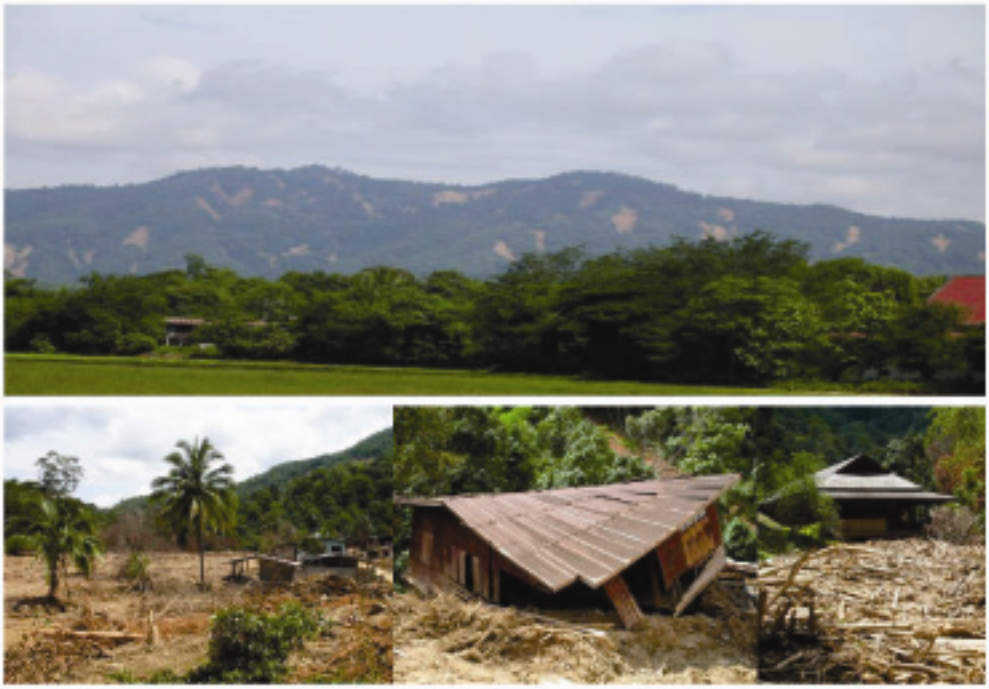
RAPID ASSESSMENT

FLASHFLOOD AND LANDSLIDE DISASTER IN THE PROVINCES OF UTTARADIT AND SUKHOTHAI, NORTHERN THAILAND, MAY 2006



Urban Disaster Risk Management
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June 2006

RAPID ASSESSMENT: FLASHFLOOD AND LANDSLIDE DISASTER IN THE PROVINCES OF UTTARADIT AND SUKHOTHAI NORTHERN THAILAND

1. Introduction

Uttaradit is one of the northern provinces (*changwat*) of Thailand, which covers an area of 7.838 square kilometers and is located in the valley of the Nan River. The Uttaradit province borders with Province of Phrae and Nan to the North, Laos to the east, Province of Sukhotai to the west, and Province of Phitsanulok to the south.
The province ranks the 25th inhabitants in the country with 464,474 population and ranks 54th population density with 59 inhabitant/ km².

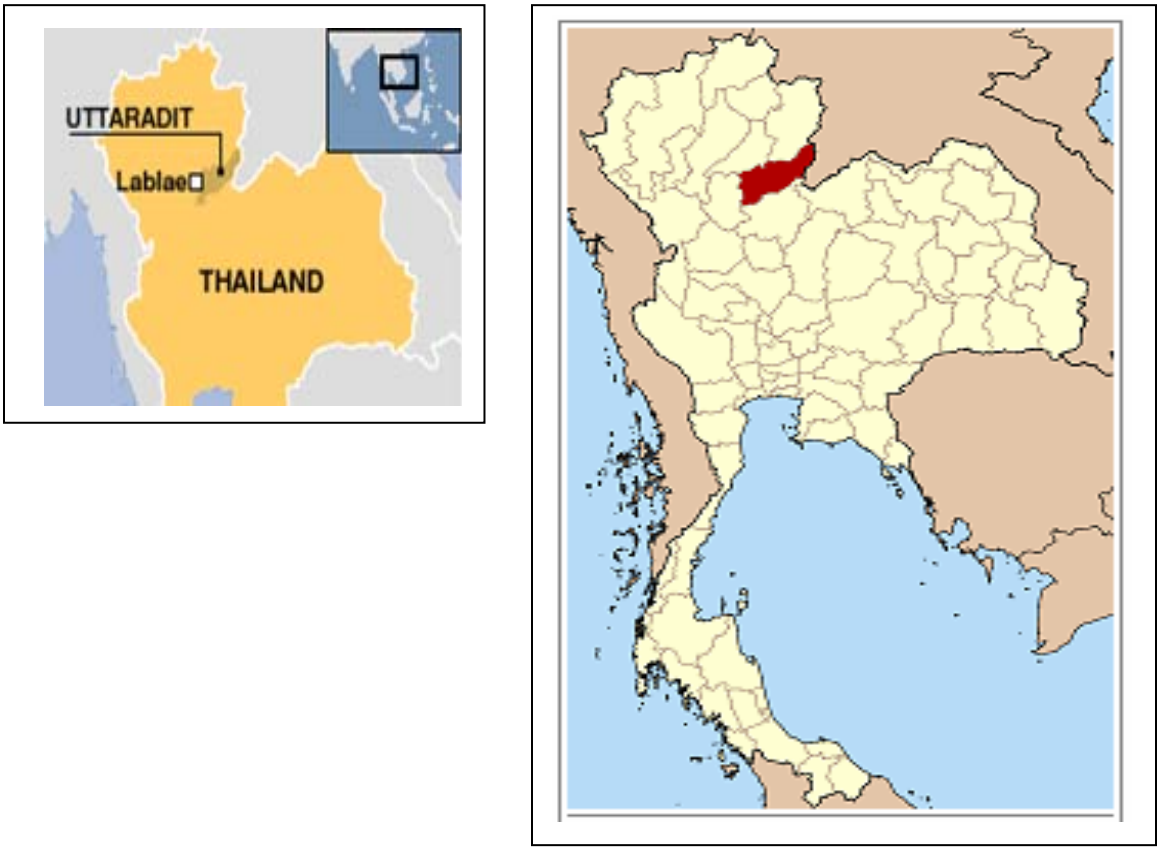
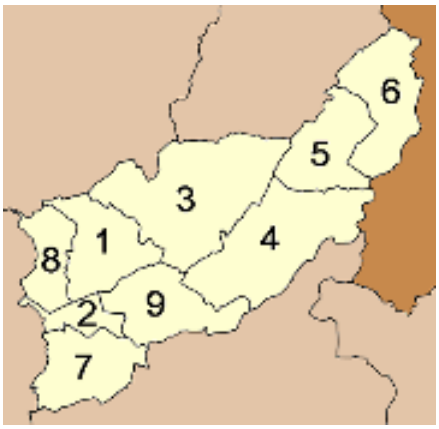


