Appropriate flood warning system in Northern Thailand

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1. Introduction

Northern Thailand located in the tropical monsoon region and most of the area consist of slope and mountainous upstream basins. This part of the country usually confronts with natural hazards such as flood, landslide and debris flow especially in the wet season of the year. The southwest monsoon that influences upon the region bring humidity from the ocean onto the land during the wet season is the main source of floods in the forms of tropical storms and depression troughs with high intensive rainfall over widespread area. Meanwhile some antecedent factors such as deforestation, encroachment of the upstream area for settlement and cropping including the extended settlement into the vulnerable part of the urban area resulted from the population growth previously support and increase the severity and frequency of those disasters. The infrastructure development such as road construction both in the mountainous areas and plains, bridge piers, dam and weir could become obstructions for the runoff drainage during the storm event afterwards. To solve these problems and to be saved from economic and life losses, the preventative measurements needed are the appropriate warning system and public awareness alert besides of the other integrative managements. Warning systems by manual operation or automatic telemeter are employed for this purpose.

2. Types of Floods in Upper Northern Region

2.1 Overbank flow inundation

Flooding in flood plain or lowland area is normally overbank flow inundation type which caused economic losses but very few of casualties. A noticeable change about this flood during the last ten years is its frequency and severity that increasing more and more especially in the vulnerable parts of the urban area.

2.2 Flash flood

This type of flood mostly occur in the steep slope area such as foothills and valleys where the runoff flow down rapidly. For the last 6 years, flash flood has trended to increase obviously both in location and severity. Many parts of the region experienced the serious losses.

3. Causes and factors of flood and debris flow

Storm events characterised by high intense rainfall over widespread could be regarded as the triggers of these disastrous phenomena. Flood and mud or debris flow will be more severe when combined with cyclonic storm, depression trough, heavy rain, soil disclosure and poor soil structure.

Land use is one of main factors. Growing single crop in upstream area such as corn, cabbage or orange orchards resulted the water source area encroachment and deforestation on the steep slope area. These factors favor the soil erosion and rapid runoff. In deforestation, stumps were left on the ground providing the immense debris flow afterwards when the ground was saturated by rain and then transported by runoff along the slope and sometime blocked by the obstructing structures such as roads, bridges or weirs. These blocked runoff and debris accumulated their power until reaching the breaking point and then flew out wildly smashing no matter what in front of them, villages, farms, plants and cattle. It destroyed all properties and cause many of casualties and left behind with all thick mud covered. Besides, the sediment brought by flood caused silting and decreased the river capacity and gave way for the next overbank flow to occur. In some case the excavation near the bank made the weak point for the river to cut the new way for it shortcut flow.

Rapid population and economic growth has resulted in increased rates of deforestation through forest encroachment both for settlement as well as for cropping purposes. The forest coverage decreased from 40% in 1975 to about 25% in 2001. In many sub-basins, the forest coverage remains less than 10 % of the total area. (Kosit) This decrease in forest cover significantly causes a high number of flash floods and debris flows in the upstream catchments of mountainous areas. Furthermore, the development of infrastructure such as the construction of roads in mountainous areas or in the plains resulted in the increased efficiency of runoff routing from hillslope to the lowlands. Engineering structures such as dams, weirs and bridge piers have also contributed to an increase in natural disasters through the obstruction of runoff drainage as well as accumulating debris until a breaking point before a flash flood overtops these structures and destroys everything in its path. Unfortunately, this problem has been aggravated due to the lack of consideration of catchment area and properties during the planning and construction phase of these engineering projects. In summary, the combination of all these factors resulted in the increase in flash floods and debris flows both in terms of frequency and scale.

Some examples will be given to highlight the high frequency of occurrence of flash floods in the northern region. On 3 May 2001, a flash flood occurred on the two adjacent tributaries of the Yom River in the Wang Chin district, downstream of Phrae. Some villages were destroyed and 30 villagers were killed. The flash flood was caused by a low pressure tropical storm. Intense rainfall of 310 mm was recorded at the Thoen district while 286 mm was recorded at the Wang Chin district within a day. At Wang Chin district, this rainfall amount was the maximum of the 44 years in record, having a return period of 350 years. The basin catchments of these two districts were 254 and 87 km^2 with very steep slopes in the upstream areas (Kosit,Thanu,2002). The ecology and environment of the catchments were heavily damaged. The flash flood occurred again just two weeks later and it swept through the channel at high velocities and then overflowed the banks and spread through the residential and agricultural areas along the floodplain, destroying obstructions along its path. This event was very damaging because most people built their residence on the floodplain areas.

