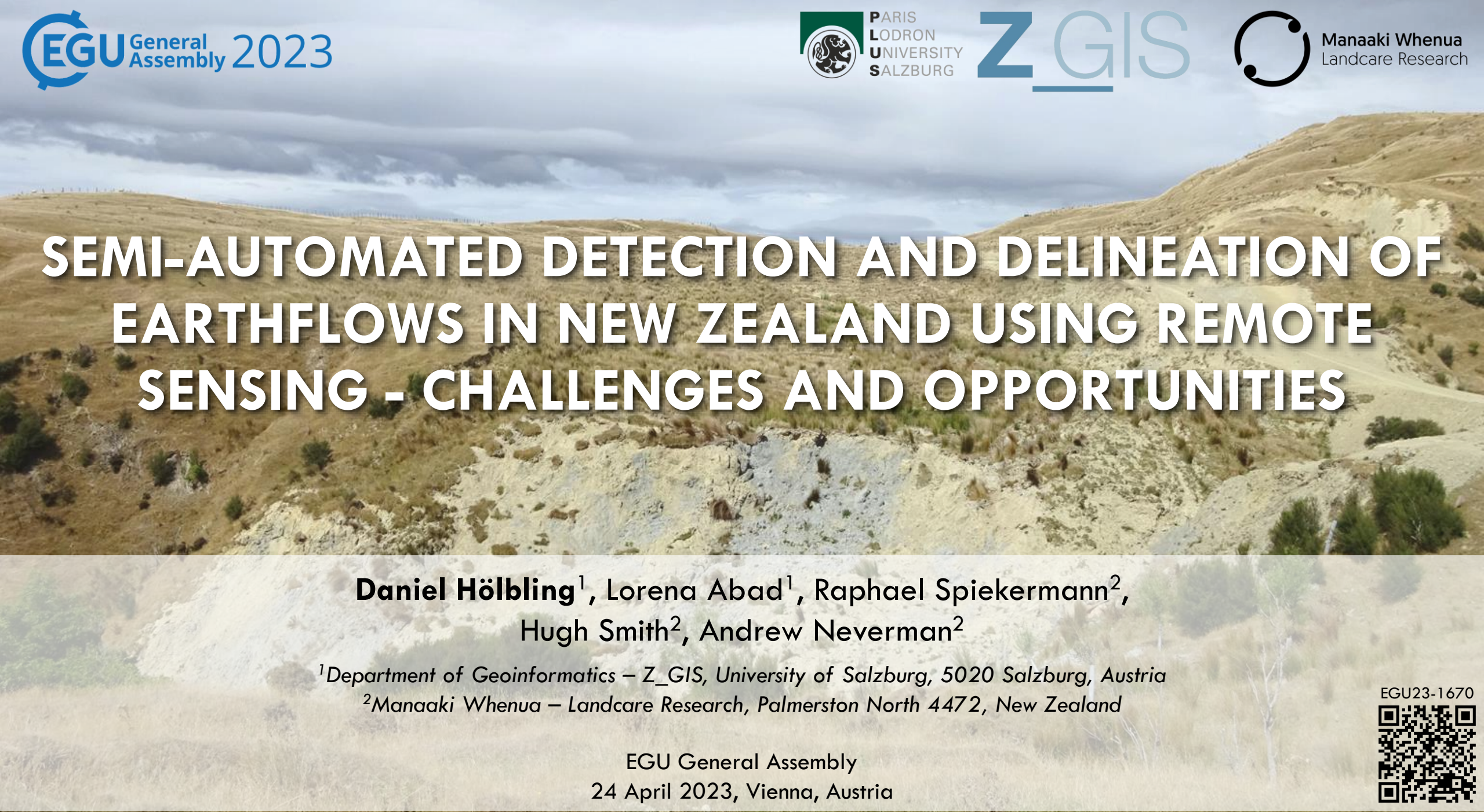

SEMI-AUTOMATED DETECTION AND DELINEATION OF EARTHFLOWS IN NEW ZEALAND USING REMOTE SENSING - CHALLENGES AND OPPORTUNITIES

