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Workshop on "Resilience to natural hazards through AI solutions"

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Adding value to post-disaster mapping with AI

Filippo Catani

University of Padova - Machine Intelligence and Slope Stability Laboratory



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DEPARTMENT OF
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MACHINE INTELLIGENCE
AND SLOPE STABILITY
LABORATORY

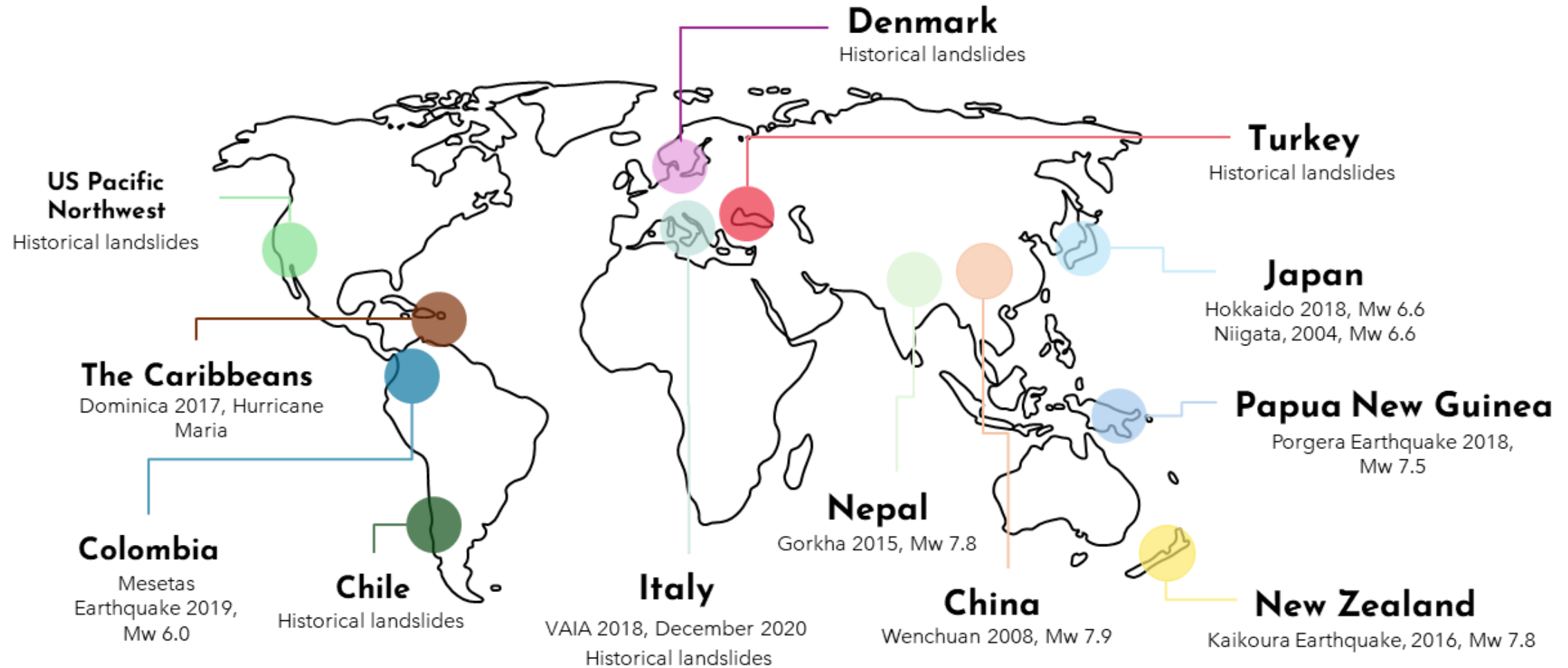
Content

- 1. Post-disaster mapping, why it is needed, what are the limitations**
- 2. Multi-temporal maps and explainability**
- 3. Adding info on mechanics and typology**
- 4. Adding info on kinematic zones and volumes**
- 5. Extracting info from time series (InSAR)**

