Application of the approach of susceptibility analysis in rock slopes considering geological data resolution from regional to site scales

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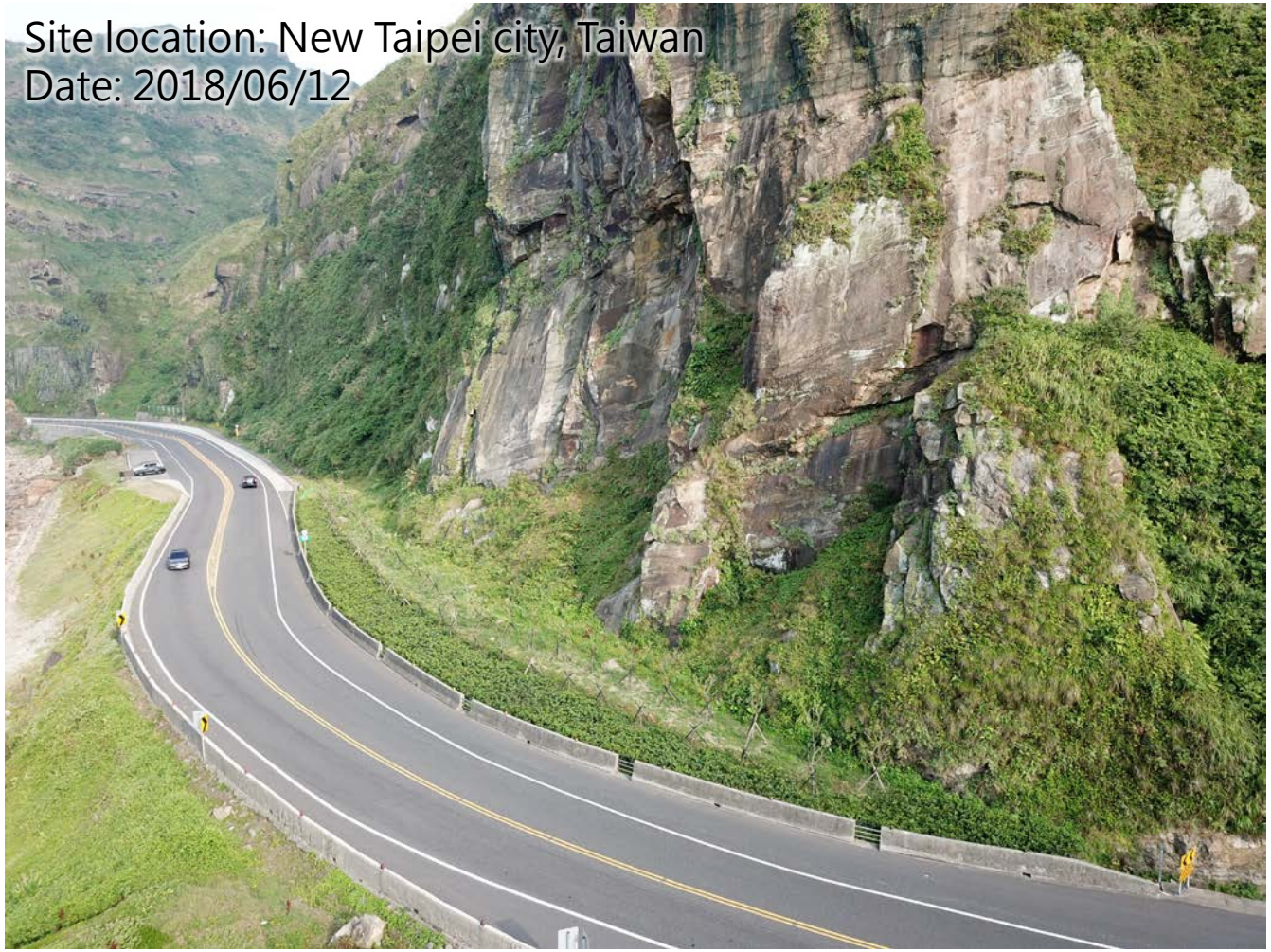
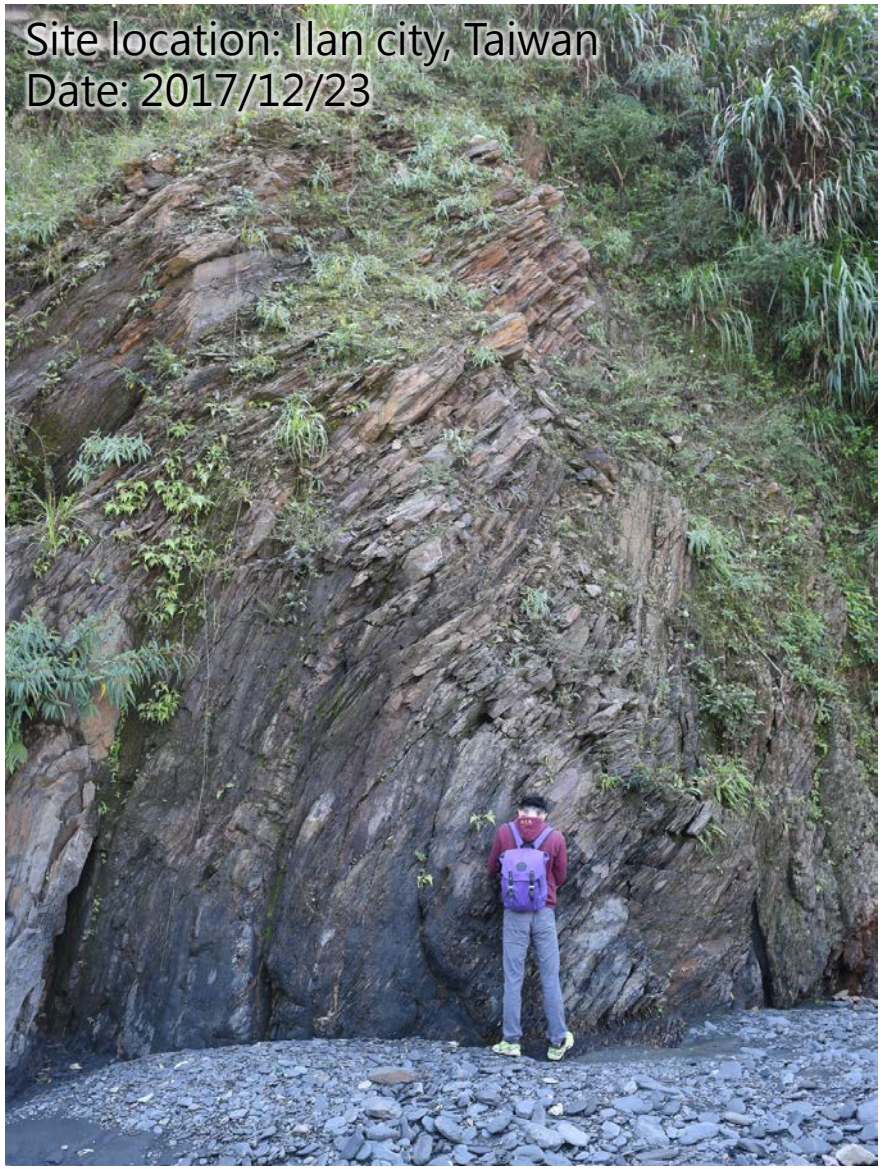
Rock slope failure in Taiwan

