VOL. 9, NO. 3, MARCH 2014 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

EVALUATE THE CAUSE OF FLOODING OF UPPER MUN RIVER IN NAKHON RATCHASIMA

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ABSTRACT

This work was a study to find the causes of flooding in the economic areas of Nakhon Ratchasima province which area is the one of the northeastern plateau of Thailand. This study analyzed the amount of rainfall and runoff, which is rain gauge stations, 20 stations. The causes of flooding were the actual rainfall is higher than the amount of water quite predictable. Capabilities of the drainage of canal were not sufficient to accommodate the amount of great flood from the north to the downstream, which flowed through downtown and the community. The size of the structures that were made by people in communities such as check dam, were not standardized enough to drain the floods in the quantity and at the appropriate moment. The Nakhon Ratchasima City Municipality has grown and expanded continuously to enhance the community that it made the invaded area of the canal which it caused the performance of drainage of Lamtakong lower and Lam Boribun decreased. System of water storage and system of slowing of great flood in the watershed before it flowed into the city and the community were not enough. The drainage of the Lamtakong dam was not relative to the water demand by the seasons. Manages absences for ability receive water of the canal to accommodate the drainage of the dam such as maintenance, and removal of garbage and weeding in the canal. The canal was made to shallow from the accumulation of sludge and soil sediment. Construction of residential encroachment into the canal caused the cross-sectional area of drainage decreased.

Keywords: flooding, runoff, Nakhon Ratchasima, city municipality.

INTRODUCTION

Lamtakong is one of the canals in the Mun watershed and has a total length of 220 kilometers. It has headwaters in the Dong Phaya Yen Mountains and the San Kamphaeng Mountains at Pak Chong district, Nakhon Ratchasima province, Thailand. It flows through the community at large to four communities including Pak Chong district, Sikhio district, Sungnoen district, and Nakhon Ratchasima City Municipality. It joins with the Mun River in the Chaloem Phrakiat district, Nakhon Ratchasima province. Lamtakong watershed area is 3,310 square kilometers that is 18.52 percent of the total watershed area in Nakhon Ratchasima province. The Lamtakong watershed area is a steep slope in the flow through the Pak Chong district into the Lamtakong dam. While the central and lower watershed area of Lamtakong has low slope to the relatively flat. Lamtakong is canal that has many branches. Branch is important to urban communities as Lam Boribun. Lam Boribun has a total length of 35 kilometers and separated from Lamtakong on the grounds prior to Khamthaleso district. It is almost parallel to the Lamtakong through the Muang Nakhon Ratchasima district and confluence with the original Lamtakong at Chaloem Phrakiat district before flowing into the Mun River. The plains of both sides of the Lamtakong and Lam Boribun in Muang Nakhon Ratchasima district have a width of about 5-8 kilometers that they are the large plains and the most important in this watershed as shown in Figure-1.

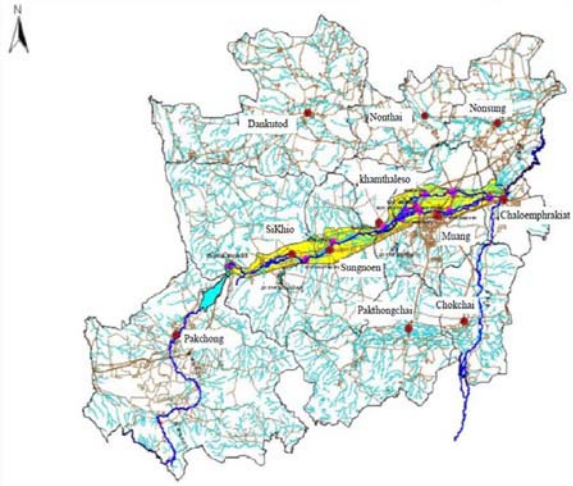

Figure-1. Main canal and its branches in the Lamtakong watershed.