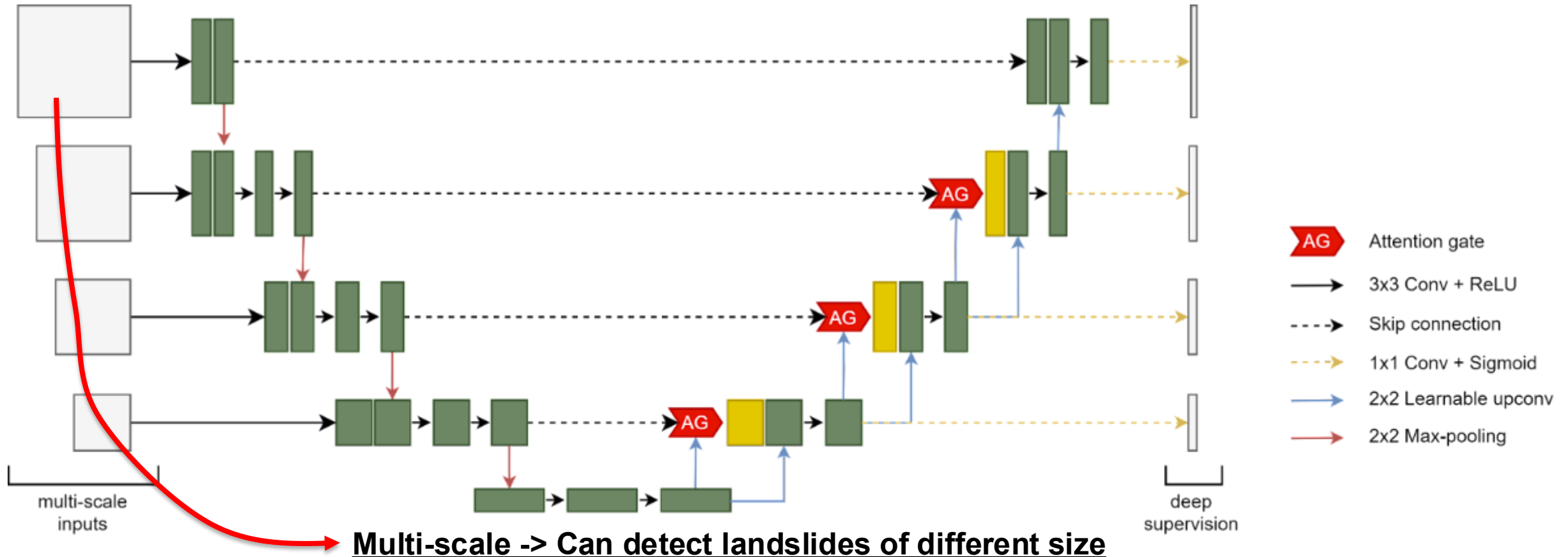
Post-disaster Gaps for Landslides

1. **State-of-the-art methods (based on AI) provide affected areas with segmentation – No info on type of process or sub-process**
2. **After main trigger (weather related or EQK) we have multiple activations (10^4) and each one becomes a local residual risk source**
3. **Precursors are lost after trigger?**
4. **How to fine tune 10^4 numerical simulations for short-term post-event risk scenarios?**

