評估地滑體積和落石運動路徑之案例研究

The Case Sturdy for Evaluation of Landslides Volume and Moving Paths of Single Falling Rock

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Outline

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- Information
- Numerical Model Analysis 數值分析
- Research procedures 研究程序
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  - Numerical Analysis of Rockfall
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Introduction

- Landslides can be triggered by intense rainfall, earthquakes or human activities.

極端降雨、地震或人為活動可能誘發地滑。

- The study use UAV's aerial photos are used to build the 3D model, orthophoto and digital surface model .

使用無人機的航空照片用於構建3D模型，正射影像和數字表面模型(DSM)。

Introduction

- Compare the digital terrain model before and after the landslide to evaluate the terrain change of slope and landslide volume.

比較滑坡前後的數字地形模型(DTM)，評估斜坡和滑坡體積的變化。

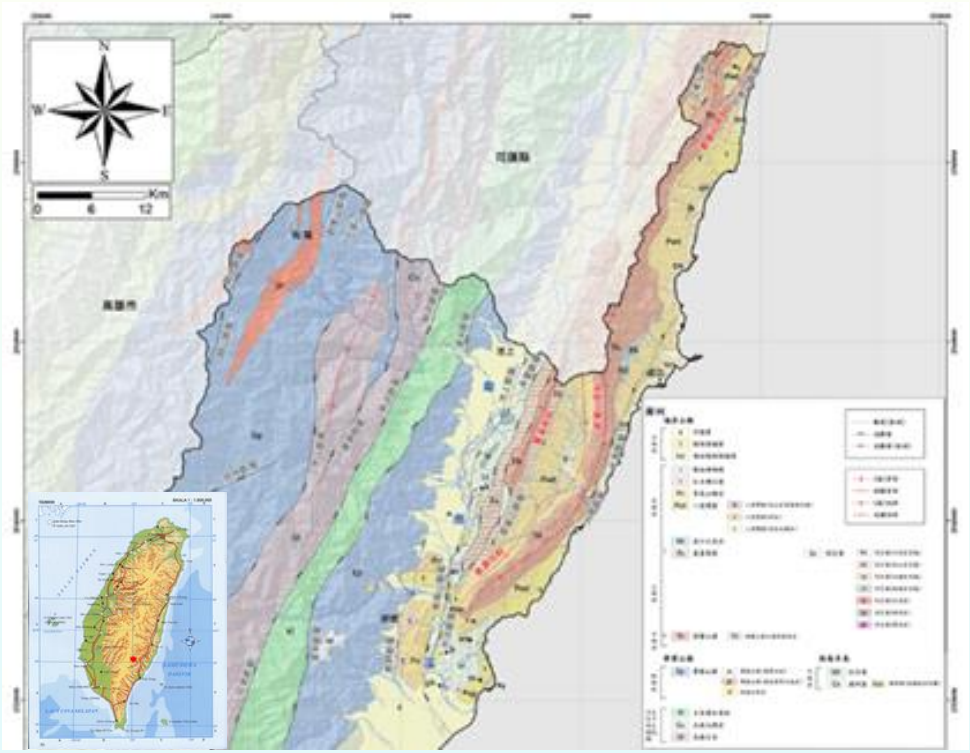
- Assess the motion track and form of the rock on slope.

評估斜坡上岩石的運動軌跡和形式。

Information

- On September 15th, 2016, typhoon Meranti occurred, with the rainfall of 513.5mm accumulated rain and 19mm/hr rainfall intensity, inducing the first landslide that ranged about 5.62 hectares.

