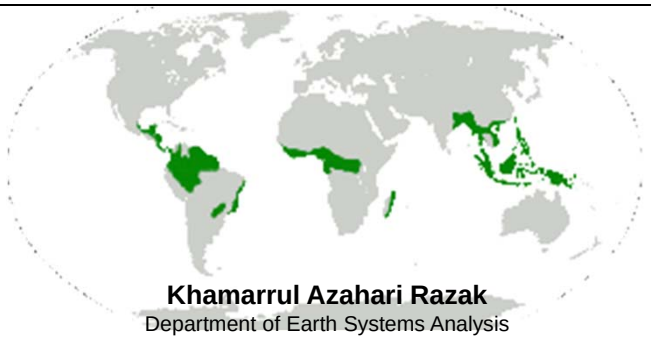
Mapping elements at risk for landslides in the tropics using airborne laser scanning



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Acknowledgement:

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INTRODUCTION

- Elements at risk is defined as objects which possess the potential to be adversely affected.
- emphasis to the buildings, population and infrastructure, which are at particular risk for landslides.
- It is an essential component for vulnerability assessment and required for a total risk calculation.

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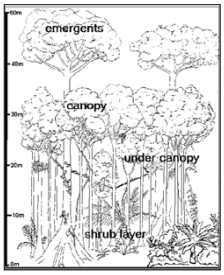
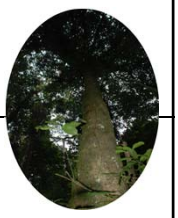
Mapping elements at risk for landslides

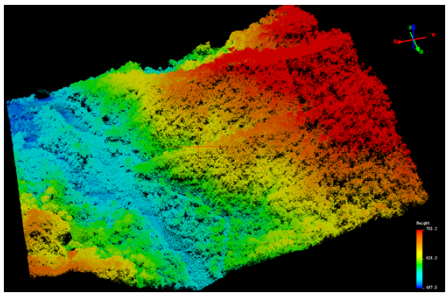
- Characteristics of elements at risk are required to be properly collected.
- In the tropics, mapping process is rather difficult because of climatic, topographic and anthropogenic factors.
- A rapid and accurate inventory of the elements at risk in the mountainous equatorial regions is needed.



Airborne laser scanning in the tropics



- An appropriate tropical-building detection method and its parameterization is scarcely well-documented.
- Extracting the building footprint, from low point density and imperfect ALS data in the tropics is a challenging task.
- A complete quantitative assessment on the extracted buildings are hardly accomplished.



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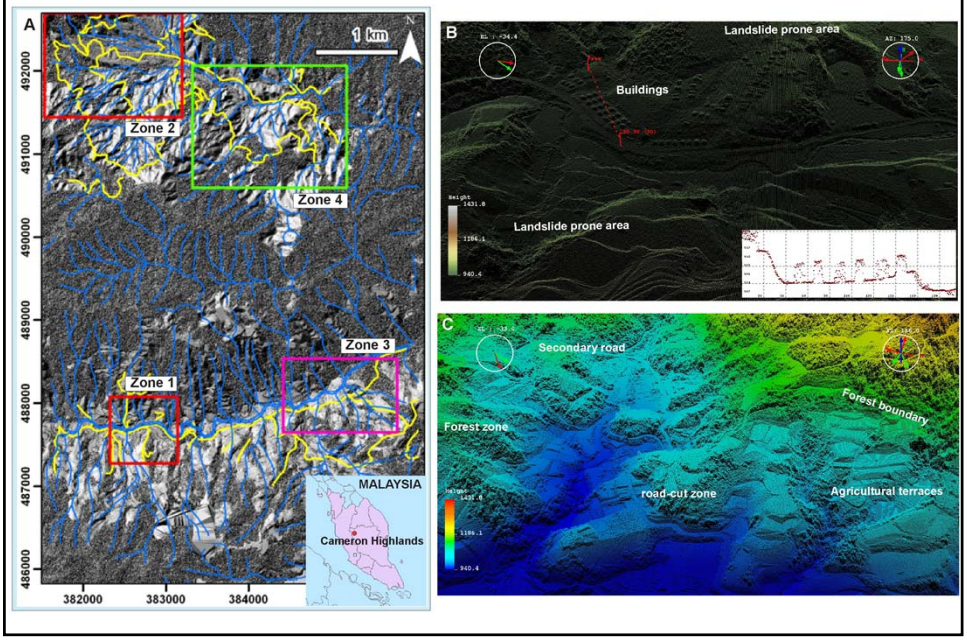
STUDY AREA: Cameron Highlands, Malaysia