Training datasets must incorporate diversity



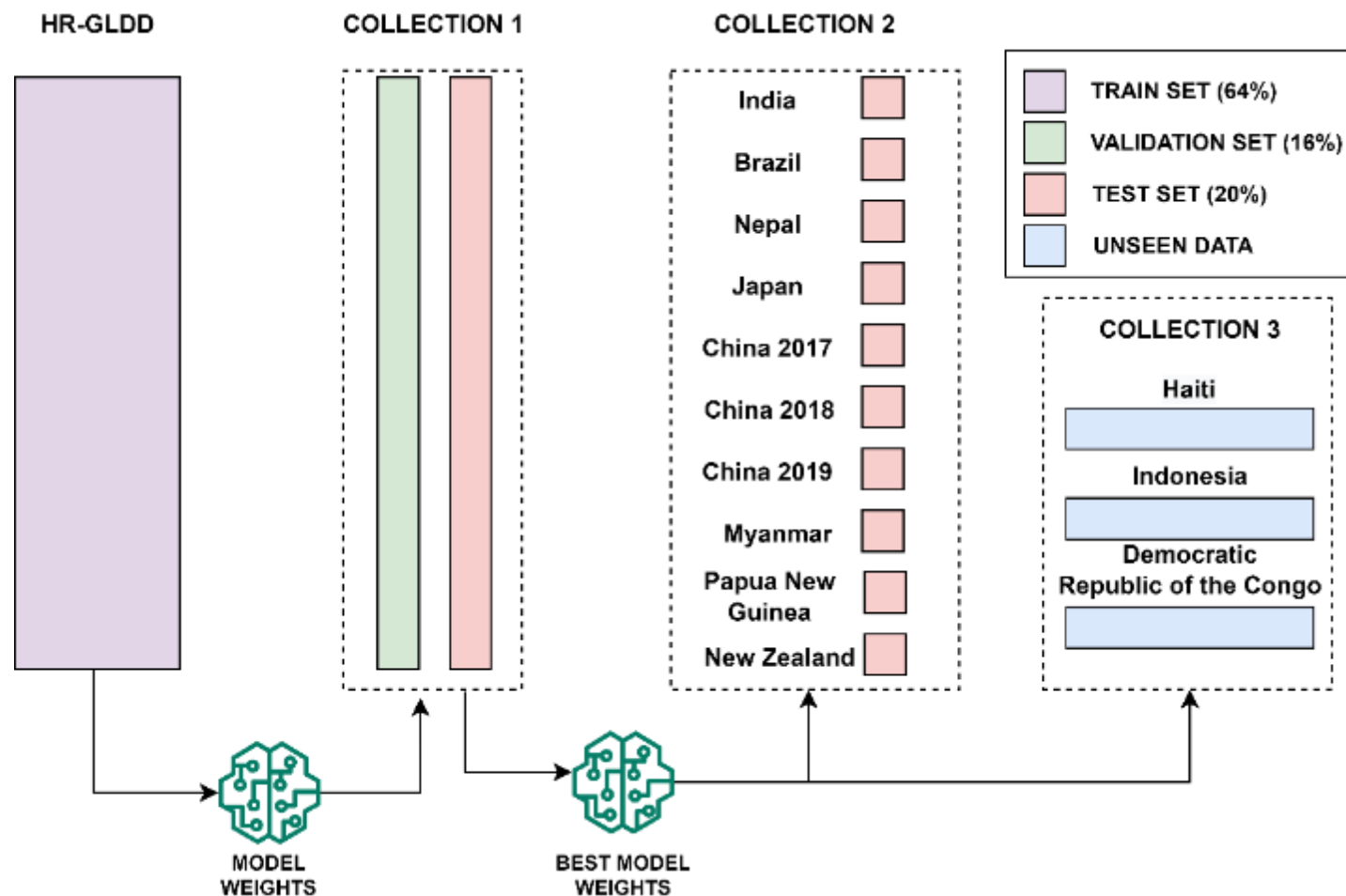