2016年09月15日莫蘭蒂颱風帶來累積降雨量513.5mm、降雨強度19mm/hr造成第一次崩塌事件，其崩塌面積約5.62公頃。



Numerical Model Analysis -Soil material

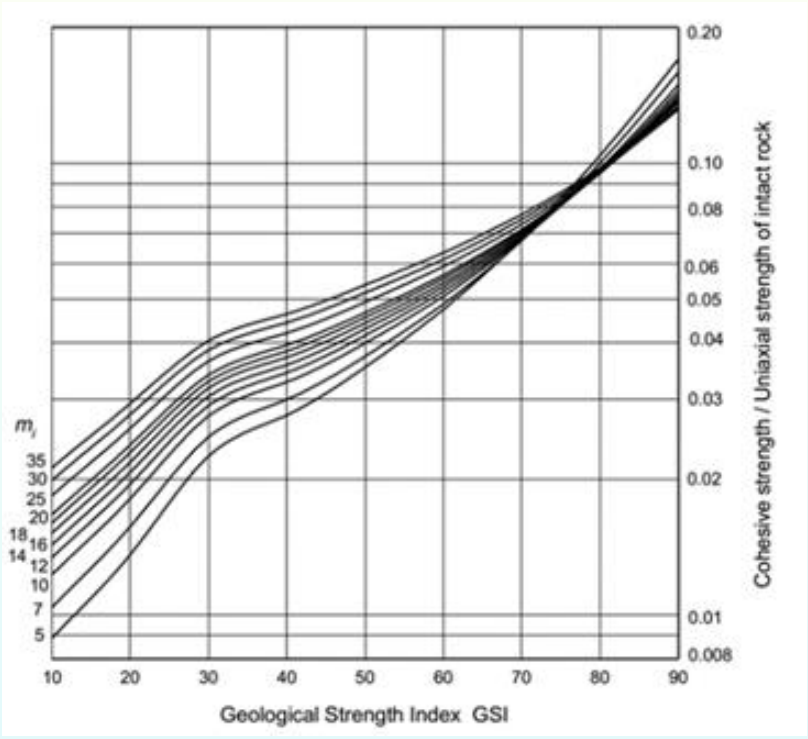
Grade	Uniaxial Comp. Strength (σ_{ci}) MPa	Values of the constant (m_i)	Geological strength index (GSI)	Cohesive strength / Uniaxial etrength of intact rock (c/σ_{ci})	Cohesive strength (C) KPa	Friction angle (φ°)
R1	1-5	7-11	10-15	0.011-0.015	11-15	17-21