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EARTHFLOWS IN NEW ZEALAND

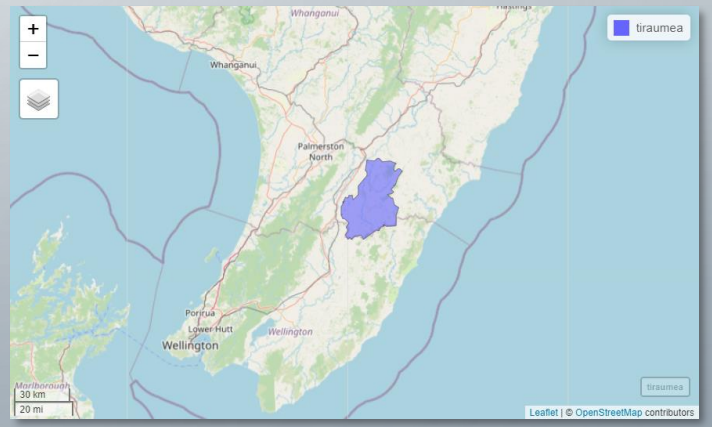
- Earthflows are complex landslide phenomena that can occur on gentle to moderate slopes in plastic, mixed, and disturbed earth, often under under saturated conditions
  - Tens of metres to kilometres in length
  - Significant internal deformation
  - Lobate flow-like morphology
  - Slow and intermittent movement with active and inactive states
- Implementing effective erosion mitigation measures requires detailed information on the location, extent, and spatial distribution of these features

Earthflows on the North Island of New Zealand. Earthflows are indicated by the yellow dashed line (photographs: © Manaaki Whenua – Landcare Research (MWLR) (a), D. Hölbling (b, c)).

REMOTE SENSING-BASED EARTHFLOW MAPPING

- Earthflows are usually mapped manually
  - Expert interpretation based on characteristics discernible from optical and topographic data
- Semi-automated detection and delineation of earthflows is challenging
  - Complex features with transitional boundaries
  - Varying internal homogeneity and appearance
- How to implement the required expert knowledge into semi-automated mapping?

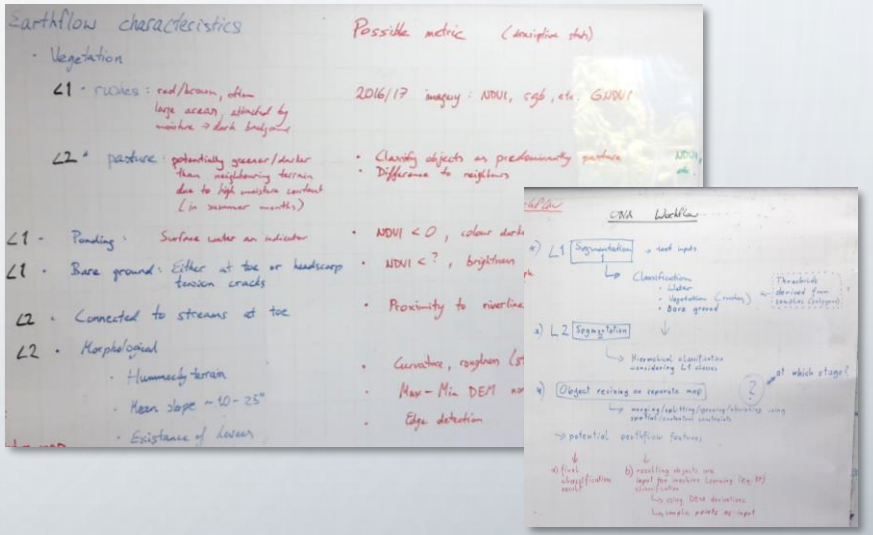
→ *Develop a knowledge-based approach to semi-automatically detect and delineate earthflows, using aerial photography and a high-resolution digital surface model (DSM) within an object-based image analysis (OBIA) framework*