Figure 1. Location of Uttaradit Province in Thailand (not to scale)

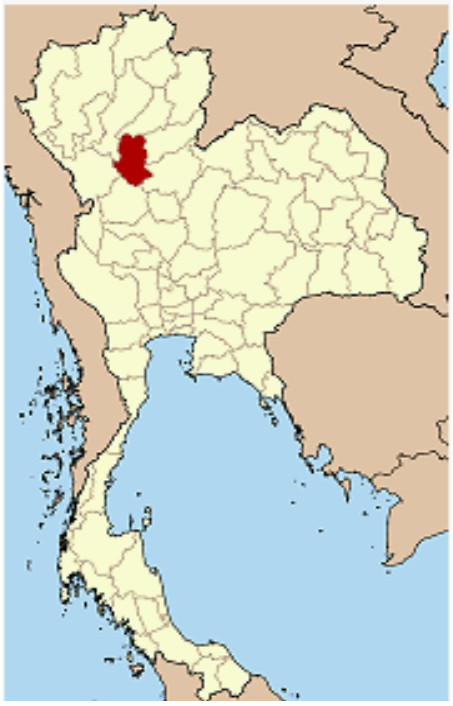
The province is subdivided in 9 districts (*Amphoe*). These are further subdivided into 67 communes (*tambon*) and 562 villages (*mubaan*). The district division in Uttaradit can be seen in figure 2 below.

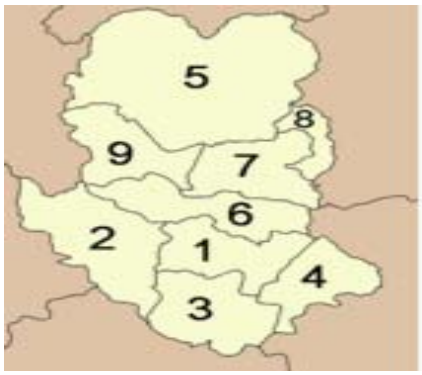


1. Muang
2. Tron
3. Tha Pla
4. Nam Pat
5. Fak Tha
6. Ban Khok
7. Phichai
8. Laplae
9. Thong Saen Khan

Figure 2. Subdivision of Uttaradit Province (not to scale)

Sukhothai Province covers an area of 6.596.1 square kilometers and is located in the valley of the Yom River.





1. Muang Sukhothai
2. Ban Dan Lan Hoi
3. Khiri Mat
4. Kong Krailat
5. Si Satchanalai
6. Si Samrong
7. Sawankhalok
8. Si Nakhon
9. Thung Saliam

Figure 3. Location of Sukhothai Province in Thailand and its subdivision (not to scale)

It borders with Province of Phrae, Uttaradit, Phitsanulok, Kamphaeng Phet, Tak and Lampang. The province ranks the 41st inhabitants in the country with 593,264 population and ranks 49th population density with 90 inhabitant/ km². The Sukhothai Province is subdivided into 9 districts (*Amphoe*) which are further subdivided into 86 communes (*tambon*) and 782 villages (*mubaan*).

2. Flashflood and Landslide in Uttaradit and Sukhothai

Flash floods triggered by days of heavy rain whose peak was on 21-23 may 2006 affected five provinces in the northern part of Thailand, killed hundreds of people and trapped thousands of other people. The floods, following three consecutive days of downpour, inundated several districts on the provinces of Uttaradit, Sukhothai, Phrae, Nan and Lampang. As of 19 June 2006, Department of Disaster Prevention and Mitigation (DDPM) announced that the flash flood has affected five provinces, 26 districts (*amphoe*), 171 sub districts (*tamboon*) and 1200 villages. The number of dead people reached 87 while there are still tens of people missing. Houses are swept away in the affected areas and some other infrastructures were affected too such as bridge, road, drainage systems and agricultural areas.