METHODS

Airborne laser scanning measurement

- Acquired by the Department of Survey and Mapping Malaysia
- Airborne Laser Terrain Mapper (ALTM) 3100 laser scanning system, coupled with ALTM-IMU was used
- 40 million point clouds in a rugged forested terrain of 32 km2

Landslide recognition in the tropics

- Based on expert knowledge and high resolution ALS-derived images.
- The landslide filter is utilized, which specifically to deal with complexity of landslide morphology beneath dense vegetation.

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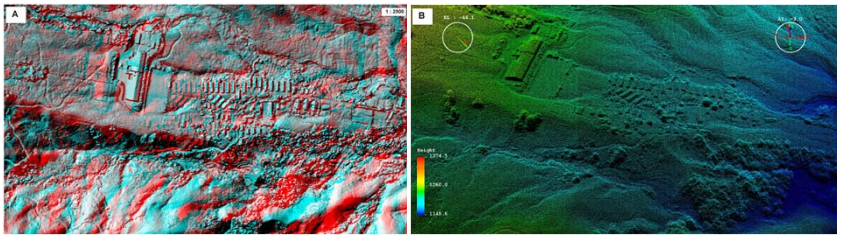
METHODS

Building extraction in the tropics (Building Filter)

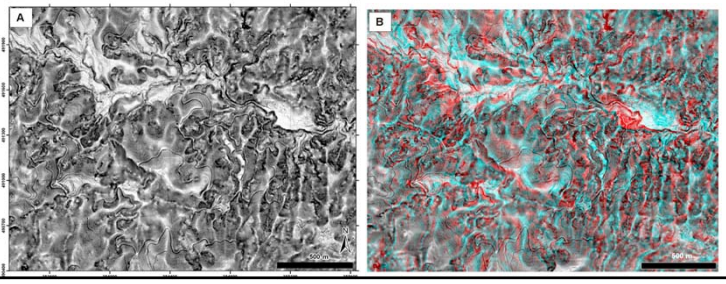
- It was implemented based on a hierarchical robust interpolation (HRI) method: a robust interpolation algorithm and weight function.
- The cell sizes, minimum size of building and minimum slope are the main parameterizations.
- Utilize of the edge detection and surface growing technique for a building detection, as implemented in the HRI method.
- The filter was considered low point density of ALS data, local knowledge on building geometric and topographical elements.