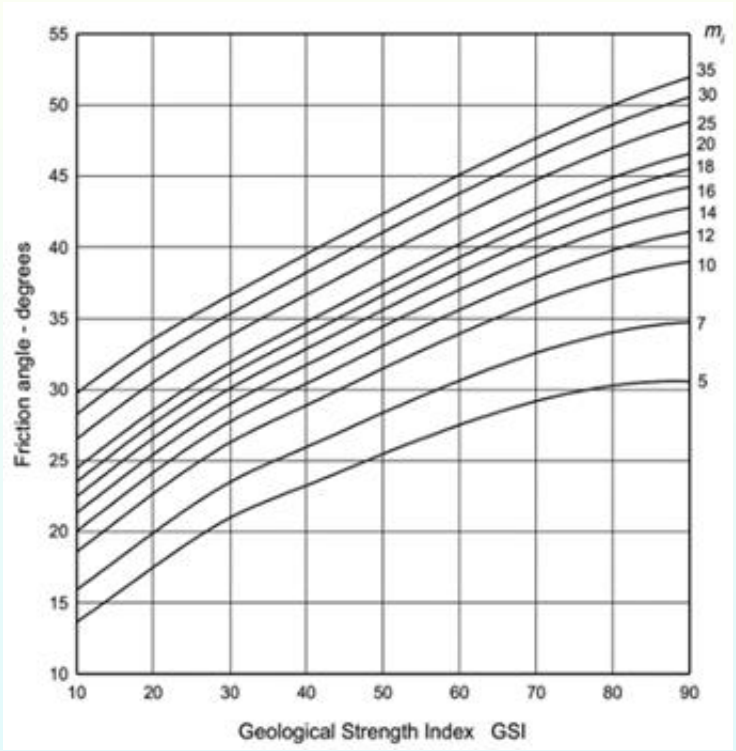
(σ_{ci})：material constant 岩石的單壓強度

(m_i)：related to the frictional properties of the rock 反應岩石的摩擦特性

Geological Strength Index (GSI) 地質強度參數

Numerical Model Analysis -Soil material

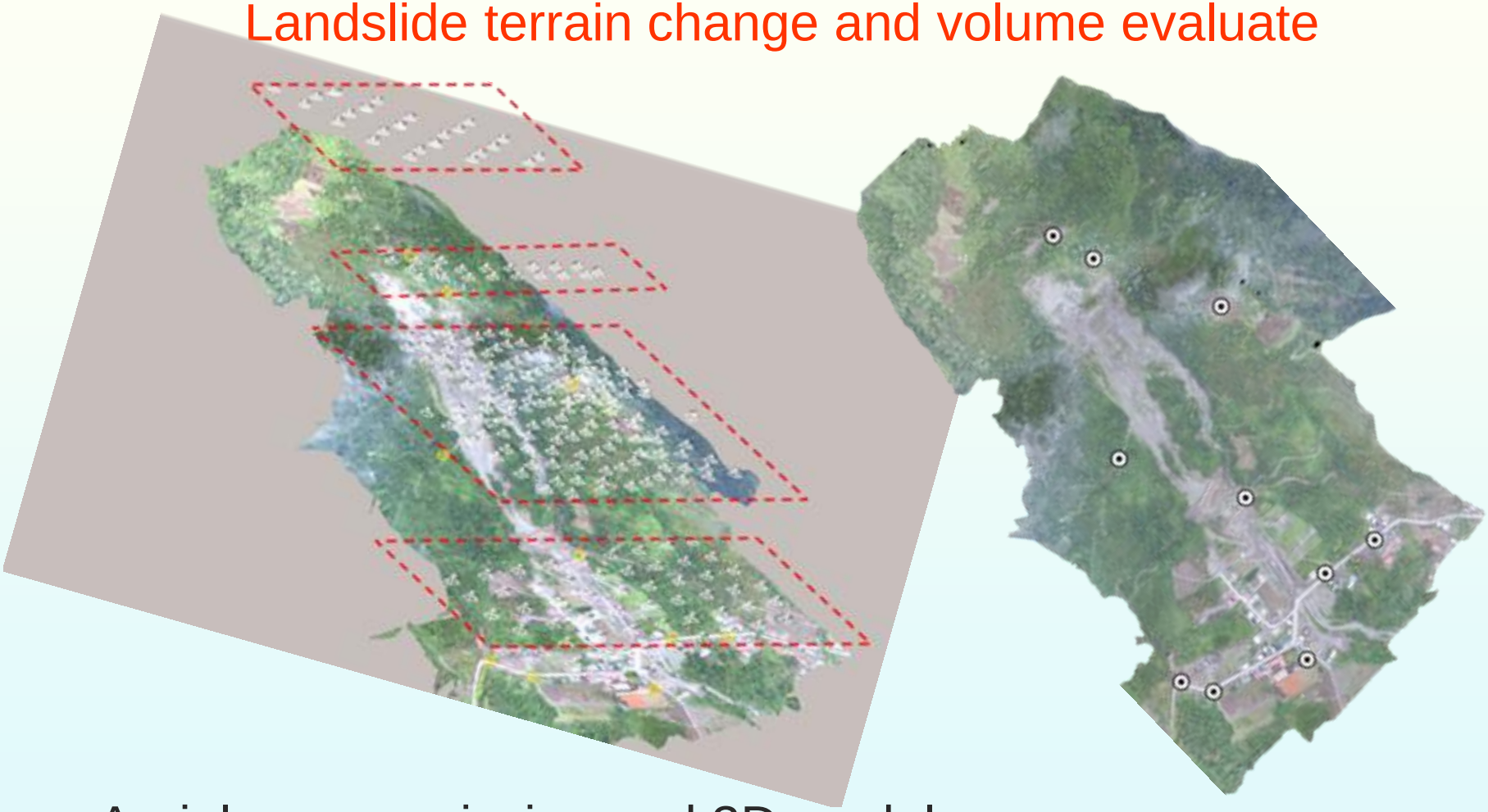




Marinos and Hoek,2000

滑坡地形變化和體積評估

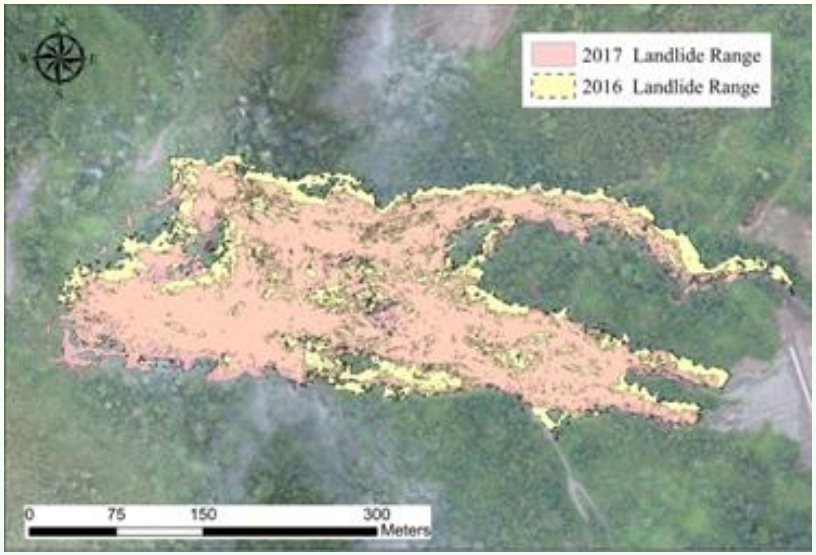
Landslide terrain change and volume evaluate



