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Preliminary Analysis on Multi-Devices Monitoring of Potential Deep-Seated Landslide in Xinzhuang, Southern Taiwan

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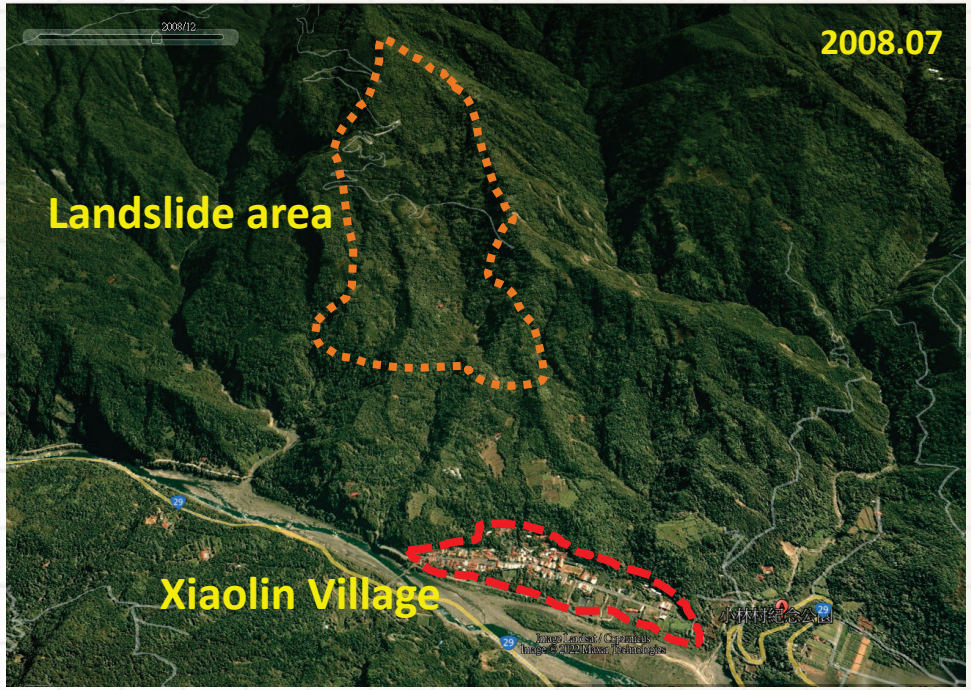
Deep-Seated Landslide in Taiwan

Xiaolin village was buried by a large scale landslide event in 2009 induced by Typhoon Morakt. There were 490 casualties and 200 buildings destroyed.

Taiwan authority try to prevent this kind of disaster reappear and identify the prone area with following conditions:

(1). Landslide area > 10 ha
(2). Landslide depth >10m
(3). Landslide material > 100,000 m^3
(4). With inhabitants or protection objects

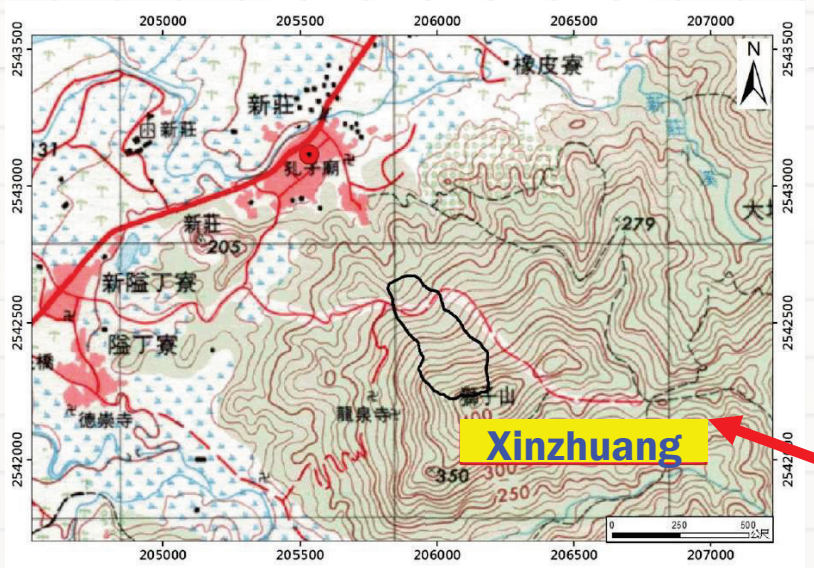
If the site meet the criteria, it was called "**Deep-Seated Landslide Prone Area**" in Taiwan.
There are 98 sites identified, and our study area is one of the sites.