Other cases of flash flood and debris flows occurred on 11 August 2001 at Nam Koh and Nam Chun villages in Lom Sak district, Phetchabun Province. These villages were located at the two adjacent streams of the Pa Sak River system. At about 3:00 a.m., a very strong current together with debris flows destroyed these two villages within 2 hours. 131 people were killed and 5 went missing. 207 houses were totally destroyed while 515 houses were partially damaged. Approximately 191 acres of agricultural land were damaged (Kosit,2002). The total loss was estimated at about

4.7 million US dollars. Similar disasters occurred in 1976 with 43 casualties and in 2000, with 10 casualties at different locations of the Petchabun Province.

The most recent debris flow disaster occurred on 2 September 2002 at Ban Kongkha village in Mae Sariang district, Mae Hong Son Province where 10 people were killed and 26 missing. 202 houses were totally damaged and 121 houses partially damaged including a hospital, 2 churches and 4 schools. And on 16 September 2002, a flash flood at Mae Raek village, Mae Chaem district, Chiang Mai totally damaged 12 houses and partially damaged 55 houses. Various organisations collaborated to study the causes and mitigation measures in response to this flood event at Mae Raek. It was concluded that the main causes of the flash flood were related to the geological structure of the catchment, deteriorating forest cover and landuse changes.

To prevent the damage caused by natural disasters and to reduce the losses, the following data measure and collection have been prepared by the organisations concerned. Warning signals and necessary information related to any possible disaster need to be quickly distributed to local residents through various information channels.

4. Flood Warning System Management

Prediction and Warning mainly based on 2 factors analysis;

4.1 Rainfall

Rainfall can be regarded as the main factor which trigger off the flood, if there is no rain, there is no flood. Because rainfall will become runoff and discharge of the river that may cause the flash flood or overbank flow inundation afterwards. But however the scale and severity of flood relate with physical characteristics such as gradient, distance, river meandering, channel friction, surface coverage, types of land use and constructing structures. hence rain is the first factor to monitor.

Rainfall Periodic Monitoring

(a) Monthly Rainfall: 6 months of wet season are influenced by the southwest monsoon from Indian ocean which bring the humidity onto the region during May to October. The heavy rainfall normally occur during early months of the season but sometime reinforced by tropical storms and depression troughs from South China Sea during July to September causes the possibility of serious floods. So these periods of the year are considered for flood monitoring and alert.

(b) *Weekly Rainfall:* Weekly weather forecasting, updated weather maps and animated satellite images by the meteorological department (TMD) are the good sources for monitoring the direction and movement of storms before and after landing.

(c) *Daily Rainfall:* Daily reports from raingauge network in the upstream area at 7:00 A.M. every morning provide the total volume of rainfall during past 24 hours for calculating the outcome of the runoff and discharge of the river. For public easy understanding, the following criteria can be used if average rainfall in 24 hours is;

- Lower than 35 mm = safe for flooding.
- 35.1-90 mm = possibility of flood, stand by and alert.
- Higher than 90.1 mm = critical status warning for preparation (however checking the discharge data is needed for confirmative warning and to classify the scale of flood).

(d) *Hourly:* Rainfall radar image updated every hour showing the location, density of rainfall and its movement direction. In the case of heavy rain on upstream area, the staff of manual raingaugesite may be stationed to report hourly to the headquarter office. The flood and landslide warning will be given when the rainfall is over than 100 mm and if over than 150 mm the residents must be ready for evacuation and if over than 200 mm the evacuation to the safety place and shelter must be operated.

