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Exploring knowledge-based and data-driven approaches to map earthflow and gully erosion features in New Zealand

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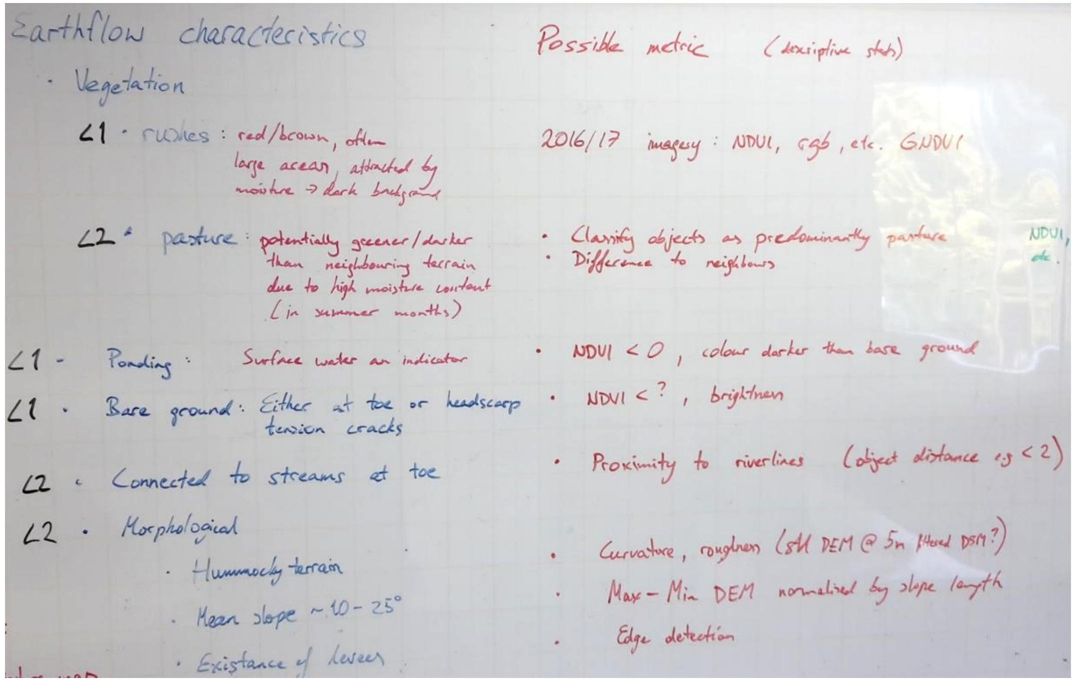
Read the abstract here:

https://meetingorganizer.copernicus.org/EGU22/EGU22-1093.html

Knowledge-based **earthflow** detection

2. Concept and workflow definition

- Defining a workflow for semi-automated earthflow detection using object-based image analysis (OBIA)
- Identifying earthflow characteristics that can be derived from aerial photography and DSM data as input for the classification



1. Motivation

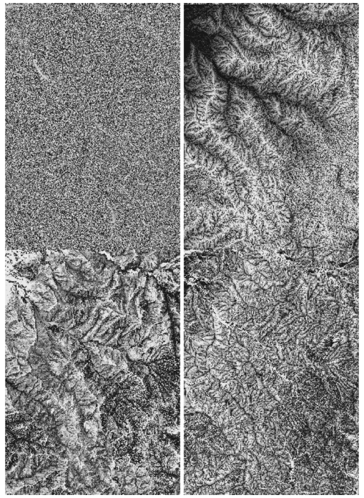
In New Zealand, earthflows and gullies are - next to shallow landslides - important erosion processes and sediment sources in hill country areas. Implementing effective erosion mitigation measures requires detailed information on the location, extent, and spatial distribution of these features.

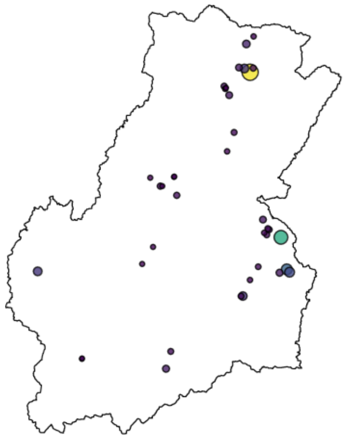
Earthflows in the Tiraumea catchment, North Island, New Zealand. Earthflows are indicated by the yellow dotted line (photographs: © Manaaki Whenua – Landcare Research (MWLR) (a), D. Hölbling (b, c)).