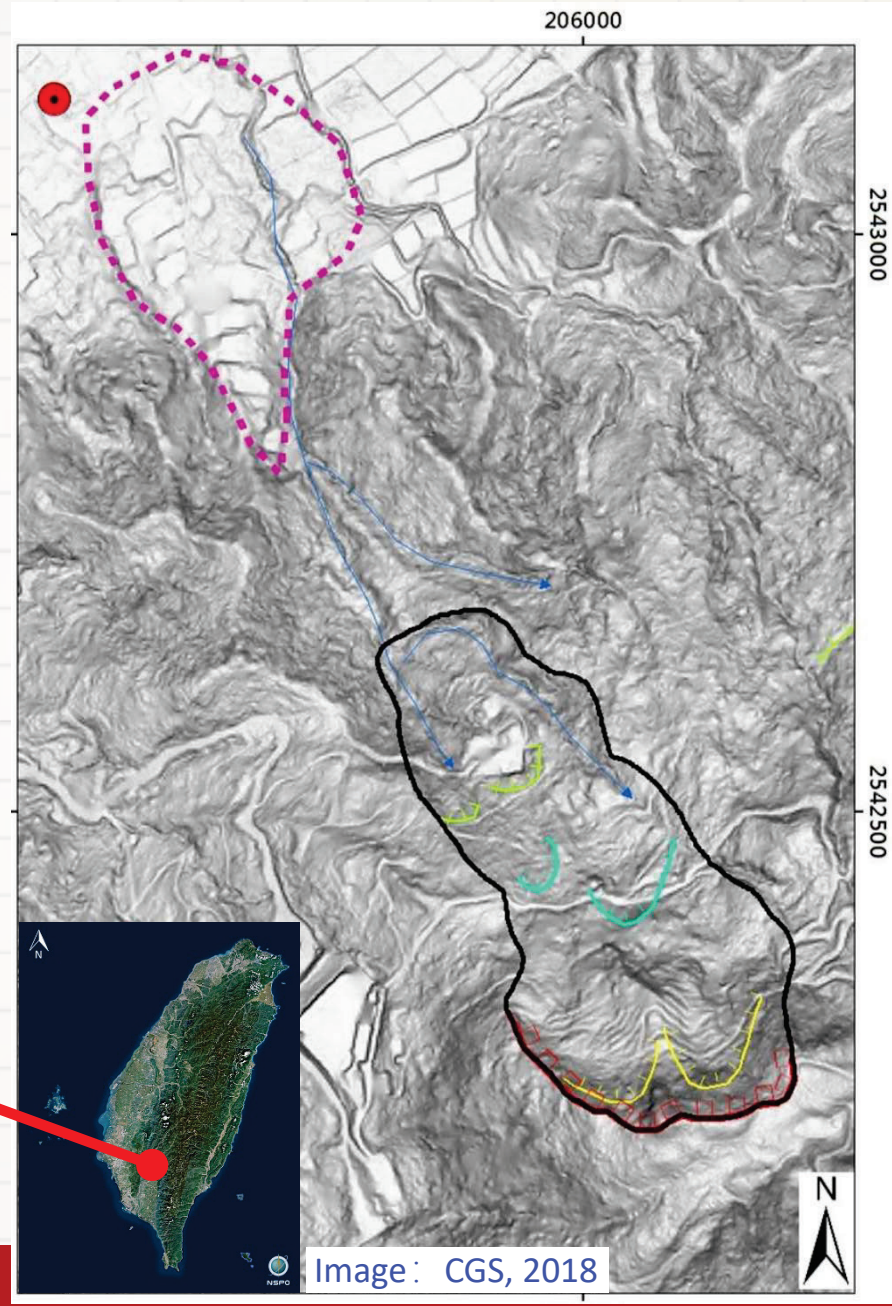


Study Area

Xinzhuang potential deep-seated landslide area has been identified by Taiwan authority where is located in Kaohsiung City, southern Taiwan, it covers a 10.3 hectares' area and 20 buildings with an average slope of 22.8 degrees. The elevation is from 200m to 430m.