The rather severe flooding in the central and lower watershed area of Lamtakong that was causing damage to property as in 1996. Lamtakong Dam had draining with the high rate was 132 cubic meters per second. It contributed to the damage in Nakhon Ratchasima City Municipality and farming areas on both sides of Lamtakong of Nakhon Ratchasima province. Flooding in the Lamtakong watershed was most often in the month of October, the rainy season in Thailand. A cause of the flooding was heavy rain in the area for several days and spread cover throughout the Lamtakong watershed. In 2010, heavy rains make the water flowing into the Lamtakong reservoir, increases to the storage level

(Storage capacity of the dam is 314.49 Million cubic meters by +277.00 m. of the mean sea level: MSL). The water flowing into the Lamtakong reservoir increased continuously until the water level was higher than the service spillway as 1.0 meter (the volume of water was 365.27 Million cubic meters). It more exceed the capacity of the dam that was reinforced by stop log sheets from the original level of storage as at +278.00 m. of MSL. The new storage capacity of the dam is 353.00 Million cubic meters. While, the capacity of the canal could be received was 90 cubic meters per second at the downstream of Lamtakong dam before Muang district. At the same time, it also had the heavy rain at the downstream of Lamtakong dam that it made has flooding from forest flowed down in the Lamtakong. There are also various water overflows from the reservoirs that located in the Lamtakong watershed such as Lamtakong reservoir, Sap Pradu reservoir (Sikhio district), Huai Yang reservoir (Muang district) and the drainage slowly to confluence point with the Mun river at Chaloem Phrakiat district because the water level in the Mun river was higher than in Lamtakong. They made the flooding rice paddy areas, communities, and housing from Sikhio district, Sungnoen district, Khamthaleso district, and Muang district as wide area.

METHODOLOGY

Study area

Nakhon Ratchasima province has 7.55 million rais of agricultural areas, rice areas of 5.88 million rais and irrigation areas of 0.755 million rais. Location of Nakhon Ratchasima City Municipality is the center of the province. It is located in the Muang district of Nakhon Ratchasima province and is between 14-16 degrees north latitude and 101-103 degrees east longitude. It is located about 174-206 meters above sea level and has areas of 37.5 square kilometers, or about 23,500 rais. An area of Nakhon Ratchasima City Municipality is 4.96 percent of the Muang district, or about 0.18 percent of the province. Character of the area is flat and tilted to the east, the northern part of the city are the lowlands, southwestern is a plateau, and characteristic of soil is a sandy loam soil. Nakhon Ratchasima City Municipality has Lamtakong that it has length about 12 kilometers and flows through downtown to north side.

Study method

This work was a study to find the causes of flooding in the economic areas of Nakhon Ratchasima province which is one of the northeastern plateaus of Thailand. The data used in the modeling were rainfall, runoff, evaporation, the behavior of water flow in the river, water levels in dams and reservoirs, the data of various hydraulic structures, and flooded areas. This study analyzed the amount of rainfall, which is rain gauge stations, 20 stations. This study used Thiessen Polygon and Arithmetic method to analyze the average daily rainfall, the maximum rainfall, and isohyets. In addition, this study also analyzed the amount of runoff from rainfall statistics in the past 30 years (1980-2009), water levels, rate of drainage of the dam and river cross-section data of the Lamtakong watershed. The annual rainfall in the Lamtakong watershed was between 711.9 to 1397.7 mm, with an average of 1081 mm. September had the most rainfall with an average of 234.8 mm as shown in Figure-2.