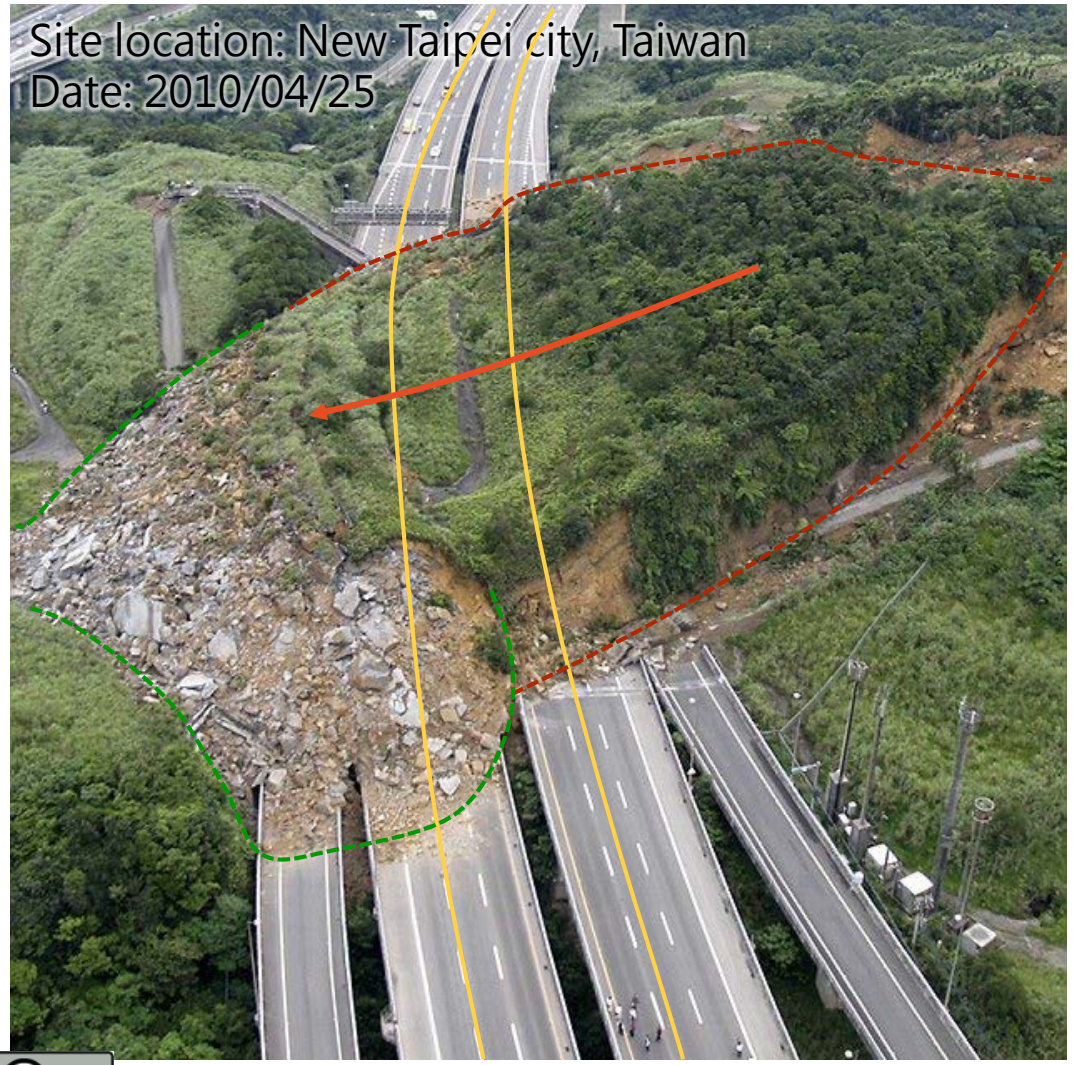
- Single event: rock fall/ toppling

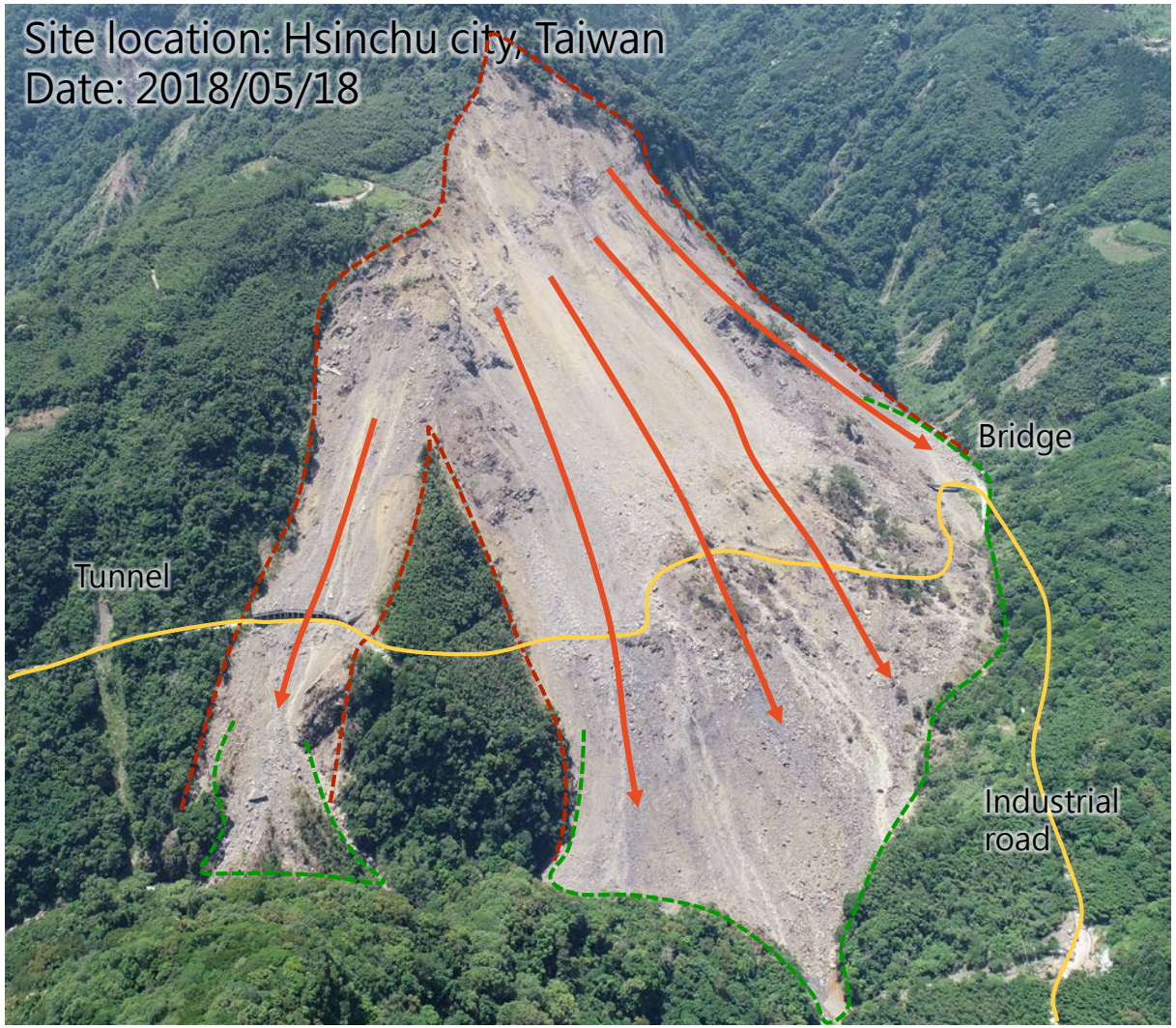




Rock slope failure in Taiwan

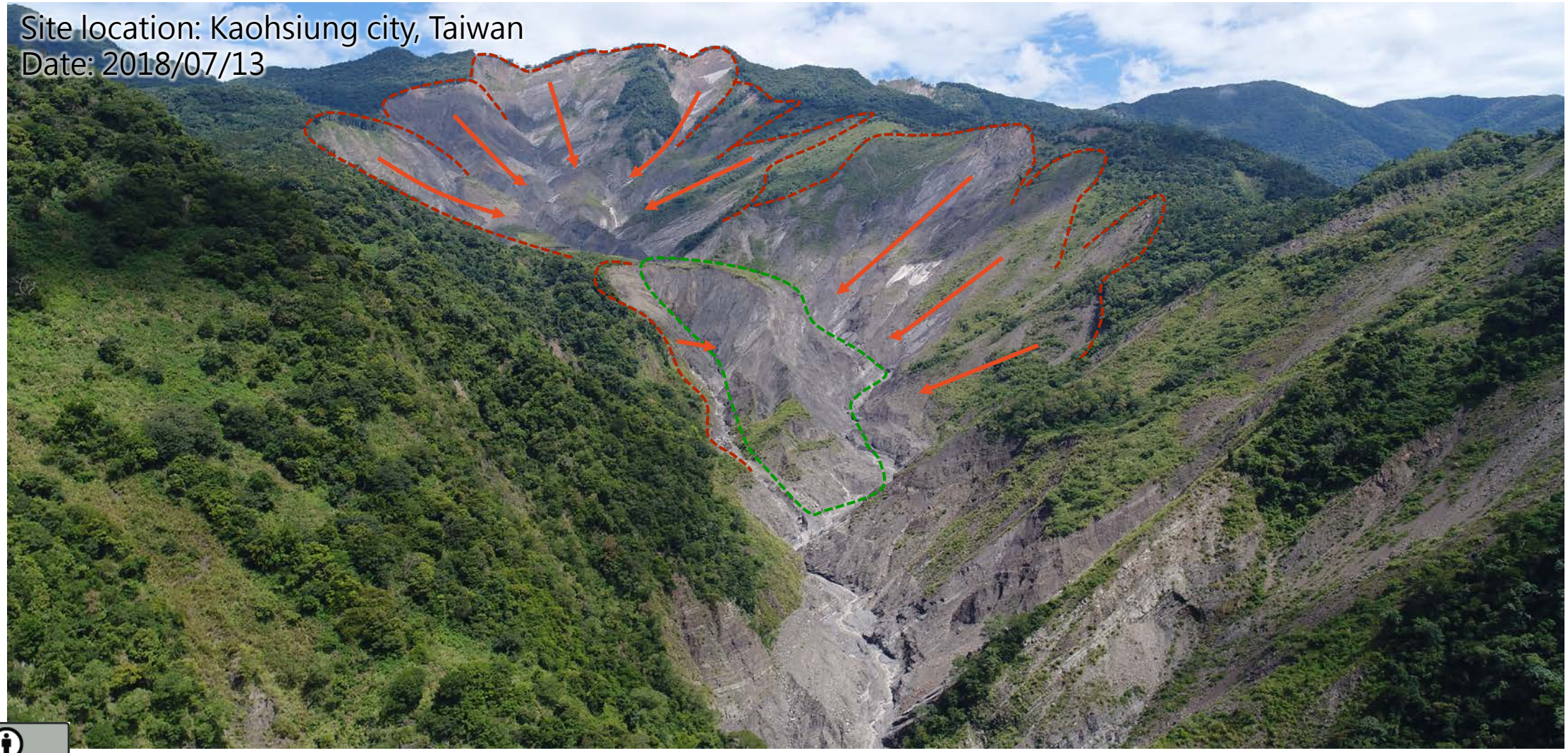
- Single event: rockslide





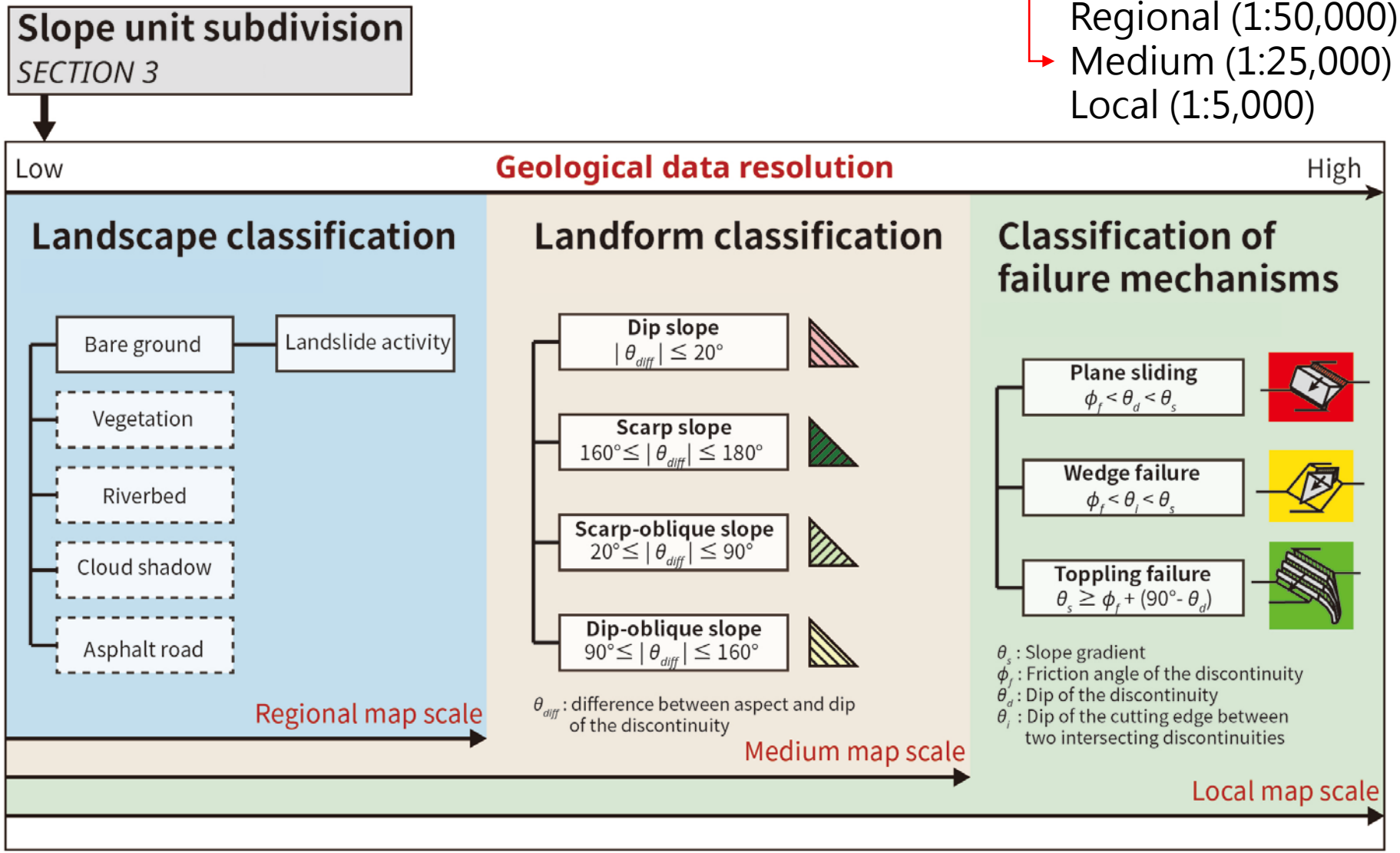
Rock slope failure in Taiwan

- Compound disaster



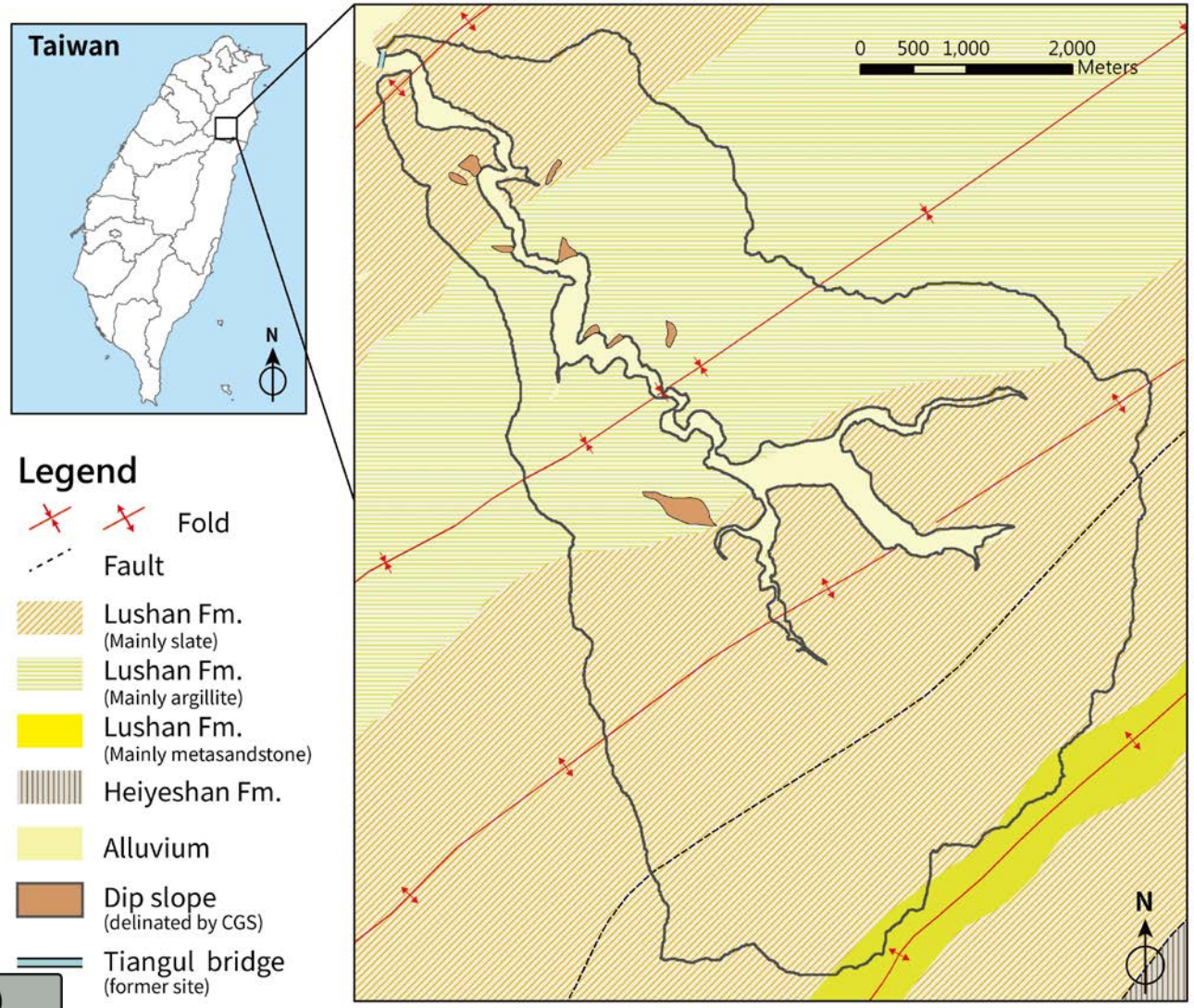
Purposes

- Produce rock slope susceptibility maps at different map scales
  - Regional (1:50,000)