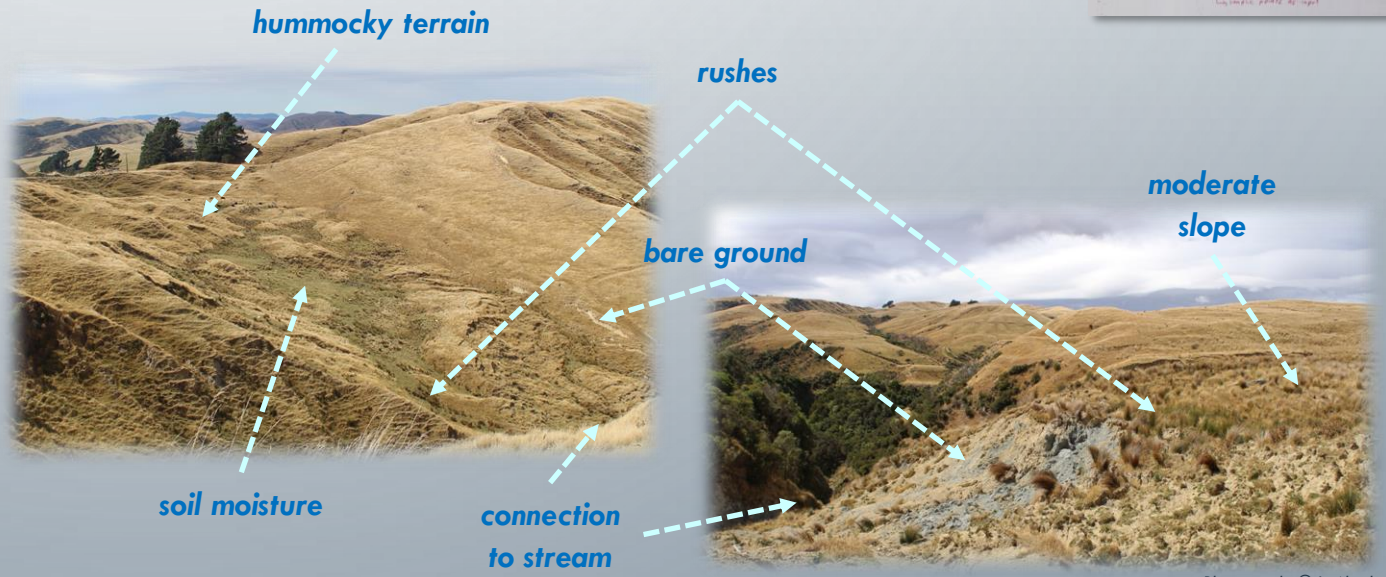


Tiraumea catchment in the southern part of the North Island of New Zealand

CONCEPT AND WORKFLOW DEFINITION

- Earthflow detection using OBIA
- Identifying earthflow characteristics that can be derived from aerial photography and DSM data as input for the classification
  - existence of bare ground
  - hummocky terrain
  - rushes
  - moderate slope
  - connection to streams
  - surface water
  - higher soil moisture