(e) Rainfall data report by telemetering network updated of 10-minute interval transferred to the center office by modem connection and showing on the website can give the real time details of data measured at each site. For example we can monitor the river situation of Mae Wang Basin at http://geoss.tkl.iis.u-tokyo.ac.jp/geoss/

4.2 River water level

The Hydrology and Water Management Center for Upper Northern Region of the Royal Irrigation Department (RID) has developed correlation equations from the flood levels recorded by the upstream and downstream hydrological stations. The flood travel time or lag time was investigated and the critical upstream water level was defined for announcement of flood warning to the downstream area. The lag time relationship between river water level peaks of upstream and downstream stations can be used for predicting the flood and normally the latter station always located in the flood risk part of the city or residental area. The travelling time of the peak volume from the upstream site to the downstream site means the time for the public to alert and preparing themselves after receiving the early warning (Fig.1 and Fig.2).

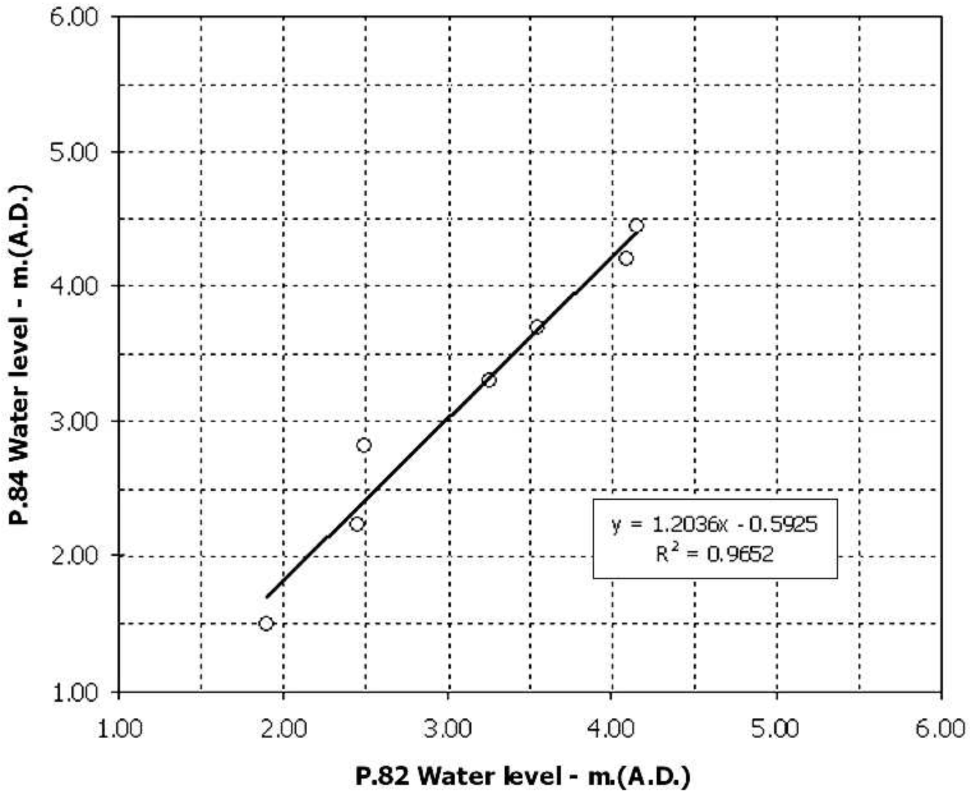

Fig.1 Correlation of water level between P.82 and P.84

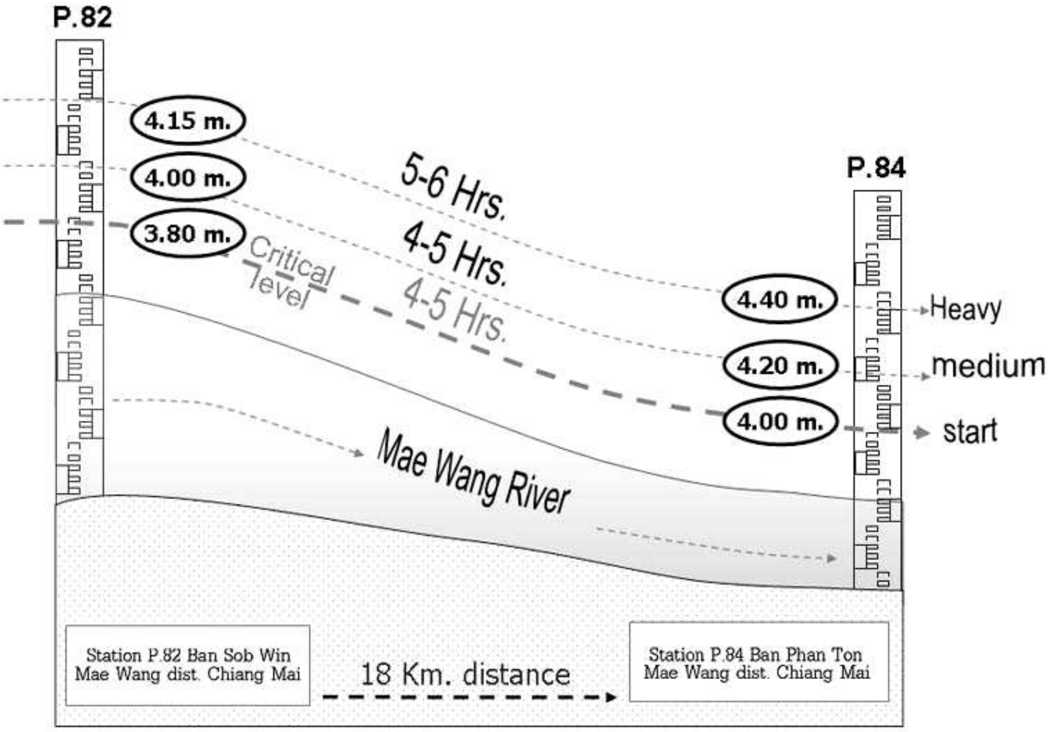

Fig.2 Correlation of water level lag time between P.82 and P.84 for public understanding

4.3 River discharge

The channel capacity value at the flood risk area by cross section survey can be used for warning if we know the coming volume of discharge from upstream is over than the limit of its capacity there will be a probability of overflow bank inundation so the residents must be given the warning.

5. Telemetering Research and Pilot Project in Mae Wang Basin

Hydrology and Water Management Center under supporting and cooperation with the University of Tokyo, proceeds the pilot project of telemetering system research programme by installing the network of 16 automatic raingauge sites in the Mae Wang Basin, Mae Wang district of Chiang Mai. This research aims to process the factors integration related with flood such as rainfall, runoff, water level, ground water level, temperature, humidity, evaporation, radiation and wind. The data are real time collected by automatic data loggers and directly transferred to the center office by modem connection and then uploaded to the website instantly so any people can