  - Medium (1:25,000)
  - Local (1:5,000)

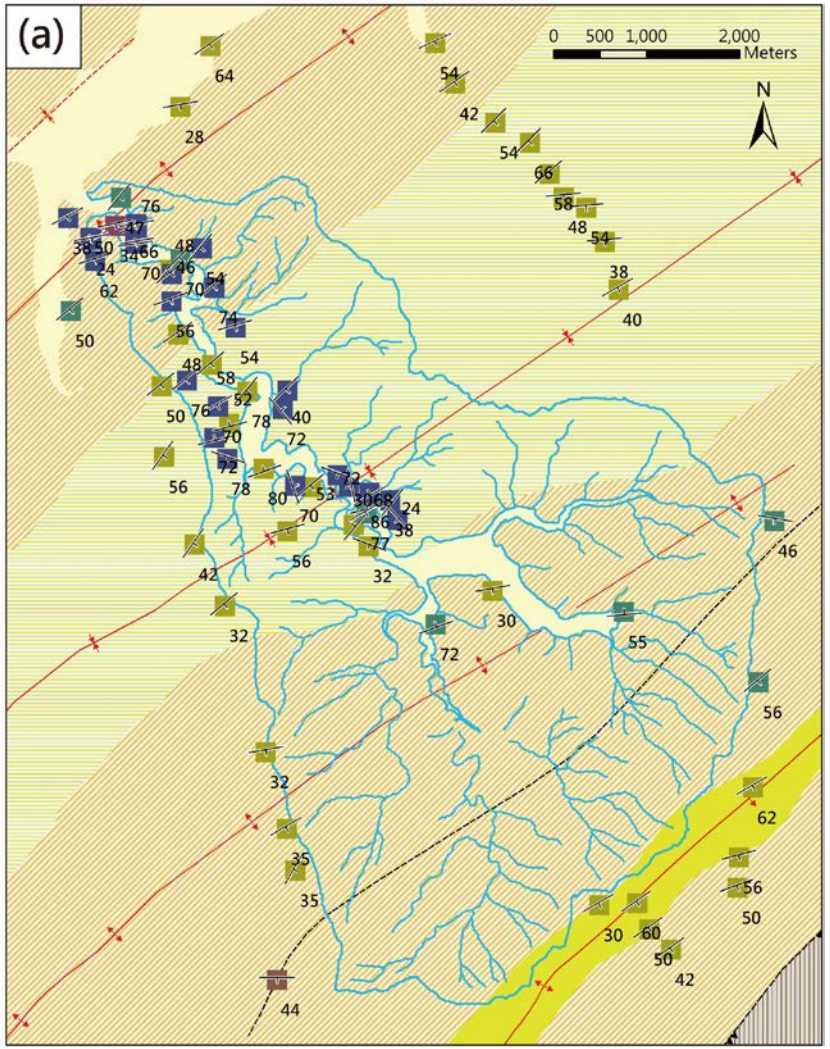


Study area

- Tiangul creek basin, Ilan city, Taiwan



Study area
(Collected geological data)



data from 1:50,000 geological map

data from Ogasawara (1933)

data from Tseng (1978)

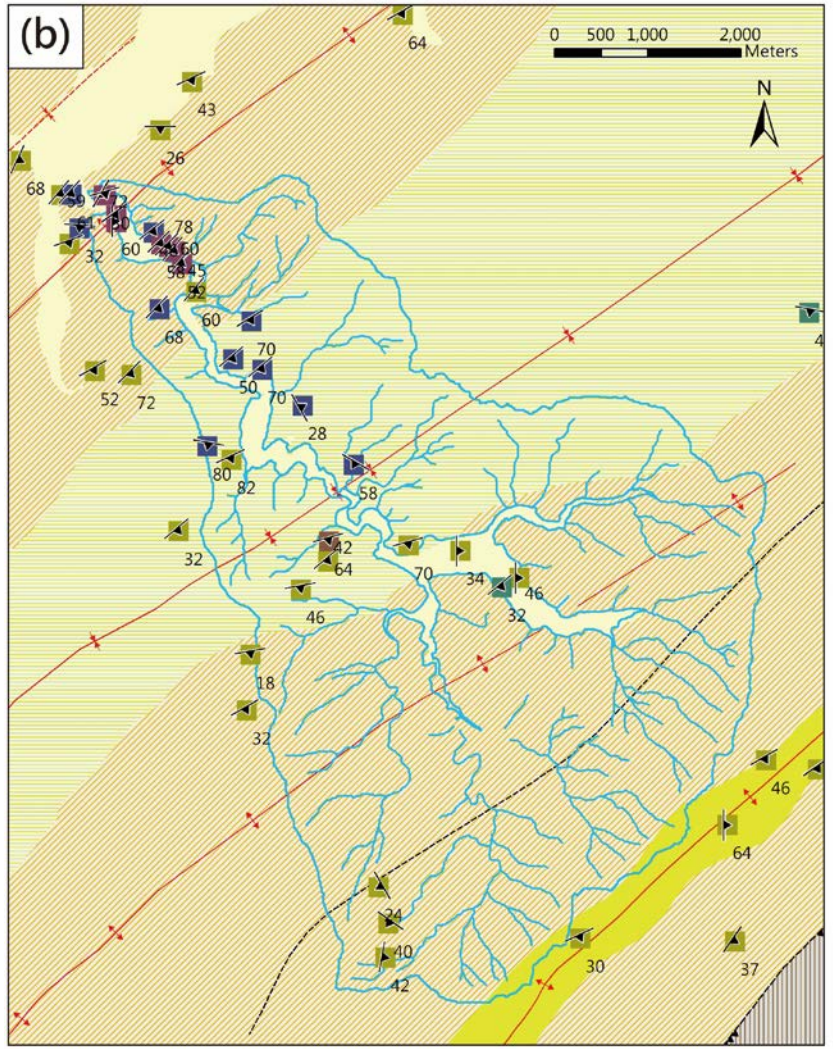
data from Lo (2012)

data from 2015 field investigations

bedding — 42 data

cleavage — 32 data

Total of 74 geological data.



Study area
(Collected geological data)

