Report

Life with landslides in Myanmar

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This is a report of field survey in Chin Sate of Myanmar during 17th to 21st June, 2017, planned and funded by the International Consortium on Landslides (ICL).

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The place we visited

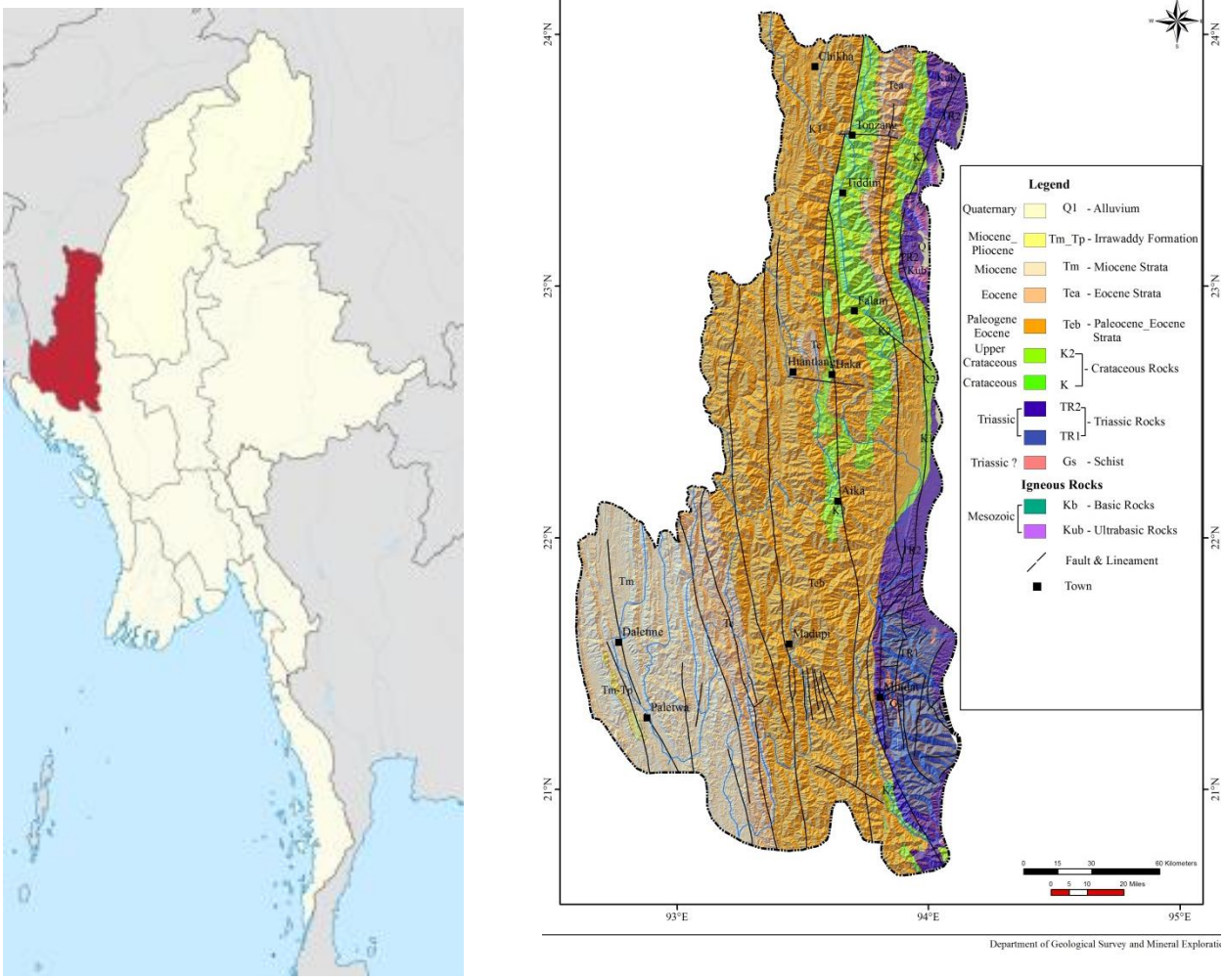
Chin State is a state in western Myanmar, bordered by Bangladesh in the southwest and the Indian state of Manipur in the north and the Indian state of Mizoram in the west. The population of Chin state is about 478,801 in 2014 census. The capital of the state is Hakha, situated 1867 m above sea level. The state is a mountainous region with few transportation links. Chin State is sparsely populated and remains one of the least developed areas in the world.

