EARTH SCIENCE

FDL 2022

FDL

NeurIPS 2022 Workshop
Tackling Climate Change with Machine Learning

Deep Learning for Rapid Landslide Detection using Synthetic Aperture Radar (SAR) Datacubes

Vanessa Boehm, Wei Ji Leong*, Ragini Bal Mahesh*, Ioannis Prapas*, Edoardo Nemni, Freddie Kalaitzis, Siddha Ganju, Raul Ramos-Pollan*
**Equal Contribution*

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Climate Change AI

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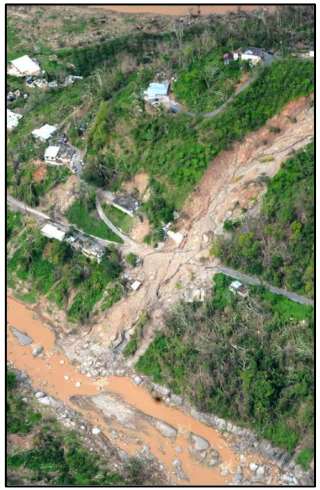
INTRODUCTION

Landslide change detection using SAR images with Deep Learning

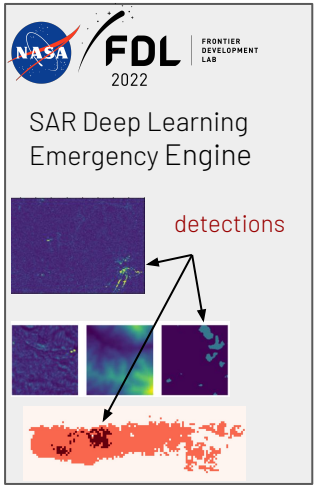
LANDSLIDE



NEXT REVISIT
SENTINEL-1 / NISAR

day or night any weather any clouds

LANDSLIDE MAPPING



EMERGENCY INTERVENTIONS

Rapid Assessment of Disaster from Space

Analysis ready SAR Datacubes

Sentinel-1 Granules

Landslides

INPUT: SPATIOTEMPORAL QUERY

- Area of Interest
- Temporal Range

InSAR with ISCE2

Datacubes published at https://doi.org/10.5281/zenodo.7248056

Cloud

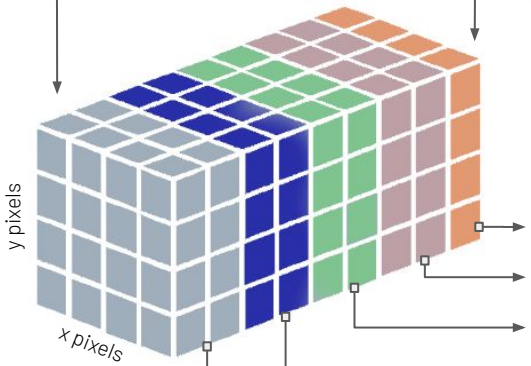
STAC SpatioTemporal Asset Catalog

Intermediate

COG CLOUD OPTIMIZED GEOTIFF

Analysis-Ready!

Zarr

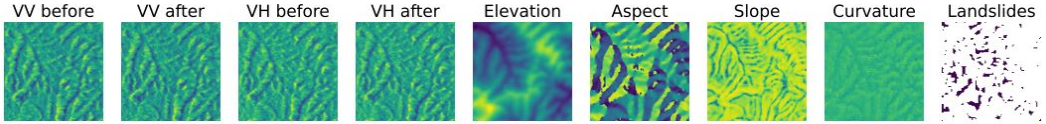


OUTPUT: REGIONAL ZARR DATACUBES

- Puerto Rico
- Hokkaidō, Japan
- Gunung Talamau, Indonesia
- Kaikōura, New Zealand

- Geographic metadata
- Landslide labels (Segmentation maps)
- Topography (Digital Elevation Model, slope, aspect, etc)
- Time-series of intensity data (VV, VH) pre- & post- event
- Time-pair phase-derived data (coherence, interferogram)