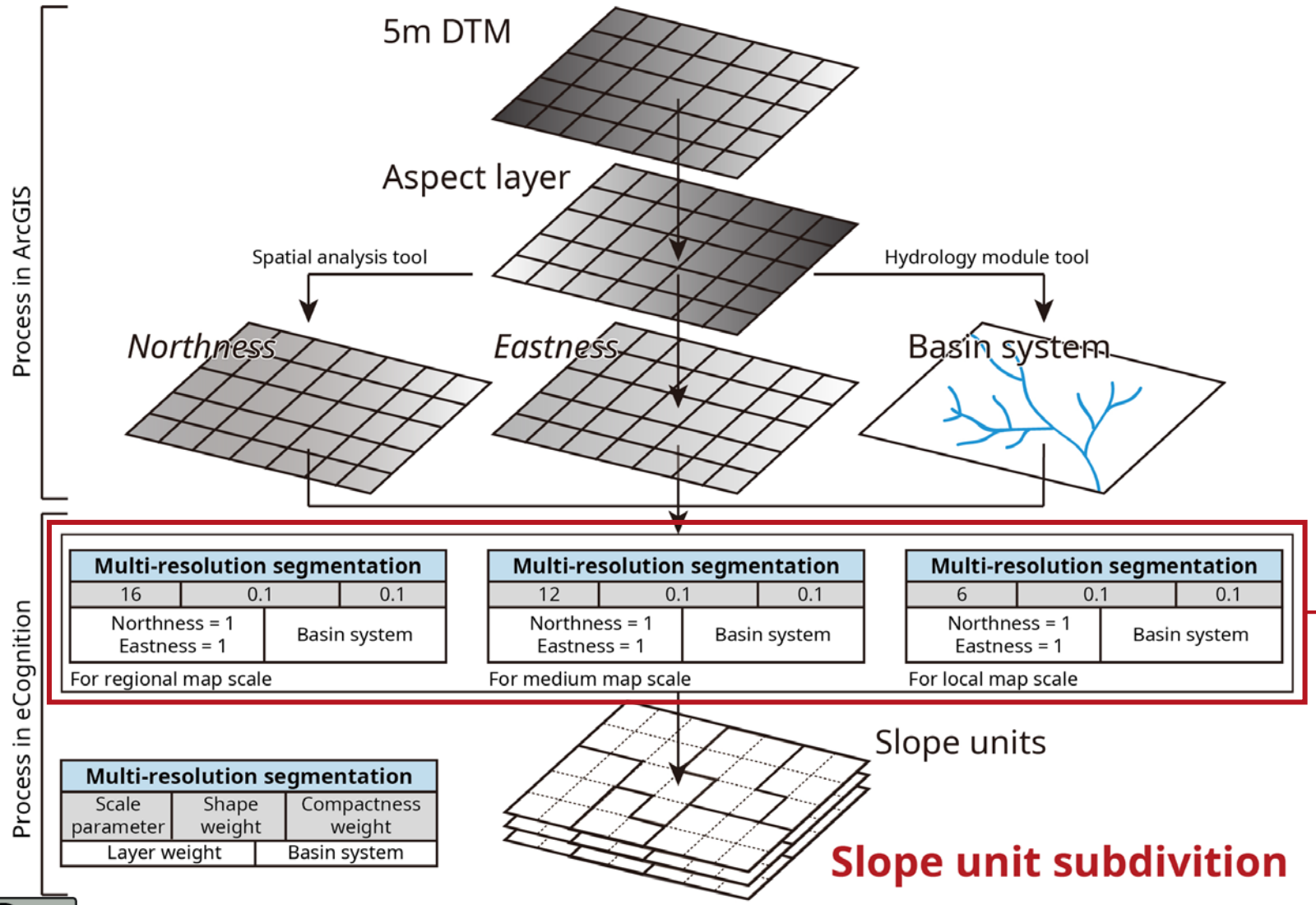
Table I Statistics of bedding data

Data source	Scale	Numbers	Percentage (%)
Ogasawara (1933)	1:100,000	0	0
Tseng (1978)	1:100,000–1:50,000	5	12
CGS of Taiwan (1995, 2008)	1:50,000	11	26
Lo (2012)	1: 5,000	25	60
Field investigation	< 1: 5,000	1	2

Table II Statistics of cleavage data

Data source	Scale	Numbers	Percentage (%)
Ogasawara (1933)	1:100,000	0	0
Tseng (1978)	1:100,000–1:50,000	1	3
CGS of Taiwan (1995, 2008)	1:50,000	11	34
Lo (2012)	1: 5,000	8	25
Field investigation	< 1: 5,000	12	38

Slope unit subdivision



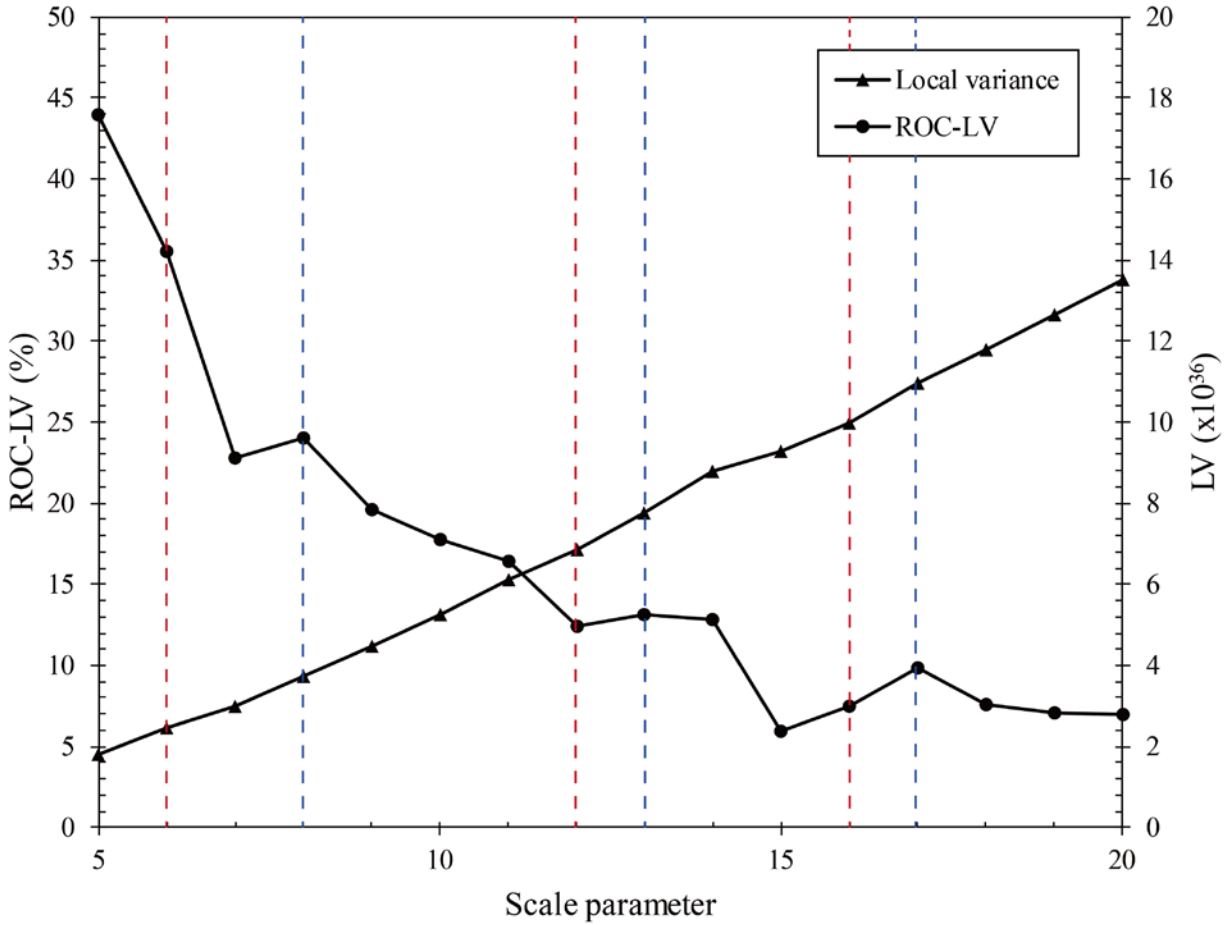
Object-based image analysis (OBIA)

Slope unit subdivision

- Strategy 1:
  defines temporary SPs by evaluating the homogeneity of each object. (Drăguţ et al., 2014)

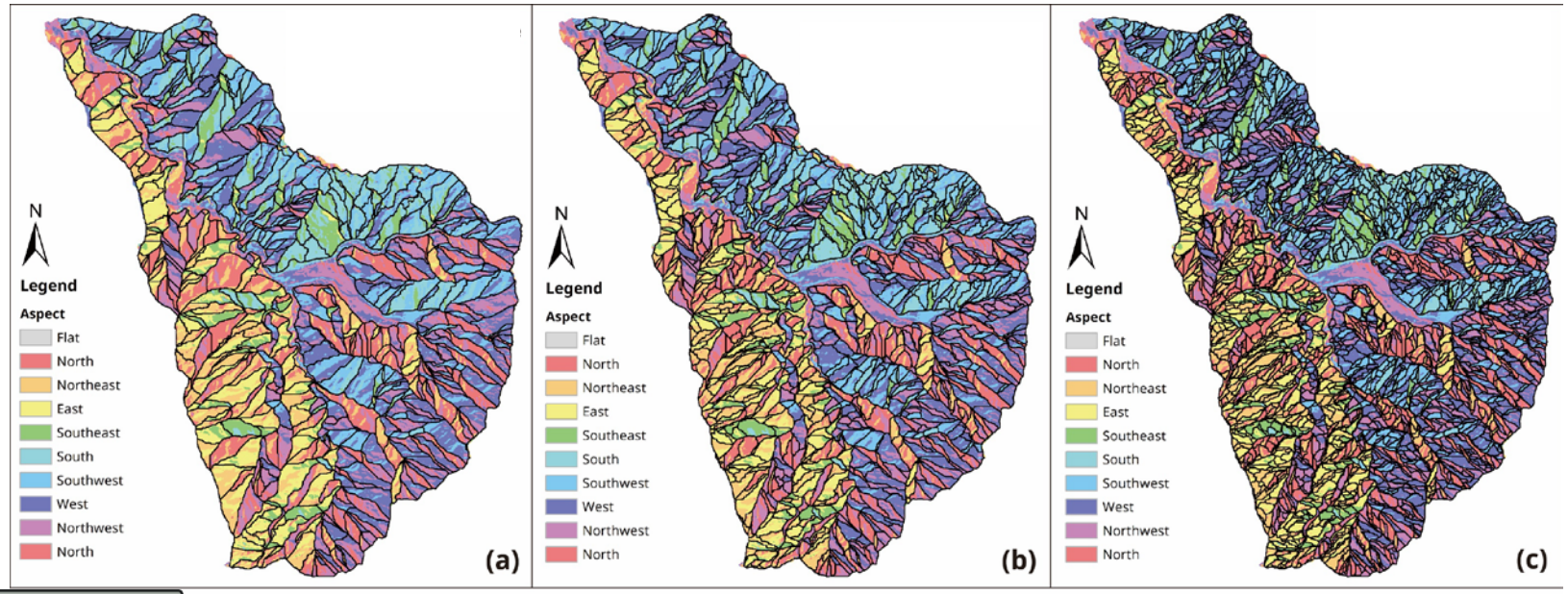
- Strategy 2:
  verifies the SU size according to the map scale. (Calvello et al., 2013)

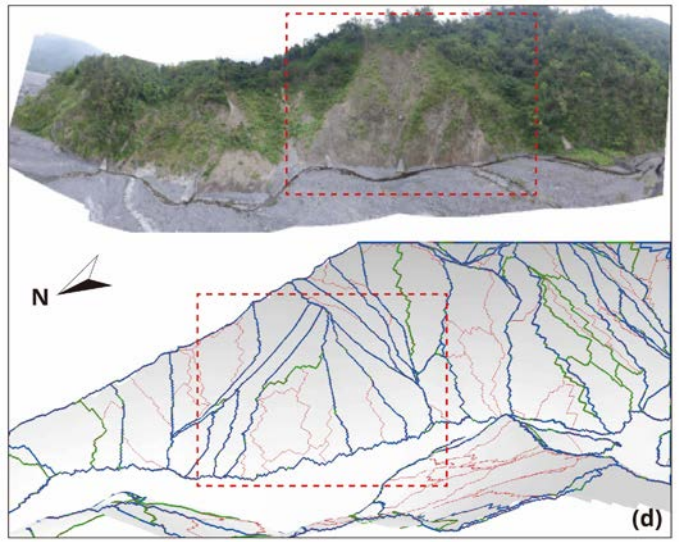
- Strategy 3:
  compares the standard deviation of the terrain aspect within an SU with a threshold of 40°.