Detection must be scale-independent



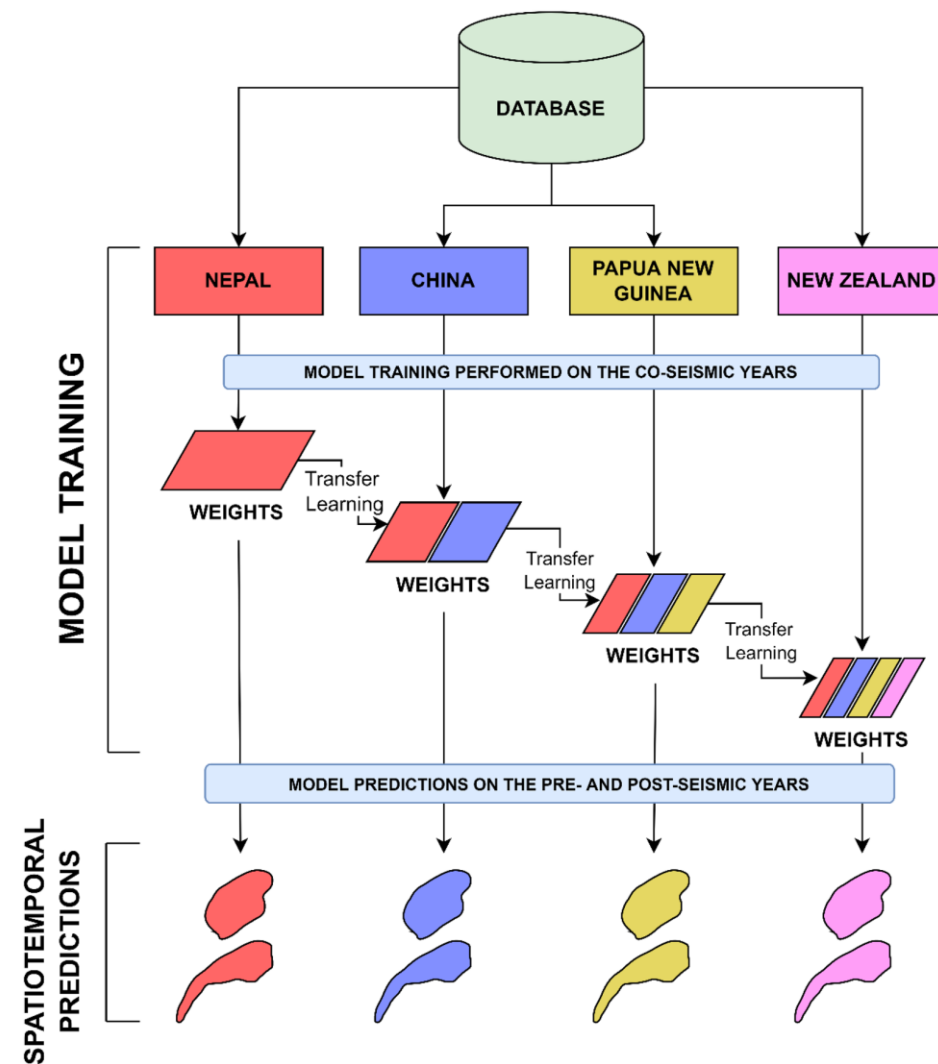
Bhuyan et al., 2023 – GISc. Rem. Sens.

