FLASH FLOOD EVENTS IN MU CANG CHAI AND MUONG LA ON AUGUST 3, 2017 - CAUSES AND PREVENTION MEASURES

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Abstract: *In the early morning of August 3, 2017, the two flash flood events occurred in Kim Noi and Nam Pam watersheds in Mu Cang Chai and Muong La districts, respectively. The analysis of rainfall data and field surveys shows that the severe events related to extreme local rainfall (>100 mm in 6 hours) accompanying with steep topography (>40% slope) and low vegetation cover. Therefore, flood is formed fast with short concentration time. Furthermore, narrowing cross-sections on stream by 25-80% cause flow clog and temporarily generate small dams. When the amount of floodwater exceeded the capacity of these small dams, water from dam break generates flash flood and sweep everything in downstream. The paper aims to provide short- and long-term measures to prevent and reduce flash flood damages.*

Keywords: *flash flood, flow clogging, flash flood causes.*

1. Introduction

In the morning of 3/8/2017, flash floods occurred in two basins of Kim Noi stream, Mu Cang Chai district and Nam Pam River, Muong La district. The flash floods caused great damages to people and property. In Kim Noi commune, 2 people died, 12 people were missing, 29 houses were completely washed away, the estimated damage is approximately 160 billion VND. In Muong La, flash floods killed 12 people, 5 people were missing, 375 houses were damaged. Especially, Na Ten village in Nam Pam commune has been wiped away, 45 households have been washed away completely. Floods destroyed many roads, electricity systems, irrigation systems and crops. The estimated damage at Muong La district has been estimated at over 660 billion VND.

a) Kim Noi watershed

Kim Noi is a small stream that flows into Nam Kim stream on the left bank. The stream used to be gentle with a basin area of 5 km^2, the average slope basin is 48%. The mainstream length is about 2.5 km with an average slope of 16%, dividing into two parts by stream slope. The downstream part is around 600 m from the outlet to upstream with mild slope <10% and gradually expanding streambed. In this part, the footprint of the ancient stream is exposed to the loose rocks that are the remnants of flash floods in the past (Figure 1). Local people now still live in this area. The upstream part is steeper with a slope of over 17% and narrow streams flowing between two rocky cliffs. Stream cross-sections in this part are around 8 m corresponding to the highest flood mark. In the basin, the primeval forest is almost disappearing, and crop fields are mainly maize and rice.

b) Nam Pam watershed

Nam Pam is a large stream, flowing directly into Da River immediately after Son La hydro power plant. Nam Pam basin area is about 110 km^2, the average slope of the basin is about 40%. The mainstream is nearly 13 km long, stream slopes about 10.5%. The Pi Toong stream is the largest tributary to the right of the Nam Pam stream with a basin area of 34.6 km^2 (accounting for one-third of the whole basin area). However, this basin has fairly flat terrain, the average slope of the basin is 30% and stream slope is only about 4%. Therefore, the potential for flash floods in the Pi Toong tributary is not high. In fact, the flash floods on 3/8/2017 and 14/8/2017 indicated that flash floods only occur along the Nam Pam stream (Figure 2).

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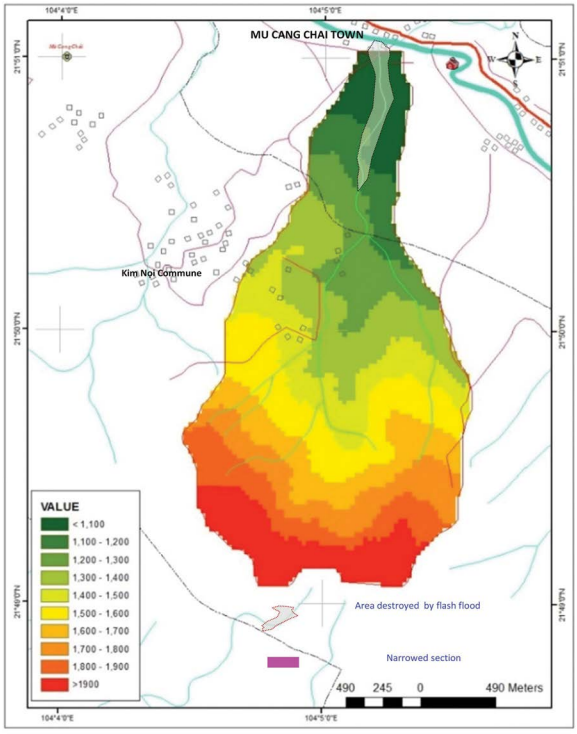