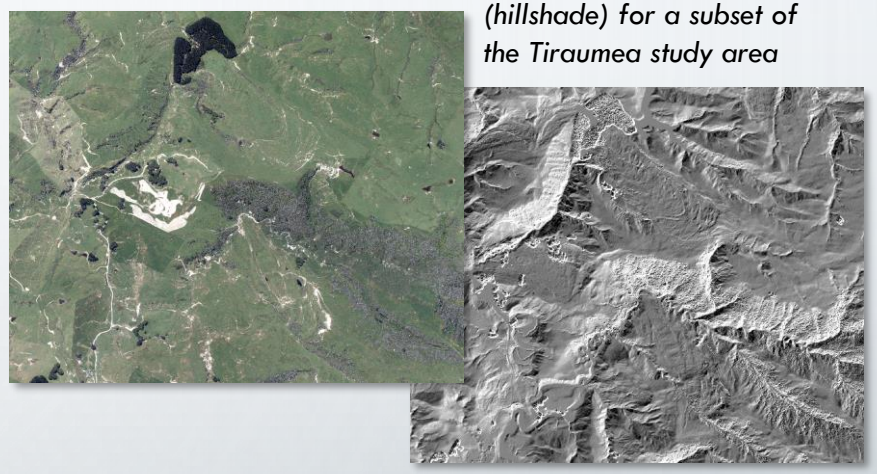




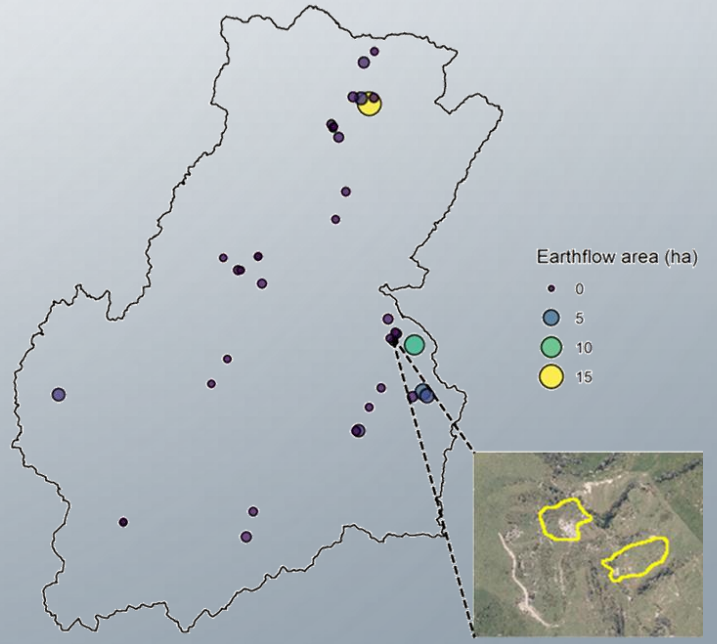
Photographs © L. Abad

DATA

- Aerial photography from 2016
  - 0.3m resolution
  - R-G-B-NIR bands
- LiDAR DSM (1m) from 2016
- River channel network derived from the DSM
- Manually delineated reference polygons
  - No consistent and complete reference dataset was available
  - Different datasets with different quality