Attention Deep Supervision Multi-Scale U-Net

Data Leakage Avoidance and Incremental Training

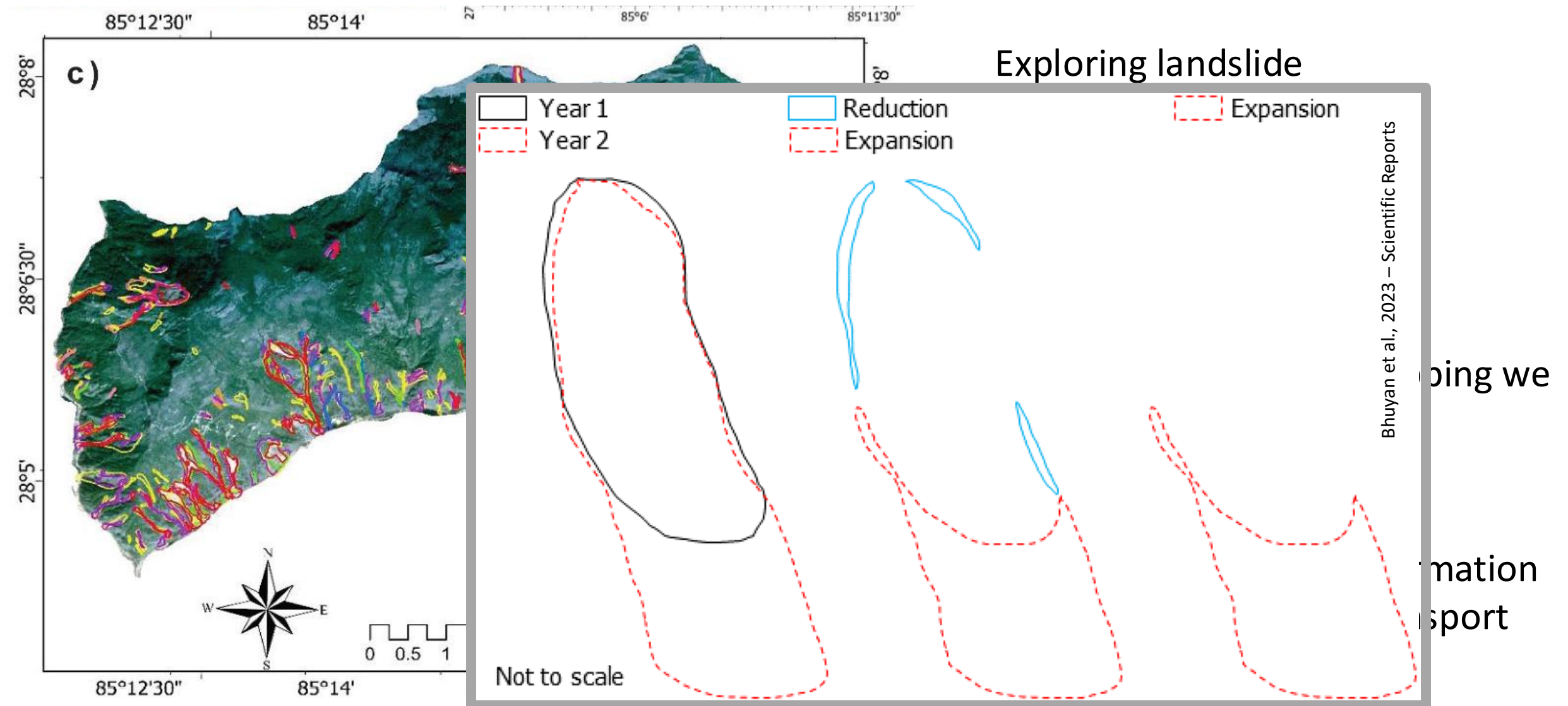


Meena et al., 2023 - ESSD



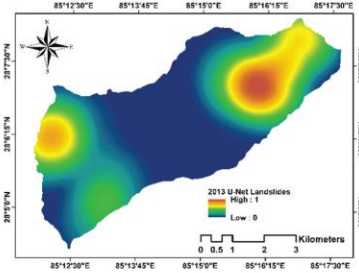
Bhuyan et al., 2023 – Scientific Reports

Adding multi-temporal information

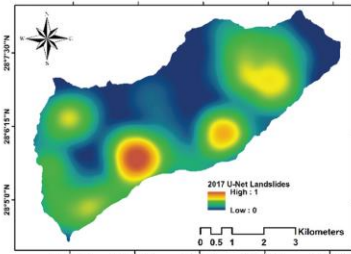


(Bhuyan et al., 2023, GISsc. Rem.Sens.)