Table 1. The effect of the disaster in number (Source: DDPM, 2006)

Province	**District / Amphoe**	**Dead**	**Missing / Lost**	**House Damage**	
				total	**partial**
Uttaradit	Laplae	23	4		
	Thapa	29	24		
	Muang	23			
	Sub total	75	28	483	3478
Sukhothai	Si Satchalanai	6	1		
	Si Samrong	1			
	Sub total	7		89	156
Phrae	Muang	5		135	345
Nan				1	
Lampang					
	Total	87	29	708	3979

In Phrae, the flooding has damaged many furniture factories, which are main business of the province. Number of totally-damaged houses is 708 while there are about 3,979 houses which are partially

damaged. Due to the inundation, there were more than 2,000 people were trapped and forced to climb the roofs of their houses or in trees to safe their life. Number of people affected is 352,016 and so far the government has evacuated 108,542 household and 10,601 people. The estimated total damages cost caused by the flood is Baht 308,615,331 exclusive of damaged houses and individual property (DDPM). Table 1 summarizes the effect of the flash flood in numbers.

In addition to the loss of life, number of infrastructure losses or affected was also recorded. There are 1028 roads which are damaged, 176 bridges, 314 drainage systems, 714,793 agricultural areas/rai, 226 schools, wats and other government offices and 245 dikes/seir and mines.

3. Observations and discussion.

On 16-17 June 2006, a team of ADPC and Department of Mineral Resources (DMR) conducted a two-day field visit in the Province of Uttaradit and Sukhotai to see the effect of landslide and flashflood disaster that hit the area on the 21-23 may 2006. The ADPC team comprised of Mr. NMSI Arambepola, Director of UDRM, Mr. Muhibuddin Bin Usamah, UDRM Project Coordinator and Ms. Suree Sungcharoen, ADPC Administrative Coordinator. A team from Department of Mineral Resources comprised of Dr. Wisut Chotikasathien, Senior Geologist and two Junior Geologist namely Mr. Kritapob Akarawinthawong and Mr. Pradit Noolo. The team visited two districts in Uttaradit Province namely Laplae and Tha Pla. In Laplae, field observation was conducted in Ban Pha Moob, Ban Maharaj and Ban Chang resort in sub district of Huay Dong. In Tha Pla, Ban Nam Ta and Ban Nam Lee in the Nam Hman sub district were visited. In Sukhothai, the team visited Ban Mae Khu in the sub district of Ban Teuk, district of Si Satchanalai. During the field visit, interview with some local people was conducted to gather more information about the floods from the victims. The findings, observations are discussed in detail below.

3. 1. Communities affected have a poor Risk perception.

The villages affected are not new settlements and it appears to be that they have been living in the same place for more than 50 years. However the affected communities continue to live in a flood plain where flooding is highly probable, due to the poor perception of impending Risk. Since there were no significant floods during the last 50 years, communities perceived areas to be safe. The affected villages have grown to become hot spots and targets for flash flood

events. Communities risk life in such situations due to several reasons. In the early civilizations, communities even tend to set up habitation closer to sources of water and areas suitable for agriculture practices due to the richness and futility of soil layer. Although most of them enjoy modern facilities such as pipe borne electricity water they tend to harness the richness and convenience in living closer to the source of water. Therefore all communities have become elements at high risk and were living subjected to vulnerable conditions although they perceive the areas to be safe.

Few houses have been constructed on hill slope in the immediate neighborhood but not on the high slopes. However they have not considered the appropriateness of the location with regard to risk potential when selecting the location for the house. Therefore some houses have been destroyed due to slope failures while some others located on or in the vicinity of dry streams were destroyed due to gully erosion or debris attack coming trough the gullies

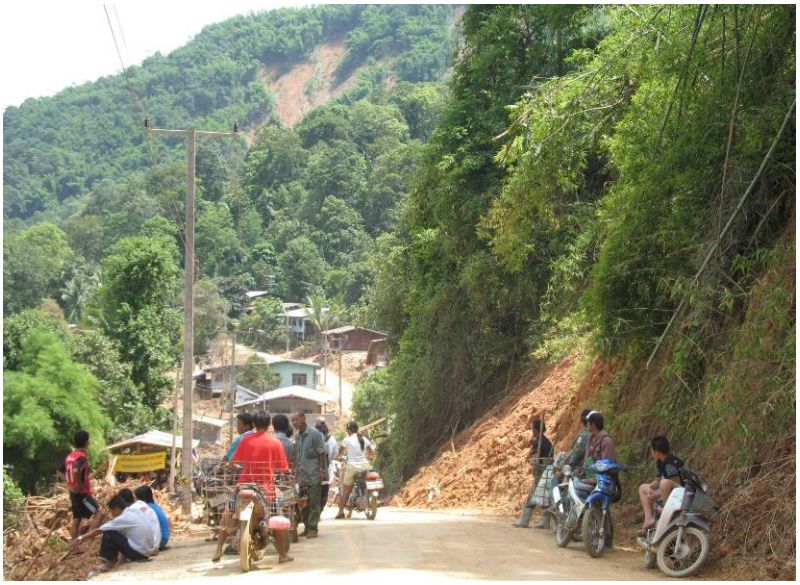


Figure 4. Poor practices of settlement: construction of houses on hill slope

Traditional practice of housing on stills has helped to great extent to reduce the losses of life. As per the views of the communities affected most of them were evacuated when the floodwaters came to the community but houses have been destroyed due to subsequent debris flows and flash flood currents. However some of the modern houses have not adopted the ancient practice of construction on stills and suffered heavy destructions.

