2011 Disastrous Landslides at Khao Panom, Krabi, Thailand

Suttisak Soralump

Geotechnical Engineering Research and Development Center (GERD)

Faculty of Engineering, Kasetsart University

Introduction

Near the end of year 2010, the heavy rainfall had poured into the southern part of Thailand causing wide spread flooding and debris flow. The debris flow was observed in Nakorn Sri Thamarat province and classified as made-made landslide. While the resume process was on its way to recover 2010's disaster, in 2011, an extreme event has happened again. More than 1200 mm of precipitation was recorded within a few days. Even more wide spread flooding occurred in many southern provinces and large landslides are observed in Khao Panom, Krabi province (Fig 1). In Krabi, at least 3 villages were seriously damaged and 10 people have lost their lives. The infrastructures such as roads and overflow weirs have been destroyed. The topographic of the area has been changed, especially along the debris flow paths. The debris flow length is about 2.5-3.0 km with the largest wide of 500m. This area has been studied before and has been announced by the Department of Mineral Resources (DMR) to be a landslide prone area. Furthermore, it was recorded that even larger landslides and debris flow had occurred before in Khao Panom, Krabi in almost 49 years ago (in 1962).

Topographic and geologic condition

Khao Panom is the mountain that located in the central area of Krabi province. The mountain ridge lines in north-south direction (Fig 2). The mountain was formed by the extrusion of granitic rock through the sedimentary rock (Fig 3). Therefore the center area of the mountain consists of granitic rock (Kgr) with steep slope and high elevation. Surround the center area is a colluvium zone of granite debris. The outer area is the highly fractured sandstone, mudstone and others sedimentary rock. Metamorphic rock is also found near the contact zone between extruded granite and sedimentary rocks.

Near the end of March 2011, the heavy storm has hit the eastern part of the mountain. Three sub-watersheds have suffered with large precipitation and finally the debris flows has occurred on the 28th of March (Fig 2). The accumulate precipitation of over 1,200 mm was unofficially reported by the cup-type rain gauge in which recorded by the villagers. Large granitic boulders of up to 10 meter in size were found at 2 km from the landslide sources (Fig 4). These granite boulders have tremendous energy and force in which destroyed the houses and man-made structures in their path.