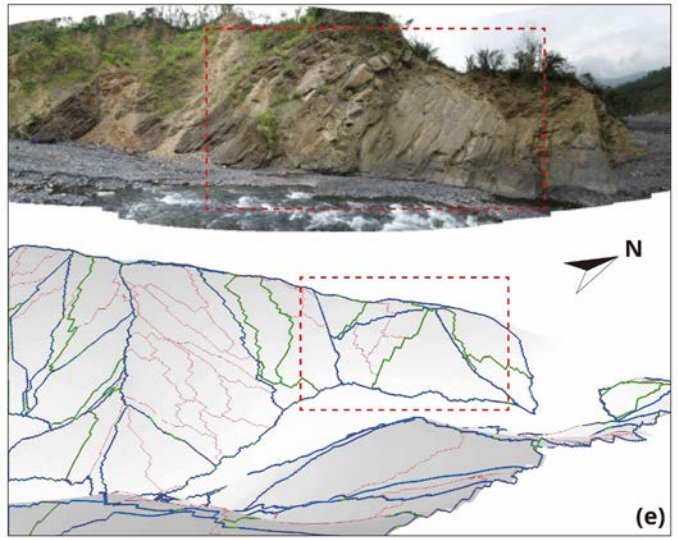


Slope unit subdivision

Map scale	Scale parameter	Total numbers	Average area (hectare)	Average SD of slope aspect	Suggested area of SU by this study (m^2)
Regional (1:50,000)	16	663	5.0	41.1	50,000
Medium (1:25,000)	12	1222	2.7	39.1	27,000
Local (1:5,000)	6	2788	1.2	37.2	12,000







Landscape classification
(Regional map scale; 1:50,000)

Multi-resolution Segmentation

Scale parameter 40	Shape weight 0.3	Compactness weight 0.5
Layer weight Panchromatic = 1; Slope layer = 1	N/A	