Image： CGS, 2018

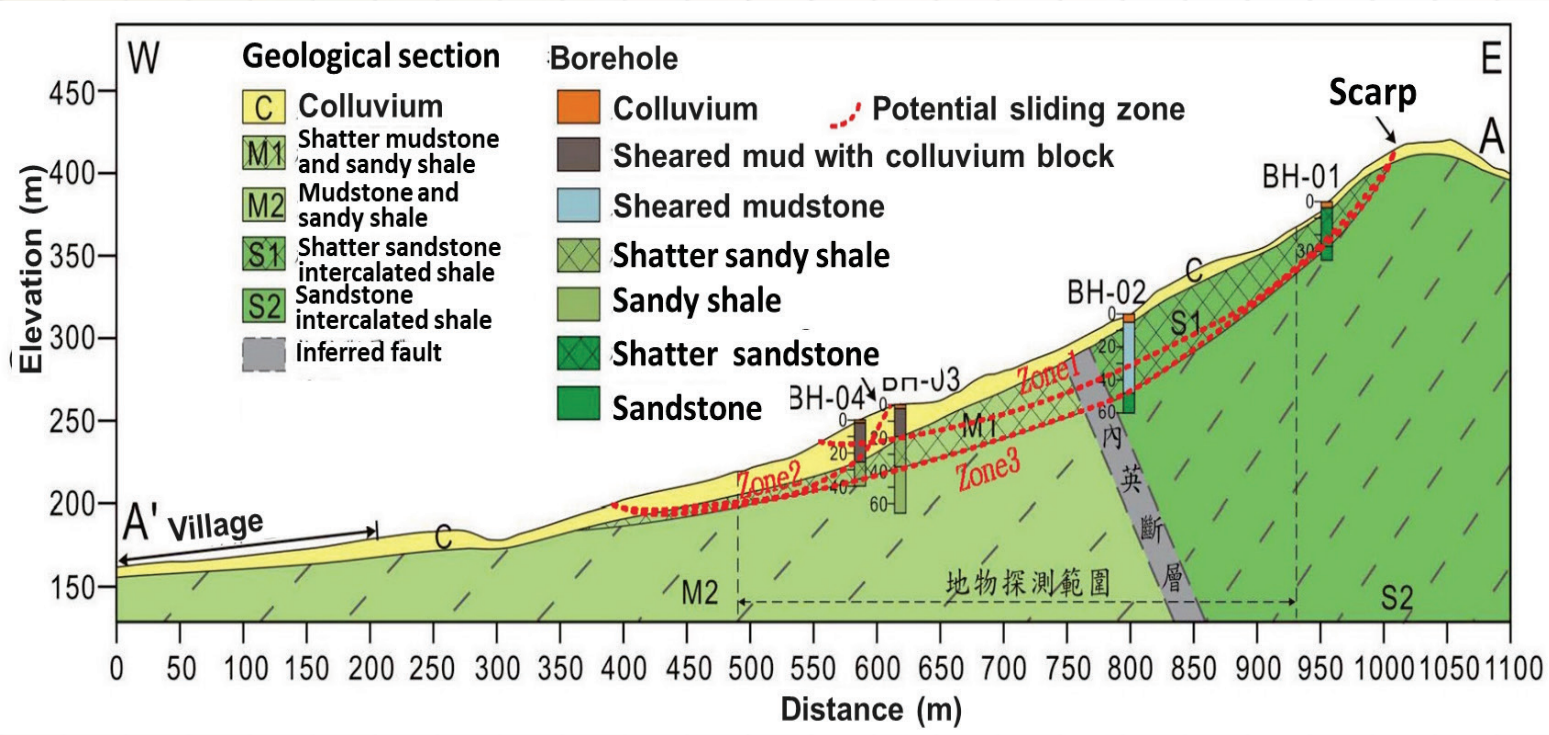


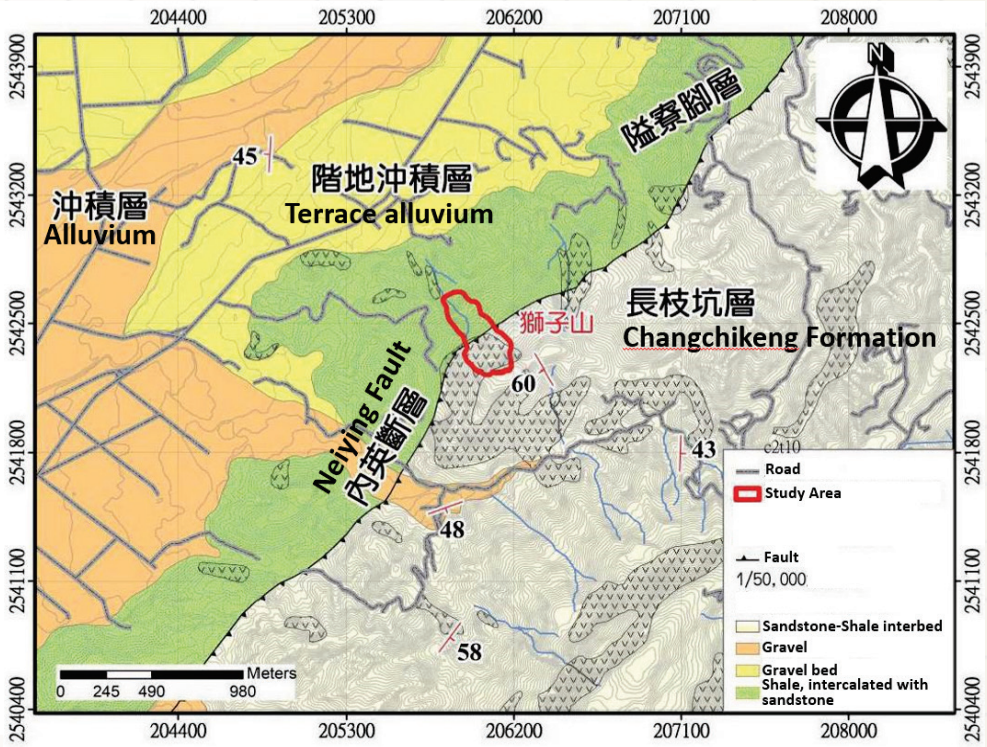


Image： CGS, 2018

Study Area

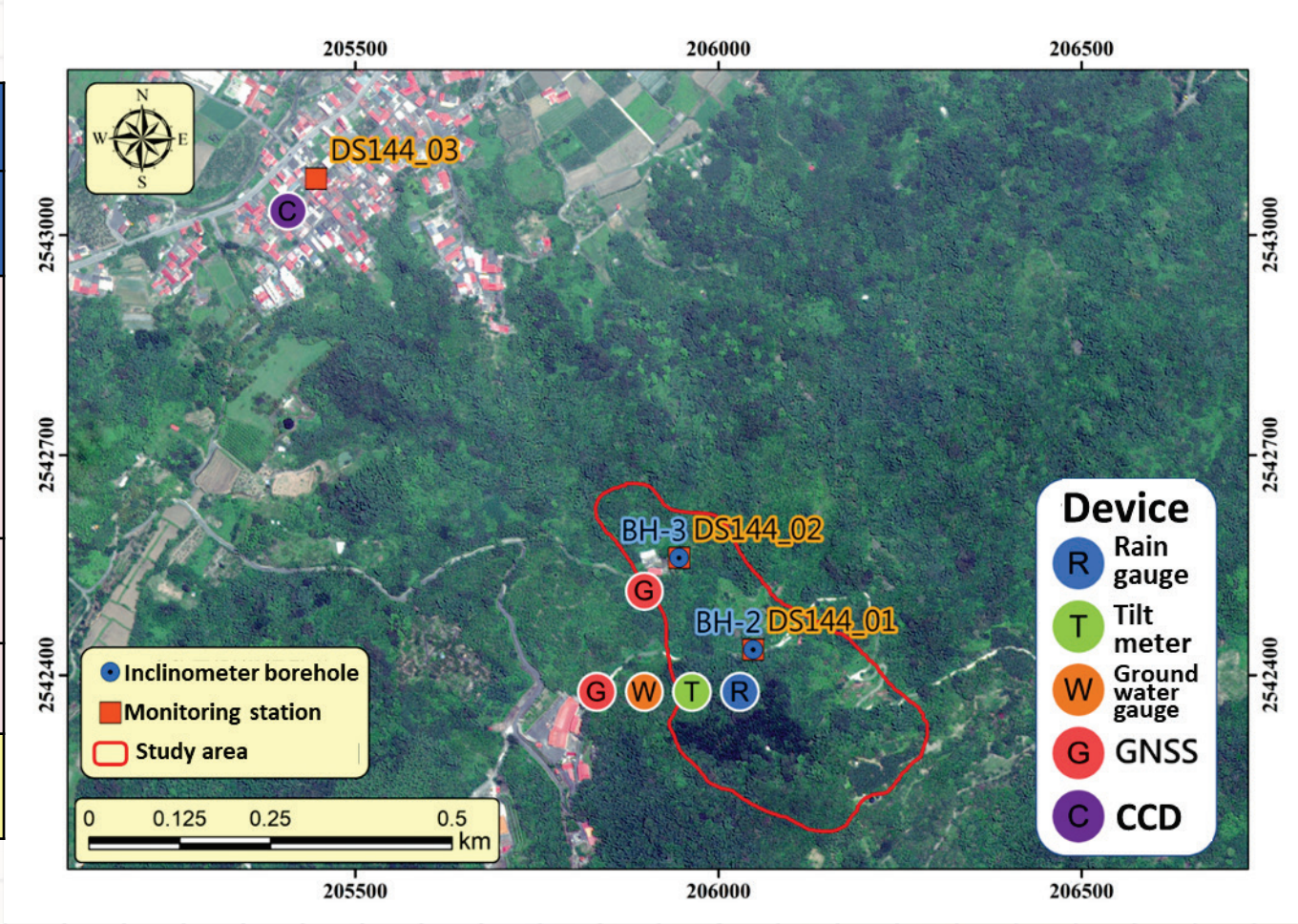
The lithology of the upper slope is sand-shale interbedded with highly sand contented, which differs from lower slope in shale with mud contented. There is a fault called Neiying fault in the middle area. The estimated glide plane is 30~50m below the surface.