Suttisak Soralump, Kasetsart University; Soralump_S@yahoo.com

Figure 1. 28th of March 2011 lanslide in Khao Panom, Krabi province

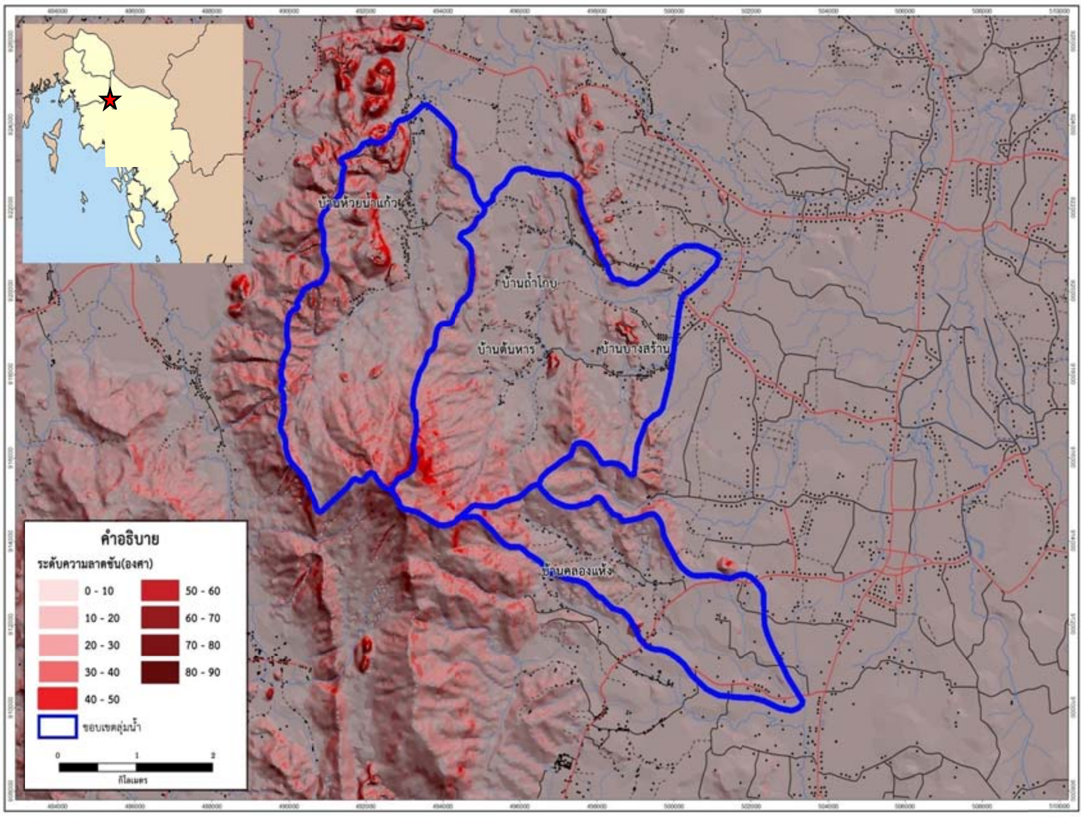


Figure 2. Three sub-watershed of landslide affected area

Suttisak Soralump, Kasetsart University; Soralump_S@yahoo.com

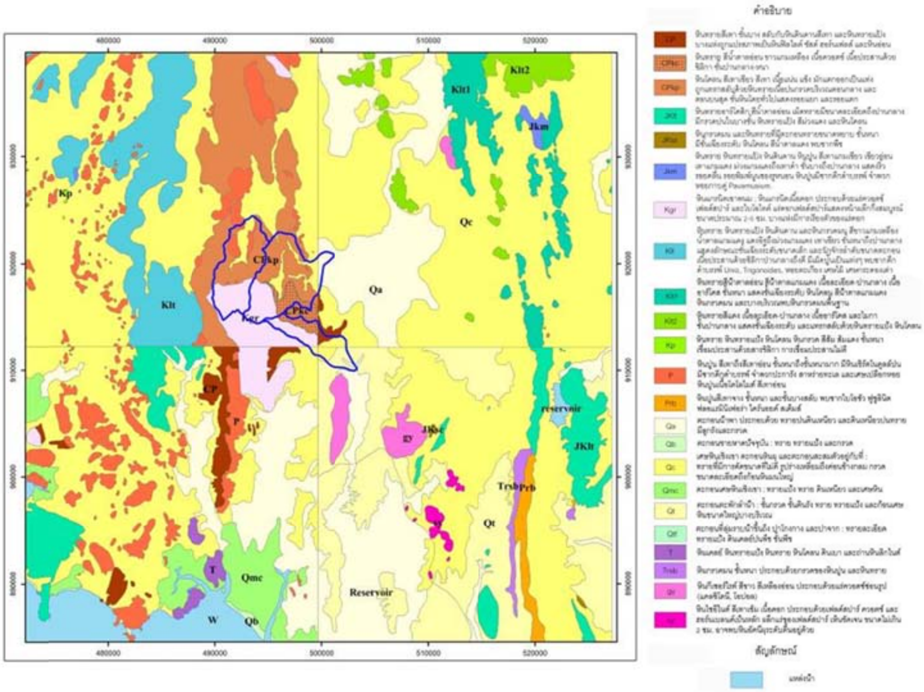


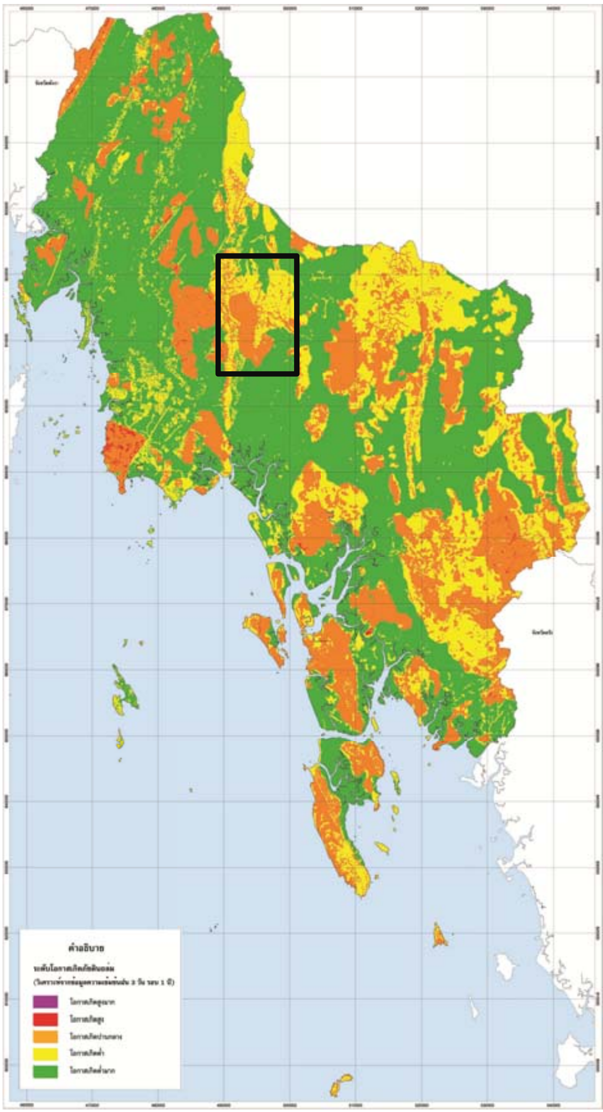
Figure 3. Geologic map of Krabi showing three affected area (Department of Mineral Resources)

Figure 4. Large size of boulder found about 2 km from landslide sources.