Assign class
Threshold
Brightness > 62

Vegetation

Merge
Vegetation

Unclassified

Assign class
Threshold
Slope < 12

Riverbed

Unclassified

Nearest Neighbor
Domain
Brightness, Pan and Slope

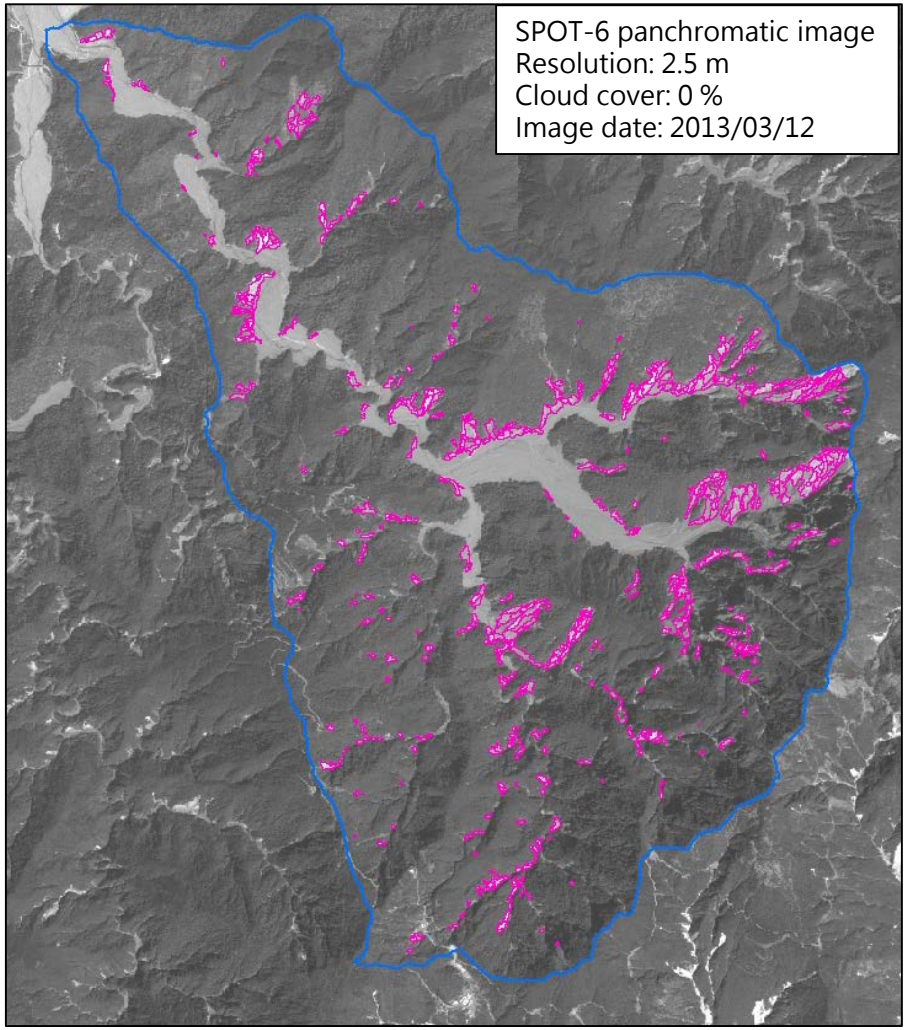
Cloud shadow

Bare ground

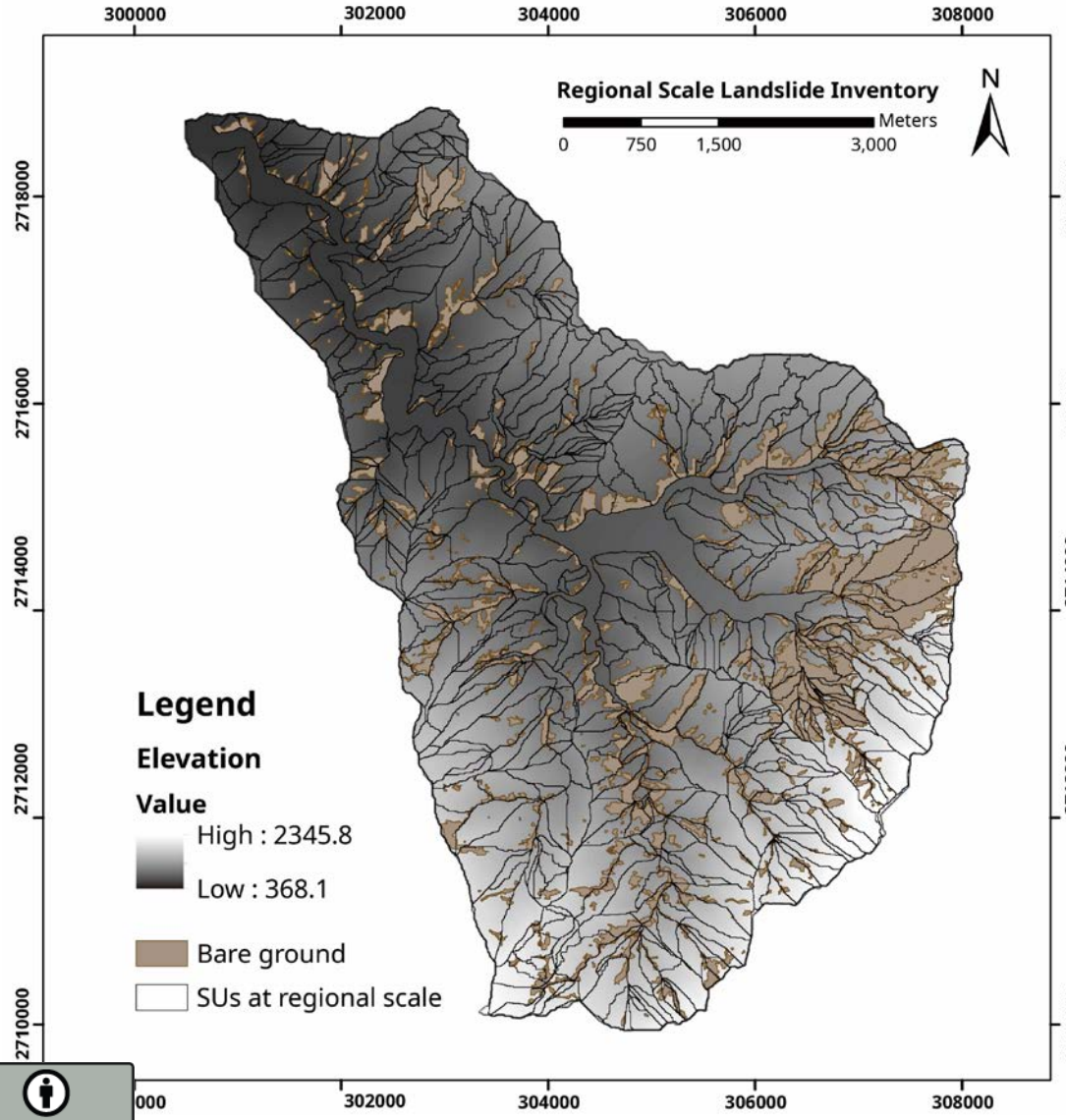
Asphalt road

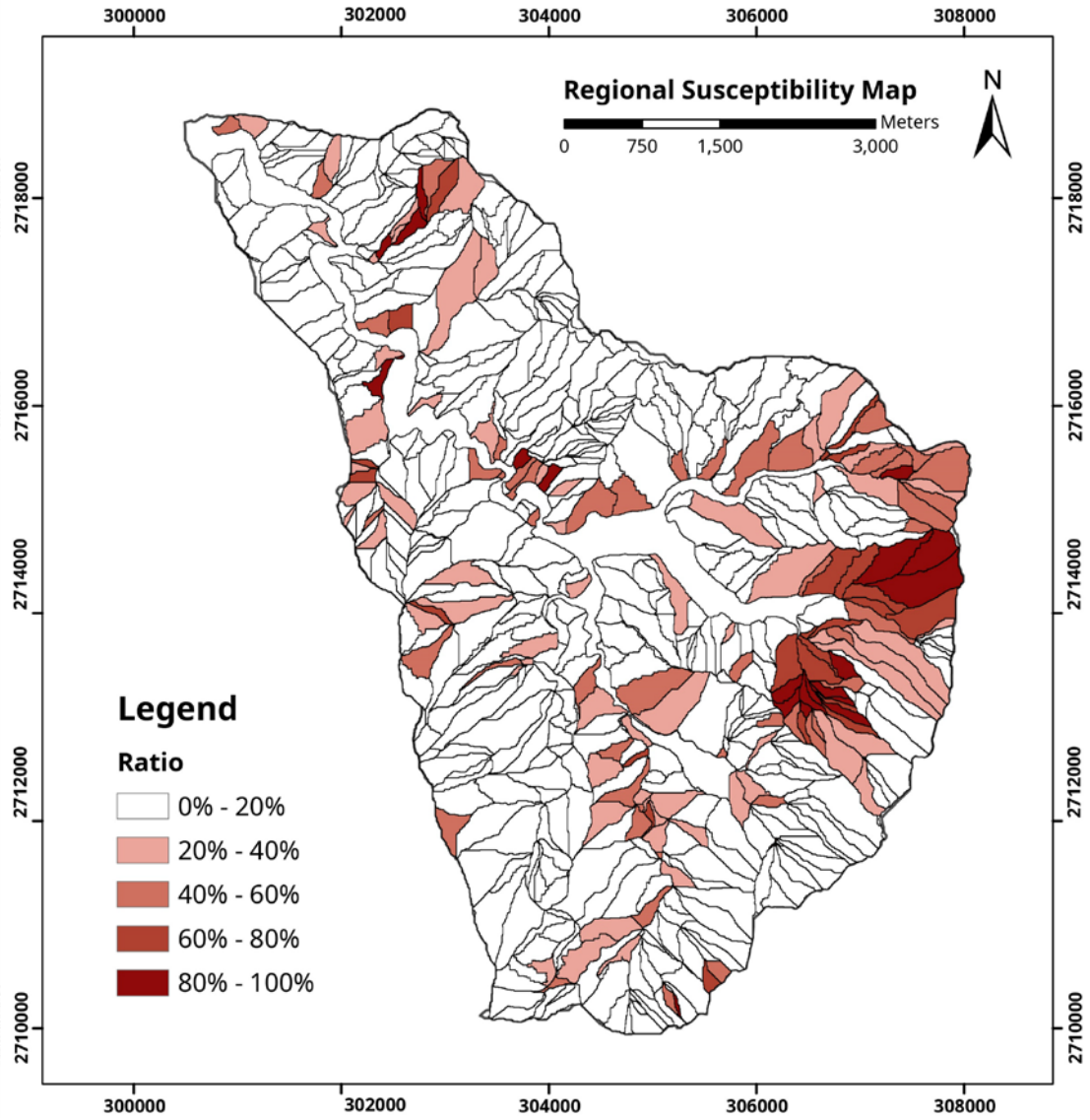
Merge
Bare ground

Landscape classification
at regional scale

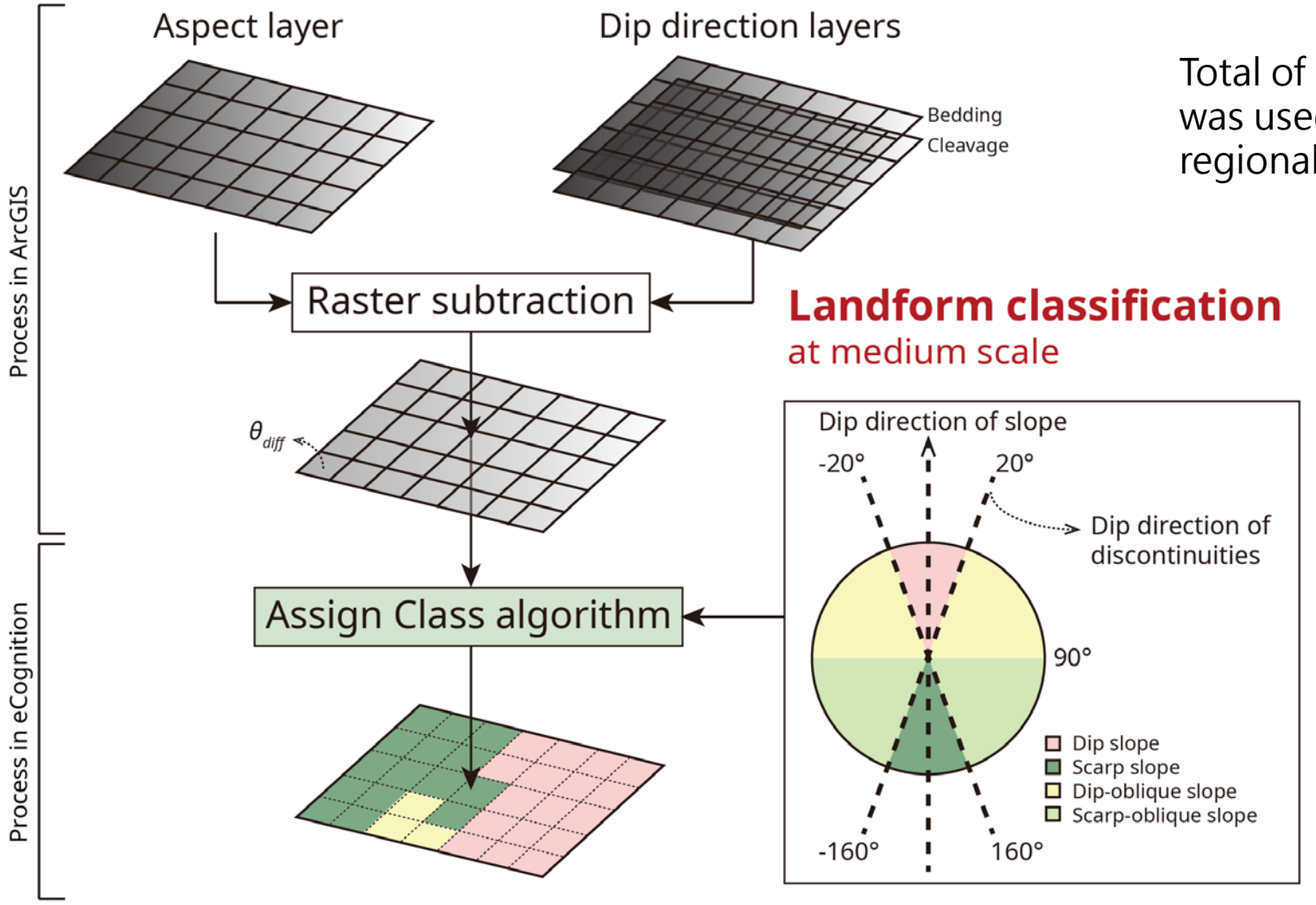


Landscape classification
(Regional map scale; 1:50,000)





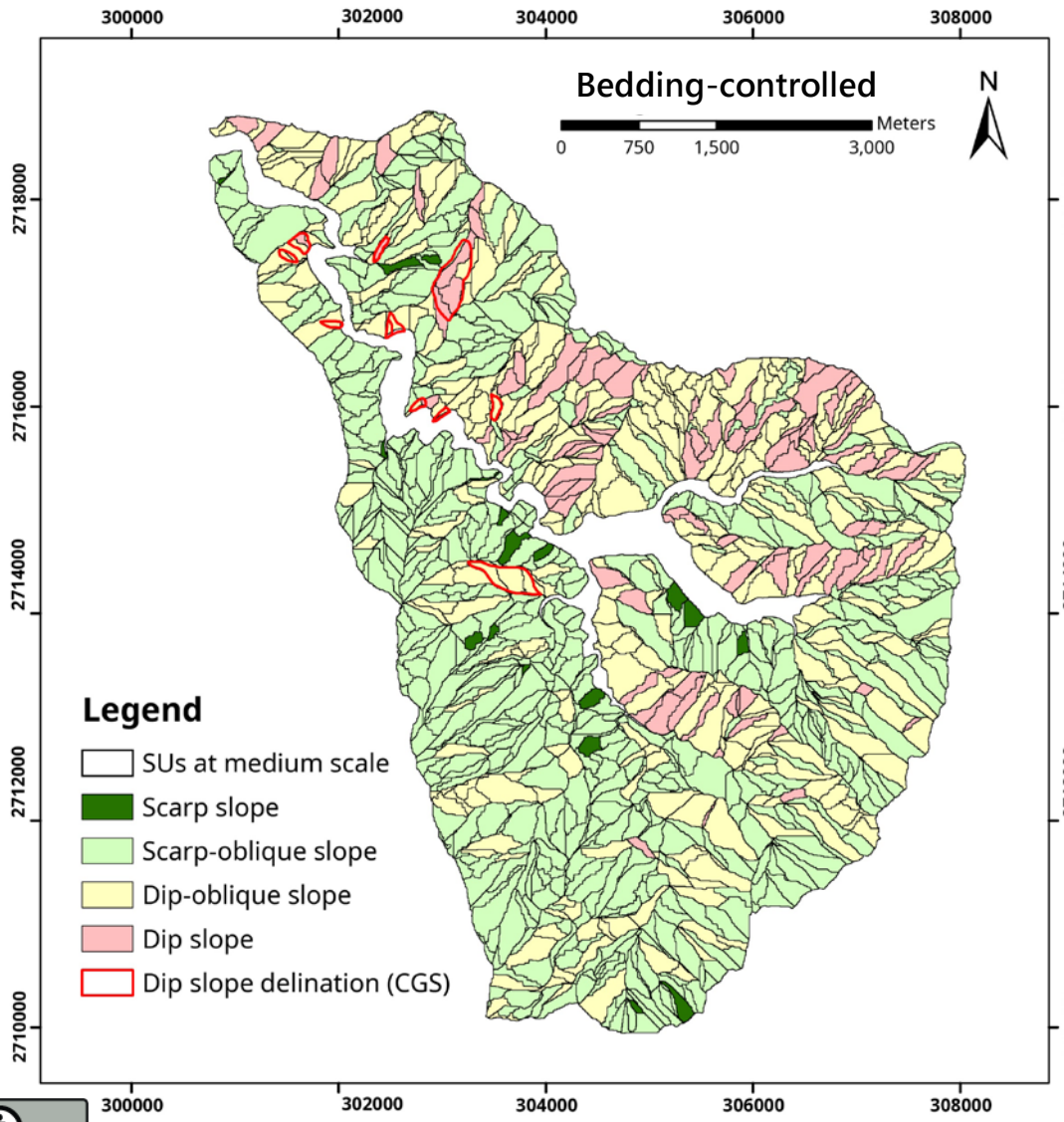
Landform classification
(Medium map scale; 1:25,000)

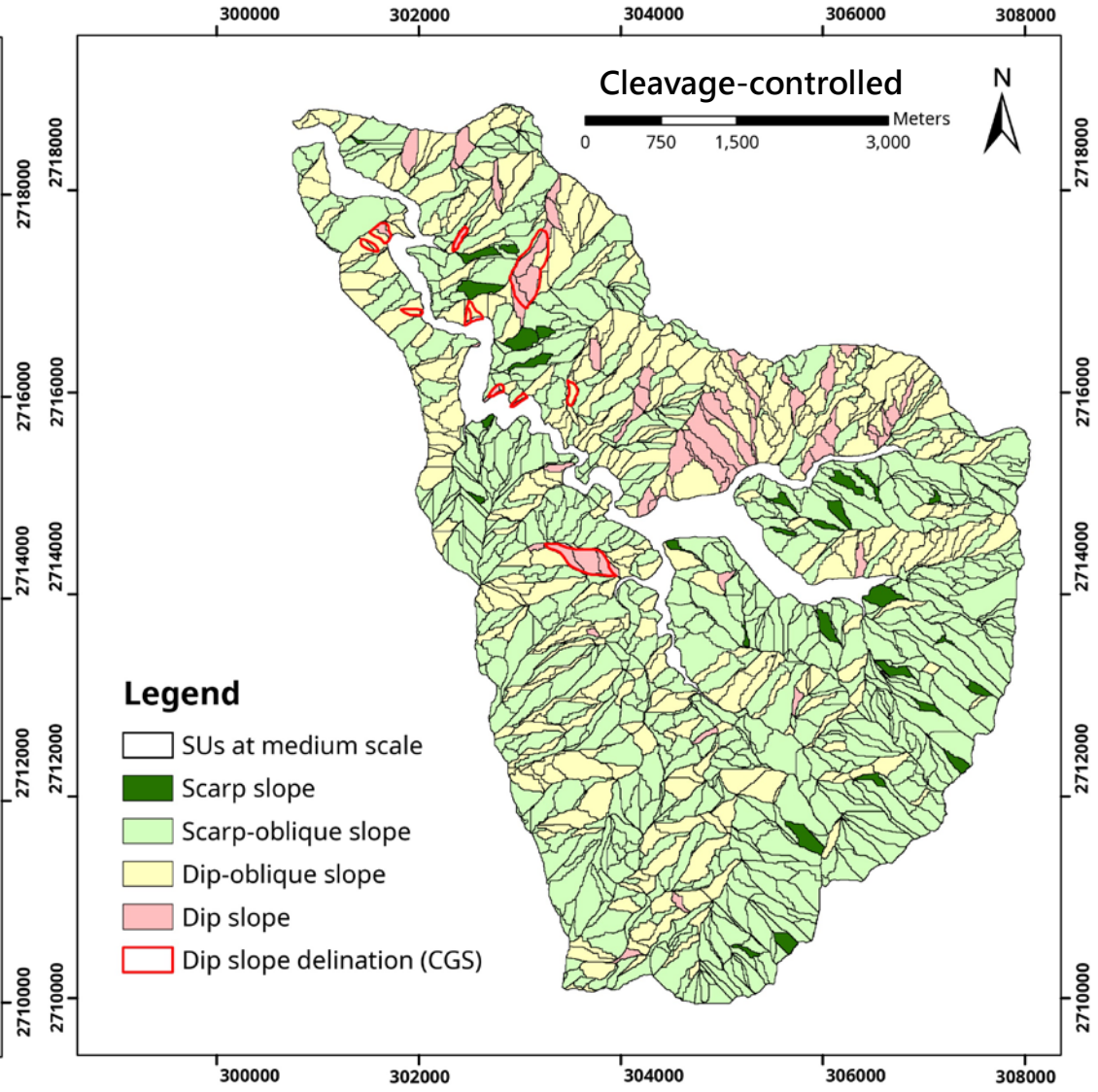


Total of 74 geological data was used in the analysis of regional scale.