3. Data preparation

- 32 terrain derivatives were computed from the LiDAR DSM
- Manual delineation of reference polygons and calculation of statistics for the terrain derivatives → supports the threshold selection in OBIA

Tiraumea study area (subset)

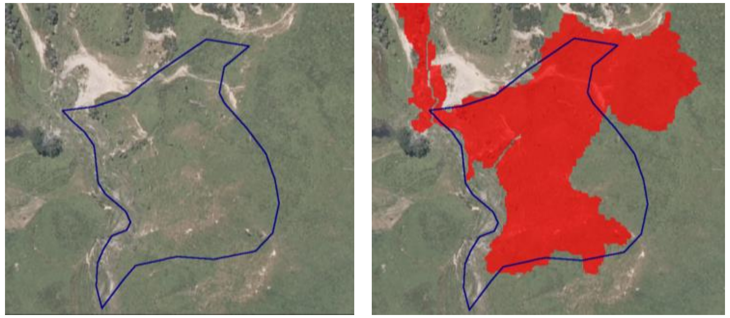


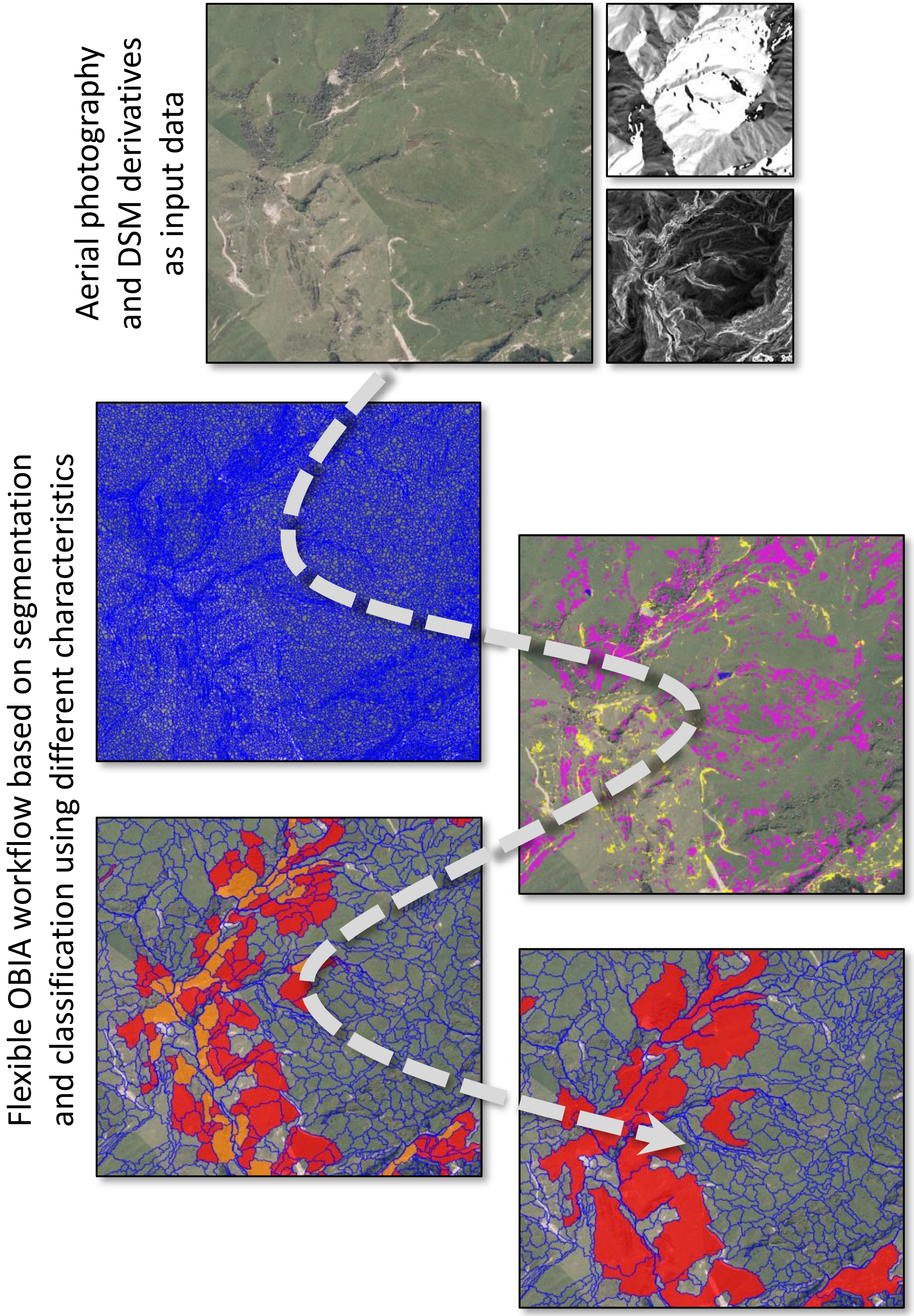


Manual delineation

OBIA earthflow mapping

- Creation of a knowledge-based earthflow detection 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 on a fine segmentation level