Landslide susceptibility map

DMR and GERD had developed the landslide susceptibility and hazard map of Krabi province since 2005 (Fig 5). The analysis was done by considering various landslide susceptible factors which are slope angle, geologic structures, drainage paths and land use. The triggering factor was also considered which is the rainfall precipitation in various return periods. Weighting factor analysis was used in order to give the weight to the anticipated factors to calculate the hazard scores of the 100x100 grid in GIS program.

From the developed map, it is found that the landslide location occurred in 2011 is located in a high landslide susceptibility zone. This is because of southern granite is the rock that most susceptible to cause landslide in Thailand (Soralump, 2010). During the field investigation in Khao Panom after the landslide has occurred, the landslide scars were found mostly in granitic mountain (Fig 6). Some scars were observed in sedimentary rock surrounded but those scars are look more like erosion rather than the slope failure. However, further investigate need to be done in order to understand the behavior of this landslide.



Suttisak Soralump, Kasetsart University; Soralump_S@yahoo.com

Figure 5. Landslide susceptibility map of Krabi (DMR and GERD, 2005)

Figure 6. Landslide scars on granitic rock.

Critical rainfall envelop

By collecting the rainfall data (before and during the 28th of March 2011, Fig 7) from various rain gauge stations, the data were used to plot and compare with the critical rainfall envelop made by statistical data by Prof. Warakorn Mairaing. 3 days accumulated rainfall was used to plot with daily rainfall data. From Fig 8, it can be seen that landslide had occurred before the plotted data has reached the critical zone (action criterion line). The problem with this prediction is because of the location of rain gauge stations are not located near the landslide area (Fig 9). This is because of the landslide area is in the remote location where the communication of the data could not be provided. This is one of the major problems of landslide warning system in Thailand. Therefore, in those remote areas the cup-type rain gauges were distributed to the residence people. DMR issued the rough but effective criterion of critical rainfall to be used with the cup-type rain gauge. The evacuation will be issued if the precipitation is recorded to be 150mm per day. Furthermore, if precipitation is recorded to be more than 300mm in a few days the preparation for evacuation must be done. Therefore, with those criteria, during the debris flow event in March 28th the residence was self- warned and evacuated themselves to the safer ground.