Figure 5. The destruction of traditional houses due to slope failures (above) and its proximity to the streams.

3. 2. The early warning systems within the community not effective or is not in existence.

There is an early warning system in place in some of the villages affected by the event due to the efforts of the Department of Mineral Resources (DMR) and Department of Disaster Prevention and Mitigation (DDPM). The two departments should be commended for identifying the risk in advance and initiating the establishment of community based early warning systems. But since flood occurred past

midnight when all community members are faster sleep the early warning could not be materialized, as it desired to be. Also many due to the heavy rain could not hear the public address system installed within communities. Although we can expect more positive impact from the existing system when events happen in day light similar system is not very effective in the night during odd hours. Also the early warning cannot be very effective during the early monsoon season since members of the community are not very vigilant. All disaster events are capable of reveling the vulnerabilities of existing systems and this is again a good lesson to all stakeholders involved in community based systems as we have to expect unexpected events and situations in all our dealings.

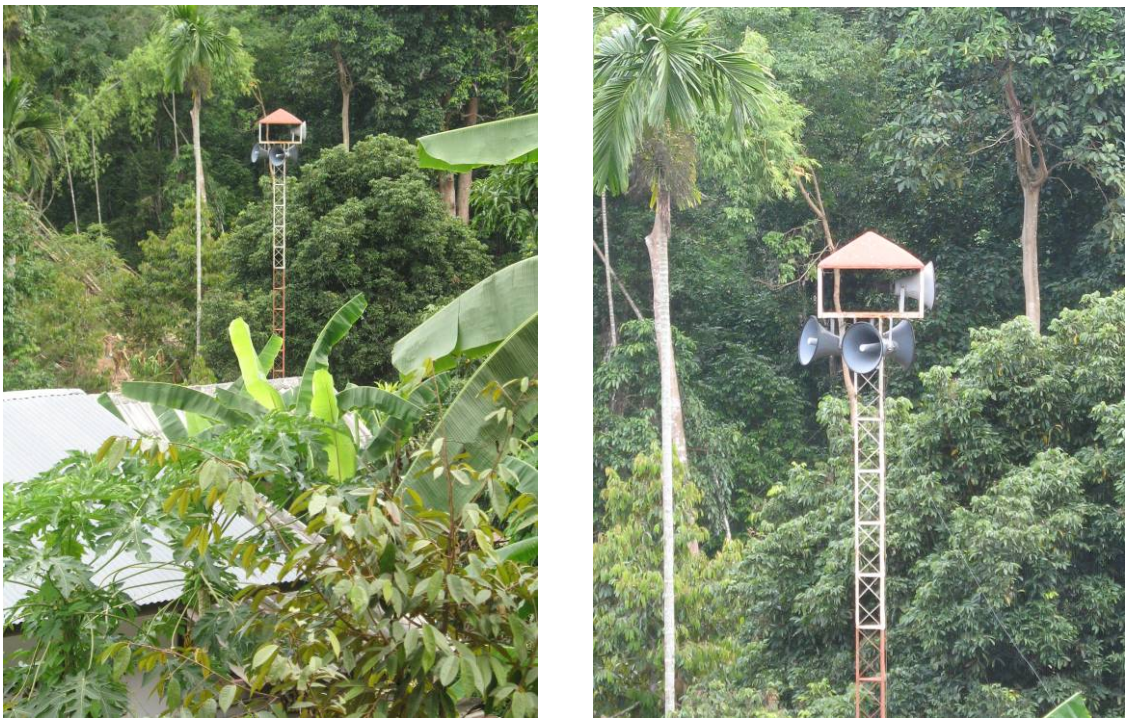


Figure 6. The public address system for the community. There is a need for establishing the community-based early warning system.

3. 3. The rainfall was so intense to the extent of creating slope destabilization in many slopes.

Although the hourly rainfall data is not available, it appears to be that rainfall was very high, consistent and unusual. As per the observation of communities during two to three hour period preceding the event the rainfall was very heavy. They have not experienced in the past such heavy consistent rainfall over a period of two to three hours at a

stretch in the past. Such rainfall over a effected area was responsible for many earth slips in and around the settlements got affected. Since the catchments are smaller in size the kind of rainfall they experienced have created flooding to a depth of meter or few meters in almost all communities. Floods in the city of Uttaradit and other urban areas resulted later but it is a cumulative effect of rainfall in a much larger catchment area.

It is important to discuss the reason for this kind of unusual rainfall and also large amount of slope destabilization created by such an unusual rainfall within a single day. The evidence of such events in the past such as events took place in Petchabun province (flash flooding in village Ban nam Koe in 2001) is suggesting that this kind of unusual rainfall is connected with low pressure systems created by cyclonic wind. Although we do not have the evidences in hand to establish direct relationship, it is imperative to connect the event with low-pressure system development due to cyclone Chan Chu that has serious effects in Central Vietnam province of Dan nag. Danang and Uttradit, Pisanluk, Sukothai provinces are located within a similar altitude and cyclone Chun Chu occurred about the same time so it cannot be a simple coincidence. If rainfall during the week can be plotted, this relationship can be established. However, we are unable to obtain hourly rainfall within the areas covered by the affected zone of the low-pressure system.

