Scientific Investigation and Monitoring Result of Potential Large Scale Landslide

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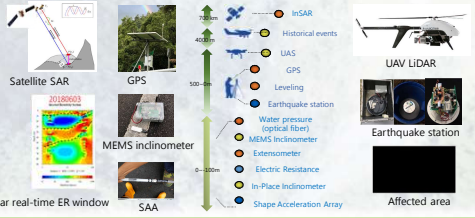
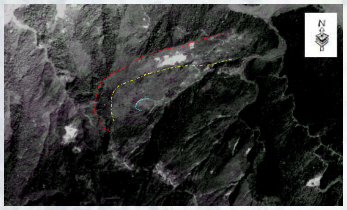
行政院農業委員會水土保持局 Soil and Water Conservation Bureau, Council of Agriculture, Executive Yuan

Vision

- Past : Trace the mechanism and history of large-scale landslide with modern scientific and technological methods, develop a method for assessing the risk of potential large-scale landslide
- Present : Integrate new development technologies to conduct different spatial and time-scale observations, identify potential locations of high-risk, conduct relevant observations and detailed investigations, organize appropriate observation methods and integrate analysis of observational data
- Future : Gradually develop the precursory conditions and disaster prevention actions for large-scale landslide, detect the landslide precursors with apex technology, and propose early warning conditions and influences



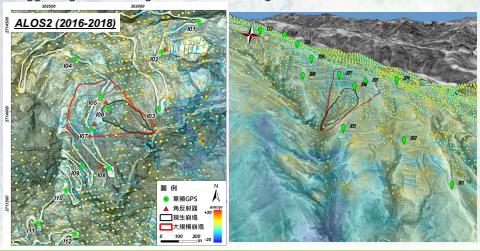
Potential slides 50 years before



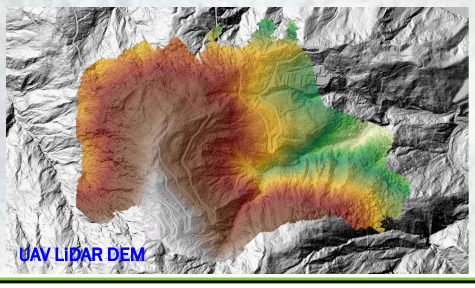
1957 US air force

Global ground deformation acquire from SAR

- Same location TCP points are captured form fringes of each pairs with ALOS-2
- Suggesting field investigation and sensor alignment

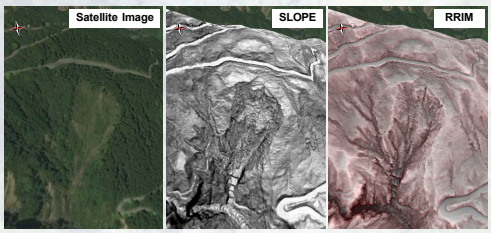


UAS LiDAR DSM vs. DEM



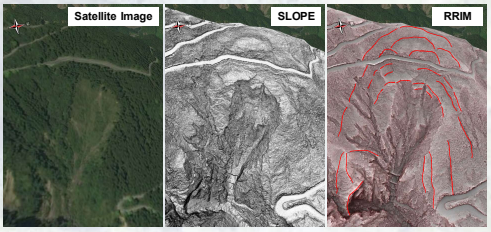
Airborne vs UAV LiDAR(1/2)

Airborne LiDAR Data

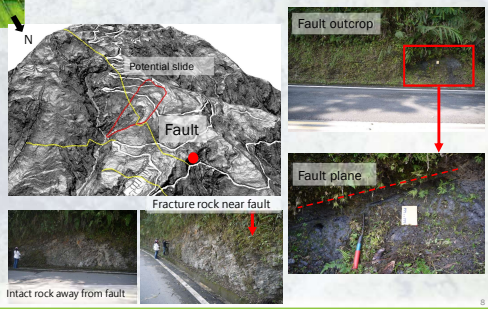


Airborne vs UAV LiDAR(2/2)

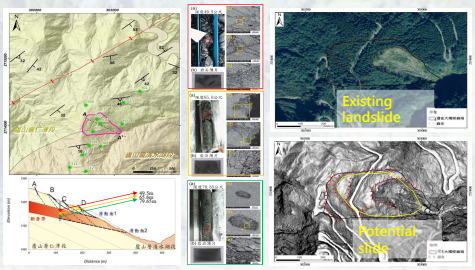
UAV LiDAR Data



Field investigation/verification



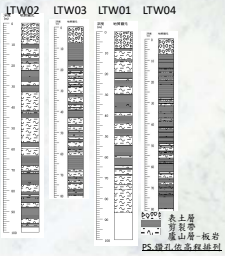
Geological investigation – 2D geological profile



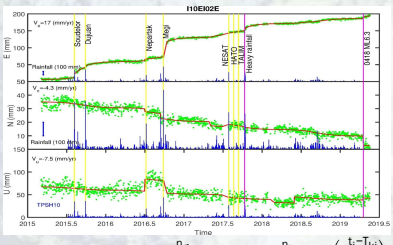
Core identification

- LTW04 cores are extremely fracture
- Shear zones of LTW01, LTW03, and LTW02 are close to each other when comparing with LTW02

LTW鑽孔分布圖

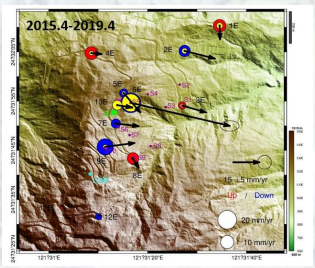


GPS position time series

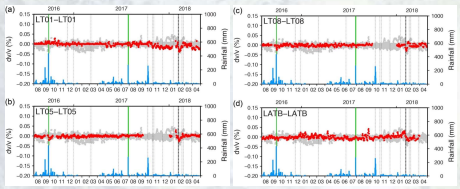


$$y(t_i) = a + bt_i + c\sin(2\pi t_i) + d\cos(2\pi t_i) + \sum_{j=1}^{n_g} g_j H(t_i - T_{gj}) + \sum_{j=1}^{n_k} k_j \exp\left(-\frac{t_i - T_{kj}}{\tau_j}\right) H(t_i - T_{kj}) + v_i$$