Figure 1. Kim Noi watershed

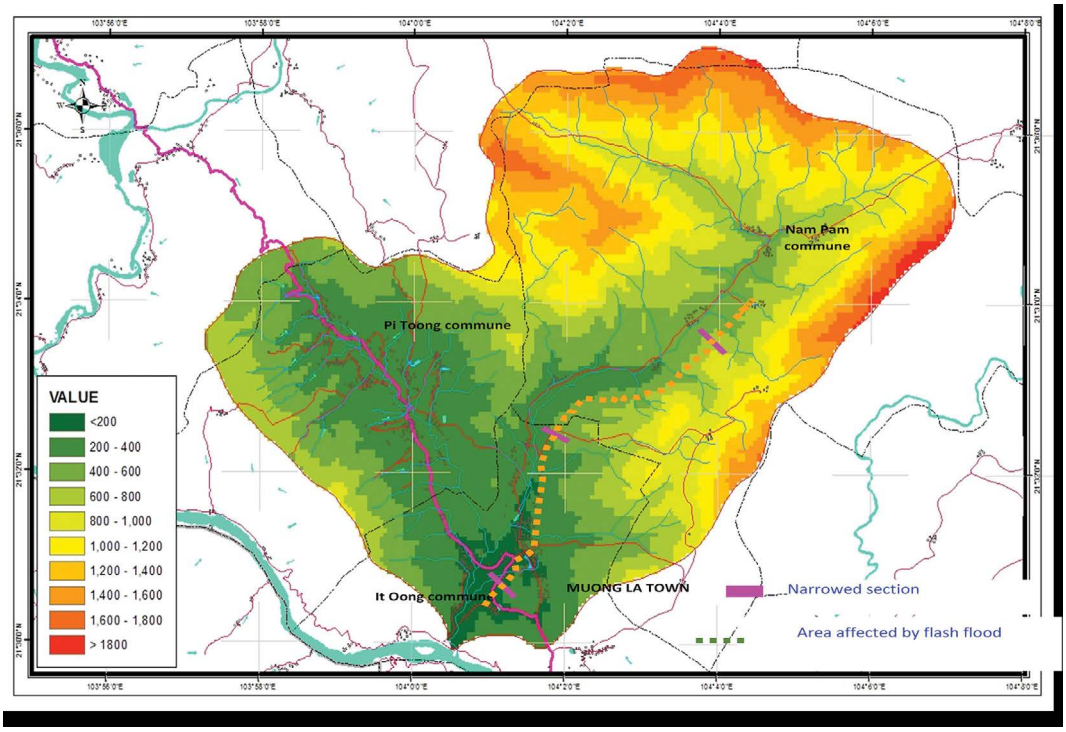

Figure 2. Nam Pam watershed

2. Study on flash flood causes

a) Flash flood in Mu Cang Chai

According to the information of the people living upstream (Kim Noi village), heavy rain occurred from midnight to the morning of 3/8/2017. However, the rainfall from 1-7h on 3/8/2017 measured at Mu Cang Chai station downstream is only 36 mm, not reflecting the actual situation in the basin. Rainfall measured at some upstream stations from 1h-7h on 3/8/2017 at Khau Pha is 116 mm, at Nga Ba Kim is 100 mm (Figure 3). From the landslide trail of the steep mountain slopes showed that in the upstream, extremely heavy rain could range from 100-200 mm in 6 hours.