The road to Hakha is unpaved and curved halfway up the mountain. The mountains run north-south direction. The road heading west, with forming a snake-like pattern, cross over the north-south

trending high mountains, rivers and deep gorges. Its direct distance is short but rout distance is much longer than it. People call it "Road of Death" since many people were killed by car accidents.

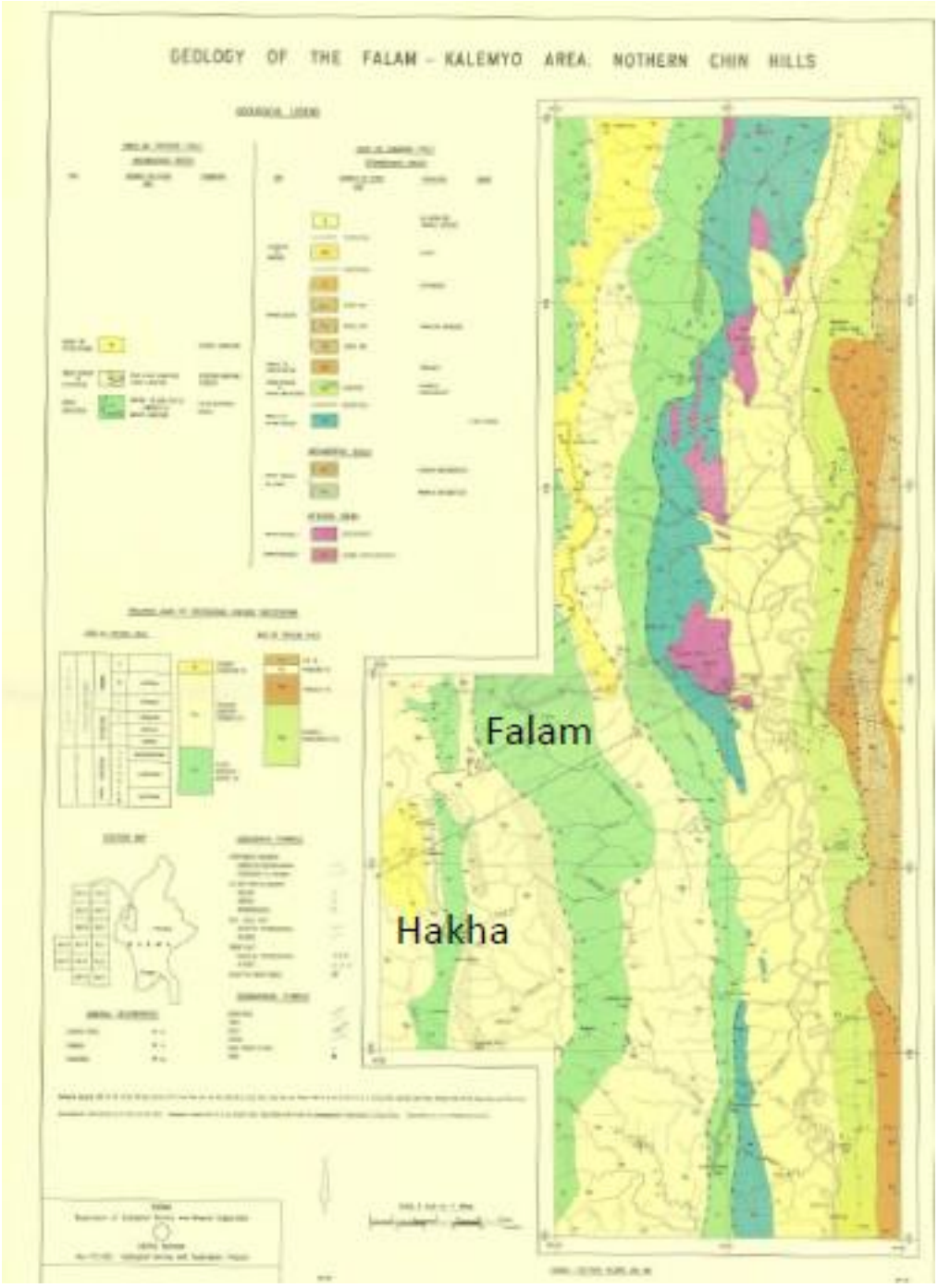
Geology synchronized with topography is attributed to the Indian plate collision. By the collision, Myanmar spans a very complex and broad tectonic belt (e.g., Socquet et al., 2006). This motion is primarily expressed by right-lateral slip on the Sagaing fault, which bisects Myanmar from south to north (Win Swe, 1970; Curray et al., 1979; Le Dain et al., 1984).