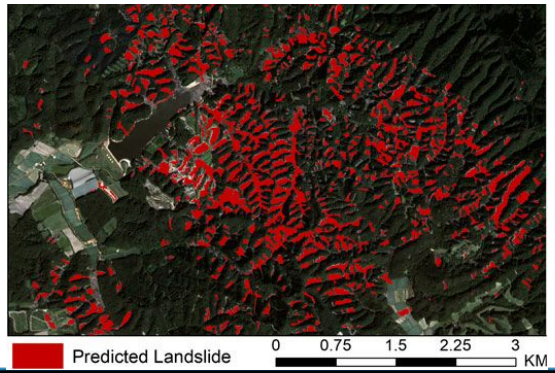
Experiments

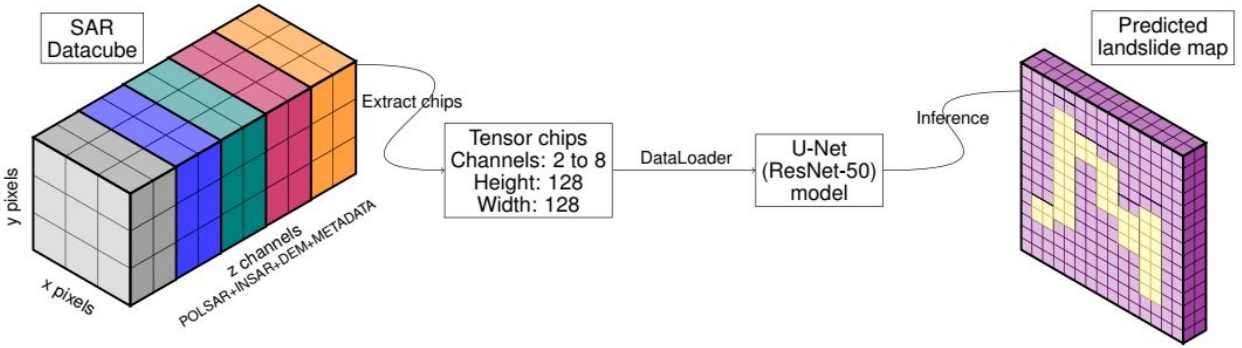


Hokkaidō dataset

aerial photograph

overlaid labels





Training (216 chips), Test (61 chips), U-NET++, Cross-Entropy Loss

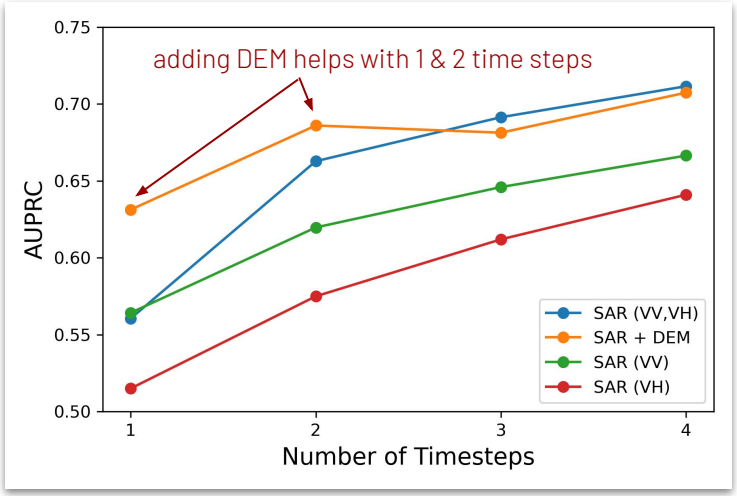
SAR (VV): Only VV band before and after the earthquake - 2 channels
SAR (VH): Only VH band before and after the earthquake - 2 channels
SAR (VV,VH): Only SAR bands (VV and VH) are used before and after the earthquake - 4 channels
SAR+DEM: SAR bands (VV and VH) before and after the earthquake, plus DEM-derived data (elevation, slope, aspect, curvature) - 8 channels

For each input configuration, we train using 1, 2, 3 or 4 time steps (average pixel-wise into 1 channel) before and after the event.

Results

Performance measured with the
Area Under the Precision-Recall Curve (AUPRC)

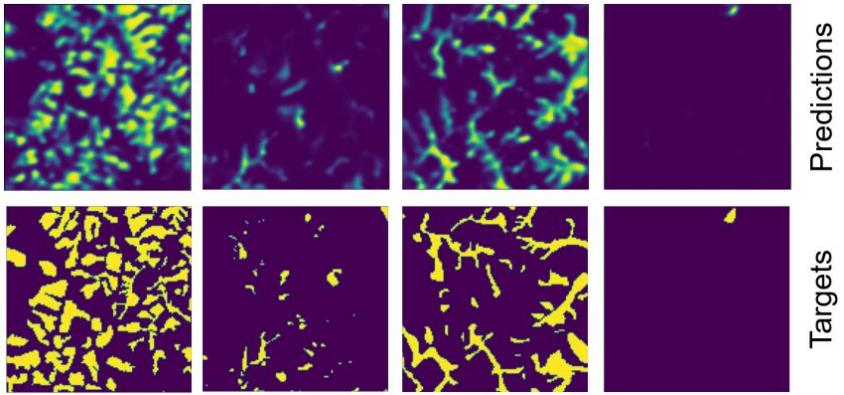
- More timesteps improve landslide detection
- Complementarity of the bands
  SAR (VH) < SAR (VV) < SAR (VV,VH)
- Adding DEM helps early detection



<u>*Random model*</u>
AUPRC=0.09

<u>Only DEM features</u>
AUPRC=0.17

more time steps improve results



Predictions of the best model on the test set
match very well the target label

Conclusion

1. Deep Learning models on SAR data perform skillful Landslide Detection.

2. Elevation data enhance rapid detection capabilities, when having access to few satellite passes.

3. We release our datasets and code.
   Datacubes in four regions for Landslide Detection - https://zenodo.org/record/7248056
   Code - https://github.com/iprapas/landslide-sar-unet

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