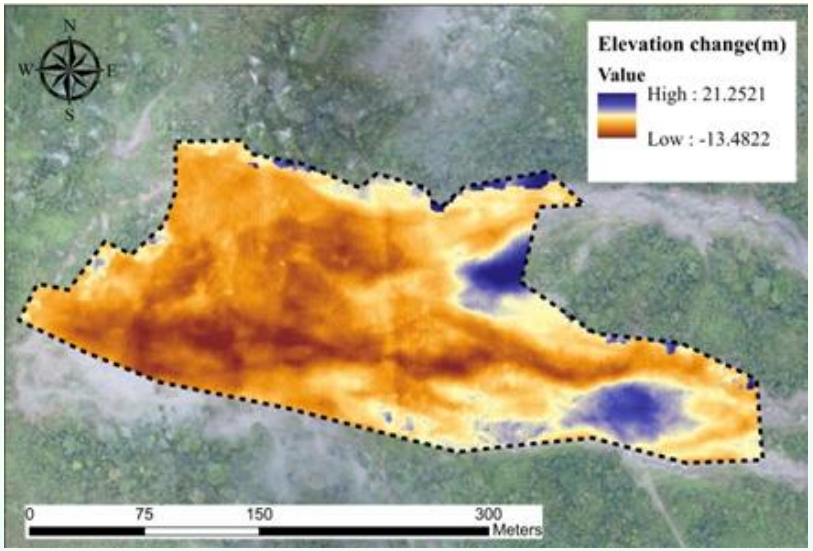
Aerial survey mission and 3D model

空中考察任務和3D模型

Depth(m)	Number of Grid (m^2)
0~2.5	9415
2.5~5.0	12175
5.0~7.5	10715
7.5~10	7316
10~13.48	1964



Orthophotos comparison between 2016 and 2017
2016年至2017年的正射圖比較



Terrain change after landslide
滑坡後地形變化

Numerical Analysis of Rockfall

- geometry and material properties.