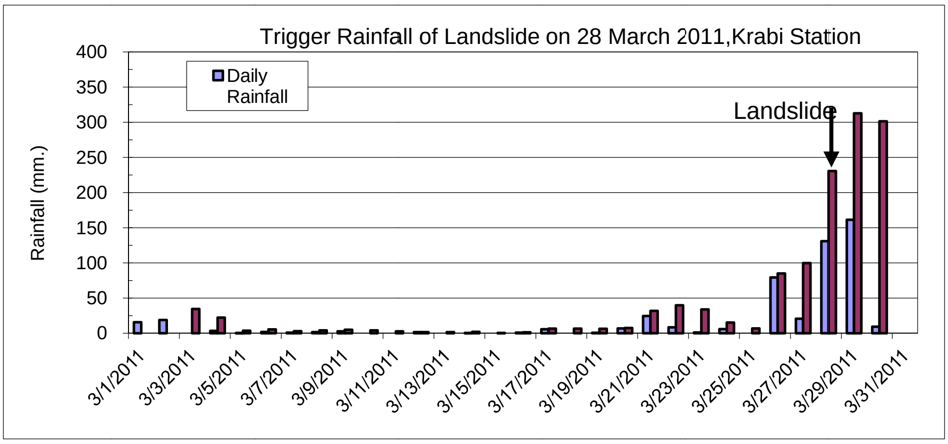


Figure 7. Daily rainfall recorded before and during the 28th March's landslide

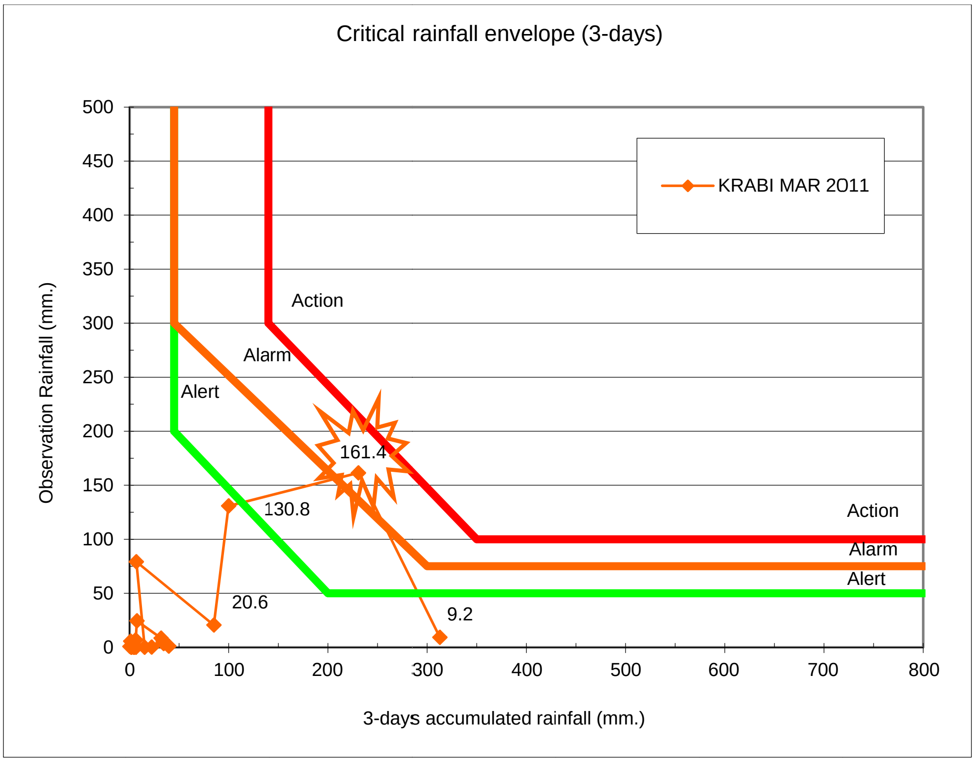


Figure 8. Daily rainfall and 3-days accumulated rainfall plotted using 28th of March 2011 rainfall data and comparing with the landslide criteria.

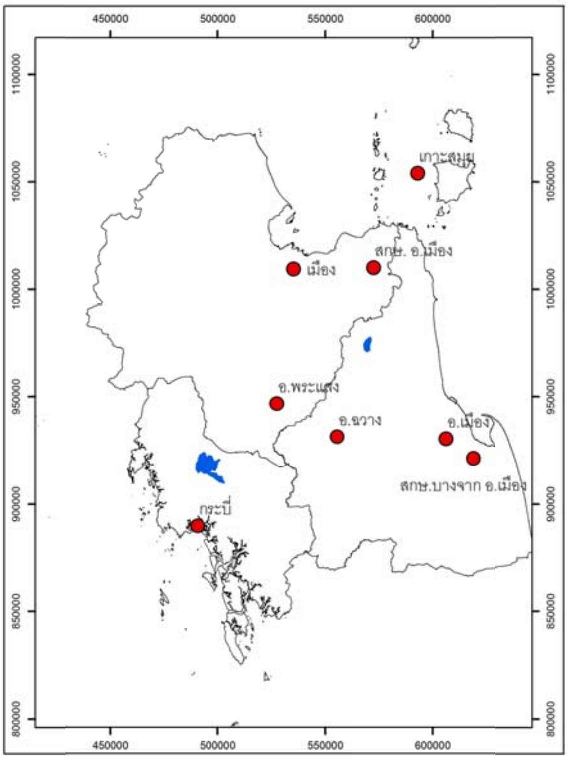


Figure 9. Location of rain gauge stations used for analysis.

Suttisak Soralump, Kasetsart University; Soralump_S@yahoo.com

Conclusions

1. The landslide susceptibility map done by weighting factors techniques seems to be accurate since the geologic factor of Khao Panom and slope angle are quite dominate other factors.
2. In Khao Panom, comparing between two basic geological units, it is clear that the southern granite unit is more vulnerable for landslide than the sedimentary unit surrounded.
3. The criteria envelop and the rough criteria issued by DMR seem to work well with this situation.
4. For automatic warning by using automatic rain gauge data, there seems to be problem with the limitation of communication of data in the remote area. This problem is now being solved by the current research of GERD by using the interpretation of precipitation data from satellite image for putting into the infiltration and stability model.

References

1. Department of Mineral Resources (2005*) Landslide hazard study in 6 provinces affected by 2004 Tsunami* Prepared by Geotechnical Engineering Research and Development center, Kasetsart University.
2. Soralump, Suttisak (2010) *Rainfall-Triggered Landslide: from research to mitigation practice in Thailand.* SEAGS/AGSSEA Geotechnical Engineering Journal, Volume 41, Issue 1, March 2010.

Suttisak Soralump, Kasetsart University; Soralump_S@yahoo.com