Assessment of Landslide Susceptibility Area using RS and GIS in Krabi

Preechaya Kittipakawat*, Suttisak Soralump, Alice Sharp, Jessada Karnjana, and Masashi Matsuoka

***Abstract*— *In this study, THEOS satellite images application is used to classify the land use and scars of the landslide area for the risk assessment of catastrophic landslides in the area, Na Khao subdistrict, Krabi province. Satellite image in 2012 and 2015 was interpreted supervised classification method. In 2012, there were signs of landslides clear indicates the area affected is wide. A difference from 2015, the forest revived, leaving no trace behind. But the groove on the mountain from all the signs of the landslides is still noticeable. In this continuously accumulated situation, landslides will cause severe damage. The traces have occurred earlier, erosion makes it easier and faster than ever before. Together with the functionality of Geographic information system. The overlay data water sources, geological features, and scars of the landslide to analyze and zoning landslide. Geography and geological characteristics are mostly granite, and it has a high rate of decay. This type of rock increases in the landslide. The most dangerous landslide area is mainly concentrated in the southeast of Na Khao, with the elevation of 360m ~ 1350m. The mineral composition when disintegrated a layer of sand or loamy soil, sandy clay soil. This will impact on many settlements and construction sites. Moreover, it may cause the loss of life and property. Besides, some houses are located on the slopes, and some plains cut down the hillside. It is a factor to accelerate the flow of soil. The result from this study can be zoning the susceptibility area. Law development should be used to control the area to prevent the risk of a landslide. For reducing a loss of life and property. Also, the responsible person can survey to investigate to verify the accuracy of the visual interpretation and to use the information reliably.*

***Keywords*— Landslide, susceptibility area, RS, GIS.**

1. INTRODUCTION

Landslides can have a severe negative impact on the socio-economic and environmental state of individuals and their communities. Minimizing these impacts is dependent on the effective identification of risk areas by using a susceptibility analysis process. In such a process, output maps are generated to determine various levels of threat to human populations. The cause of the landslide base, cumulative rainfall in the area, the geology of the rocks of origin, topography and other causes, such as human-caused changes in land use, population growth, etc. But the main factor was the catalyst for the event, the accumulated rainfall is excessive.

Information of the landslide in data collection since 1970-2011 reported 152 events (Soralump, 2011). This landslide is divided into events that cause damage over a wide area and with a damaged spot (Phattanaprateep, 2016). From the current researches, satellite data are widely used to improve surveys information. At present, natural disasters have become more severe, cause losses of life and property. Getting the locations of the landslide occurred can be used to find impacts by analysis with the landslide inducing factors. In this study, Na Khao subdistrict, Khao Phanom district in Krabi province is selected due to the huge the landslide event in 2011 which many people were killed and injured.

This research aims to introduce data from satellites in order to help to detect the areas affected by the landslide and to compare images which were taken before and after the landslide of the two areas. Enhancing the interpretation of satellite imagery provides a more accurate analysis to prevent accidents in advance. Efficiently reducing the risk of the landslide can be done through the preparation of surveillance and warning to decrease the losses from the landslide. Geographic information system (GIS) has evolved from performing functionalities such as geographic database management to geovisualization analysis and are now able to provide advanced scientific and mathematical analysis between multiple map layers (Eastman, 1995). Consequently, GIS is well suited and extensively applied to the design and development of robust decision support systems capable of evaluating choices from advanced spatial data analysis techniques at various scales of analysis (Phattanaprateep, 2016). GIS is used as a tool to overlay water resources, the geographic coordinates information, contour lines and scars of the landslides and geological features to enhance the accuracy of data from satellite image

Preechaya Kittipakawat (corresponding author) is with the Advanced and Sustainable Environmental Engineering (International Program), Graduate School, Kasetsart University, Bangkok 10900, Thailand. Phone: 66-4-634-2570; E-mail: preechaya.kit@ku.th.

Suttisak Soralump is with Geotechnical Research and Development Center (GRED), Faculty of Engineering, Kasetsart University, Bangkok 10900, Thailand. E-mail: fengsus@ku.ac.th.

Alice Sharp is with 3School of Biochemical Engineering and Technology, Sirindhorn International Institute of Technology, Thammasat University, Pathum Thani, 12120 Thailand. E-mail: alice@siit.tu.ac.th.

Jessada Karnjana is with National Science and Technology Development Agency, 111 Thailand Science Park (TSP), Phahonyothin Road, Khlong Nueng, Khlong Luang, Pathum Thani 12120, Thailand. E-mail: Jessada.Karnjana@nectec.or.th.

Masashi Matsuoka is with School of Environment and Society, Tokyo Institute of Technology, Japan. E-mail: atsuoka.m.ab@m.titech.ac.jp.

interpretation.

The goal of this research is to map the impact zones that obtained from the landslide history to prevent recurrence and to decrease the damage.