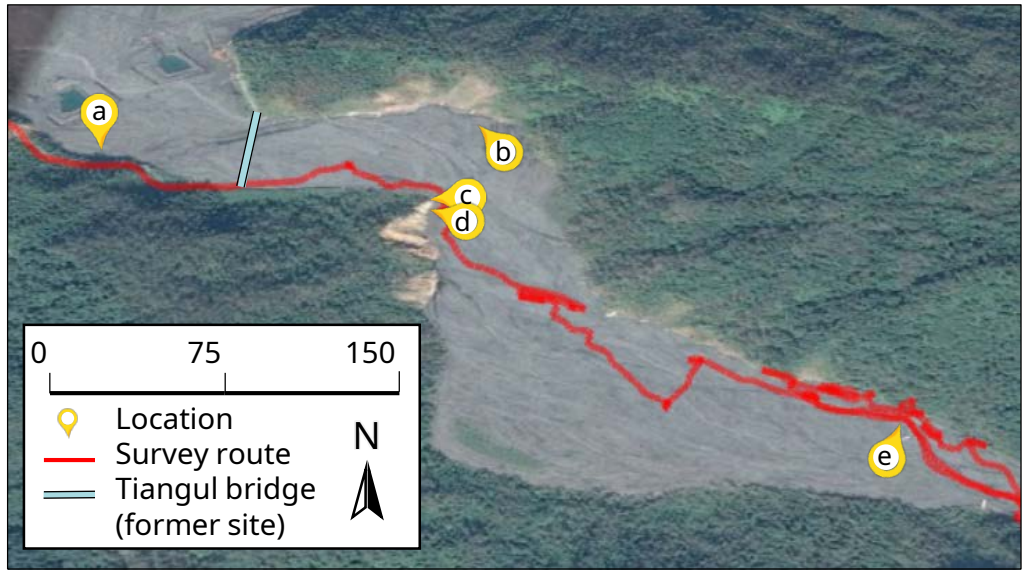
Landform classification

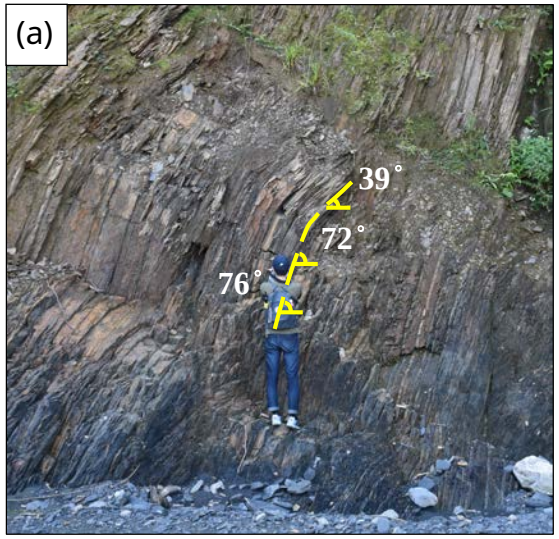
(Medium map scale; 1:25,000)



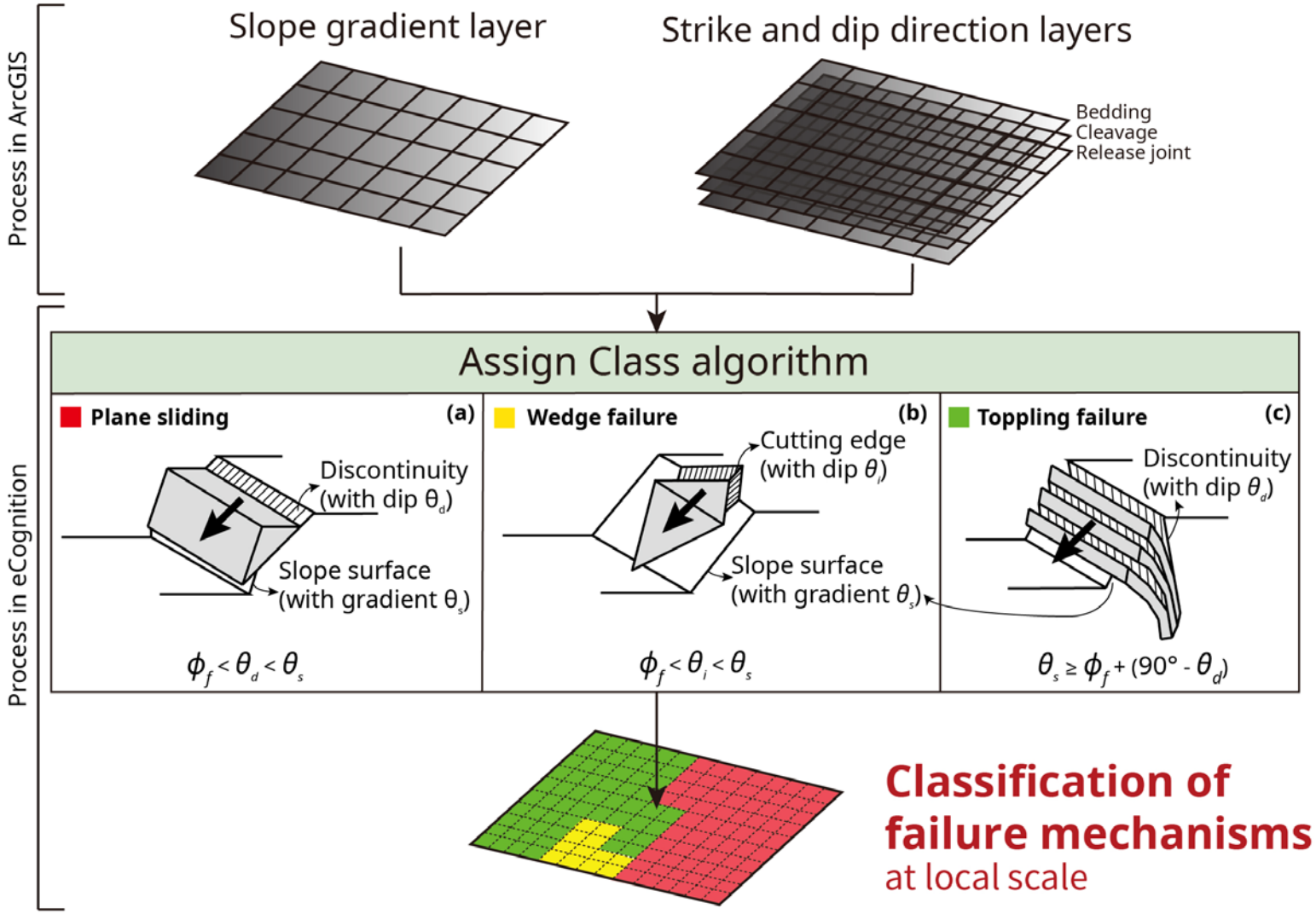


Landform classification
(Medium map scale; 1:25,000)

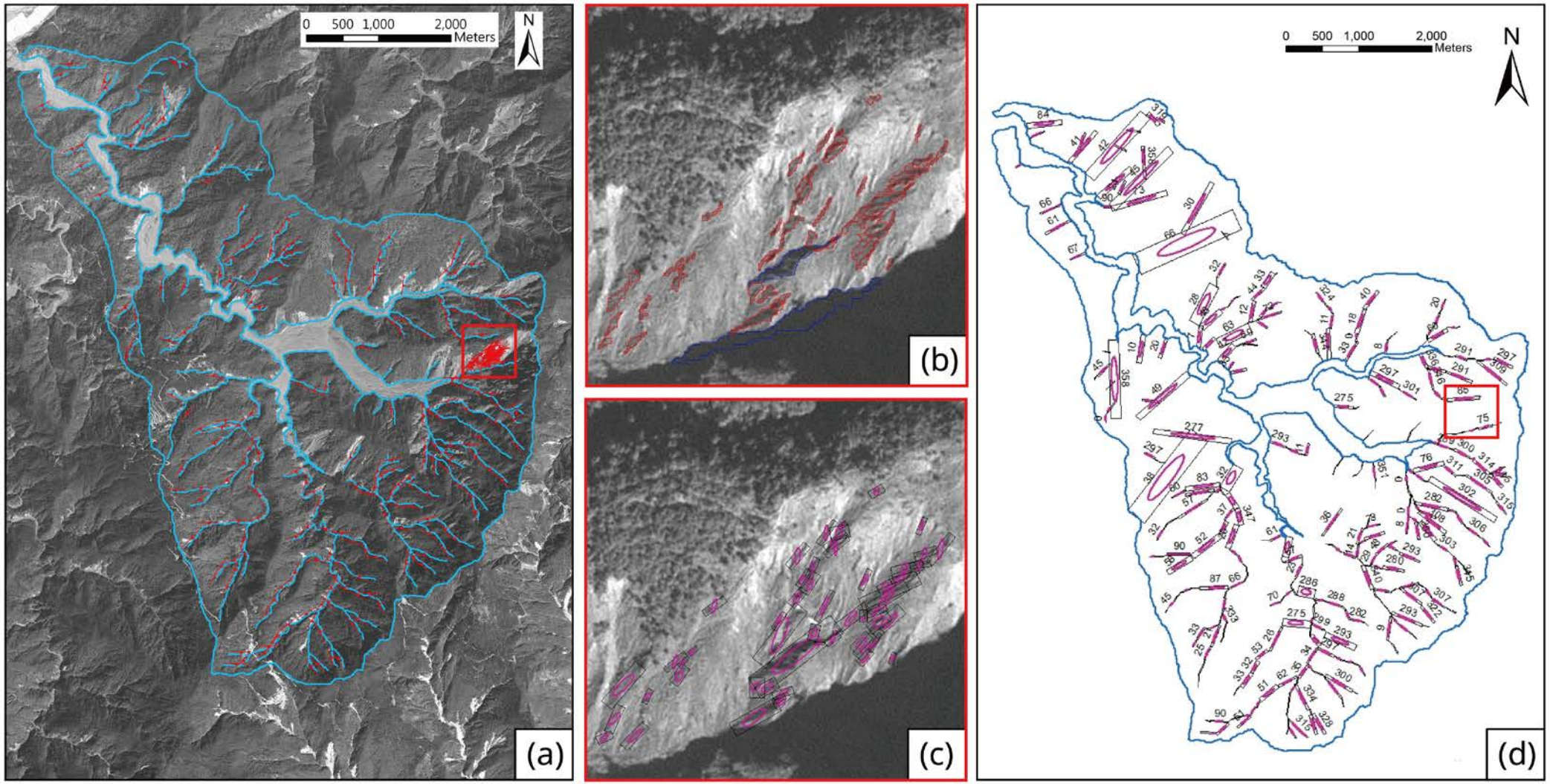




Classification of failure mechanisms
(Local map scale; 1:5,000)