幾何和材料屬性

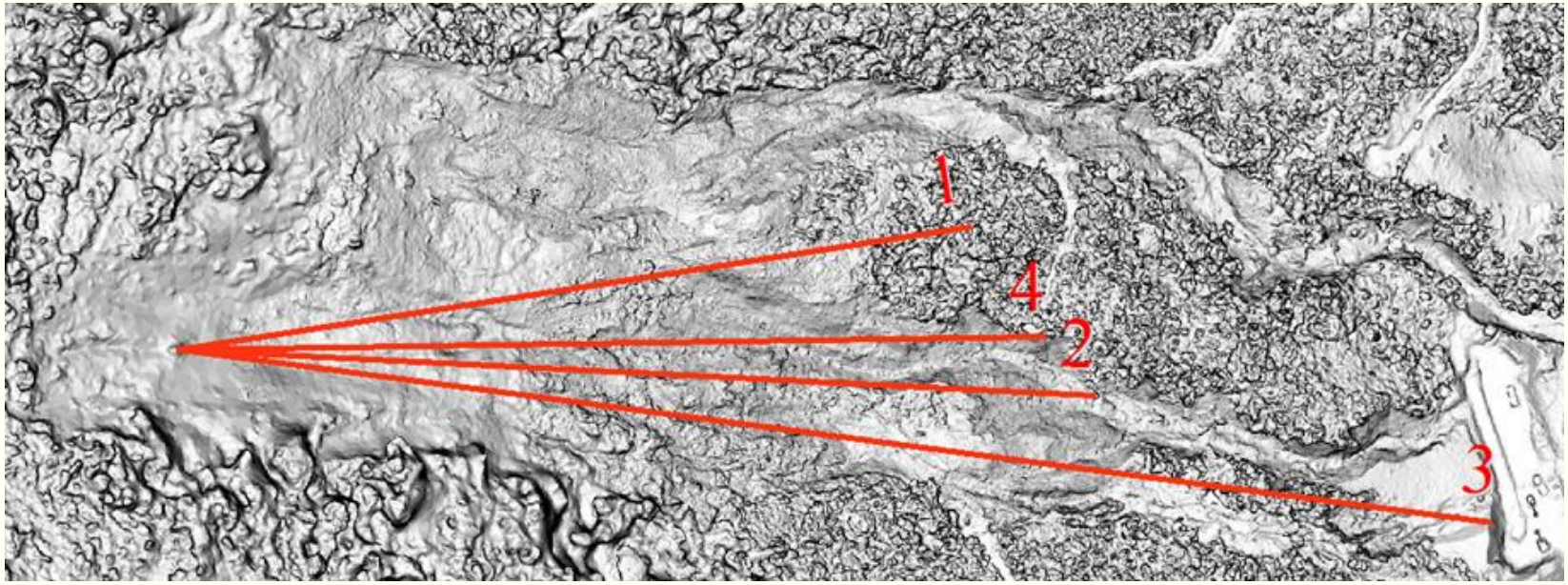
- friction coefficient. 摩擦係數
- rock density. 岩石密度
- Soil material parameters. 土壤材料參數

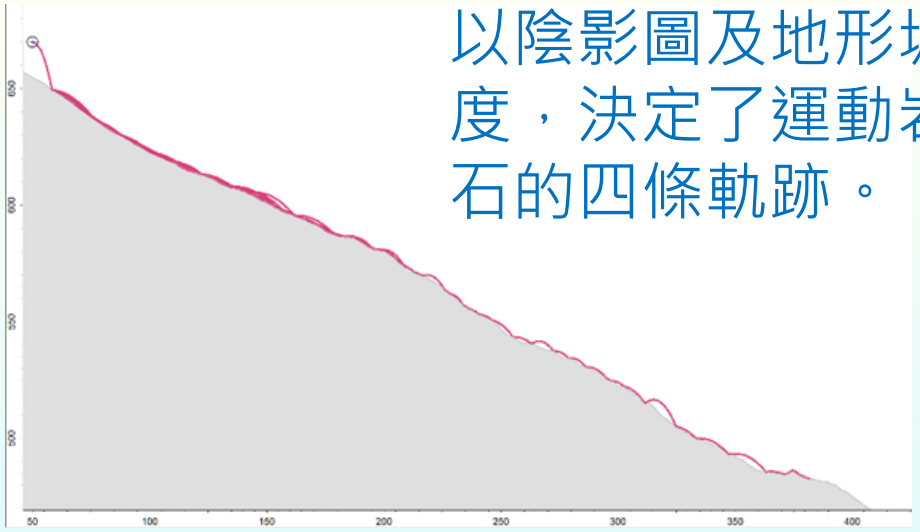
Assumes

- This study assumes the rock is moved by the influence of the foundation loss and earthquake.

假定岩石受到基礎損失和地震的影響。

- Two erosion depth :
  - 3.60m (rock height)
  - 13.48 m (maximum erosion depth)
- The seismic acceleration 400 gal.