2. STUDY SITES

Krabi province has many areas which have a high incidence of the high mountain the landslide due to the composition of granite, mudstone, and sandstone. Khao Phanom Benja Mountain has recorded the highest potential of the landslides. Nakhao subdistrict is selected for this study. It locates in the Khao Phanom district and has 8 villages which are Ban Na Khao, Ban Bang San, Ban Ton Phong, Ban Khao Din, Ban Huai Nam Keao, Ban Ton Han and Ban Khao Wu Phlat. Phanom Bencha Mountain has topography with a very steep hillside, and it is a forest area. There are 2 main streams which are Phor Tak canal, flow from the valleys of Khao Phanom Bencha to Ban Huai Nam Keao, Ban Khao Din, and Bang San canal, flow from the valleys to Ban Toh Han, Ban Bang San, Ban Ton Phong and then converge with Por Tak canal. Regarding geology, this area consists of sediment including shale, limestone and igneous rock which is granite. Granite in Khao Phanom Bencha has significantly joint in horizontal direction thus may have been decayed rapidly. The thick layer of sediment founded in the foothill indicates that the landslide was severe. This study area has covered about 150 square kilometers with the population around 8,179 people from 1,926 households. The latitude and longitude are N 912970.78 m and E 494830.46 m, 47P.

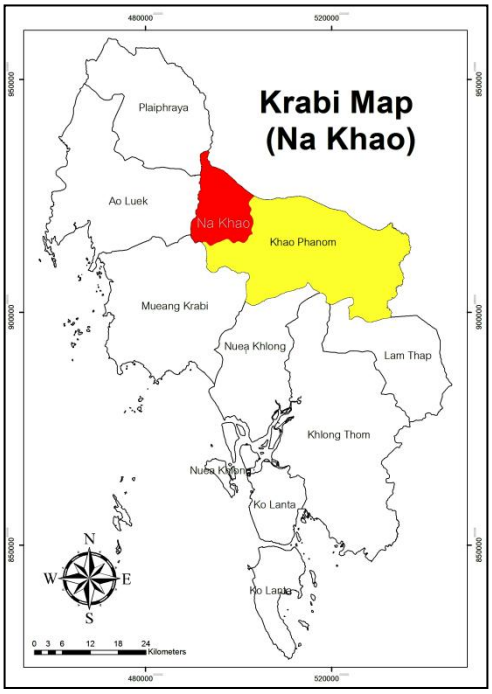


Fig.1. Map of study sites in Krabi Province.

3. PROGRAM AND DATA PREPARATION

Program

Theos satellite data Multi-Spectral and Panchromatic, ERDAS IMAGINE program are used to refine satellite imagery and ArcMap programs is used to analysis data and mapping.

Data Preparation

Geological features

The characteristic of the rock structure and from the decay of different rock makes each area has a different landscape. The topography of the cause of the landslide is easy, including areas with a high slope or there are a lot of streams. Furthermore, the topography is the front groove areas receive the rain. The area is vast and complex, but the main river valley has only one line could have caused the landslide more than other areas.

The effect of weathering rocks with cracks, and in the active fault zone. Especially powerful of fault is high rates of decay because there is a gap between water and air through chemical reactions easily. The stone layer so decays faster than the other area. The rock was intruded by igneous rocks that are inserted by pressure, or areas, where there are hot springs and mineral water from hot mineral sources because chemical changes in the rock to make rock decay rate, high efficiency. Structural geology that is powerful and has a chance to move again passes through the northeast to southwest from north to south.

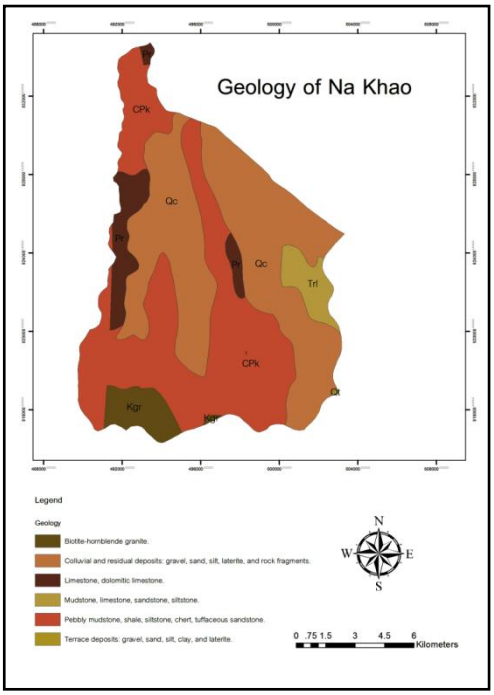


Fig.2. Map of Geology in Na Khao.