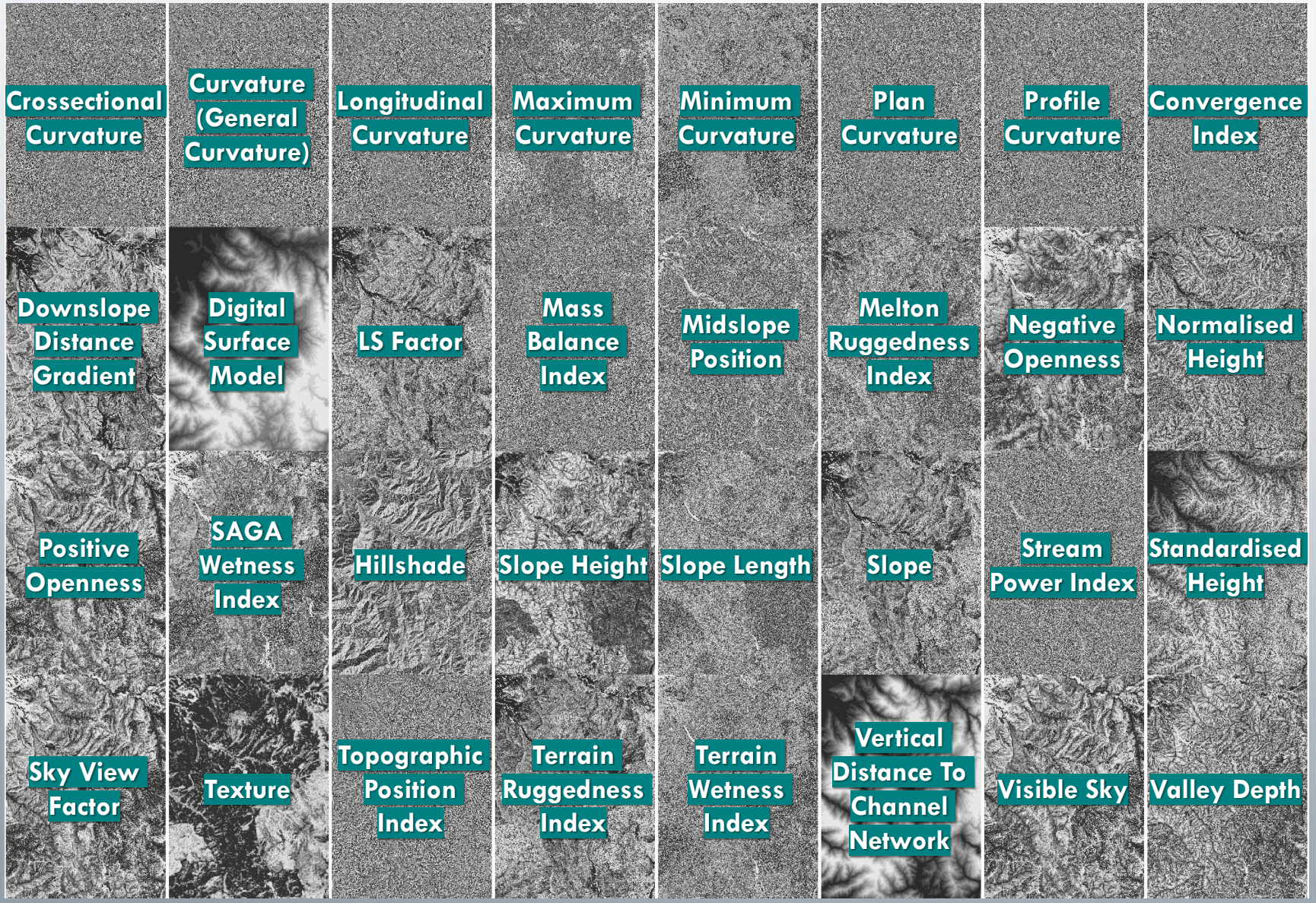


Aerial photograph and DSM (hillshade) for a subset of the Tiraumea study area

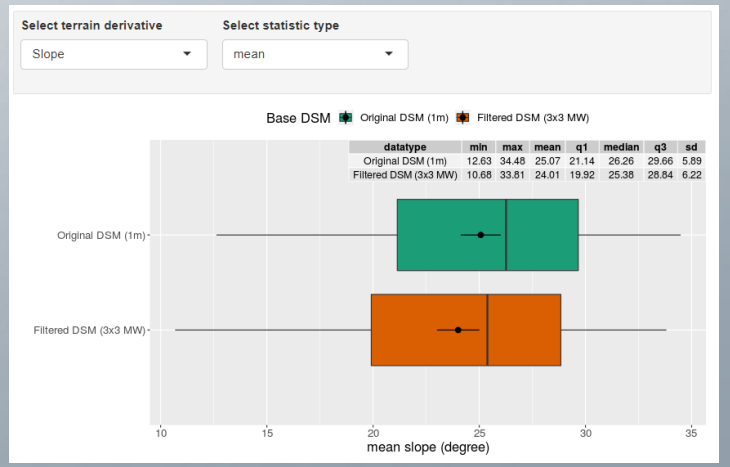


Location and example of manually delineated earthflows

TERRAIN DERIVATIVES

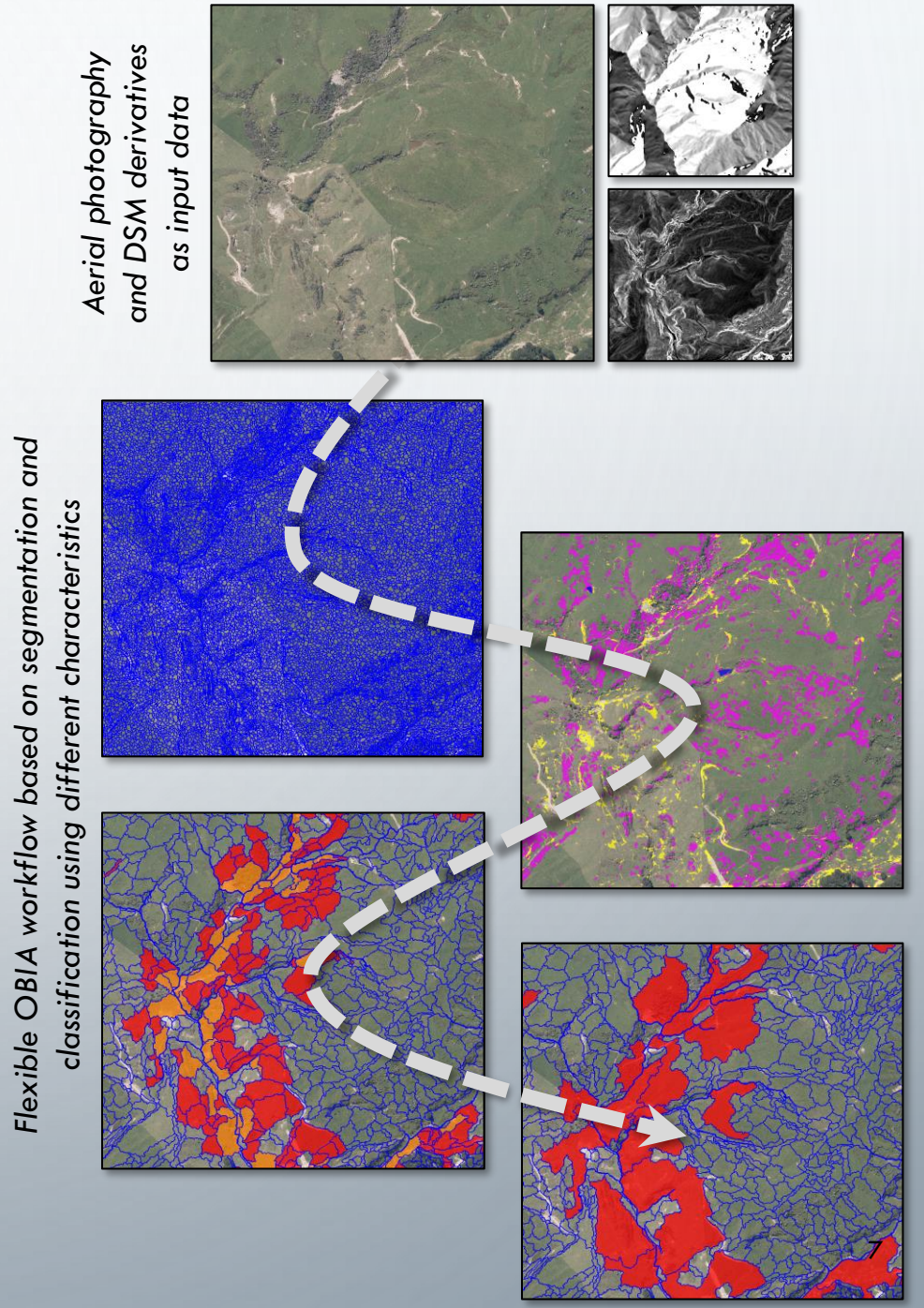


- >30 terrain derivatives were computed data using SAGA GIS
- Calculation of statistics for the terrain derivatives using the reference polygons
- These derivatives were (partly) used within the OBIA workflow to support threshold selection