  - Classification of potential earthflows on a coarser segmentation level if objects contain bare ground, rushes and water on the finer level and based on various image object characteristics
  - Merging potential earthflow objects
  - Removing false positives based on DSM derivatives
- Comparison to manual mapping & field validation





Data-driven **gully** mapping with deep learning

Mangatu study area

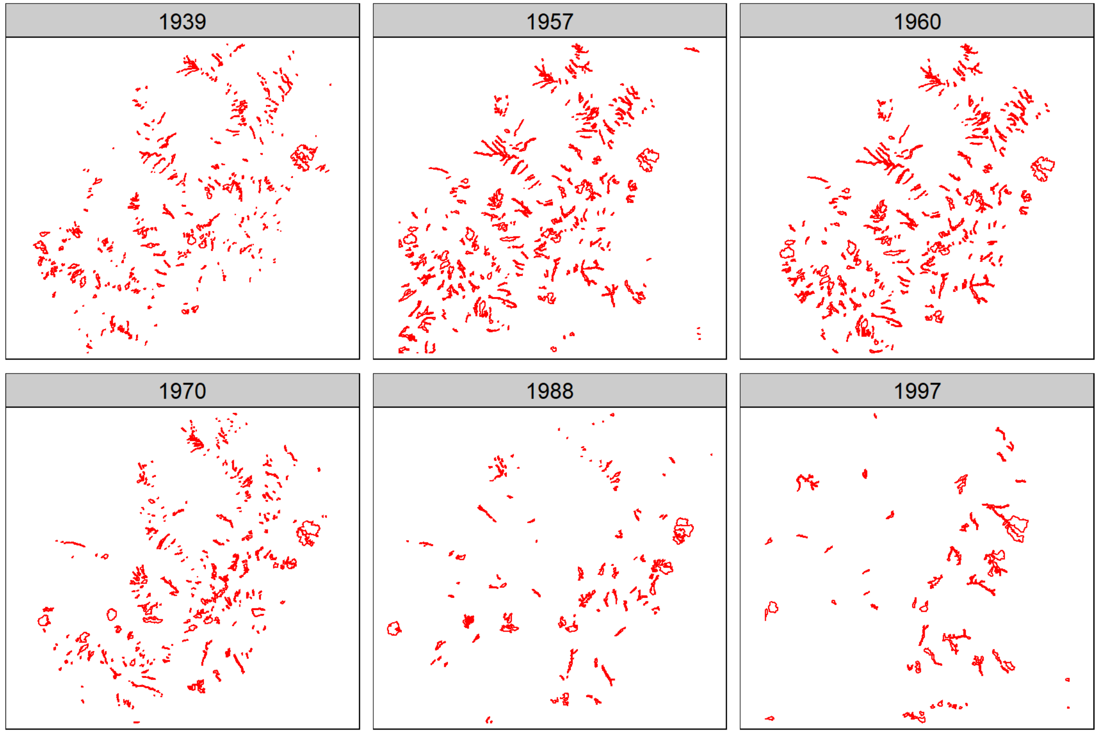
1. Aim

Train a deep learning model to identify and map gully erosion in the Mangatu catchment in New Zealand.