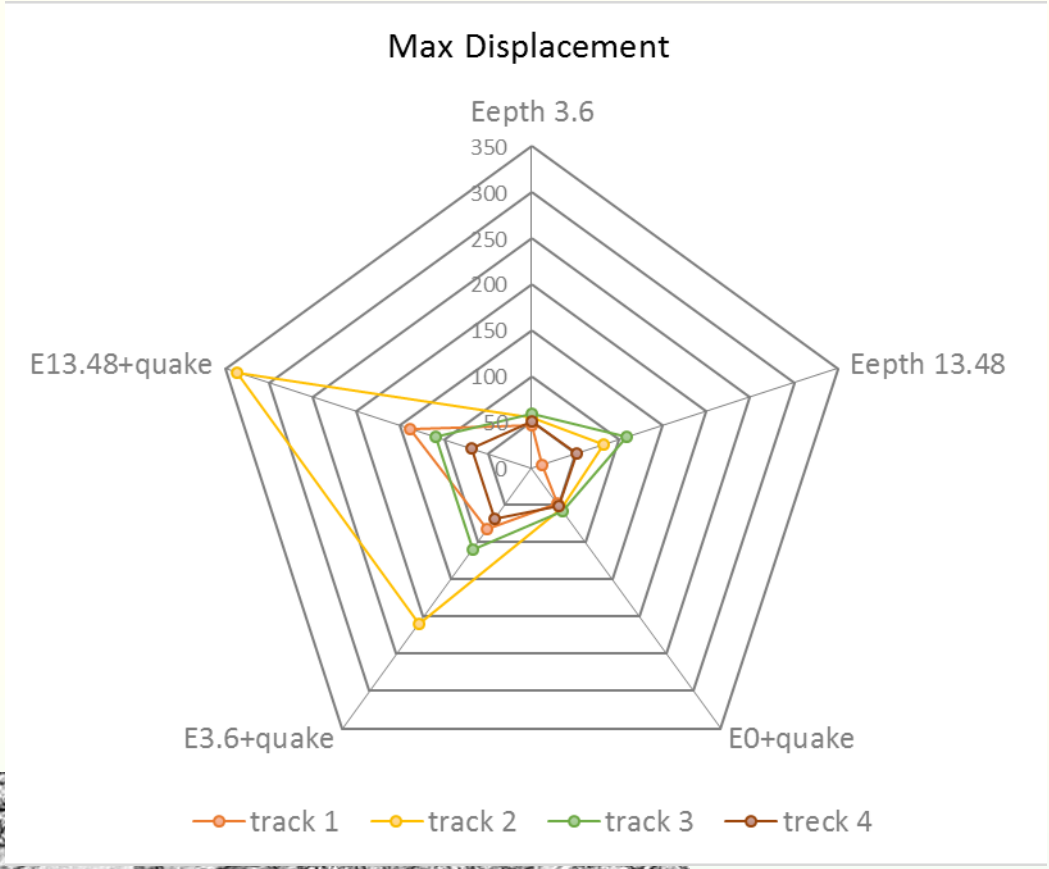


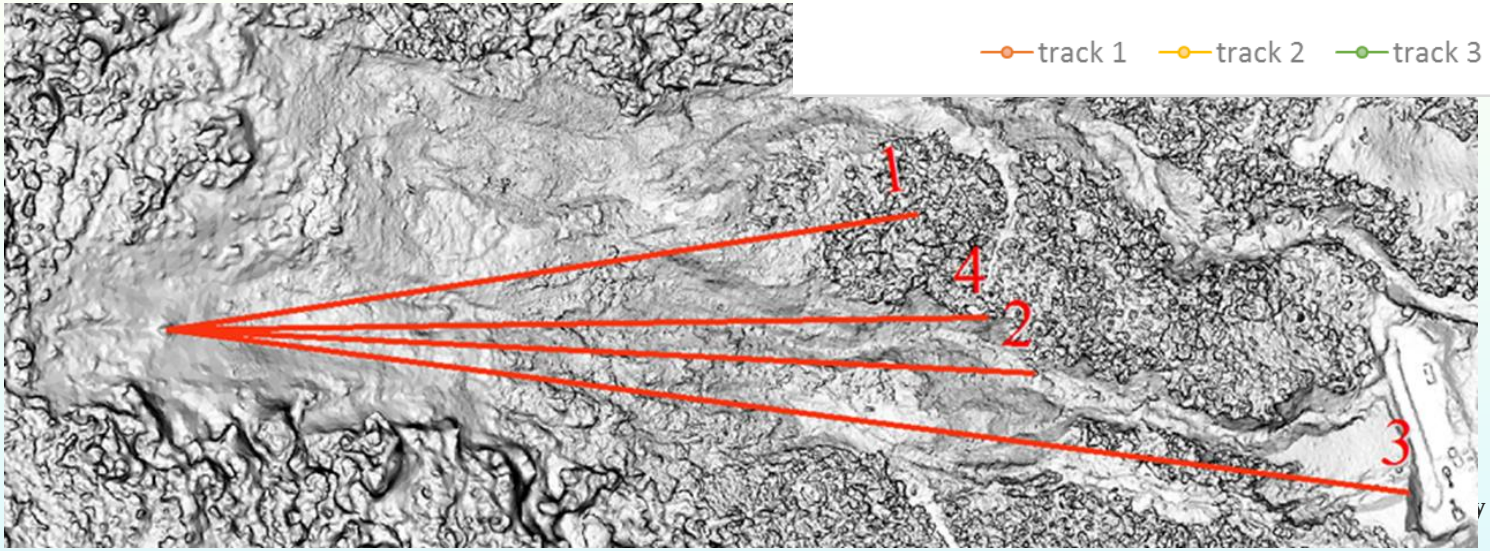


以陰影圖及地形坡度，決定了運動岩石的四條軌跡。

According to the terrain slope and the shadow map, the