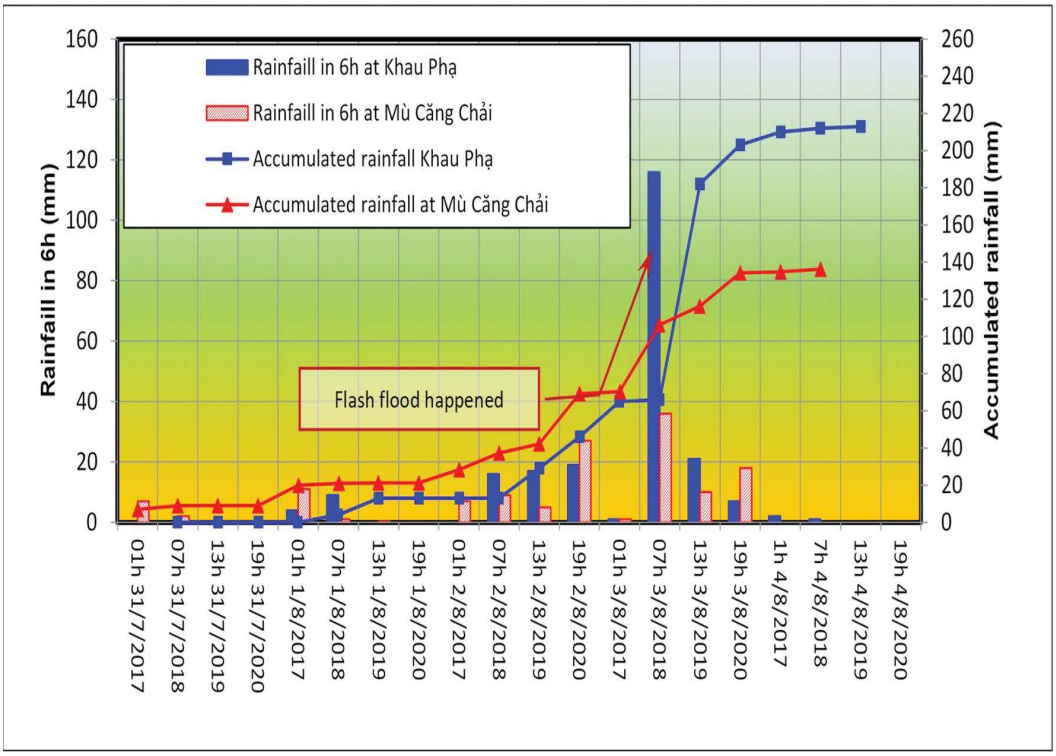

Figure 3. Rainfall at Mu Cang Chai and Khau Pha Gauges

In addition, the total rainfall in July at Mu Cang Chai station was quite large, up to 513.5 mm which made the soil moisture saturated and soil became loose.

From the location where the Kim Noi stream flows into Nam Kim stream to the upstream about 600 m, the cross-section of the stream narrowed about 50%, the two sides of the stream are vertical cliffs, the width is only about 7-8 m. There is a deep pit at this location. From here, the release cap began to develop, streams gradually expanded. This is a congestion of the flow, trees, and rocks that make up temporary dams, forming natural water tanks for rainwater storage. When the water was big enough to break the dam, it poured down from the top abruptly, carrying many of the rocks and soil of the ancient streams which were loose due to rain for many days, to the downstream, wiping out the houses and plants along the flow. The damaged stream is only about 500-600 m (Figure 4).

Generally, in small watersheds (<5 km^2), such rainfall amount rarely generates huge amounts of water down to downstream in a short time and causing flash floods. The actual reasons are the local heavy rain and narrow streams that build up temporal reservoirs in the upstream. The reservoirs with weak dams become "water balls" and easily explode. If an upstream dam breaks, the downstream ones will consecutively break and throw huge water amount to downstream like dominos.

Figure 4. Photos of Kim Noi stream after flash flood

b) Flash flood in Muong La

Comparing to Kim Noi stream, Nam La watershed is approximate 24 times larger and the stream is 20 times longer. The flash flood in Nam La, thus, is more extreme. The observed data of 12-hour rainfall (19:00 to 7:00 3/8/2017) at Muong La station is 115 mm (Figure 5), at Khau Pha is 116 mm and at Nga Ba Kim stations near Kim Noi watershed is 100 mm. This high-intensity rainfall occurred in large basin area combining with a steep watershed accumulated to a huge amount of water that is potential for flash floods. Along the Nam Pam stream to It Ong direction, there are three sites with stream cross sections shrinks from 25-80% (Figure 2). The detailed description is given as follows.

The flash flood occurred on the Nam Pam stream, Muong La district, which stretched over 10 km along the stream from the center of Nam Pam commune to the It Ong commune.

- The 1st place: The stream flows through Hoc village, where the river valley is narrow, the right bank is argillaceous rock steep, the left bank is less sloping, the valley is unbalancing V-shaped. The estimated area of cross-section corresponding to the height of flood mark reduced 25%.

- The 2nd place is located upstream of Na Loc village about 300 m. At this location, the valley shrinks abruptly, both 2 banks of the river are steep cliffs, the valley in the V shape, the stream bed width is about 5-10 m, the discharge section area shrank 80%.

- The 3rd place is Nam Pam Bridge. Road to the bridge, piers and abutments of the bridge narrowed the natural river cross-section by 55-60%. The flood flow of Nam Pam before passing over Nam Pam Bridge was supplemented with a large amount of water from the Nam Toong

stream on the right. The accumulated flood of 2 tributaries met the narrow area Nam Pam bridge and broke down the abutment bridge to the downstream (Figure 6).