Eocene closure of the Neo-Tethys and the subsequent onset of the Himalayan Orogeny as India was moving north marks an inversion of the stress directions from east-west compression to east-west extension in the Indochina block (Leloup et al., 1995). At the major tectonic event, slip sense over the field is north-south trending strike slip.



Morphology and regional geological map of Chin State (Publication is authorized by Department of Geological Survey and Mineral Exploration)

The major components of rocks are mud stone and shale and their high pressured metamorphic rocks, slates. They were accreted to the Indochina terrain during Cretaceous and Tertiary.



Geology of the Falam – Kalemyo area northern Chin hills (Department of Geological Survey and Mineral Exploration and United Nations (1977)).

Slate along the road to Hakha.

Heading to Hakha

We started Kalay city located on basin of central Myanmar at 1 pm on 17th June, 2017. The level of the city is around 140 m. We climbed up heading west by 4-wheel drive cars. The highest level we reached was 2100 m + above the sea level. With elevation increasing, temperature was lowering about 10 degree with climbing up to Hakha.

We were forced to stop several times, because roads were blocked by mud and stones. They actually slid down. These are landslides often caused by heavy rains and floods in July and August. Big machines and local people work to take over the mud and stones, which are surprisingly supported by Japanese funds. It is impressive that Japanese serve them in remote areas.

It takes seven or eight hours to drive from Kalay to Hakha even though no landslide and no heavy rain. In fact we arrived at Hakha after 11 pm, so it took 10 hours.

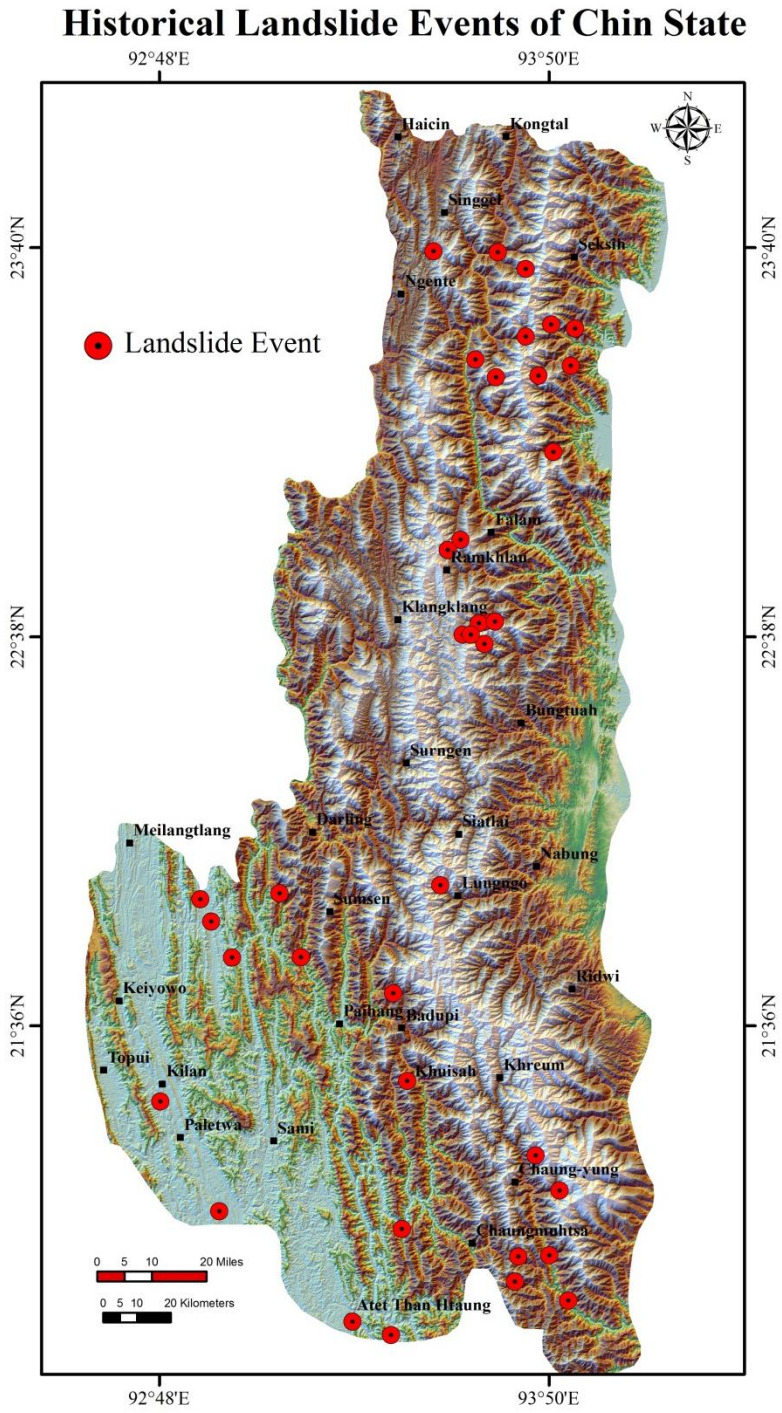
Landslides blocked our road.