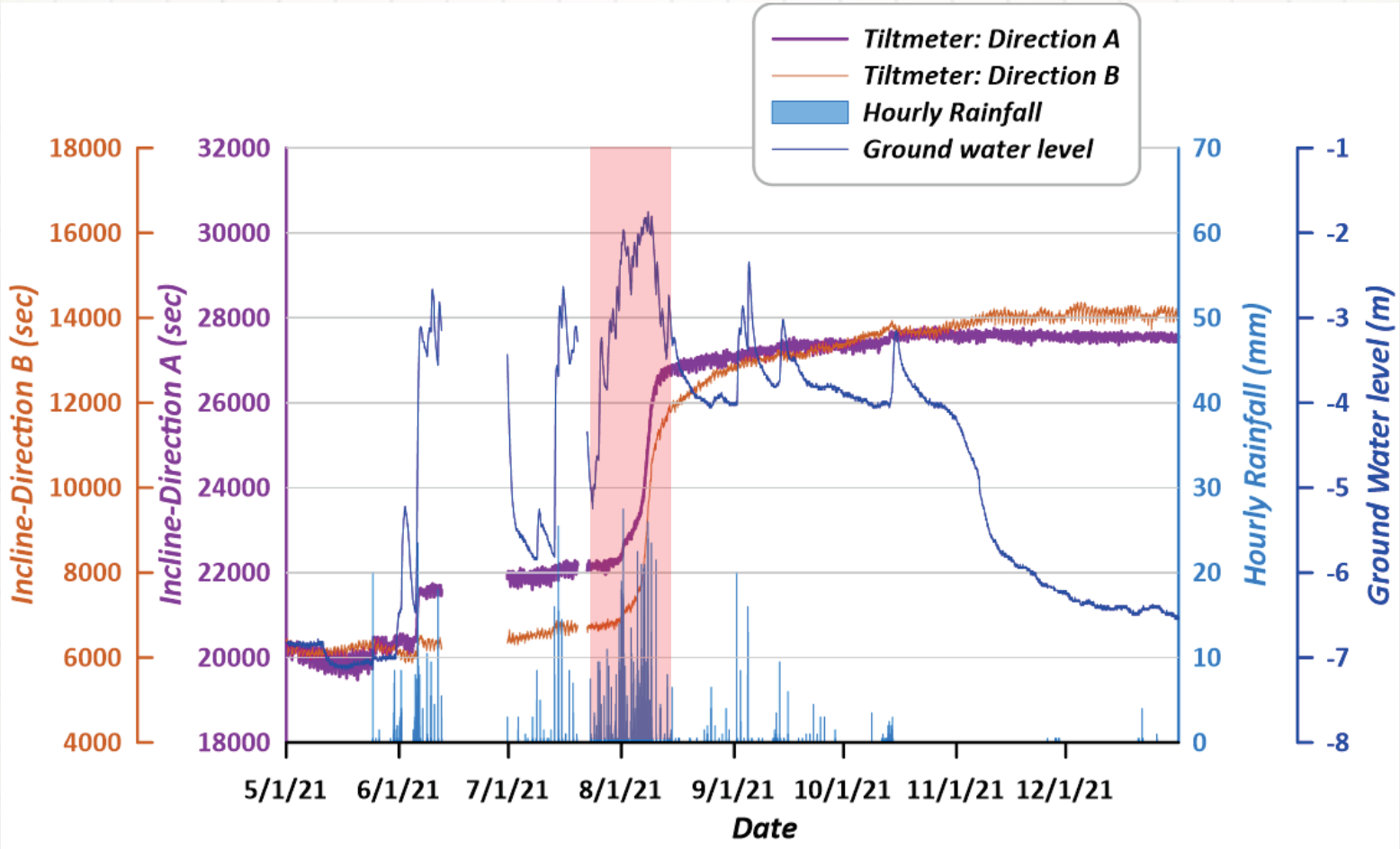
Study Area – Monitoring Device

Monitoring Device			
Station No.	TWD97		Items
	X	Y	
DS144_01	206,048	2,542,435	1.Raingauge x 1 2.Ground water gauge x 1 3.Biaxial tiltmeter x 1 4.GNSS x 1 5.Inclinometer Borehole (60m)
DS144_02	205,946	2,542,560	1.GNSS x 1 2.Inclinometer Borehole (65m)
DS144_03	205,446	2,543,077	1. CCD x1
Memo	Except for borehole inclinometers, all the items transmit data every 10 minutes automaticlly.		



Analysis of Monitoring Data (DS144_01)

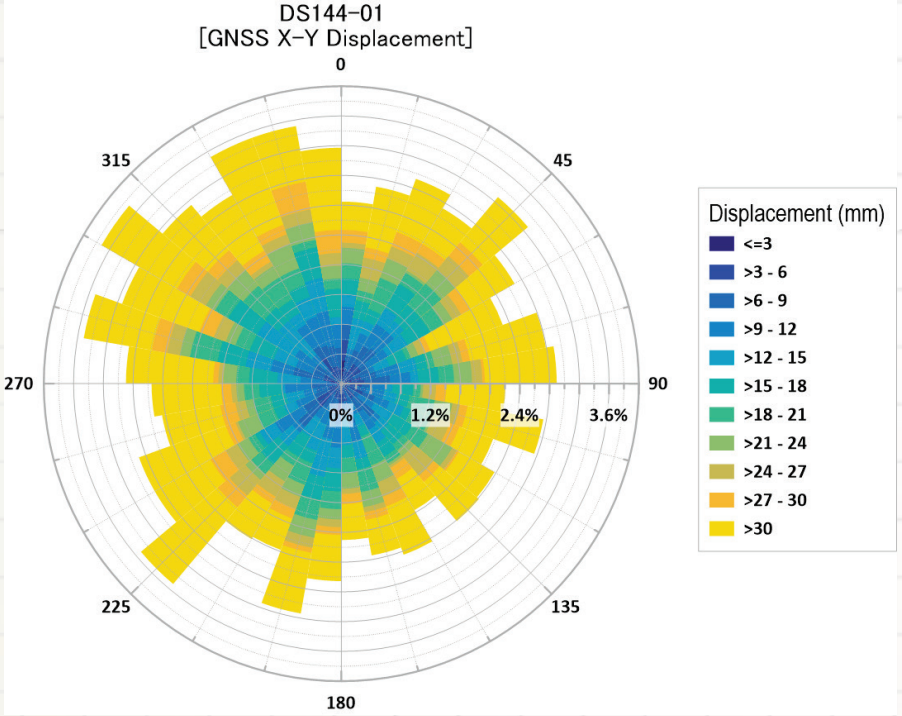
The biaxial tiltmeter in DS144_01 showed a significant increment during 7/20~8/10. There was a long duration rainfall event that had risen the groundwater level from -6m to -1.8m and the tilt angle increased for 5000~6000 sec (about 1.3~1.6 degree) .