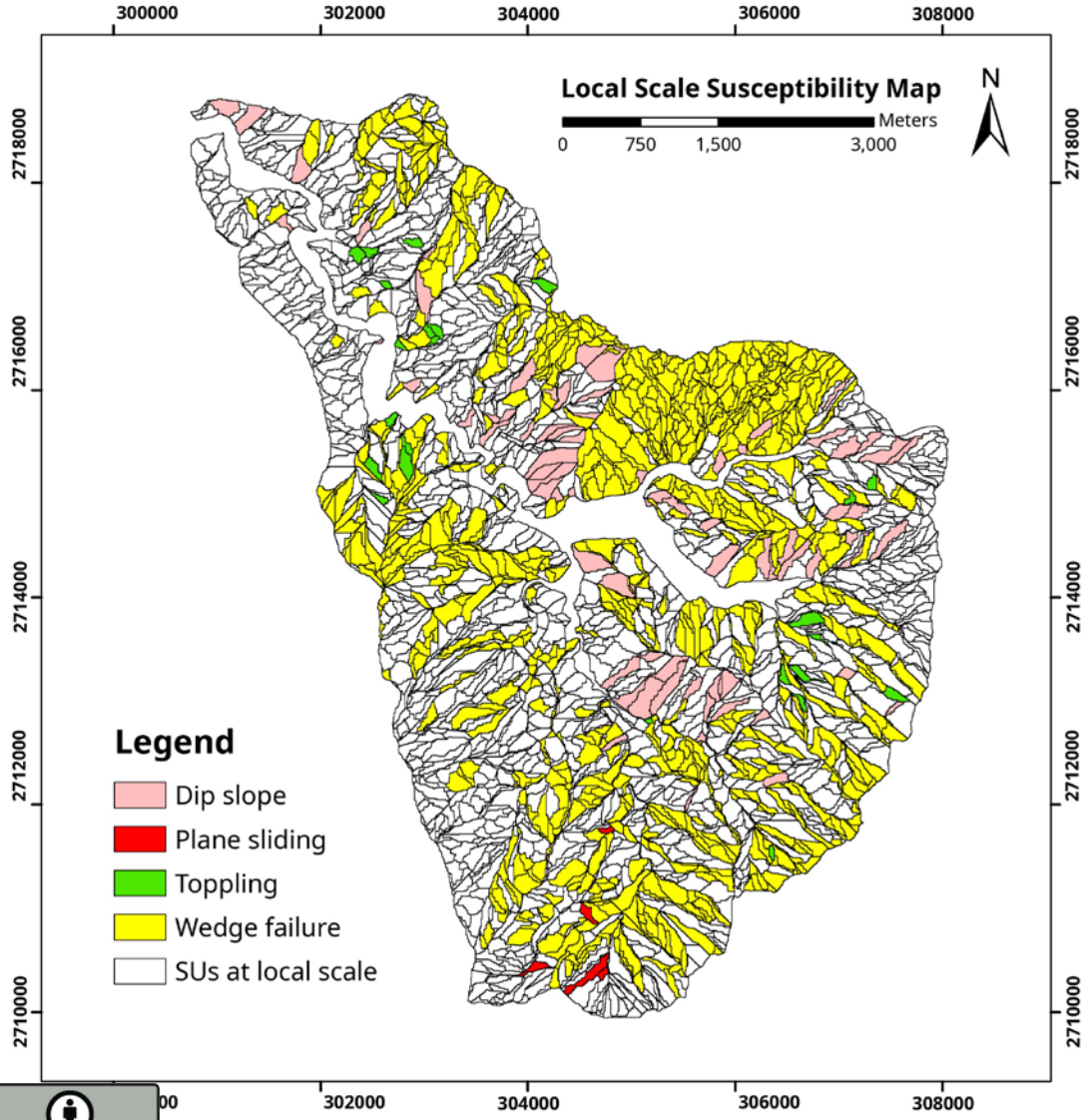
Classification of failure mechanisms
(Local map scale; 1:5,000)

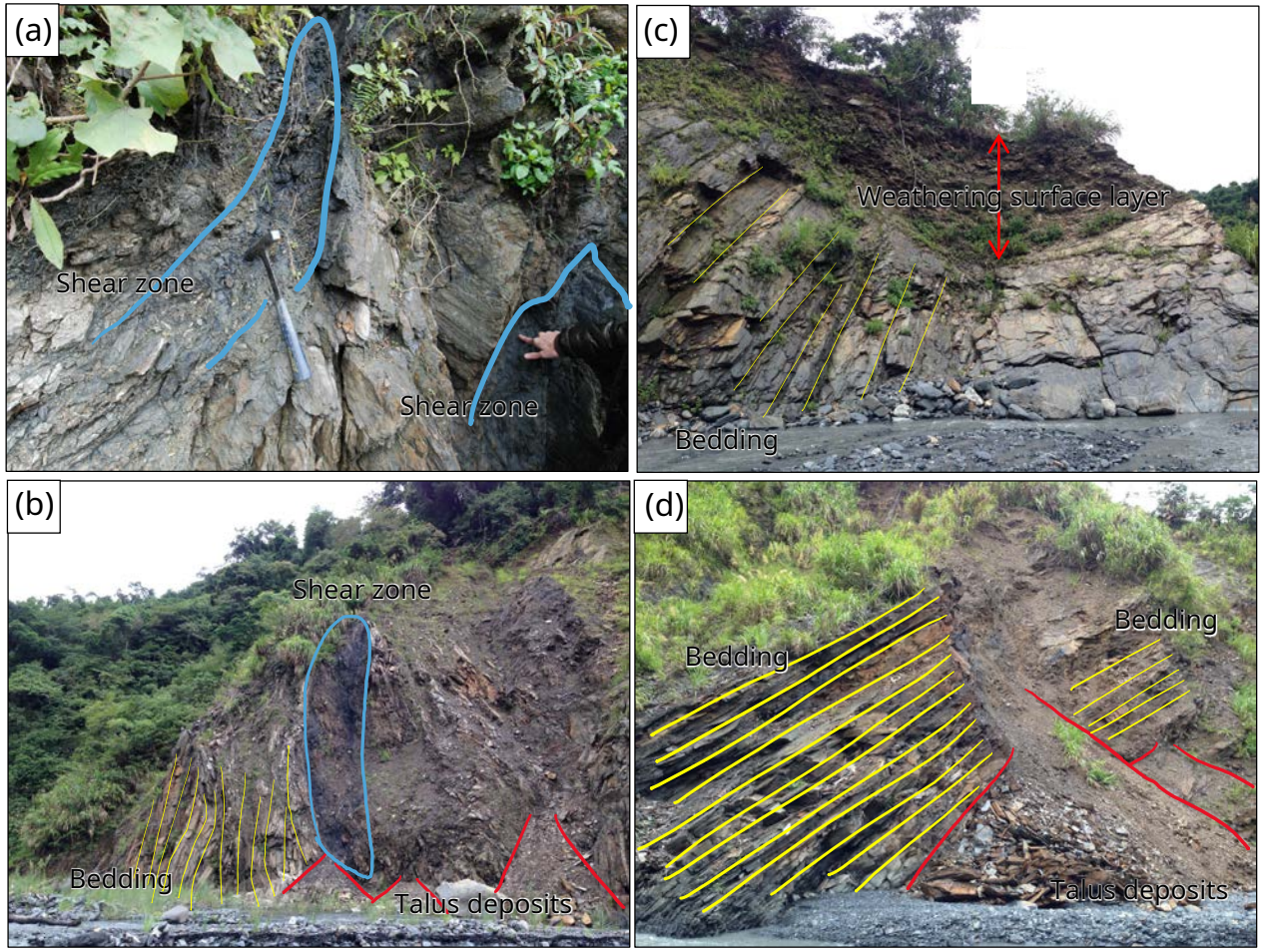


Numbers of geological data increased from 74 to 306.

Classification of failure mechanisms

(Local map scale; 1:5,000)



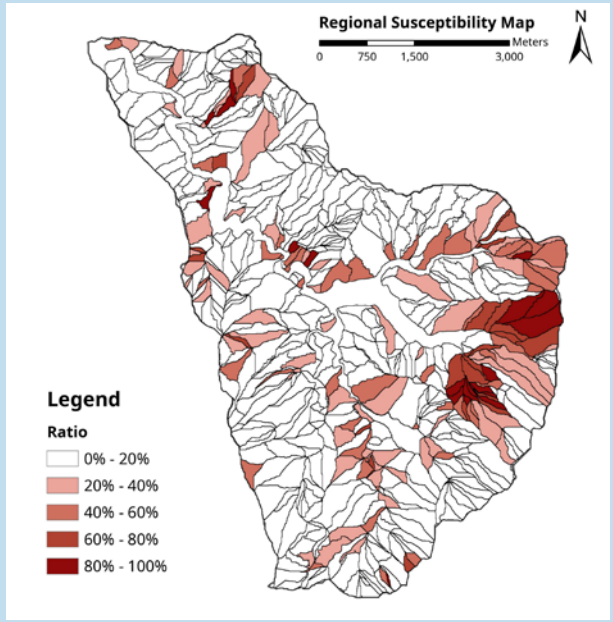


Conclusions

Large — **Slope unit dimension** — Small

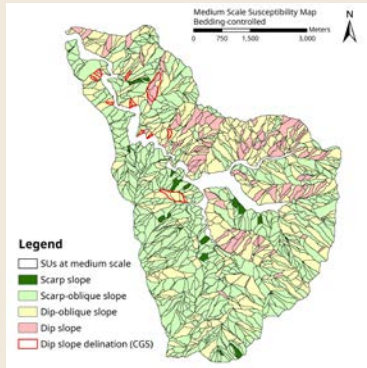
Low — **Geological data resolution** — High

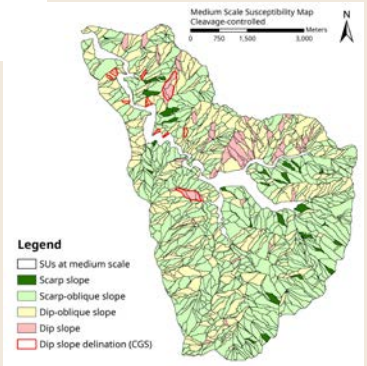
Landscape classification



Regional map scale

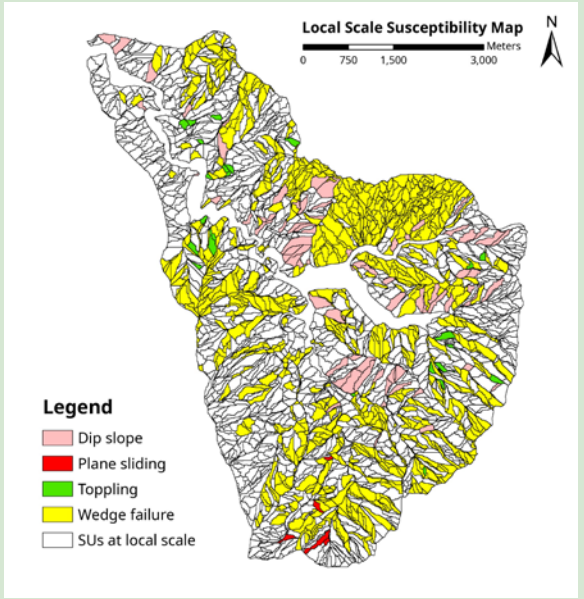
Landform classification





Medium map scale

Classification of failure mechanisms



Local map scale

Using higher-resolution terrain data, such as LiDAR and UAV-based DSM

Site map scale (>1:1,000)

Thanks for your listening

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Lin, C. H., Lin, M. L., Peng, H. R., & Lin, H. H. (2018). Framework for susceptibility analysis of layered rock slopes considering the dimensions of the mapping units and geological data resolution at various map scales. *Engineering Geology*, *246*, 310-325.