On the way, we took dinner at a town. The name of town is Falam, which was founded by the British in 1892. After the formation of Chin State, it was the capital city until the administrative offices were moved to Hakha in 1974. The town spreads from the Baptist church and people grow rose and play tennis, offering atmospheres of England.

Downtown of Falam.

Landslide

The steep terrain of the Chin State causes landslides. Heavy rains triggered landslides destroying roads, bridges, houses and villages every year.



Historical landslide events of Chin State (Information source from Myanmar Information Management Unit, and publication is authorized by Department of Geological Survey and Mineral Exploration).

Remote Sensing

The ASTER (Advanced Spaceborne Thermal Emission and Reflection Radiometer) instrument is a sensor of remote-sensing built by the Ministry of Economy, Trade, and Industry (METI) of Japan ASTER was launched on December 19, 1999 onboard NASA's Terra spacecraft and has been observing mainly land area on the earth since 2000. Japan Space Systems has archived over 2,500,000 scenes including nighttime

scenes

ASTER acquires images in all bands with a swath width of 60 km. It orbits the earth in a sun-synchronous near-polar orbit, with an equator crossing time of 10:30am, and the daytime repeat visit interval is 16 days at the equator (Abrams et al., 2015).

The ASTER, mounting optical sensor (OPS), captures high spatial resolution data in 14 bands from the visible to the thermal infrared wavelengths (VNIR 3 bands, SWIR 6 bands, TIR 5 bands), and provides stereo viewing capability for digital elevation model creation.

SWIR (Short Wave InfraRed) radiometer has 6 spectral bands in short wave infrared with 30 m spatial resolution. It is designed to acquire data applicable to various maps such as geology and high temperature.

TIR (Thermal InfraRed) radiometer has 5 spectral bands in thermal infrared with 90 m spatial resolution. It enables high accuracy observation of the thermal infrared radiation from the earth surface, and detection of surface temperature and surface emissivity.

VNIR radiometer has 3 spectral bands that range from visible to near-infrared with 15 m spatial resolution, in most cases together with backward looking data for the same location except for some observation data for emergency and night time.

ASTER GDEM (Global Digital Elevation Model) Version 2 with 30-meter postings has been released by METI and NASA on October 17, 2011. GDEM was generated from the stereo-pair of ASTER images acquired with nadir and backward angles over the same area.