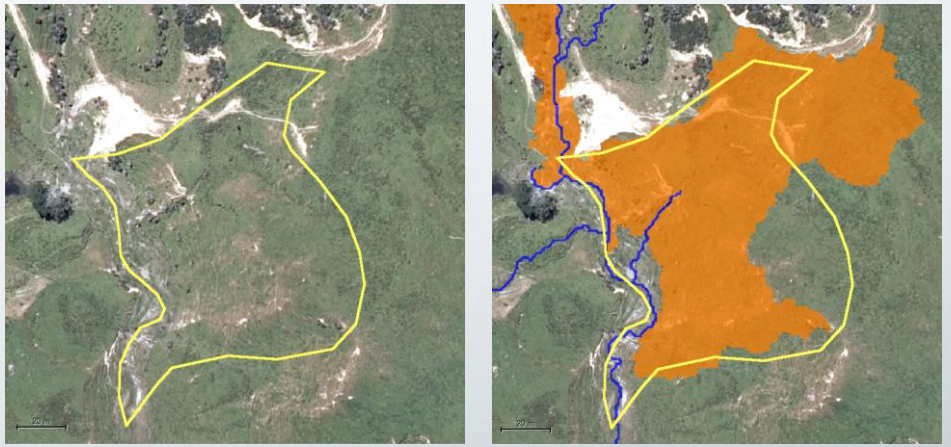
OBIA EARTHFLOW MAPPING

- Knowledge-based classification ruleset using the eCognition software
- Identification of potential earthflow locations based on spectral, spatial, morphological, contextual, and hierarchical characteristics
  - Calculation of additional layers based on the aerial photography (e.g., NDVI, NDWI, brightness)
  - Detection of bare ground, rushes, and water at a fine segmentation level
  - Classification of earthflows at a coarser segmentation level
    - if bare ground, rushes, and water exist at the finer level
    - contextual information
  - Merging earthflow objects
  - Refinement based on DSM derivatives



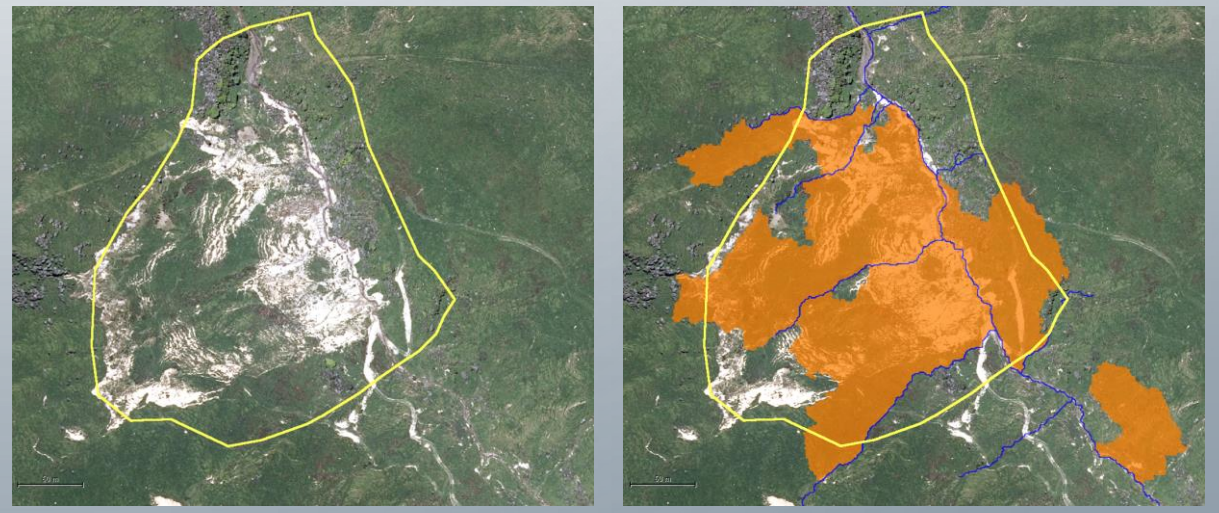
RESULTS & VALIDATION

- Comparison of potential earthflows to manual mapping
  - Approx. 87% of the reference earthflow polygons were detected
  - Delineations often differ significantly
- Many polygons were additionally mapped as earthflows → further verification is needed



Earthflow mapping examples. OBIA mapping (orange) in comparison to reference data (yellow outline). Channel network is shown as blue lines.

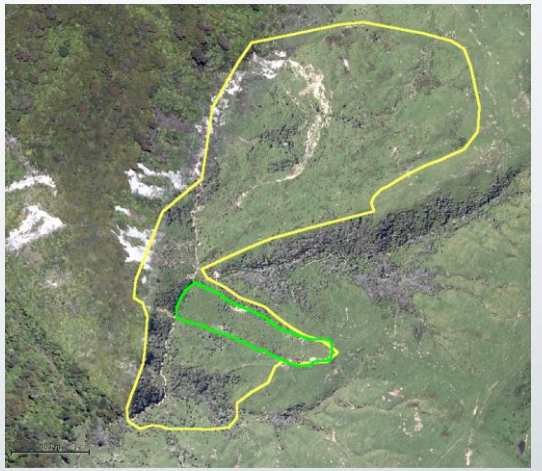
Newly discovered earthflow (orange).