Contour and Drain Stream

Drain Stream can be separated from the combination of remote sensing and terrain map and seasonal rivers. Buffer analysis is required when integrating with GIS. Contour is the height of the area. It is useful for determining the amount and direction of flow of flood water above the soil surface. The height of the area shows the slope of the terrain, which is directly related to

the flow of the water surface from space with a slope down to the plain. The area has a high hill and speeds water flow rate. The soil will absorb water and store water. The probability of the landslide in the area that would be high.

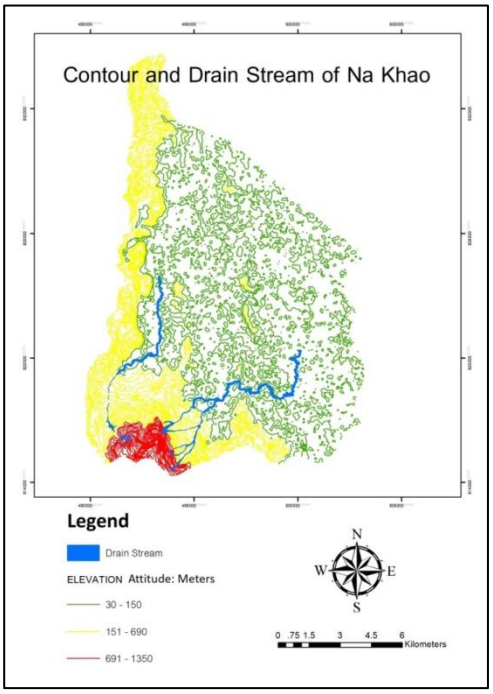


Fig. 3. Map of Contour and Drain Stream in Na Khao.

4. METHODOLOGY

In most cases, the study will start from landslide studies in that area where the landslide had occurred, then to understand the process of landslides. Causes and factors of the landslide, they can evaluate the soil area with the potential for landslides in the future. Part of the landslide, the first step is to search for traces of past landslides have occurred in the study area. In order to be aware of the risk of introduction to the landslide in the study area [1].

Preparing satellite image

Analysis of the landslide susceptibility areas in Na Khao subdistrict, Krabi province is using the methods of data using false mix colour image of THEOS satellite from GISDA (Via GISTDA TERMINAL at http://terminal.gistda.or.th). The image size is 22 x 22 square kilometers. The 2-meter image is a high-accuracy ortho image.

The landslide disaster areas derived from interpretation of satellite image through the process, image enhancement with false colour composite (R, G, and B) in 3 forms. First, a band is 4, 5, 7 for studying geography and geology conditions, and the second band is 3, 5, 7 for studying agricultural areas, and the last band is 4, 3, 2 for studying the phenomenon the landslides.

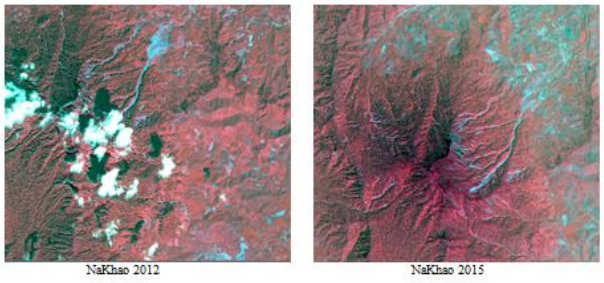


Fig.4. THEOS satellite image of Na Khao in 2012 and 2015.

Interpretation can see the details of the images show traces of the most. Pictures should be taken after the landslide occurred shortly. Give evidence clearly the landslides, if a picture taken before the landslide will not see traces of the landslide occurred in the area or if they are taken after the landslide occurred for a long time. Trees are covered up those signs the landslides. It makes unable to see signs or see clearly.

Data analysis

The traces of the landslide based on interpretation of aerial photographs and satellite images by the naked eye, and analyze on the program ArcGIS 10.0 shown in figure 5. Satellite images, these can be used to study a wide area. It covers the whole of the study area, and we can also choose an image that is associated with the occurrence of the landslides in the priority areas. Such as events, the landslide area in 2011 can use THEOS satellite image taken in 2012 to interpret. It showed traces of the landslide in areas as many.

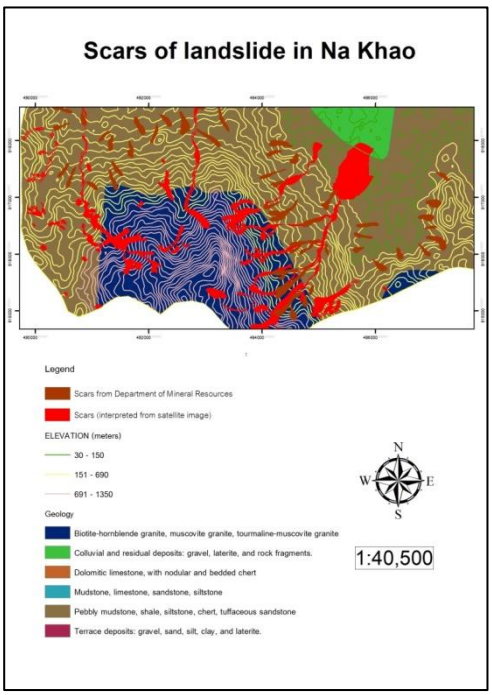


Fig.5. Map of scars of the landslide in Na Khao.