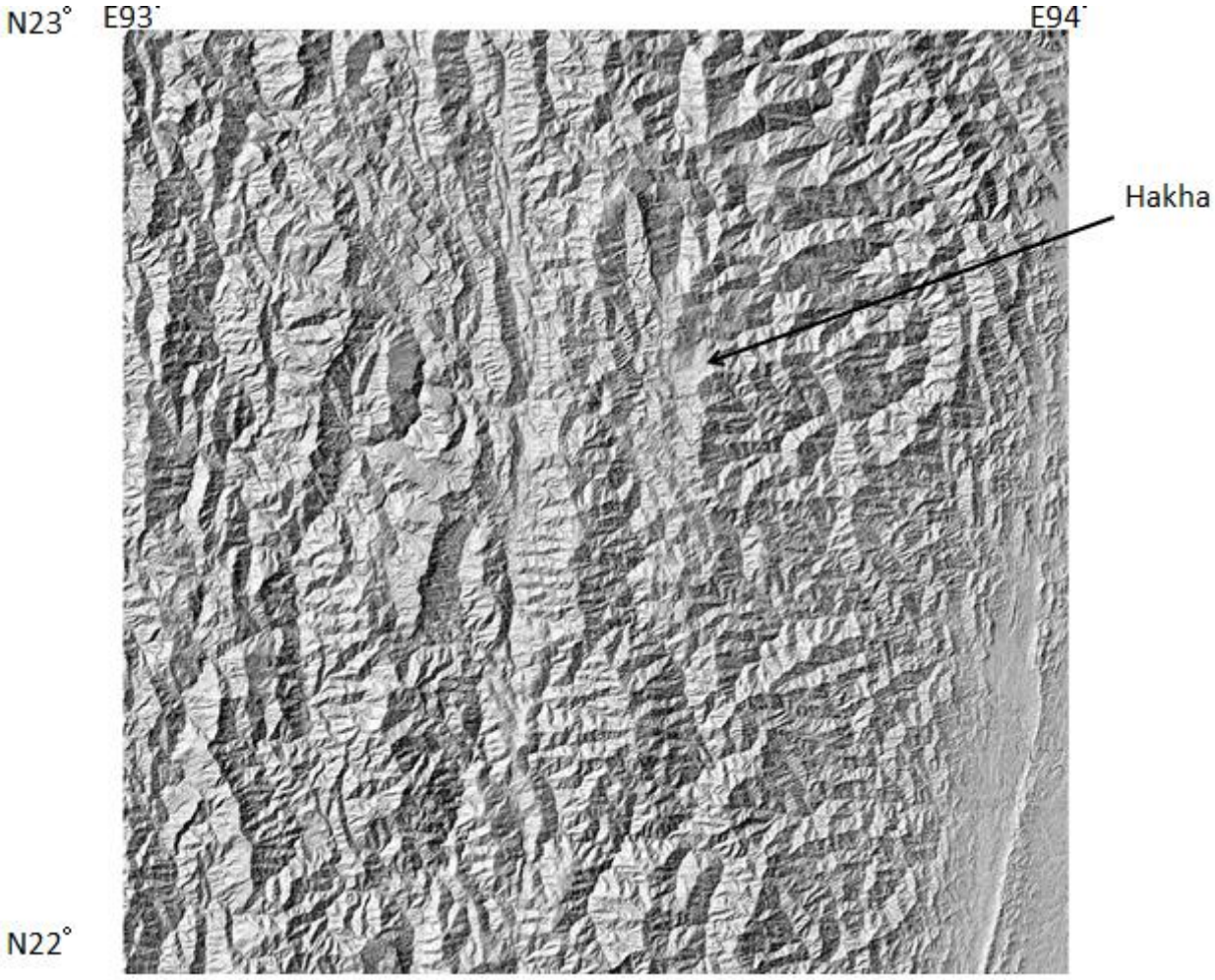
Since April 2016 the data policy has been changed, all ASTER data products are available at no cost. Consequently, the ASTER GDEM products are now open to the public (Ninomiya and Fu, 2016).

The methodology used to produce the ASTER GDEM involved automated processing of the entire 1.5-million-scene ASTER archive, including stereo-correlation, cloud masking to remove cloudy pixels, stacking all cloud-screened DEMs, removing residual bad values and outliers, averaging selected data to create final pixel values, and then correcting residual anomalies before partitioning the data into 1 x 1 degree tiles.

Remote sensing images cover a wide area in a short time and can monitor by repeated data acquisition. As ASEAN region is a typical rain forest area, the optical sensor survey is always disturbed by cloud. But repeated data acquisition enables fine-day-image selection. This advantage contributes to uniform data acquisition. GDEM was created by stacking of fine-day-images and covers the entire land areas of the world.

ASTER shows a landslide

A hill-shade topographic map from ASTER GDEM shows relief of topography. Low angle light from west-north-west casts shadows over east-south-east side of hills enhancing high elevations. The map indicates continuous topography trending north-south.



A hill-shade topographic map from ASTER GDEM.

Incidence angle of light is 60 deg. West and 10 deg. up. Dark colors correspond to hill-shades.

As this area is in a tropical monsoon region, clouds always cover the sky. Acquired interval of ASTER over one area is about 8 times a year. Searching images of Hakha area, We found few cloud free images. In fact, the average of cloud free image was one image a year. Consequently, frequency of clear sky is once among 8 times.