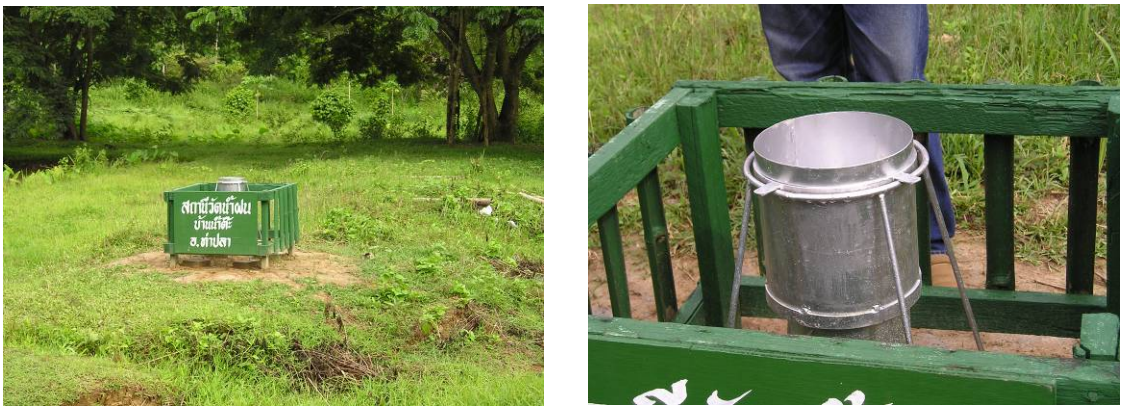


Figure 7. The newly-installed rain gauge station in Ban Nam Ta / Nam Lee in Uttaradit, the basis of developing system for recording fluctuation intensity.

This brings to the discussion two important facts to consider in future.

a.) Necessity to observe the hourly rainfall and developing a system for recording the intensity fluctuations. This is an important

factor in establishing the Threshold limits for initiation of landslides.

b.) The understanding of cyclone is low pressure systems accompanied with wind of 32 m/second or above. The metrological departments do not continue to monitor movement of low-pressure systems when it reaches the lower wind speed limits of cyclone classification. But still the low-pressure systems can bring lethal effects in terms of creating unusual rainfall and subsequent flooding and land sliding. If the low-pressure systems movement can be tracked down it can serve as an advance warning to people living in risk zones if such development can be brought to their notice in time.

3. 4. Causes of slope failures

The slope destabilization in such a vast area is connected with few factors such as soil type, strength parameters of sub soil layer, geology of subsurface formations, rainfall intensity, vegetation cover, land use slope gradient etc. Apparently slopes stood firm and stable for a period more than 50 years and then we should consider only the parameters, which can be subjected to changes over the time. Parameters such as Soil type, strength parameters of sub soil layer, geology of subsurface formations, slope gradient etc can not change since these are not influenced or subject to change due to human interventions Since the rainfall intensity influence had been discussed before it is worthwhile to discuss the importance of vegetation cover, land use in terms of slope stability.

The slopes, which were subjected to destabilization and inspected by the team, suggest that the landslides, which were inspected during the field visit, can be categorized in to:

a.) Shallow earth slips
b.) Gully erosion
c.) Failures of cuttings behind the houses or roadside cuttings.
d.) Slope or bank failures due to erosion of the foothill and destabilization of upslope area.