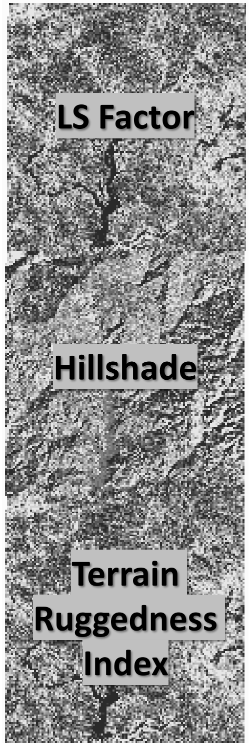
2. Data

- Reference data: outlines of **erosion features**, in particular active gullies, available from **1939 to 1997** for 6 different years
- Chip generation is done by the combination of **terrain derivatives** calculated from a LiDAR DEM

Reference data



Terrain derivatives



3. Methodology

- Workflow tested with ArcGIS Pro, where a **Mask RCNN model** was trained
- Possibility to create RGB chips with a combination of **three bands**
- Model was trained with 20 epochs and a ResNet50 backbone model

Export Training Data for Deep Learning → Train Deep Learning Model → Detect Objects Using Deep Learning

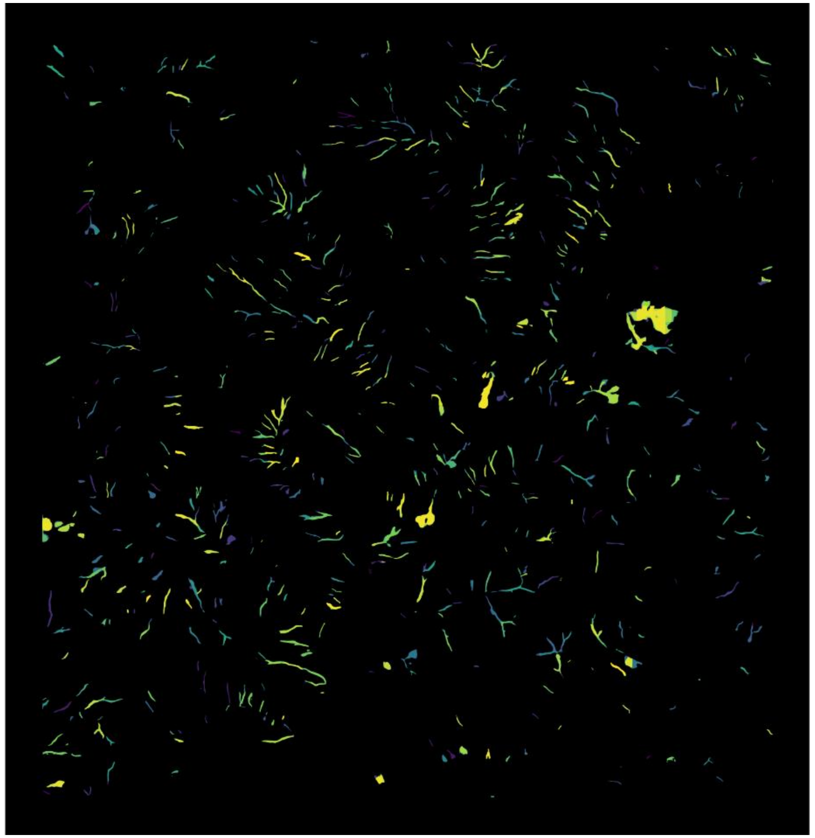
Chip characteristics:
Chip size: 2048x2048
No. of chips: 604
Gully features: 8977
Gully features/image: 15 (mean)