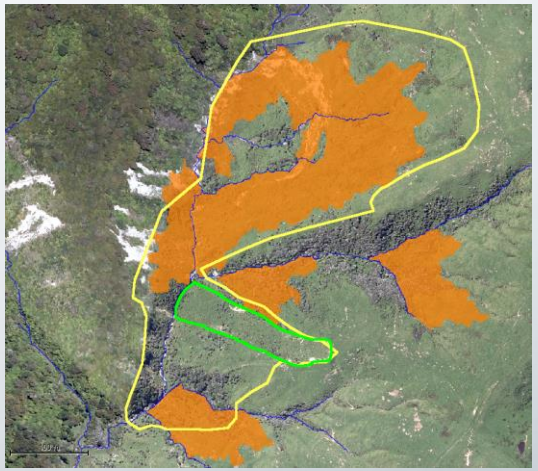


RESULTS & VALIDATION

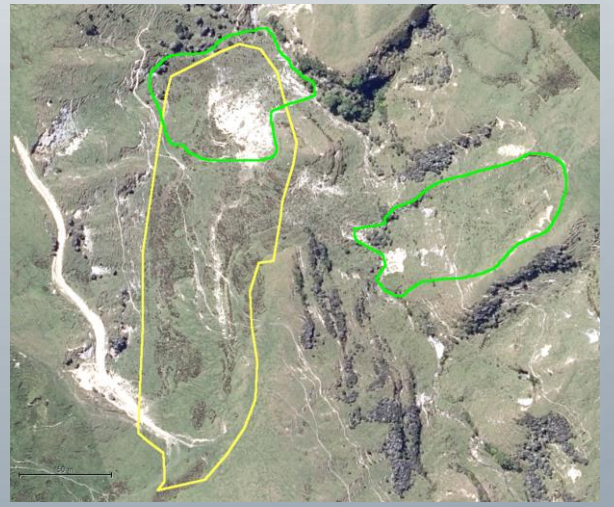
- Validation is difficult, because the creation of reliable and complete reference data requires significant expertise and effort
- Field assessment/validation is important

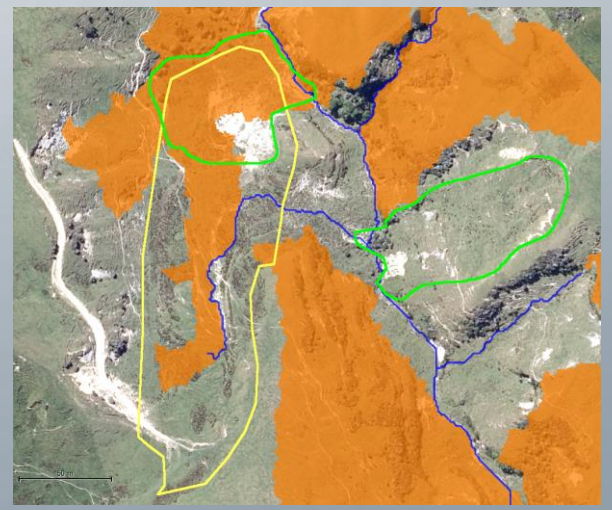
Photographs © L. Abad & D. Hölbling





Earthflow mapping examples. OBIA mapping (orange) in comparison to reference data (yellow and green outlines). Channel network is shown as blue lines.





CONCLUSION

- Semi-automated earthflow mapping is challenging
  - Complex erosion features → difficult to delineate and differentiate from other features
  - Integration of expert knowledge
  - Appropriate validation is needed
- Future work will include a comparison between knowledge-based and data-driven (e.g., deep learning) approaches
- Reliable analysis methods are needed to better understand the spatial occurrence of earthflows
  - Enable improved representation of these erosion processes in catchment sediment budget models
  - Earthflow susceptibility mapping

THANK YOU FOR YOUR ATTENTION!

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