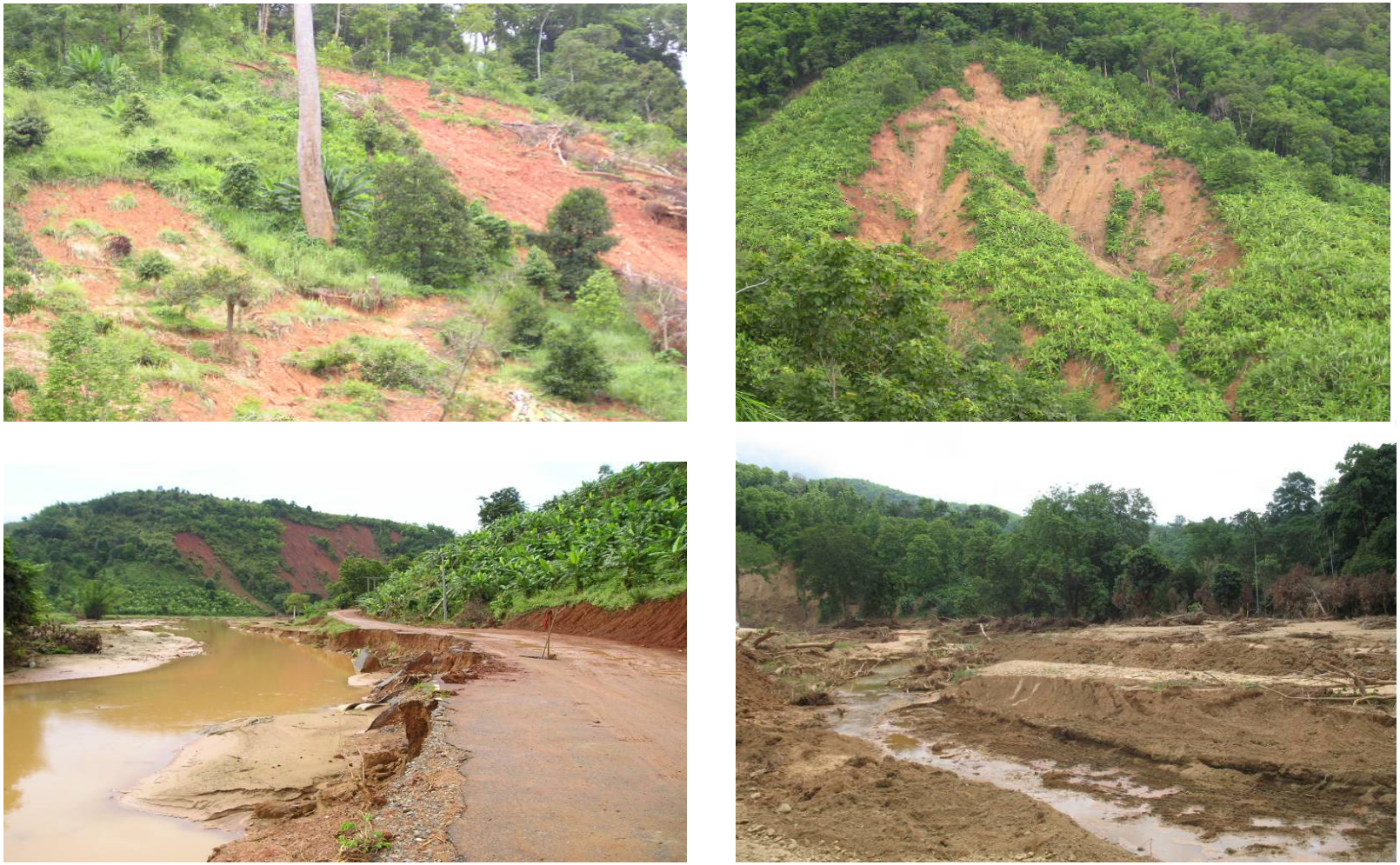


Figure 8. Categorization of the inspected landslide (a) Shallow earth slips (b) Gully erosion (c) Failures of cuttings behind the houses or roadside cuttings and (d) slope or bank failures due to erosion of the foothill and destabilization of upslope area.

Out of above four categories shallow earth slips are the predominant category and about around 80 % of failures falls within that category. Shallow failures have occurred due to saturation of the topsoil layer to a depth up to 30-40 cm. Very rarely thickness exceeds 40 cm. Most of the failures are attributed to slopes with poor vegetation cover or vegetation cover with poor root system such as banana, wild bamboo.

3. 5. Land use practices and increase in risk resulted from inappropriate land use.

The sloping land in the vicinity of the flood affected areas has been used for cultivation of various crops by villagers for a considerable time. The destabilized slopes are mostly abandoned land after farming on slopes or deforested land for commercial purposes. Lately such slopes have been covered with inappropriate types of vegetation such as banana, wild bamboo etc. Farmers usually practice slash and burn methods for farming on slopes without proper understanding of slope degradation and potential for slope destabilization. Although few decades ago it did not yield serious consequences due to rareness of the activity, continuation of such practices by many villagers, currently and frequently result in serious consequences as with the population increase, more people tend to get involved in such practices

Figure 9. Slope destabilization due to the change of forest into banana plantation.

Many people at different levels to different extent traditionally are involved in deforestation;

- Farmers remove tree branches for domestic needs (fencing and trellising)
- Villagers living in the neighborhood remove trees for housing and other community need
- Shifting farmers destroy some parts of the forest for domestic traditional cultivation practices
- Businessmen cut trees for timber for commercial level selling
- Service oriented activities such as road construction, human settlements development and expansion etc

Figure 10. Slope degradation due to weak vegetation cover.

Most of them do not know the ill effects of such disturbance to slopes and vegetation. Therefore this has to be handled through programs for creating awareness on ill effects and exercising control through land use policies on usage of slopes within a catchment for reduction of risk to communities living in flood plains.

3. 6. Impacts of slope destabilization and flash flooding to human settlements within the flood plain.

Many houses have been destroyed due to flash flooding and due to the lethal attack associated with accompanied debris. Mostly debris consists of timber logs, tree branches and uprooted trees of different

sizes. The mass of debris has been created by destabilization of slope, the sub soil layer and vegetation over the same and transportation it by the floodwaters.

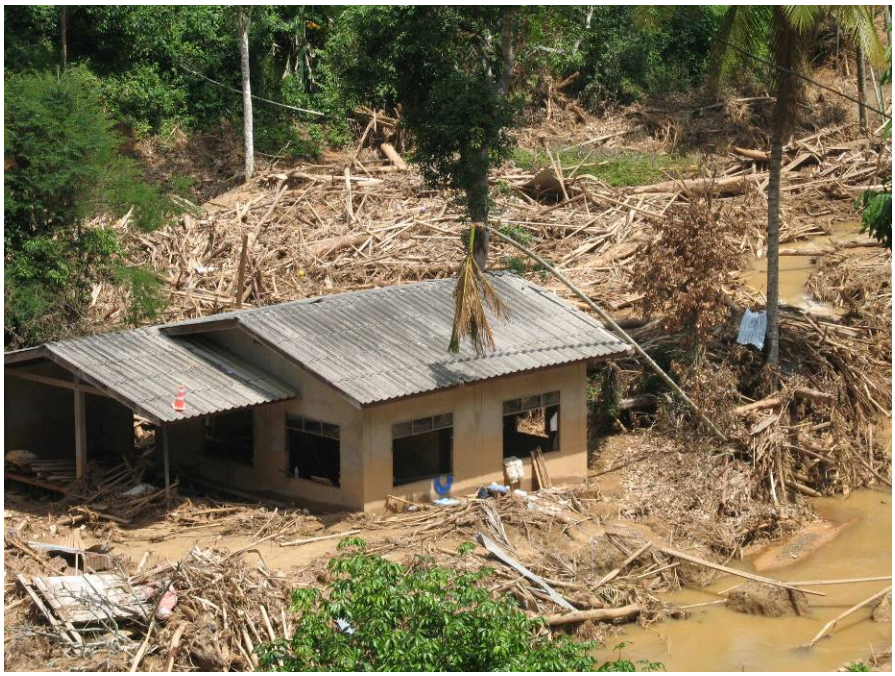


Figure 11. Mudslides consisted of rocks, earth, uprooted trees and other debris. The flood removed the top soil due to the unstable slope and weak vegetation cover thus the land being eroded and transported into the stream.