access the information about the river situation by themselves. And by this project, measurement technique and warning system of the hydrology center is developed from basic manual to advance method with multiple high technology instruments. And at the same time, the staffs are trained and learn new know-how to improve their operation. With all of these, the hydrology center is coming to a new milestone and hopes that the flood monitoring and early warning will be much more reliable with accuracy and efficiency to protect the people from losses. Furthermore, the collected data could be used for developing the hydrological model that can be generally applied for another area affected by flood in the future.

6. Public awareness

Public information and education about flood risk, flood hazard and ways of coping with flooding were provided for the people by campaigns through the meeting, workshop, press, radio and television, especially as a flood season approaches. Meetings with the local administrators and involving offices were hold in main cities such as Lamphun, Lampang, Phrae, Nan, Phayao and Chiang Rai which experienced heavy flood in recent years. Posters and pamphlets in local languages are displayed and distributed at the same time. Residents in flood risk area is the main target for the warning. For Chiang Mai city area, Station P.1 at the Nawarat Bridge on the Ping riverside is a good landmark to place the information board and moving sign board for the public relations because it is convenient for the people in the flood risk area can get the updated information directly besides of the internet website www.hydro-1.net and another mass media such as radio, television broadcasting and car announcement by the municipality.

7. Conclusion

To effectively protect people's lives and habitat against floods and debris flows, the following measures are recommended:

(a) The development of an integrated system of data collection and monitoring, followed by subsequent forecasting, transmission and warning through a suitable telemetering system for flood warning in the main basin as well as developing a flash flood warning system in the sub-basin.

(b) Create an effective public announcement system to disseminate flood and debris flow forecasting information.

(c) Select an appropriate technology and effective method suitable for each basin.

8. Reference

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