The traces of the landslide based on interpretation of aerial photographs and satellite images by the naked eye, and analyze on the program ArcGIS 10.0 shown in figure 14. Satellite images, these can be used to study a wide

area. It covers the whole of the study area, and we can also choose an image that is associated with the occurrence of the landslides in the priority areas. Such as events, the landslide area in 2011 can use THEOS satellite image taken in 2012 to interpret. It showed traces of the landslide in areas as many.

Geographical characteristics are factors that affect the occurrence of scars buffer 50 meters, land use, and land cover. Geological features and geology, factors can create a map from the overlay together with the landslide map to detect the susceptibility area by applying the techniques of the geographic information system to find the severity and impact of susceptibility area. Because in the study area there is a wide area and most of the area is mountainous and forest.

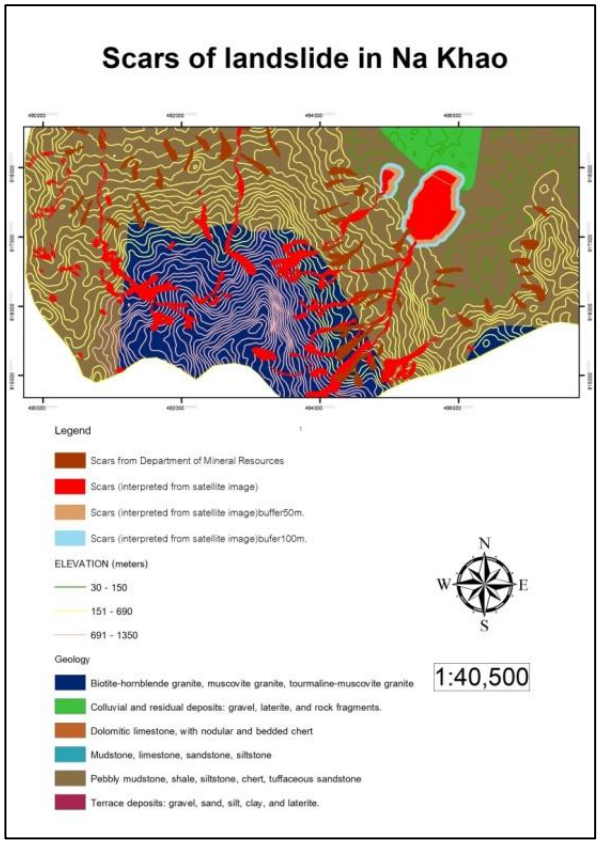


Fig.6. Map of scars (buffer) of the landslide in Na Khao

5. RESULTS AND DISCUSSION

This research wants to collect more data from satellite imagery for comparing the results of each area. Data collection and data analysis of the accuracy of the information is expected to elevation results to help in determination height of colluvium because the area is similar to plain while translating from satellite imagery.

Study of factors that affected the susceptibility area using satellite image and aerial photographs.

In the analysis of geology data, contour and drain stream combined with aerial photos before and after the landslides. The factors affected the area of the landslide consistent. From figure 7 in 2007 and eye alt 900 meters. There is a groove on the top of the granite. Grade down by elevation, but also small it doesn't effect on the house. A difference from figure 8, when time passed after 2011. The big the landslide disasters of Khao Phanom Bencha Mountain, there are many affected areas. People died, and buildings were destroyed. The traces of the landslide from the top of the granite flow down by elevation. The impact shows in the lower areas. From the picture, the signs of the landslides spread to the plains.

When you compare these two images, you will see the extent of the landslides and areas that should not be inhabited or farmed. As time passes, these traces may be eroded, or some of the rocks left behind can be slide back to the old traces.

Picture 9-10 Indicates areas affected before and after the landslides in the plains. These data can be compiled to analyze affected areas and to define hazard zones. In addition to the translation of satellite images, the data is more accurate, and we know the coordinates of the risk area of the landslide.

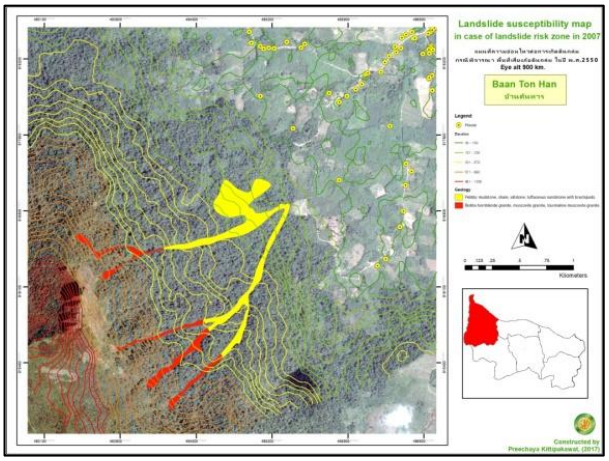


Fig.7. Map of The landslide Susceptibility in 2007, eye alt 900 meters.