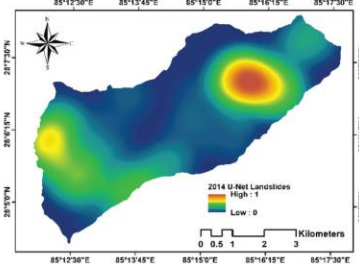
Adding multi-temporal information and Explainability



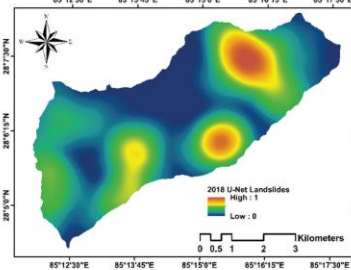
2013



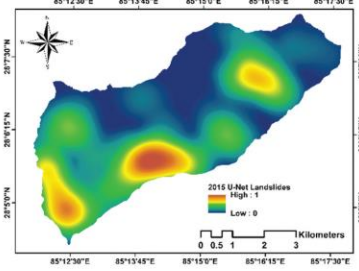
2017



2014

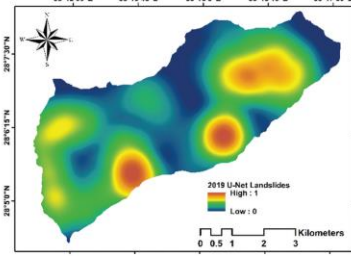


2018

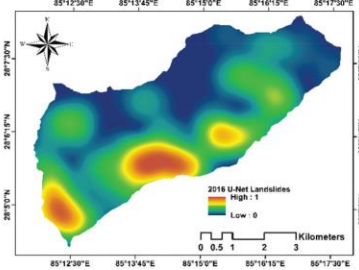


2015

↑
EQK



2019



2016

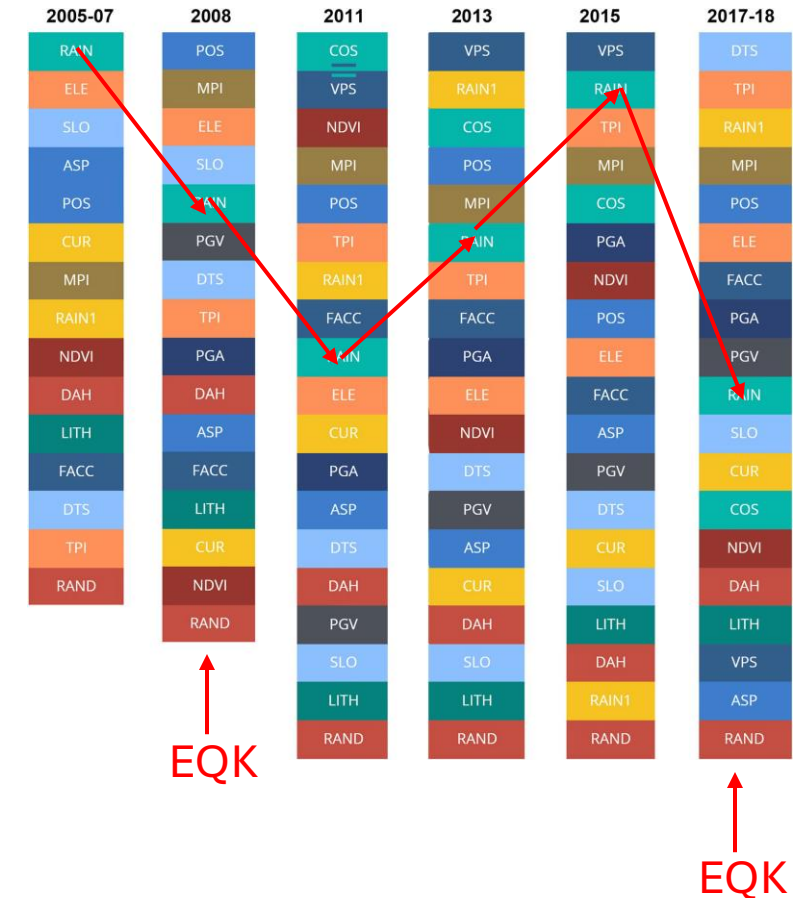
(Bhuyan et al., 2023)

Gorka Earthquake
of 2015 (Nepal)