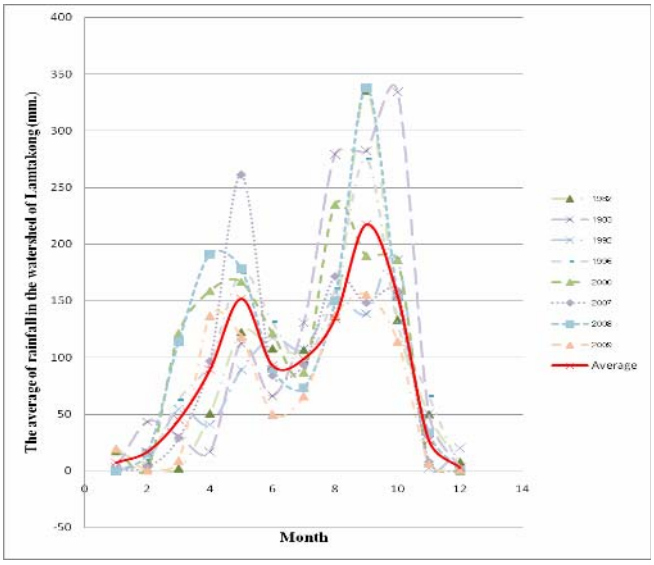

Figure-2. The average of rainfall in the Lamtakong watershed in the year of the big flood.

RESULTS AND DISCUSSIONS

Analysis of rainfall

Analysis of rainfall used data of rain gauge stations 20 stations. Thiessen Polygon Method was used to separate the total rainwater areas (3310.64 km^2) of 20 stations in the Lamtakong watershed. For example, the important stations were Pak Chong, Lamtakong dam (M.38C), Chokchai farm, Tonnam Research Center, Subthawee village, and His Majesty the King's 80^{th} Birthday Anniversary Sports Complex stations that had rainwater areas were 148.93, 172.84, 216.83, 255.55, 152.27, and 364.23 km^2, respectively and they could be calculated the weighted factor were 0.045, 0.052, 0.066, 0.077, 0.046, and 0.110, respectively. The results of analysis showed that the average of rainfall accumulation for 3 days in the watershed was 200.0 mm. and the highest value was 287.0 mm at Subthawee village station in Sikhio district of Nakhon Ratchasima province (Lamtakong operation and maintenance project, 2011). Average maximum rainfall in the watershed was 108.7 mm with a period of recurrence 15 years as shown in Table-1. The results also showed the maximum isohyets for 3 days as shown in Figure-3. In mid-October 2010, the distribution of rainfall covered areas throughout the watershed. It showed the intensity of the rainfall and regularly, especially at the Lamtakong dam and Nakhon Ratchasima City Municipality.

Table-1. The average of rainfall were analyzed with Arithmetic and Thiessen Polygon 2010 (Lamtakong operation and maintenance project, 2011).

Analysis method	The average daily rainfall (mm)			The maximum rainfall (mm)		
	14 Oct 2010	15 Oct 2010	16 Oct 2010	1 day	2 day	3 day
Arithmetic	45.03	106.0	45.4	106.0	151.5	196.5
Thiessen Polygon	42.8	108.7	48.5	109.7	170.5	200.0

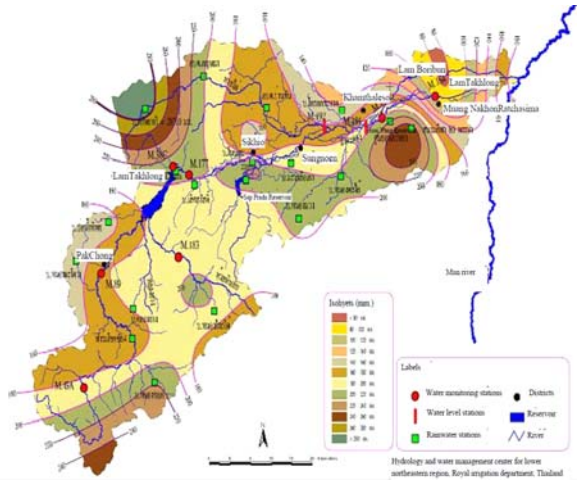

Figure-3. The maximum isohyets for 3 days on 14-15-16 October 2010 (Hydrology and water management center for lower northeastern region, Royal irrigation department, Thailand, 2010).