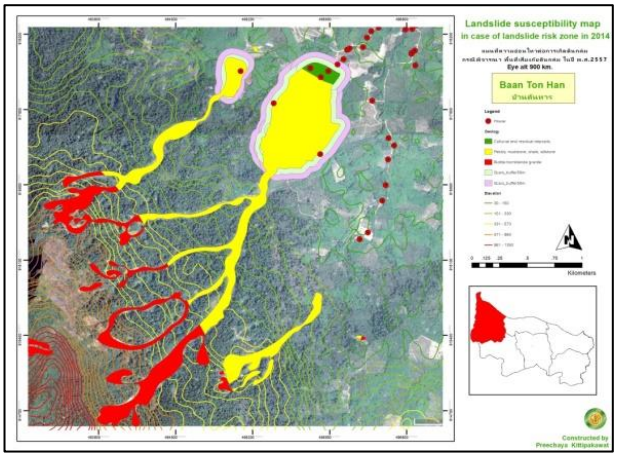


Fig.8. Map of The landslide Susceptibility in 2014, eye alt 900 meter.

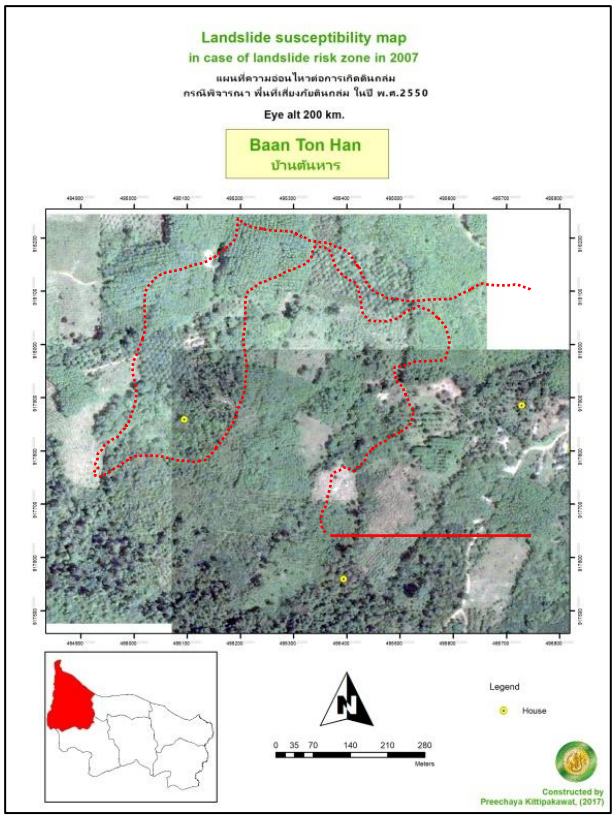


Fig. 9. Map of The landslide Susceptibility in 2007, eye alt 200 meters.

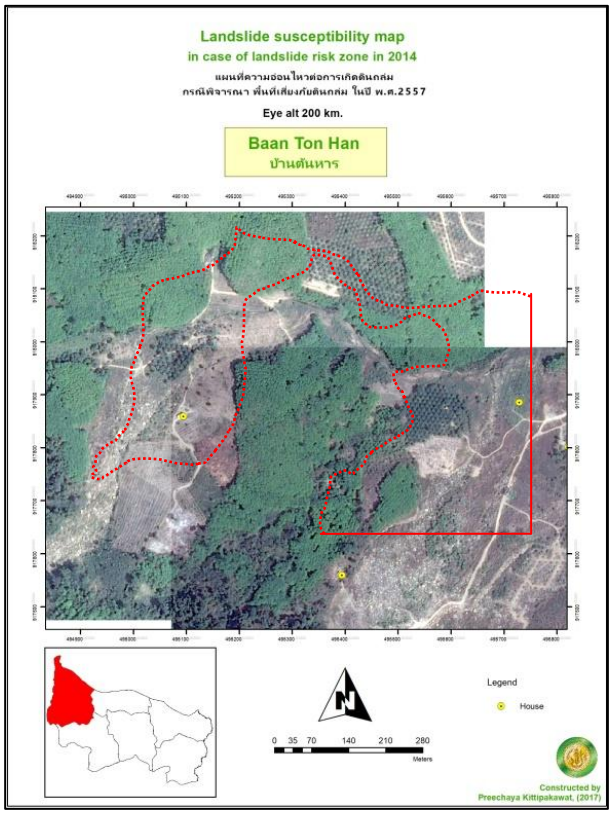
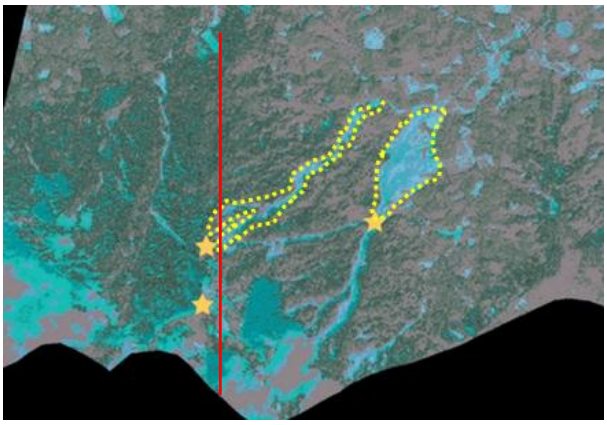