Therefore it's worthwhile to discuss the destabilizing process so that we can come to conclusions to prevent such events in future. The surface soil layer is the most important factor in this process due to various reasons. The surface soil layer provides an effective transport mechanism for water depends on the degree to which individual particles are aggregated within the soil mass and the arrangement of individual particles and aggregates. Soil permeability can change over time particularly through soil compaction or the development of thin impermeable layer at the surface. When there is a forest cover it provides a better cover for subsurface formations underneath as well it protect it through the anchorage by dense root system. The destruction effect can happen due to erosion or mass destabilization.

Destruction of the subsurface layer due to erosion can take place by repeated action of raindrops on soil particles. The energy in a raindrop dislodges soil particles and moves them with the flowing water over the soil surface. A range of factors including soil texture, degree of

compaction and chemical composition affects the soil permeability. The rate of which soil infiltrates in to soil depends on soil water content, texture, density, organic matter content, hydraulic conductivity and porosity. The slope destabilization take place due to loss of strength of the soil layer and downward movement due to gravitational force.

Figure 12. Destruction of the subsurface layer due to erosion, after the repeated action of raindrop on soil particles.

Vegetation can play a greater role in infiltration and in arresting the slope destabilization. Runoff is the portion of water that flows over and through the soils making it's way to surface water systems. Once the precipitation rate exceeds infiltration rate the water begins to move down slope and when it reaches saturation soil mass starts flowing. So the destabilization of the slope in this case mainly attributed to destabilization of the topsoil layer due to high run off. In the absence of vegetation with a deep root system it increases the possibility of slope destabilization.

The main activities of concern attributed to the slopes inspected by the team are those activities in which humans formally presently or may in future change the landscape for the purpose of resources extraction and processing (livestock farming, agriculture, etc) housing, transportation and other requirements. An analyses of land use yields

insights in to many facets of similar mountainous watershed systems including altered drainage regimes, pollutant sources created by livelihoods, natural and built features, community priorities which indirectly responsible for flash flooding due to the rapid surface runoff and resultant land degradation. This also causes accelerated sedimentation resultant from the increase in slope destabilization, transportation and deposit of sediments down the lower part of the streams. This leads to reduction of bed load of rivers and drainage systems and subsequent destructions in the downstream areas increase in siltation and overburden deposits in lowlands and cultivated areas especially rice fields, irrigation systems, fruit orchards etc. This will lead to subsequent crop failures and reduction of flood retention areas, increase in potential for soil erosion and soil fertility decline, pollution and degrading water quality as more soil particles are carried to the streams, pollution of drinking water sources such as drinking water wells etc. The main problem will be further increase risk to communities due to potential flash flood.

3. 7. Increased flood risk in urban areas such as city of Uttaradit.

The city of Uttaradit and few other urban areas located in the flood plain of the Nan River were inundated due to the heavy rain associated with the events described above.

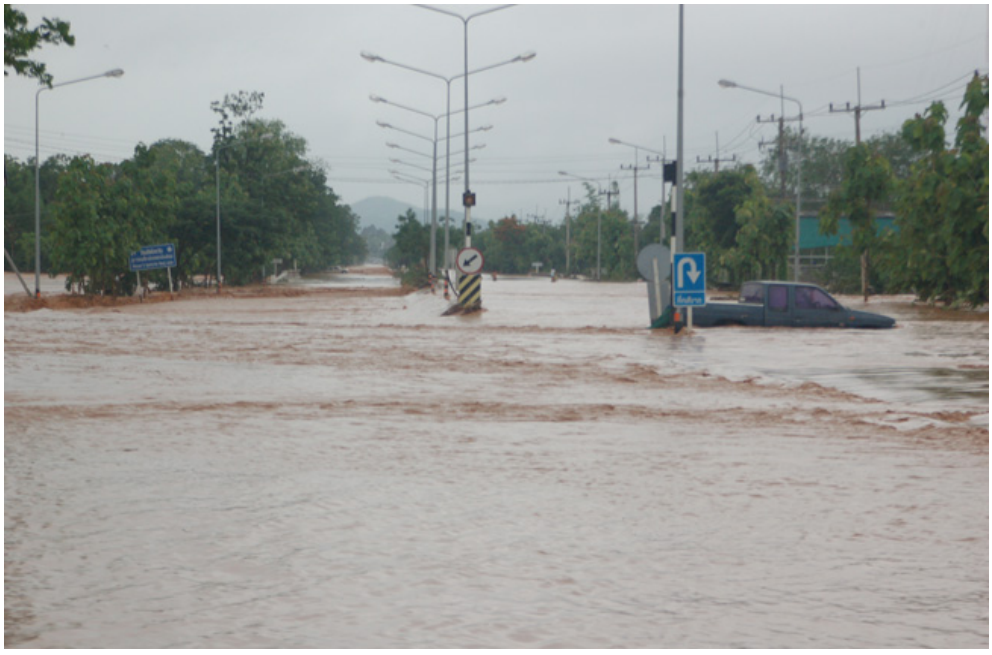


Figure 13. Flash flood due to heavy rainfall overflowed the floodplain of the Nan River, including city of Uttaradit (Source: Uttaradit Province website)