Detected gully features - validation

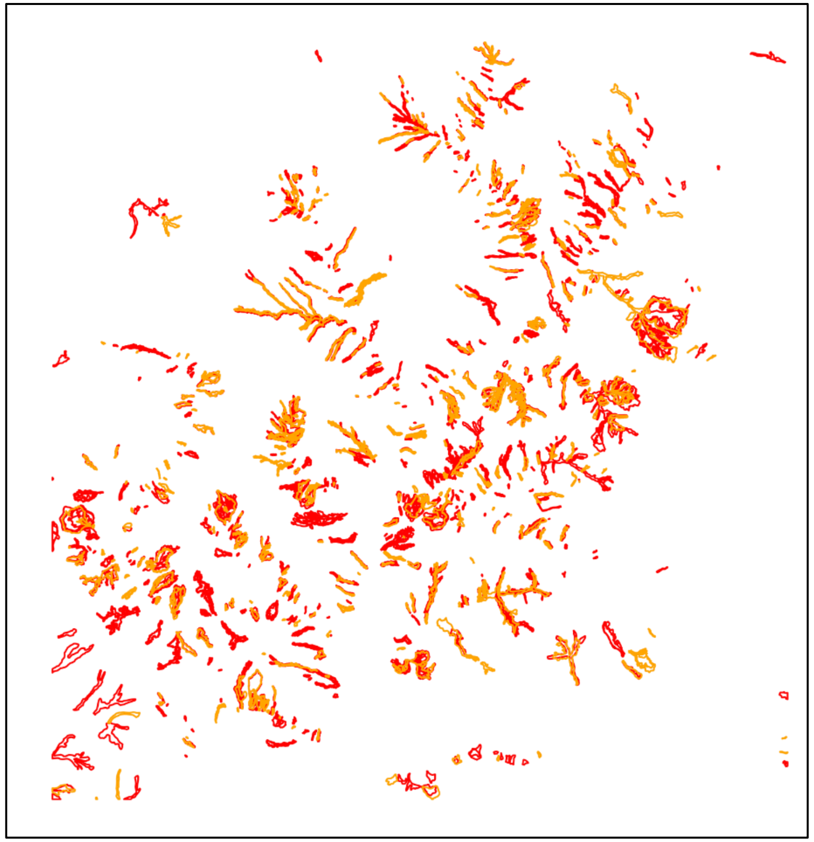
60%

overlap

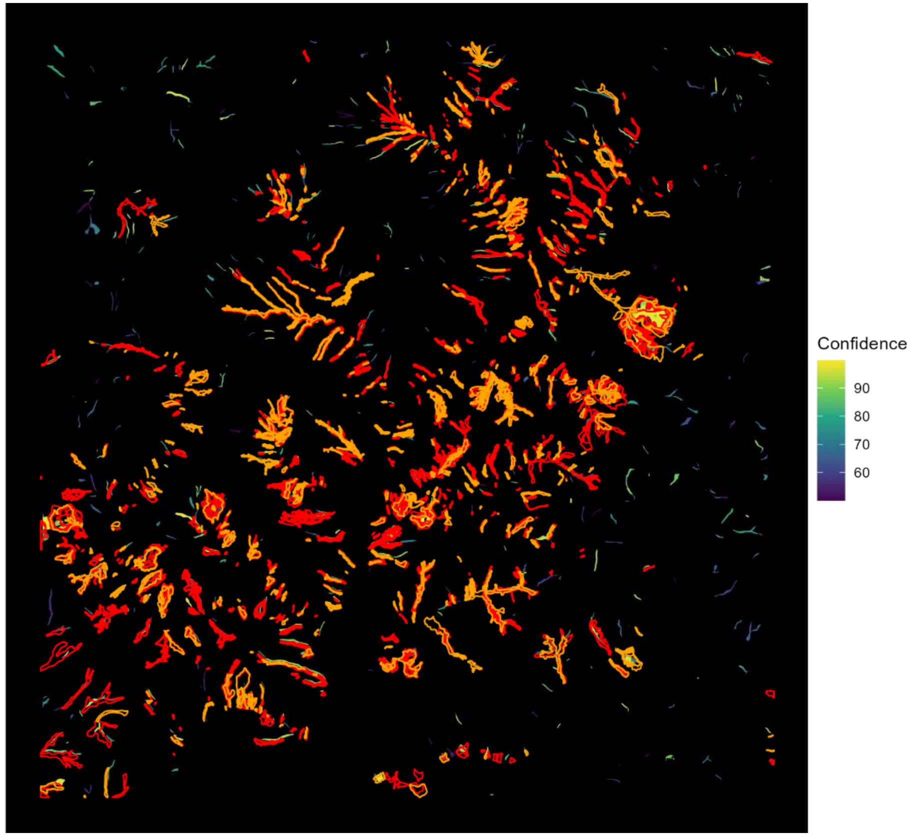
Mapping results
Indicating the detection confidence level



Reference features
Training in **red** and **testing** in **orange**



303/505 gully features from the test set intersect with the resulting gully features



Discussion & Conclusion

- Semi-automated earthflow detection is **very challenging**
- Earthflows are complex and there is a **lack of distinct characteristics** to differentiate them from other features
- Gully detection shows **more promising** results, despite the **time mismatch** between reference and training data
- **Testing** the model in a **neighboring catchment** will help evaluate the model performance better
- Overall, **reliable and targeted analysis methods** are needed to better understand the spatial occurrence of earthflows and gullies
- This will enable **improved representation** of these erosion processes in catchment sediment budget models

Acknowledgements

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