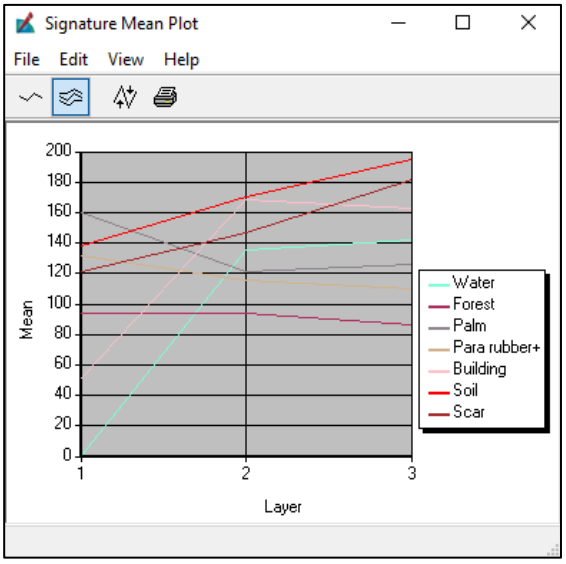
Fig.10. Map of The landslide Susceptibility in 2014, eye alt 200 meters

In this research use supervised classification to analyses satellite image. The user specifies the various pixels values or spectral signatures that should be associated with each class. This is done by selecting representative sample locations of a known cover type called training sites or areas. The computer algorithm then uses the spectral signatures from these training areas to classify the whole image. Ideally, the classes should not overlap or should only minimally overlap with other classes.

Maximum likelihood can assume that the statistics for each class in each band are normally distributed and calculates the probability that a given pixel belongs to a specific class. Each pixel is assigned to the class that has the highest probability.



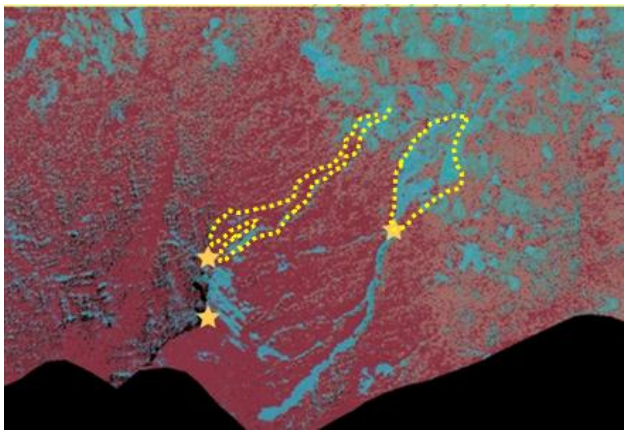
(a)



(b)

Fig.11. Classification of THEOS satellite image of Na Khao in 2012.

From figure 11 and 12, that after the classified in 2012, there are signs of the landslides clear indicates the area affected is wide. The difference from 2015, the forest revived, leaving no trace behind. But the groove on the mountain from all the signs of the landslides is still noticeable. In this continuously accumulated situation, the landslides will cause severe damage. The traces of an original have occurred earlier. Erosion makes it easier and faster than ever before.



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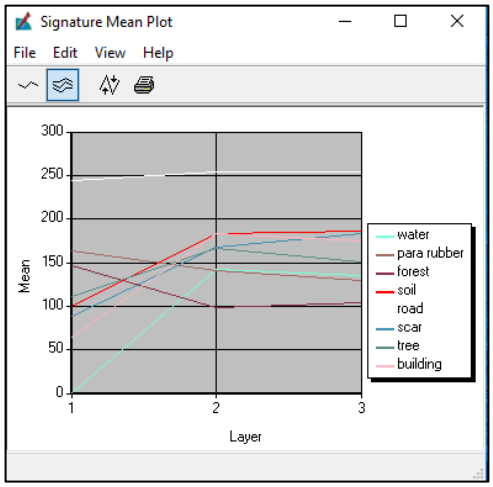

(b)

Fig. 12. Classification of THEOS satellite image of Na Khao in 2015.