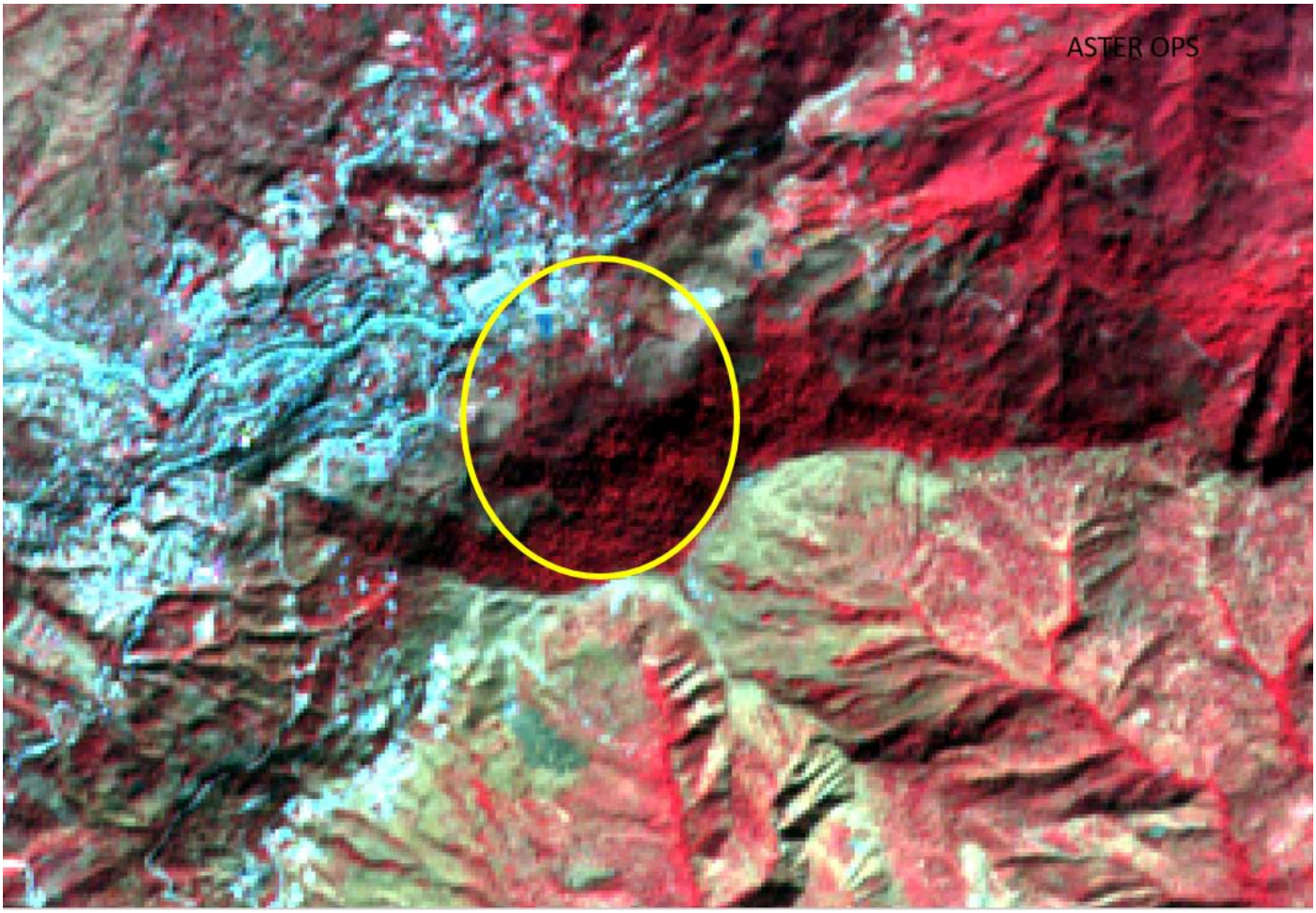
The map below shows landslides of Hakha town.

Location of landslide (from Google Map).

Time series ASTER images shows changes of landscapes. Three images of Hakha town are shown below. The first one is on 14th February, 2012, the second is on 5th March, 2013 and the third one is on 26th December, 2016.