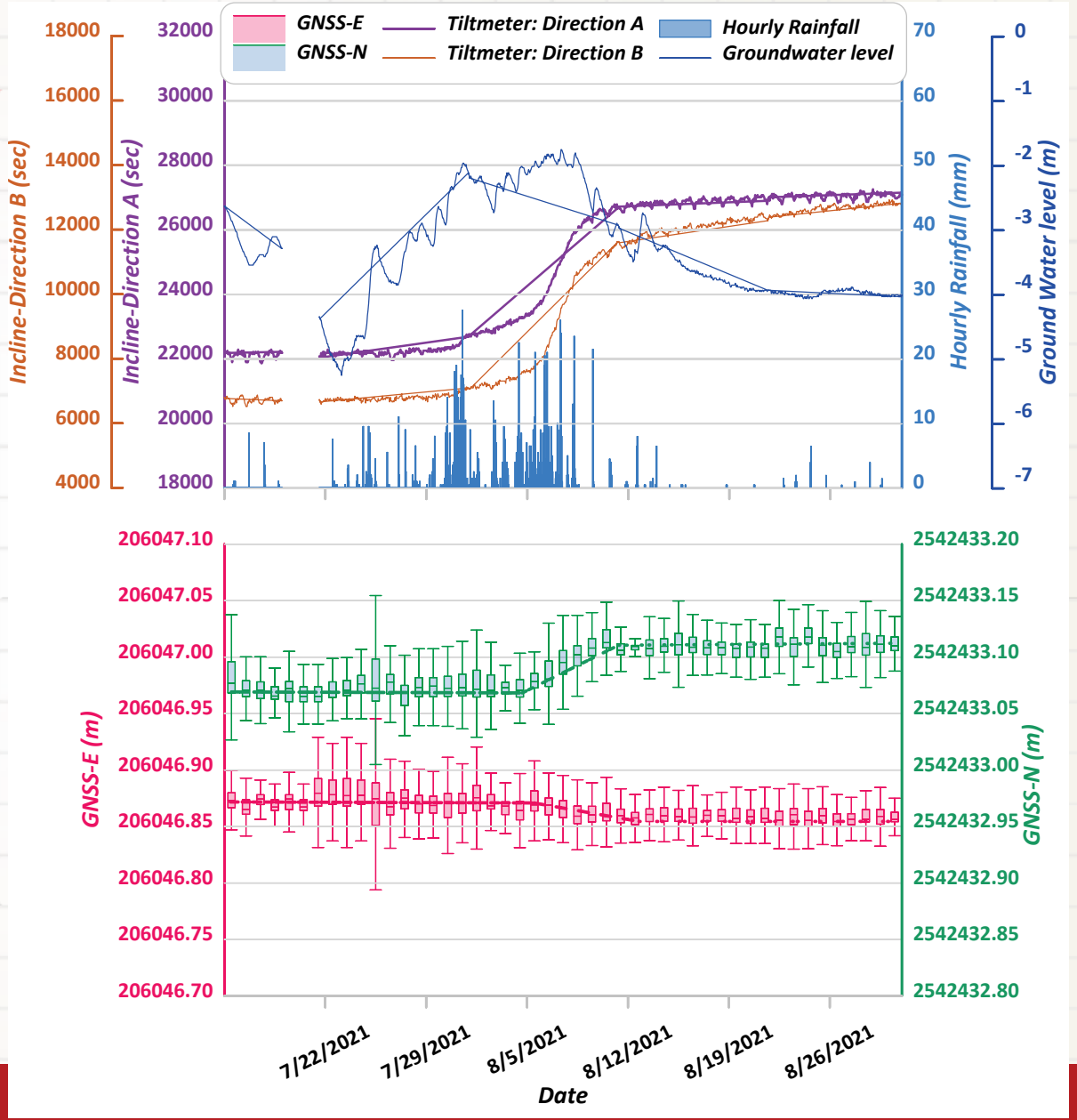


Analysis of Monitoring Data

In the same period, the GNSS also showed the displacement which GNSS-E was 2cm and GNSS-N was 4cm.

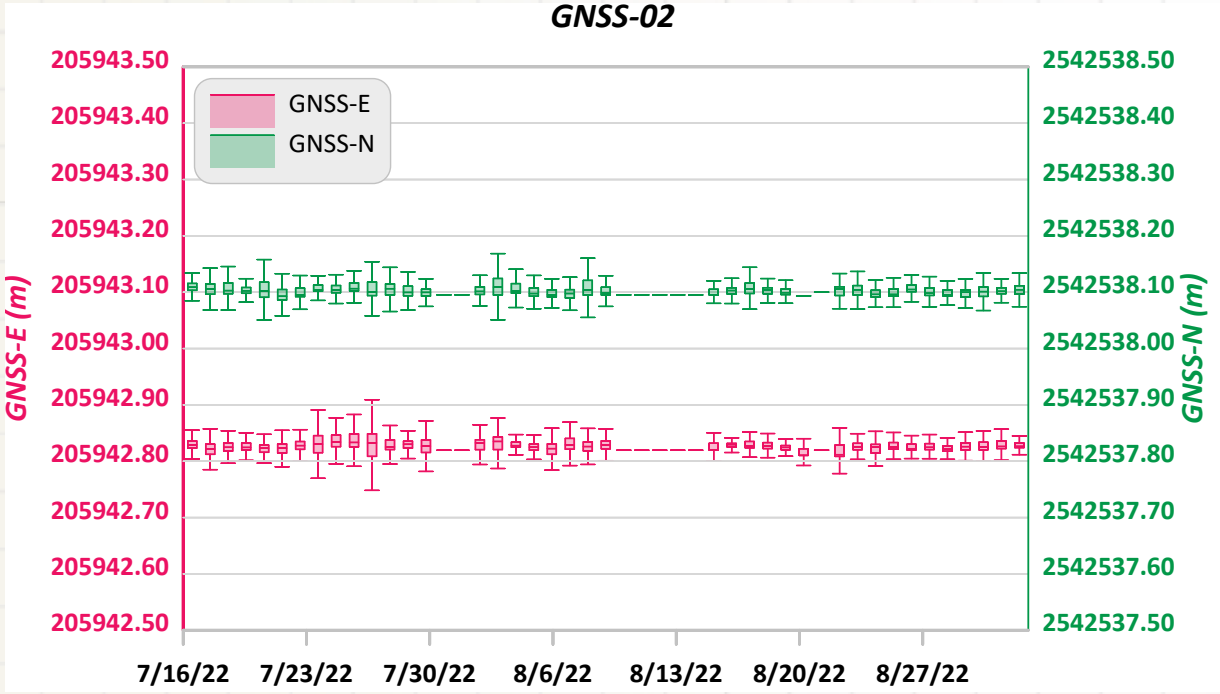
The displacement direction was about 315 degree (northwest) and consistent with field terrain.