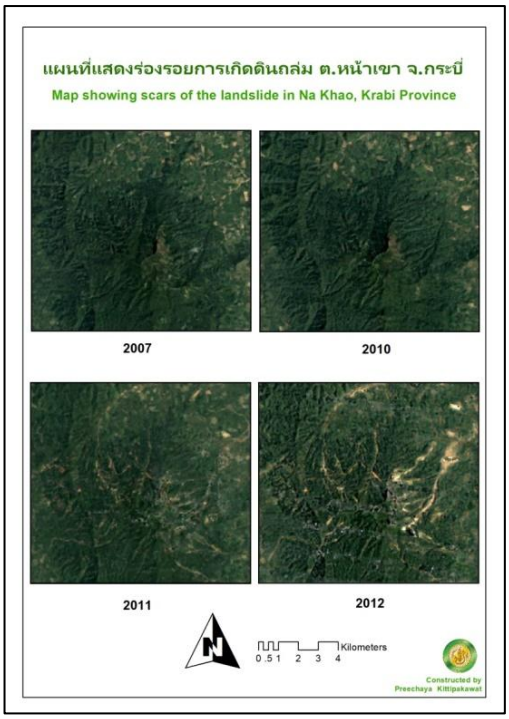

Fig. 13. Map showing scars of the landslide in 2007-2012.

In 2007-2016, there is a change in the area every year, especially after 2011, due to the landslide was occurred. Then there is a drain stream and scars of the landslide. Over time, there may be a restoration of the forest, but these traces may be eroded. Lead to get ready for the landslide disaster management, should take a residential zone to prevent the accident.

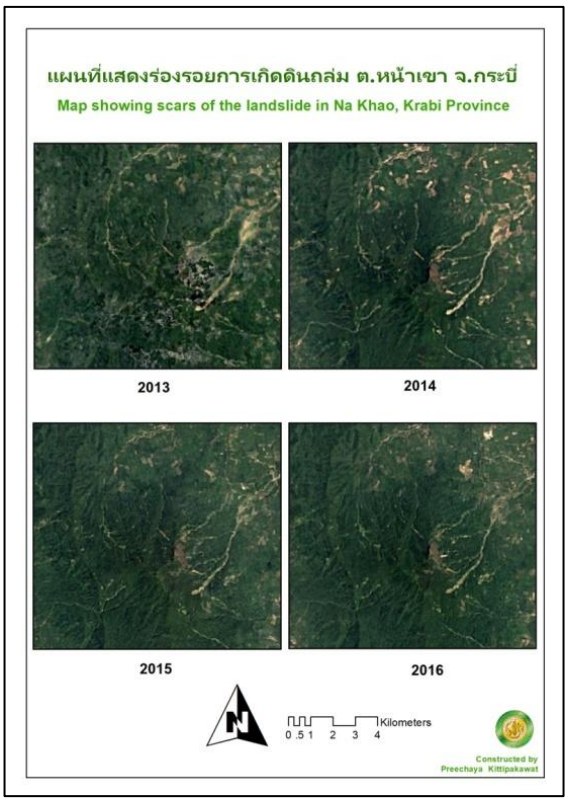

Fig. 14. Map showing scars of the landslide in 2013-2016.

Propose debris flow hazard map using satellite image and aerial photograph.

This research aims to analyses the catastrophic the landslide and detects the extent and severity of each susceptibility area levels. It is anticipated in Na Khao subdistrict, Krabi province affect life and property because geography and geological characteristics of Krabi province is mostly granite and granite has a high rate of decay. The mineral composition when disintegrated a layer of sand or loamy soil, sandy clay soil.

The survey of geology and topography in landslide susceptibility areas were affected the landslide risk areas including Ban Bang San, Ban Na Khao, Ban Huai Nam Keao, Ban Ton Han and Ban Khao Wu Phlat. Because the geology of this district is Granite sandstone, mudstone rocks, mud and gravel contaminated with siltstone. A fracture of moderate is high in some areas. The sediments are eroding it will give sandy clay and clay is a thick layer. Also, some houses are located on the slopes, and some plains cut down the hillside. It is a factor to accelerate the flow of soil.

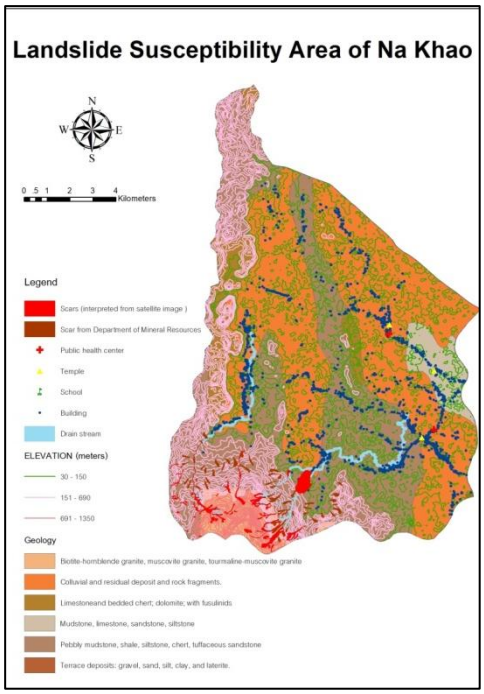

Fig. 15. Map of the landslide susceptibility area in Na Khao.