Analysis of the amount of runoff from rainfall statistics

Nakhon Ratchasima City Municipality is the main economic area of the province. Therefore, this study considered to analyze this area. The results of water level and water volume measurements at M.191 station and nearby stations before the Nakhon Ratchasima City Municipality showed that the maximum water volume that was 196.17 cubic meters per second, flowed into the Nakhon Ratchasima City Municipality. The results of water level and water volume measurements at M.164 station showed that the maximum water volume that was 123.90 cubic meters per second, flowed into the Lamtakong and the maximum water level was 5.55 meters. The water volume at M.191 and M.164 station was more than the capacity of the canal in this range (45 cubic meters per second) up to 3 times. It caused flooding at the end areas of the Lamtakong dam and the Nakhon Ratchasima City Municipality that an area was about 205 square kilometers that was flooded. Areas were flooded with an average depth of 2.22 meters, a maximum depth of 2.80 meters and a volume of floodwater approximately 236 million cubic meters. The maximum flow volume was 127.36 cubic meters per second in Lam Boribun. Runoff analysis also found that the maximum of amount of water at M.164 station was the year recurrence 11 years (Lamtakong operation and maintenance project, 2011).

Impact analysis

The model assessment in the future found that the climate change did not increased the flow of water during the rainy and dry seasons each year, significantly in the next 20 years. Flow during the rainy and dry seasons were more variable. Floods and droughts would become more frequent. The result of climate change would increase the flooding areas in the next 5 and 20 years that it was against the impact of the development that would occur in the future. Economic losses from floods and to neglect to manage water resources in the next 20 years was high, the risk of the condition of development of Nakhon Ratchasima City Municipality shown in the model in the future affected to the social and public significance. The uncertainty was one thing to be used in simulation or forecast scenarios of urban development. It did not obstruct the decision to achieve a balance between development and conservation, the studies of environmental impact with simulation of future development of the Lamtakong watershed found that water quality deteriorated from agricultural areas, industrial factories, communities, garbage dumps, livestock, wastewater, aquaculture and the transition of movement of sediment and nutrients as shown in Table-2. The changes would impact significantly on the flooded areas. They made products that people have to rely on wetlands decreased. Number of fish in their natural habitat was declining. The changes also impacted to a variety of fish species.

Table-2. The transition of water quality, movement of sediment and nutrients.

Impact analysis	Rivers / Years	2000	2015	2030	2045
Water quality	Lamtakong	moderate	good	moderate	lower
	Lam Boribun	moderate	moderate	lower	lower
Movement of sediment and nutrients	Lamtakong	normal	moderate	moderate	little
	Lam Boribun	normal	normal	little	little

Problems and causes of flooding

The actual rainfall is higher than the amount of water quite predictable. The heavy rainfall was a period of many consecutive days. Kongjun and Noipairoj (2011) said that the results of the study rainfall three days in 14-16 October 2010 showed that rainfall was 200 mm higher than the average rainfall in the month of October, which is equal to 154.6 mm. Also during the time was before the torrent, Lamtakong watershed areas both upper and lower were saturation and wet already.

Topography of the area of Lamtakong upper part is a steep slope. It caused rainfall flow quickly and the Pak Chong district area was flooded quite severe. The area of Lamtakong lower part was Muang district and Chaloem Phrakiat district. It is flat land and there is a slope less. Rainfall was in the area of Lamtakong lower part, it flowed much slower than in the area of Lamtakong upper part.