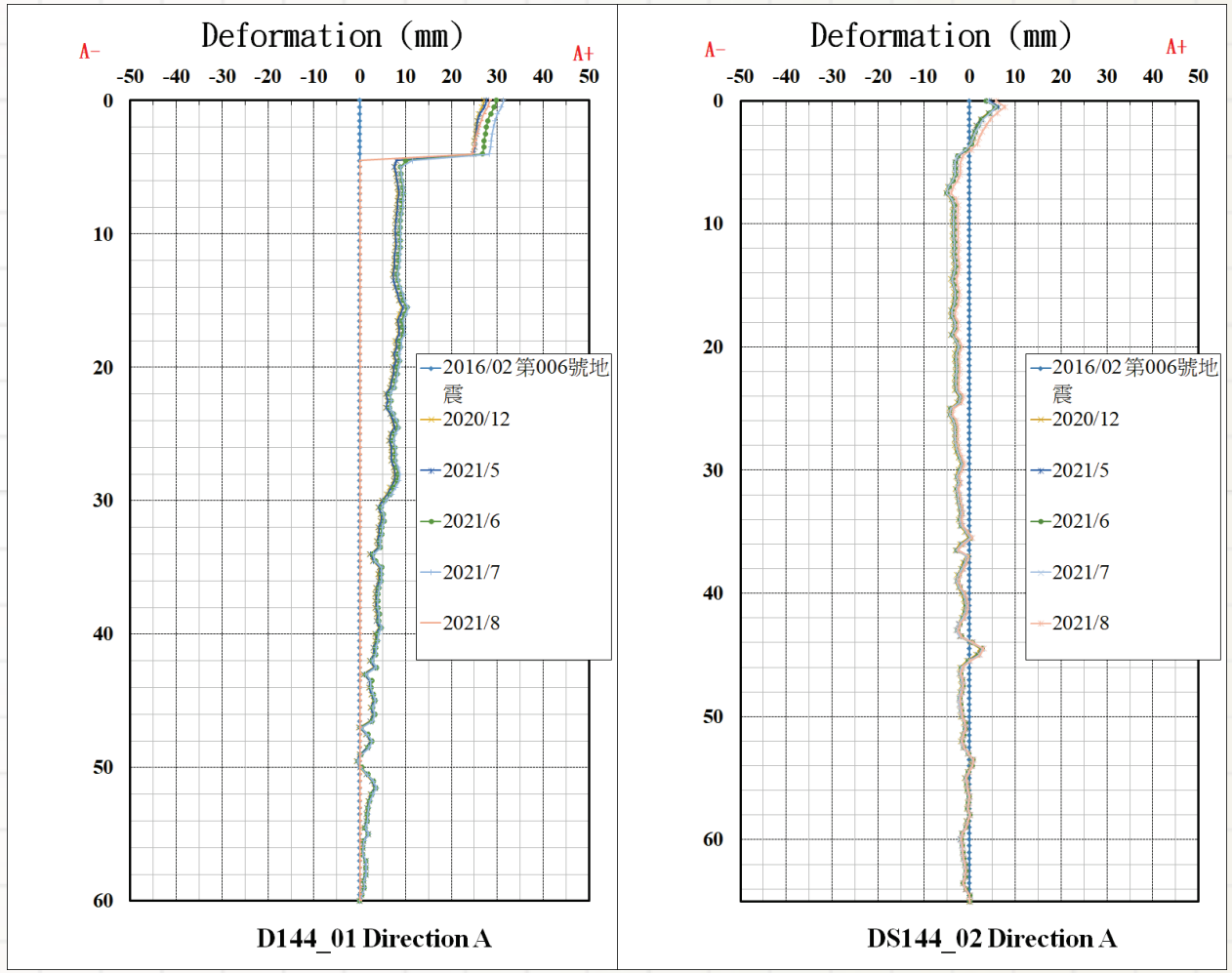




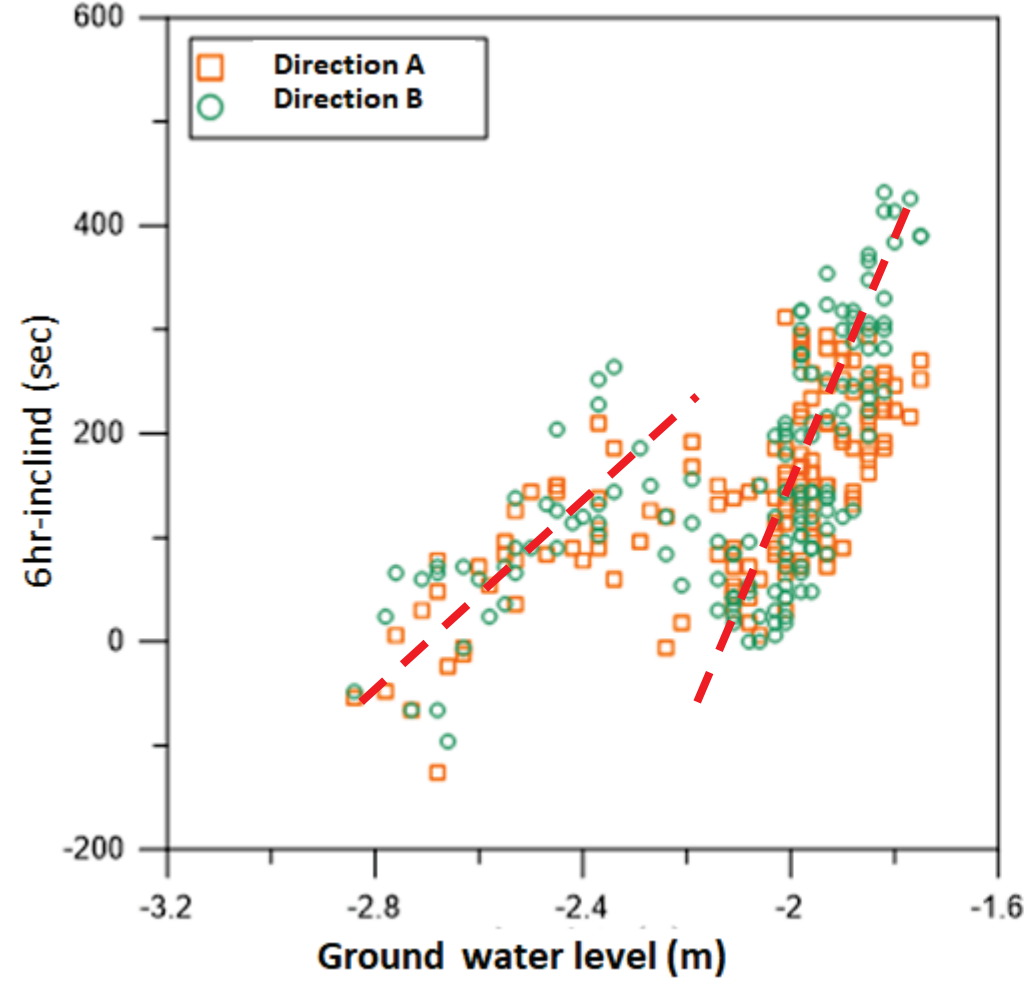
Analysis of Monitoring Data (DS144_02)