Horizontal and vertical long-term linear velocities with respect to I10



Long-term monitoring for typhoon and ground shaking effect



Red dots – dv/v measurements at that station
Gray dots – dv/v measurements at other stations
for comparison

Green line – typhoon
Dotted line – $M_L \geq 5$ earthquakes within 100 km
Blue bar – Daily rainfall

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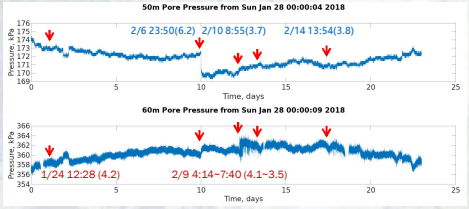
Optical fiber water pressure

2018 2/6 Hualien 23:50:42



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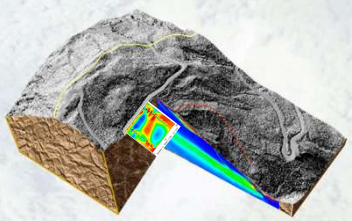
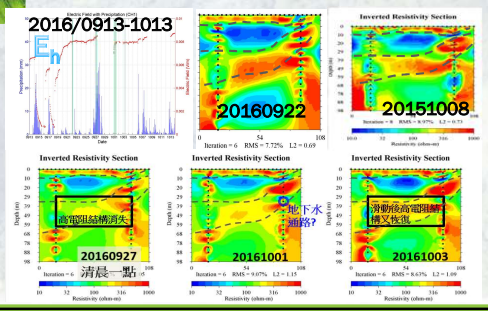
Electric resistance window in field

LTW鑽孔分布圖



Electric resistance profiles during typhoon Megi (2016)



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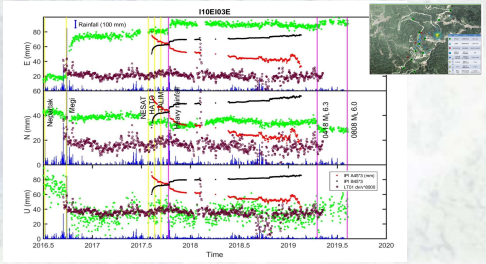
Rainfall and earthquake events(1/3)



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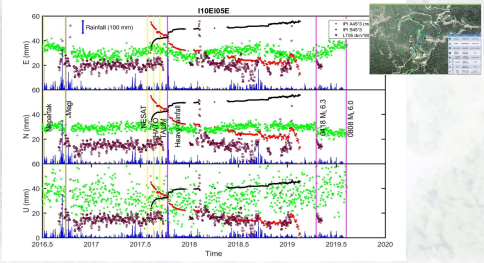
Rainfall and earthquake events(2/3)



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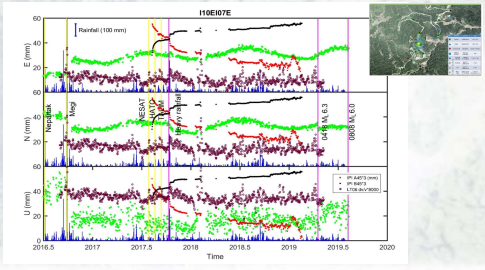
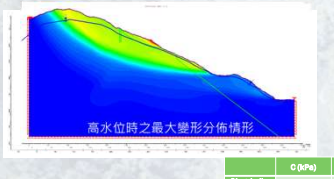
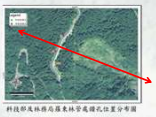
Rainfall and earthquake events(3/3)



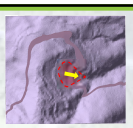
2D numerical simualtion

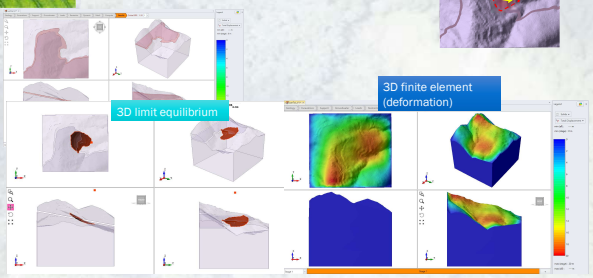




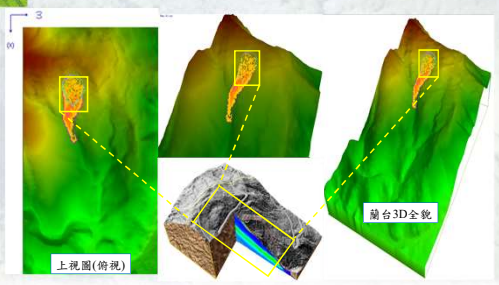
	C (kPa)	ϕ (°)	Cr (kPa)	ϕr (°)
Qinghuihu section	100	35	10	30
Renze section	75	33.5	7.5	30
Alluvium	5	30	5	30
Shear zone	10	30	1	25

3D numerical analysis





3D runout simulation



Preliminary sliding threshold for LanTai site

- **Deformation**
  - 2mm/day including ground surface and under ground
- **Precipitation**
  - 300mm for ground surface deformation
  - 800-1000mm for underground deformation (Lushan experience)
  - (500mm from temporal GPS displacement)
- **Groundwater**
  - Underground 20m/10m