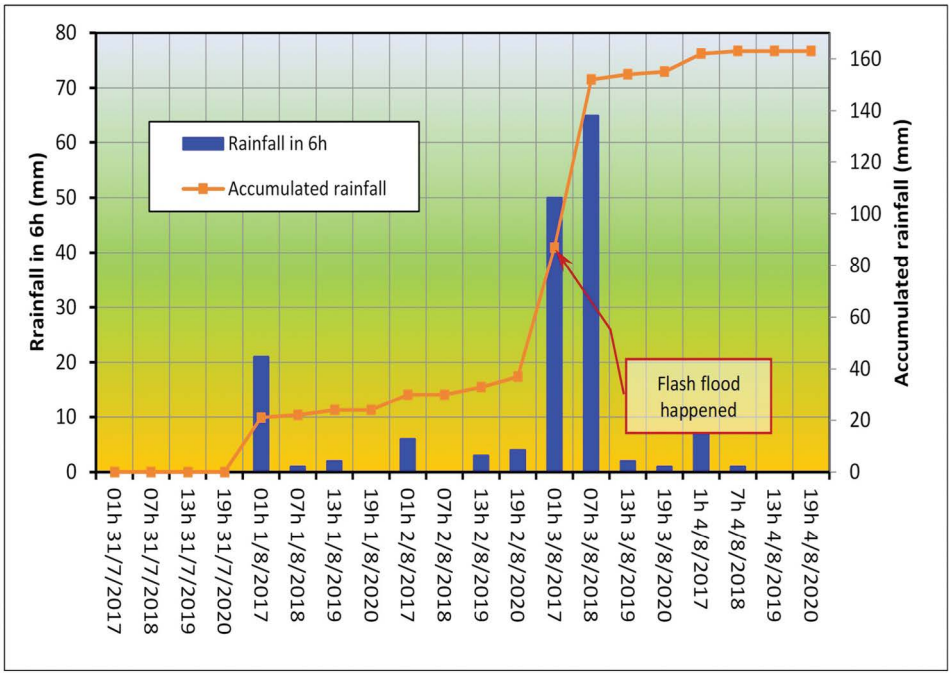

Figure 5. Rainfall data at Mu Cang Chai and Khau Pha Gauges

Figure 6. Nam Pam bridge dedtroyed by flash flood

In conclusion, the causes of the flash flood in Nam Pam stream can be summarized as follows:

- The local heavy rainfall combining with steep terrain, poor vegetation cover result in rapid flood formation and short concentration time.

- Flood waters from the slopes of the basin, with a slope of more than 40%, flow into the mainstream, pulled loose soil and rock, landslide, the trees washed away followed flow caused stream obstruction at natural and artificial narrow site, forming temporary nature lakes. When the amount of water that exceeded the tolerance of temporarily natural dams caused a dam break effect from upstream to downstream dams, creating flash flood over 10km of streams. Flood flew to It Ong to meet Nam Pam bridge, with huge amounts of water poured into congestion, causing overflow, flooding and breaking bridges to drain water to Da River.

In summary, two flash floods that occurred in the early morning of 3/8/2017 in Mu Cang Chai and Muong La are caused by locally heavy rainfall combined with water-clogging phenomenon. They are the typical floods that often occur in mountainous area with disintegration terrain and high probability of landslide.

Figure 7. The picture of Kim Noi and Nam Pan stream after flash flood

3. Recommendation of damage reduction and flash flood prevention

Especially, in 2 basins Kim Noi and Nam Pam:

- Move houses, schools etc. located in the flood risk area;

- Expand flood drainage at downstream of Kim Noi river, especially the stadium and ethnic intern school has built and blocked the floodway;

- Expand cross-section at clogging points, especially in Nam Pam river at Na Loc village and Nam Pam bridge built across the stream in It Ong town, Muong La district;

- Adjust the flow of Nam Pam stream in accordance with the natural rules and conditions, creating clearance for the flow. Technical infrastructure planning should only be implemented after having suitable flow control planning;

- Consider the resettlement plan, optimize flatlands at a higher level than the historical flood level;

- In the long-term period, reforestation should be encouraged among local people.

To minimize flash flood damage long-term solutions that needs to be implemented are:

- Investigate the upstream and downstream where has a high density of population and infrastructures. Assess flood risk for these sub-basins.

- Identify high flash flood risk streams which potentially affect the population, infrastructures. Conduct topographic survey, identify clogging points. Simulate flash floods with rainfall and clogging streams scenarios, mapping and zoning potential area affected by flash floods.

- Enhance the warning and integrate rain radar information and high-resolution satellite clouds into flash flood warning software to estimate rainfall and rainfall proceed in remote areas, especially mountainous areas where do not have detailed rainfall information. Enhance the resolution of the numerical rainfall forecasting model.

- Develop a flash flood and landslide risk map with 1: 10,000 or 1: 5,000 scales.

- Propose new settlements which are less vulnerable to flash floods.

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