four tracks of the motion rock are decided.

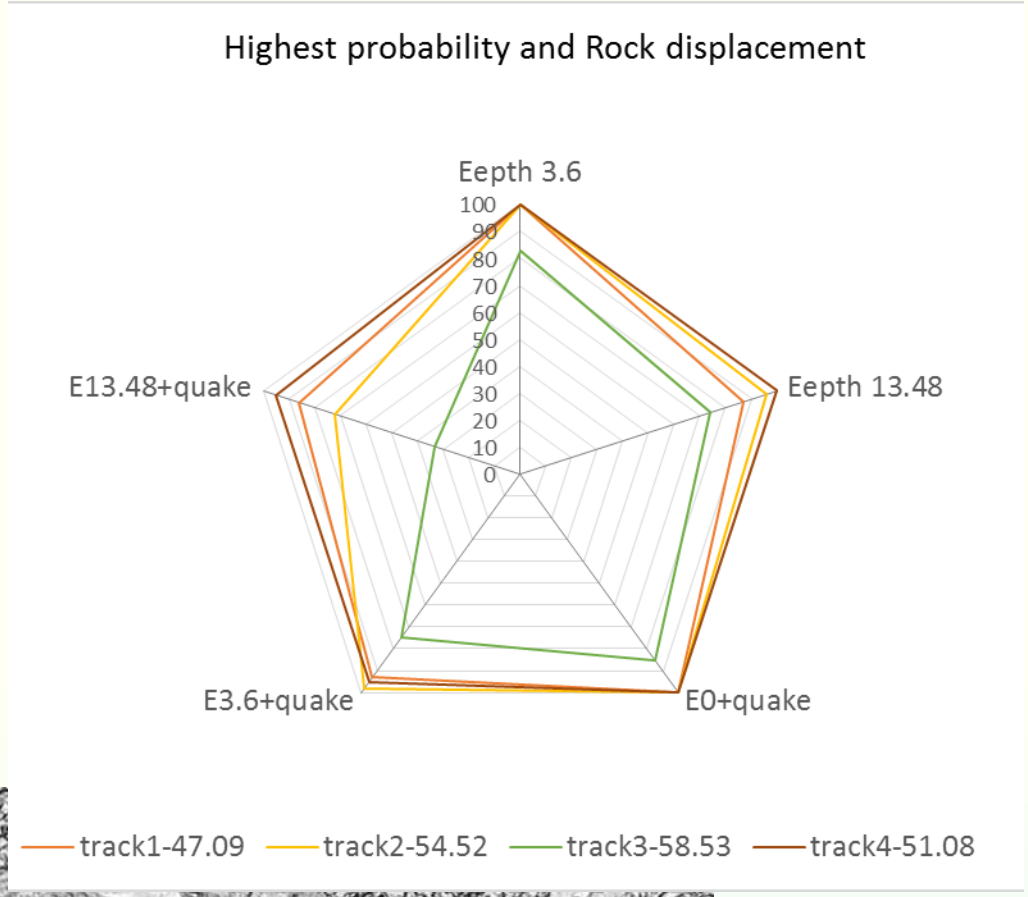
Maximum displacement
Track2,
Erosion depth:13.48m
With earthquake
About 350m