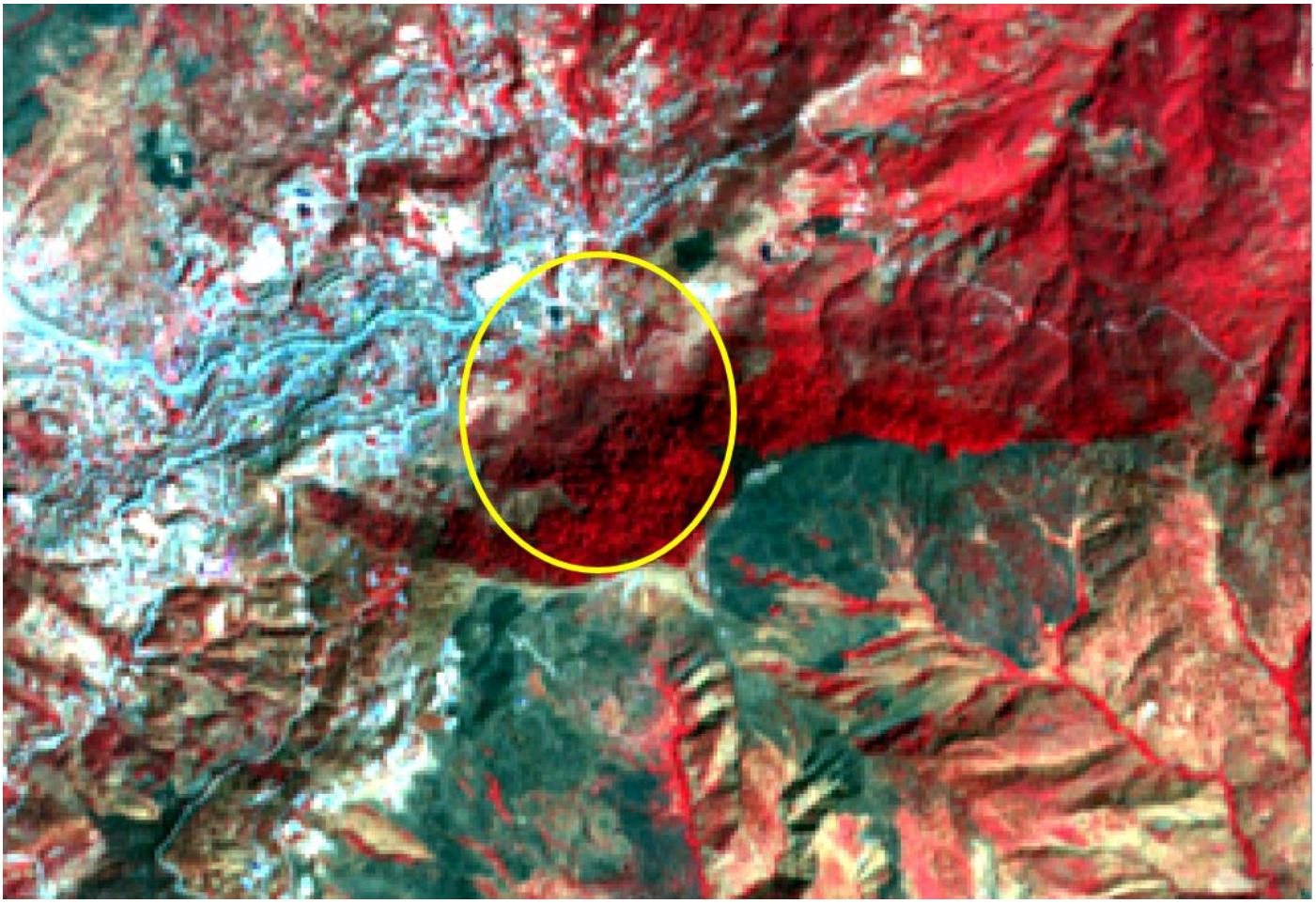
A yellow circle which is a place of landslide is indicated in each ASTER images.

The image of 14th February, 2012 shows that the yellow circle area marks red color. The red indicates vegetation, suggesting forests cover this area at this time.