METHODS

Road extraction in the tropics

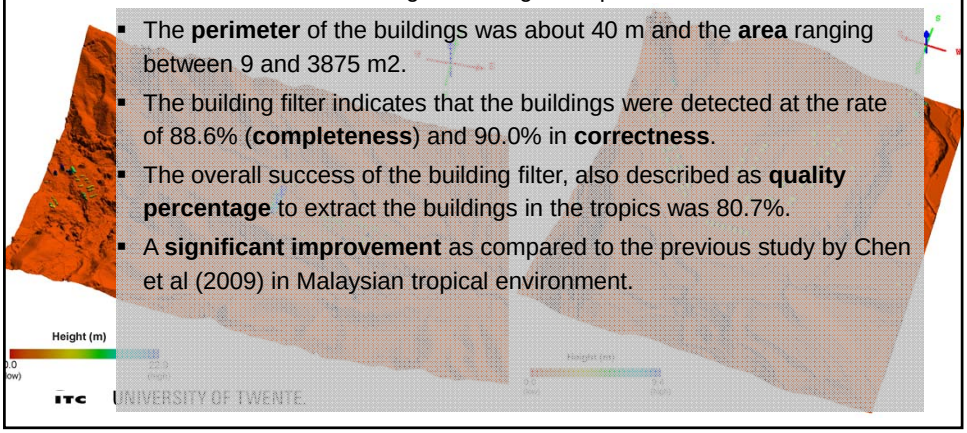
- More than 75% of the roads are located under forest.
- Utilize of 1 m ALS-derived topographic openness for extracting the roads. Types of the roads were also classified during the detection stages.
- topographic openness technique - to computes the zenith and nadir angles along the eight azimuth of DTM.



RESULTS AND DISCUSSION

Building maps and quantitative assessment of the building filter

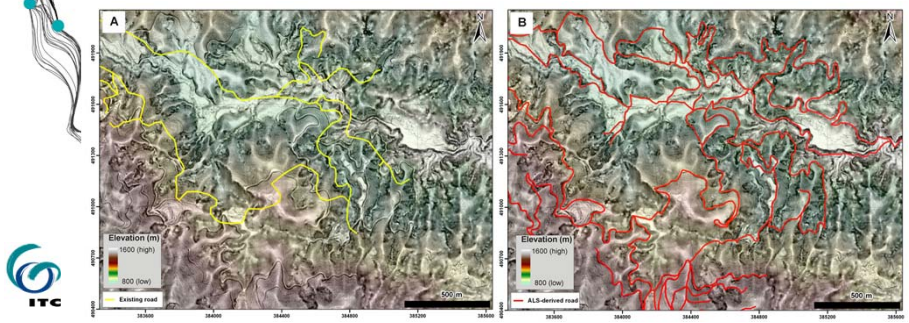
- We extracted 137 buildings with height of up to 20 m.
- The **perimeter** of the buildings was about 40 m and the **area** ranging between 9 and 3875 m2.
- The building filter indicates that the buildings were detected at the rate of 88.6% (**completeness**) and 90.0% in **correctness**.
- The overall success of the building filter, also described as **quality percentage** to extract the buildings in the tropics was 80.7%.
- A **significant improvement** as compared to the previous study by Chen et al (2009) in Malaysian tropical environment.



RESULTS AND DISCUSSION

Tropical road maps

- The topographic openness map revealed from a high resolution ALS-derived DTM provides an effective way to extract the tropical roads.
- The vertical accuracy of the ALS-derived road was about 0.68 m.
- Subsequent spatial data: road positions, length and road-gradient



RESULTS AND DISCUSSION

ALS-derived tropical roads

- we found about 58% of increment of the total road length compared to the existing road network.
- The mean gradient of ALS-derived road was in the range of 4 to 320, with standard deviation of 13.60.
- We calculated that about 28% of total road length was classified as road cuts, where usually landslides initiated and took place in these zones.



RESULTS AND DISCUSSION

ALS-derived tropical roads

- We found only 10% of the total length of ALS-derived road are identified as the primary roads, whereas the other roads are categorised as the secondary roads.
- We also observed that local farmers have tendency to cut the slopes to construct the roads and many road cuts are located on the secondary roads which are not well-maintained.
- This scenario revealed a high certainty to landslide occurrences.

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CONCLUSION

- Spatial characteristics and geometric attributes of the extracted objects are essential for landslide vulnerability assessment.
- The building detection rate and ALS-derived tropical road are significantly improved – extend to data driven approach for 3D building/road models.
- ALS is capable for a rapid and accurate mapping, which is one of the essential elements for emergency response.
- Topographic mapping technology - it should be part of the risk management and prevention policies in the disaster management.

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THANK YOU FOR YOUR ATTENTION

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