level (m.msl)		No. of inundation days	
	Observed	Simulated	Observed	Simulated	Observed	Simulated
2001	4,980	4,877	114.89	114.92	49	50
2002	6,242	6,157	115.77	115.91	60	60

The parameter set in previous step then used for simulate flood condition when flood mitigation alternative is implement. Table 3 summarized the flood mitigation scheme which affected to flood condition in terms of food depth and flood duration. The simulation results have the remarks that

- Alternatives no.4, improve channel hydraulic property by adjusting bed slope and clear out large rapid is the most efficient scheme. Therefore, it can be conclude that large rapids that acts as broad-crested weirs is highly influence to flood condition in the downstream area of Mun River basin.

- Alternatives no.5, improve channel hydraulic property by adjusting bed slope from Ubol Ratchathani town to Amphoe Phiboon Mungsahan cause an increasing discharge capacity to Mun river at M.7 from 2,400 cms to 3,200 cms. The water level decreasing in Mun River influence to water level in Chi drop down about 40 cm too.

- Alternatives no.6, the construction of storage area is the least effective alternative because its storage capacity is relatively low compare with flood volume (4,768 and 9,913 MCM in 2001 and 2002 respectively). This scheme will be more efficiency when flood volume is low. The backwater effect to upstream can be controlled by gate operation.

- Alternatives no.7, combine alternative 5) and 6) is the most appropriate alternative because this scheme is not only increase drainage capacity of Mun River but also store water from flood for dry season utilization.

Table 3: The result of simulation in each alternatives scheme.

	Alternatives no.						
	1	2	3	4	5	6	7
Year 2001 (10 years return period)							
Decreasing of flood depth (cm)	18	13	42	162	93	4	99
Decreasing of inundation day	11	3	15	26	25	-	25
Water store in storage area (MCM)	-	-	-	-	45.4	-	41.2
Year 2002 (25 years return period)							
Decreasing of flood depth (cm)	23	20	34	196	88	4	95
Decreasing of inundation day	9	2	8	13	17	-	17
Water store in storage area (MCM)	-	-	-	-	48.2	-	47.0

VI. CONCLUSION

The flood in the downstream area of Mun River basin occurred by 1) insufficient discharge capacity, 2) large rapids obstructs the flood flow and causes backwater effect to upstream, 3) decreasing of flood way section by human activities. The RID proposes 7 alternatives of flood mitigation cover river training, by pass channel and construction flood storage area. The HEC-RAS program is used for simulate flood in 2001 and 2002 (10 and 25 years return period). The simulation result shown that flood mitigation alternatives can decrease flood depth 4-162 cm. and flood duration 0-26 days in 10 years return period (2001) while decrease flood depth 4-196 cm. and flood duration 0-17days in 20 years return period (2002). The adjusted bed slope and clear out large rapids is the most effective alternative scheme but it may not be accepted by the people in Ubol Ratchathani province. The adjusted bed slope and construct flood storage area is the best alternative scheme because it can reduce flood depth and duration efficiency and store flood water from the flood for utilization in dry season.

VII. REFERENCES

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