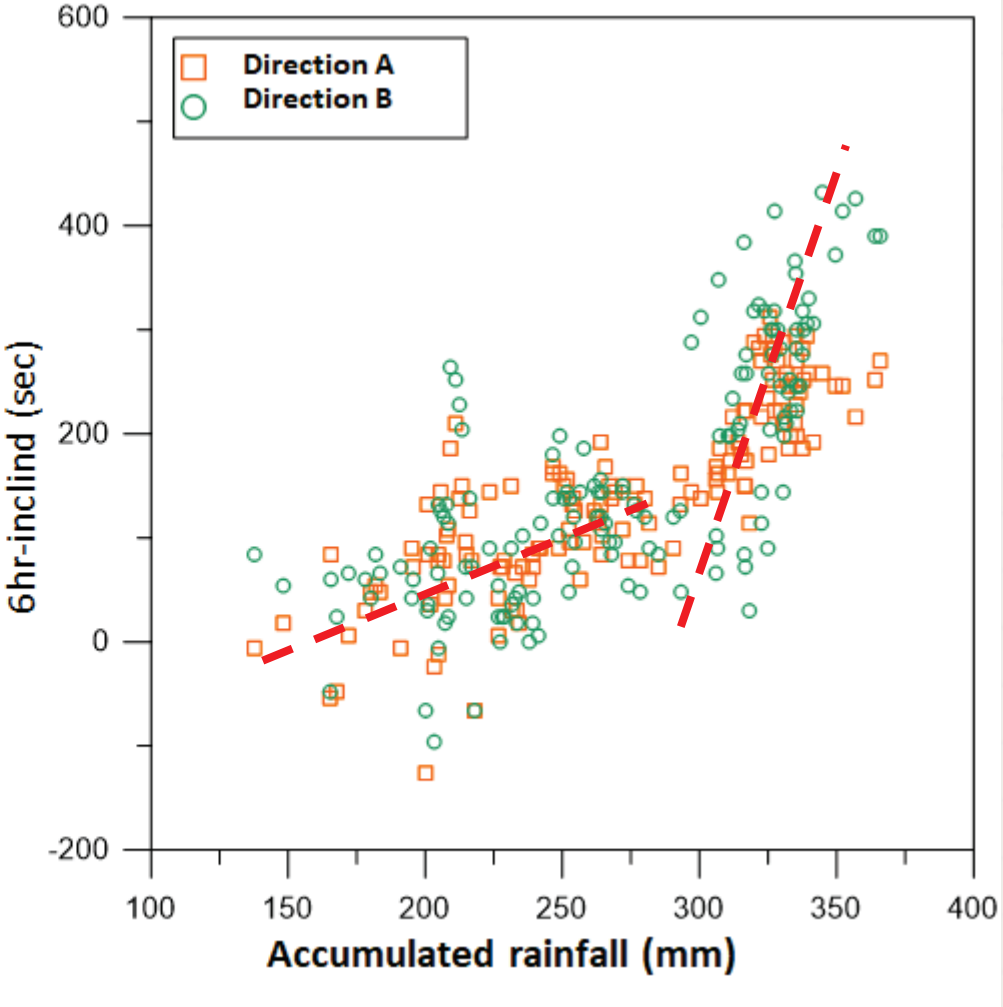
Station DS144_02 is located 200m away DS144_01, the borehole was measured by inclinometer the results showed the deformation was not significant. The GNSS-02's displacement was also not significant.





Analysis of Monitoring Data





Conclusions

The local shallow creeping (4-5 meters underground) in the central deep-seated landslide area was recorded by the tiltmeter, GNSS and borehole inclinometer measurement.

The groundwater level is the significant factor for displacements of creep in this site. The velocity of the displacement would be accelerated when the groundwater level was higher than -2.2 meters.

The 6-hours displacement has a highly correlation with accumulative rainfall and ground water level.

THANKS FOR YOUR ATTENTION

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