But since the urban area is located further in the catchments the impact only caused due to flash flooding. There was no impact from debris flow and flooding has caused more damages and looses to shops, commercial ventures and house hold items such as furniture, electronic items so on. The city transportation system, water supply, sewerage and drainage systems also were subjected to severe destruction or failure of functioning due to the event. The event has shown the vulnerability of Uttaradit city and other urban areas in the catchment area of Nan River located in the affected provinces.

4. Recommendations

1. *Hazard mapping and selection of suitable safer location for reconstruction of houses destroyed by the event as a first step in the recovery program*.

The communities in affected areas have been moved to temporary camps or living with friends and relatives. Most of them have started removal of material from the debris and even started foundation excavations for reconstruction. Thai society is very generous in donating material and providing other assistance but affected people do not intend to depend on outside assistance for a long time. Therefore relocating them faster and in safer places will be one of the priorities of authorities. It's a challenging task. But it is necessary to involve community in selecting safer locations and putting up new houses. Community level hazard and risk assessment may help to change the perception of risk; if it can be carried out during recovery process.

In some countries in Europe, it is the community practice to provide flood marks in appropriate stable locations. They used church buildings, monuments etc to have flood marks. Even Vietnam communities have a traditional practice in establishment of flood marks. This is necessary to refresh the mind of the new settlers about the devastations, which can also be used as a flood reference. It is better to develop a similar culture in communities affected by floods so that they will be able to know the risk.

In some communities they have had evacuation plans and locations. Some of the volunteers helped in search and rescue of victims. It is better if authorities can consider establishment of community based emergency response mechanism at each village affected by floods.

2. *Setting up a reliable Early warning system*

The present system is good if floods are happening during day time and if the communities can be vigilant. In order to increase the reliability and effectiveness may be some improvements can be proposed.

a. One of the problems observed is that when flood events happen during the early monsoon season and during night people can not be vigilant unless advance notice can be provided. Therefore it is necessary to set up a system to provide advance notice or adversaries on possible floods due to high rainfall, especially during early monsoon period. It can be done by establishing a provincial/district network of automated rain gauges to monitor and coordinate with the national early warning center and Meteorological department. Both institutions are well equipped with state of the art of technology of forecasting and networked with global, regional and national centers to provide reliable forecasting. If the provincial/district network can be equipped with a VHF radio network both regional centers and main station at head office can exchange data so that the provincial stations will be able to provide location specific advance warning massages to cluster of villages under their preview. If the forecasts can be conveyed to village in time(at least 06 hours in advance) through a local area network the village authorities will be able to mobilize vigilant groups to observe flood levels in the river.
b. A wind speed higher than 32 m/sec is qualified to become a cyclone and meteorological agencies keep vigil on the track always. Unfortunately, when it is lower than the qualifying mark they reduce the attention on further movement of the low pressure system within the land mass. But still such systems can create a low pressure system which can result in heavy rainfall within a localized area or a part of catchment. When such low pressure systems are pushed towards mountain range it can convert in to heavy rain (cloud burst) and the impact of such events can cause large scale destabilization of slopes. Therefore, it is better if the centers can have more attention to that kind of low pressure systems and its movements within the land mass for better forecasting of high rainfall and areas likely to be affected.
c. It is important to record not only the average daily rainfall but hourly rainfall to see the intensities. If that can be done easily

such data can be used to establish threshold limits of initiation of landslides.

d. The meteorological agencies should be careful in setting up new rain gauge stations in the flood affected areas. It should not be set up in areas which are prone to flooding. Either the location should be higher ground or otherwise the gauge should be placed on a higher location free from impact of flooding.

3. Revision of policy on land use planning in mountainous areas prone to landslides and flash floods.

It is necessary to revisit the policy on land use planning in mountainous areas prone to landslides and flash floods. The present land use observed in the area is not conducive and slope destabilization, land degradation and high erosion are connected with the current land use practices. It might also better if a reforestation program can be initiated on vulnerable slopes to prevent further land degradation. If the rice fields and farm areas are getting affected in the long term perspective it can have serious effect on livelihood options of the population living in the affected areas. Recovery programs also should consider not only the replacement of destroyed facilities, housing so on but also livelihood since most of them will have further sufferings due to destructions to farm areas and impact to the livelihoods.

4. Developing emergency response mechanism at city level

The flash flooding in urban areas within the Nan river catchment suggests the importance of setting up Urban Emergency response mechanisms. It should include training medical first responders, urban search and rescue teams, development evacuation systems, response plans and so on. DDPM is having plans for setting up such systems at present. Nevertheless, it will be better to involve not only the district authorities but also the local government level officials in setting up such systems.

Acknowledgement

The ADPC's UDRM team wishes to express our gratitude to Dr. Wisut Chotikasathien, Senior Geologist and Mr. Kritapob Akarawinthawong and Mr. Pradit Noolo, Junior Geologists from Department of Mineral Resources for providing us assistance during the field visit. The field visit would have not been so smooth without their sincere guidance and assistance. Thus, we thankfully acknowledge them.