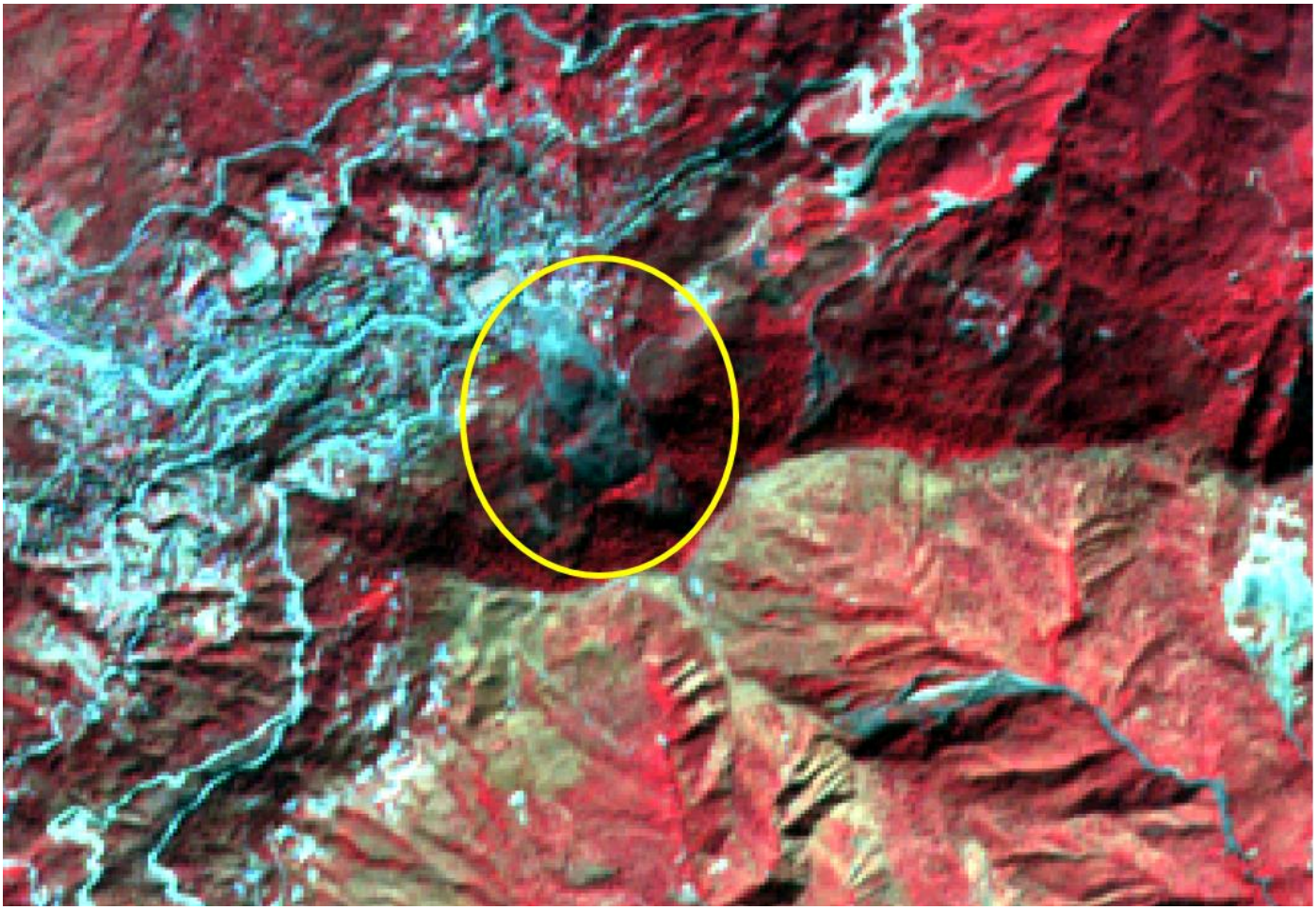
ASTER OPS image on 14th February, 2012. There are forests in the yellow circle.
(Data were downloaded from MADAS; https://gbank.gsj.jp/madas/)

The image of 5th March, 2013 shows that the yellow circle area, the same location to the pervious one, marks red color again. This also suggests that forests still cover this area by 5th March, 2013.



ASTER OPS image on 5th March, 2013. There are forests in the yellow circle.
(Data were downloaded from MADAS; https://gbank.gsj.jp/madas/)

The yellow circle area of the image of 26th December, 2016 shows a change of color mixing up blue and red indicating something happened. This is remarkably a landslide.



ASTER OPS image on 26th December, 2016. There are forests in the yellow circle.
(Data were downloaded from MADAS; https://gbank.gsj.jp/madas/)

There was a series of heavy rains in Hakha in 2015. July 2015, the rains triggered landslides, sweeping away 7000 houses and pushed more than 4000 people from Hakha into temporary displacement camps. The Chin State government began rebuilding homes along the Hakha-Falam highway, near the new compound of ministerial houses, soon after the disaster.

The ASTER images show the change of landscape caused by the landslide between 5th March, 2013 and 26th December, 2016. But unfortunately, cloud free images acquired just before and just after the landslide are not available. This is a week point of optical satellite image in a tropical area.

Even so, we found that ASTER OPS can monitor a large-scale landslide. It is worth applying the ASTER images to monitor landslides.

After the field survey, we reported our results to the Officers of the Chin State on 19th June, 2017. They were concerned about landslides very much and requested comments on mitigation of landslides and ideas about safe relocation area.

Meeting at Chin State Government on 19th June, 2017.

Back to Kalay

On another 10 hours' drive to Kalay, I thought the IUGS- Task Group on Geohazards has duty to unveil geohazards in hidden places by viewpoints of science and technology.

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