Capabilities of the drainage of canal were not sufficient to accommodate the amount of great flood from the north to the downstream, which flowed through downtown and the community. Due to the structures obstructed in Lamtakong and Lam Boribun were numerous that the size of the structures that were made by people in communities such as check dam, were not standardized enough to drain the floods in the quantity and at the appropriate moment. In addition, the invaded the area of the canal which it caused the cross-sectional area of the canal decreased. It caused the performance of drainage of Lamtakong lower and Lam Boribun decreased. System of water storage and system of slowing of great flood in the watershed before it flowed into the city and the community were not enough. It found that some of the rainfall overflowed from the spillway of Sap Pradu reservoir and Huai Yang reservoir into the Nakhon Ratchasima City Municipality. The rainfall of side flow could not be controlled (Kongjun and Noipairoj, 2011). Therefore solutions to the problems that should be considered were to find the space to reserve water in the dry season. Because another problem of the Nakhon Ratchasima City Municipality that it was a shortage of supply of raw water used for water supply in the dry season.

Drainage of Lamtakong into Mun River could be done at a lower rate than normal. Due to the floods in Pak Thong Chai district earlier this about 1 week, Pak Thong Chai district had made drainage water into the Mun River already. It made the average water level in the Mun River was higher than the water level in Lamtakong at the confluence of approximately 0.30 to 0.60 meters (Kongjun and Noipairoj, 2011).

The Nakhon Ratchasima City Municipality has grown and expanded continuously to enhance the community. Most will expand to the north and south of the downtown area, which is flat, with low levels. It blocked the flow of water, which the Nakhon Ratchasima City Municipality was currently using empty fields in the north and just south of downtown in the drainage such as the Huathalae subdistrict which is on southeast of the Nakhon Ratchasima City Municipality. The southwest area of Nakhon Ratchasima is a plateau. But the city could not be extended to the southwest, because it is adjacent to the area of the military.

The drainage of the Lamtakong dam was not relative to the demand for water by the seasons. Manages absences for ability receive water of the canal to accommodate the drainage of the dam such as maintenance, and removal of garbage and weeding in the canal. The canal was made to shallow from the accumulation of sediment. Construction of residential encroachment into the canal caused the cross-sectional area of drainage decreased. When the cross-sectional area of the canal was decreased, it made the rate of water flow in the canal reduced. The weeds and solid wastes were left in canal. It would increase the friction of the water flow and made the velocity of flow decreased as shown in Manning's formula.

SUMMARY AND CONCLUDING REMARKS

In mid-October 2010, the distribution of rainfall covered areas throughout the upper and lower Lamtakong watershed. It showed the intensity of the rainfall regularly, especially at the Lamtakong dam and Nakhon Ratchasima City Municipality. They made the flooding rice paddy areas, communities, and housing from Sikhio district, Sungnoen district, Khamthaleso district, Muang district, and Chaloem Phrakiat district of Nakhon Ratchasima province as wide area. The average of rainfall accumulation for 3 days in the watershed was 200.0 mm. and the highest value was 287.0 mm in Sikhio district of Nakhon Ratchasima province. Average maximum rainfall in the watershed was 108.7 mm with a period of recurrence 15 years. The water volume at M.191 and M.164 station was more than the capacity of the canal in this range up to 3 times. It caused flooding at the end areas of the Lamtakong dam and the Nakhon Ratchasima City Municipality. Runoff analysis also found that the maximum of amount of water at M.164 station was the

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ACKNOWLEDGEMENTS

The author acknowledge the hydrology and water management center for lower northeastern region, Royal Irrigation Department, Thailand for many data, Worapot Saejaroen, Niribon Arunyapark, and Teerawat Saenaharn for search the map of the hydrology and water management center for lower northeastern region, Kannaporn Srijunthong, Wonlop Nunthamutcha and Virot Wanlua for collection and analysis of rainfall, runoff, and the flooding data analysis of Lamtakong operation and maintenance project, Nakhon Ratchasima, Suntiphun Phunthukhun and Surasak Meesangneen. Lastly, thanks Dr. Thongplew Kongjun and Mr. Suthep Noipairoj for the analysis of rainfall, runoff, and the problems and causes of flooding in 2010.

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