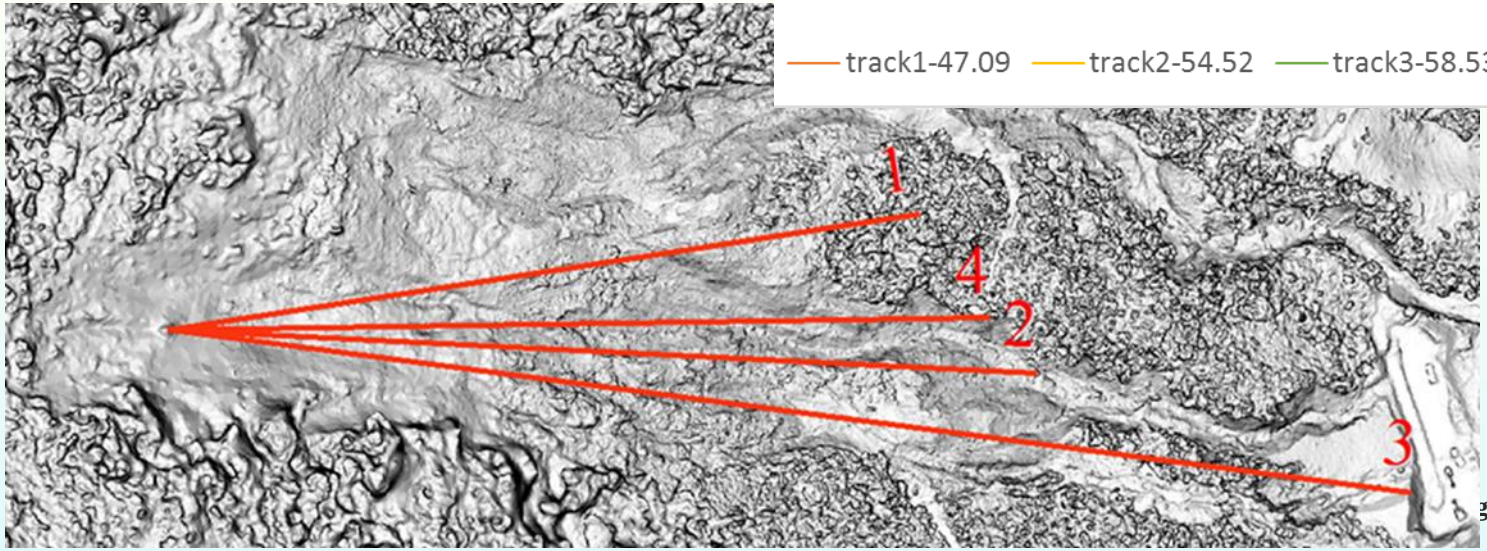




The most likely displacement distance

- Track1-47.09m
- Track2-54.52m
- Track3-58.53m
- Track4-51.08m





Conclusions

- Using UAV to record images for a wide-range area tracking can be presented details of the landslide for example the tension cracks.

UAV記錄圖像進行大範圍區域跟踪可以介紹滑坡的細節，例如張力裂縫。

Conclusions

- When the landslide happens, the surface of the area is exposed without vegetation, so the digital surface model elevation of the area is equal to the digital terrain model(DSM),therefore, it presents the exact terrain elevation.

滑坡發生時，該區域的表面沒有植被暴露，因此該區域的數字表面模型高程(DTM)等於數字地形模型（DSM），因此，它呈現準確的地形高程。

- The comparison between the pre-disaster (DEM) and after-disaster (DSM) of the landslide area elevation is the landslide volume.

地滑面積中的災前（DEM）與災後（DSM）的比較量是滑坡體積量。

Conclusions

- According to the gradient of the slope, 4 possible motion paths are predicted and of which two factors of the loss of the foundation support and the earthquake effect are assumed.

假設基礎支持和地震效應損失的兩個因素。

- The rockfall stability analysis is carried out to evaluate the fall end of each path and the probability of occurrence and to presume the most possible occurrence and damage possible rock motion path.

推測最大發生機率與損害程度最大之運動軌跡。

THANKS FOR LISTENING