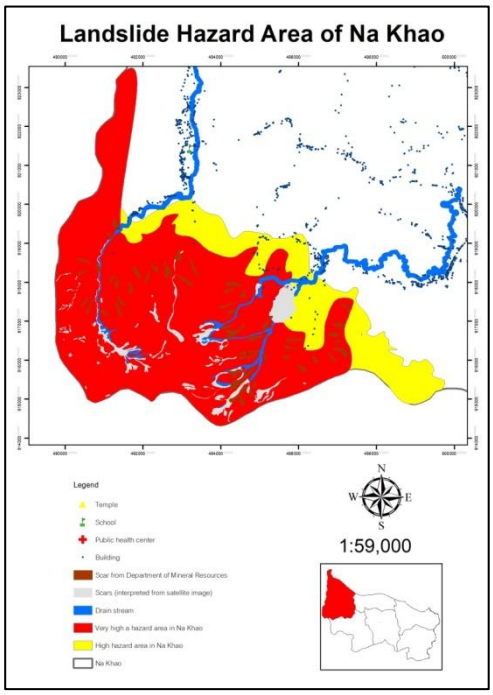

Fig. 16. Very high and high hazard area in Na Khao.

From Figure 16, the very high hazard area of the landslides is shown in red. The area should not be built housing because the elevation has high. It does geological as well as granite on the top. The high hazard area is shown in yellow. Geology is Pebbly mudstone, shale, siltstone, chert, tuffaceous sandstone, quartzose sandstone. These areas are sedimentary deposits deposited after the accident. The soil is fertile. Some people come to agriculture, such as rubber or palm oil. This area is included in the risk because the traces of debris flowed in the past.

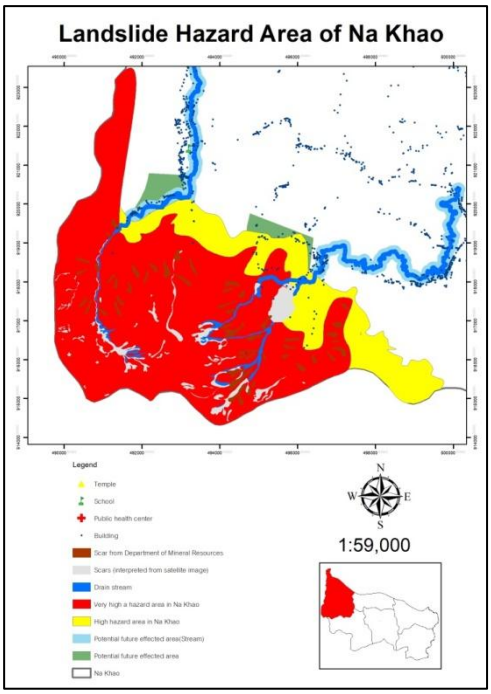

Fig. 17. Landslide Hazard Area of Na Khao.

From geology, data has colluvial or residual deposits and rock fragments. Also, Drain stream buffer 100m. Geological characteristics being located in a vulnerable area are more accessible than other types of geology because it is close to the foothills, with plenty of space. People will come to plant crops such as rubber, palm oil or to build a living. Therefore, the area may be affected in the future.

6. CONCLUSION

The most dangerous the landslide area is mainly concentrated in the southeast of Na Khao, with the elevation of 360m~1350m and mostly distributed in the Cretaceous Granite Rock. Some people come to use the landslide risk area for agriculture, such as rubber or palm oil. Moreover, it may cause the loss of life and property. Over time, more erosion can be seen from satellite imagery. This area is vulnerable to repeat the landslides. Most of the landslide is Granite: Igneous Rock and some of Mudstone.

7. RECOMMENDATIONS

1. Law development should be used to control the area to prevent the risk of the landslide and reduce a loss of life and property.
2. The responsible person should survey to examine to verify the accuracy of the visual interpretation and to use the information reliably.
3. The results of the landslide translations were translated using satellite imagery and aerial image. To verify the authenticity should be used the satellite more resolution.
4. Should increase other factors in the analysis of the accuracy and precision of the results.

ACKNOWLEDGMENT

Thanks to Thailand Advanced Institute of Science and Technology and Tokyo Institute of Technology (TAIST-Tokyo Tech) is acknowledged for the scholarship. And a part of work was financially supported by National Science Technology Development Agency (NSTDA) and Geo-Informatics and Space Technology Development Agency (Public Organization), (GISDA). The generous, Theos satellite imagery in research until success.

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