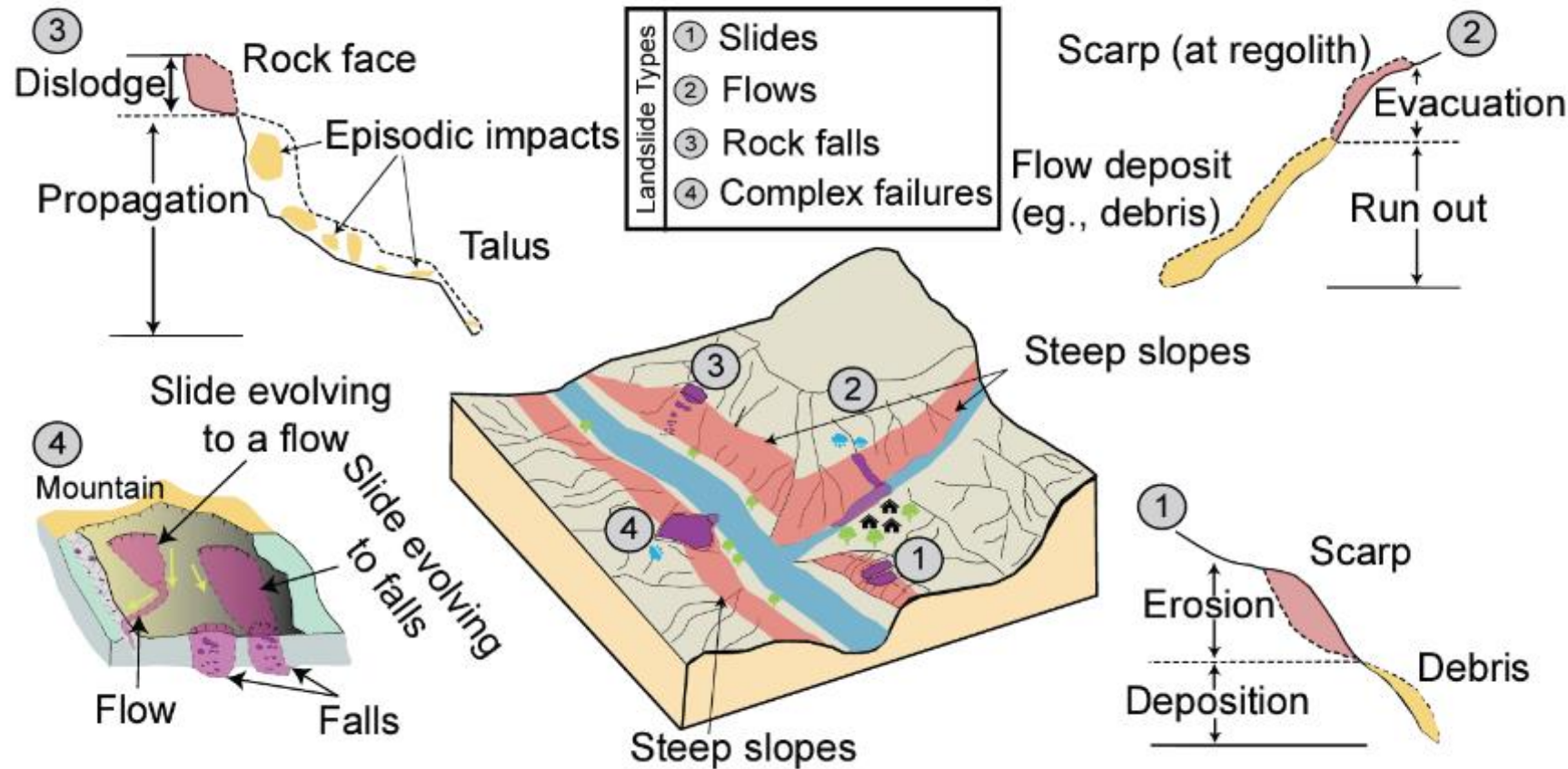
Landslide
activation density
before and after
the EQK (2013-
2019)

Possibility to
understand and
follow post-
earthquake slope
dynamics
patterns and
explaining
parameter
importance

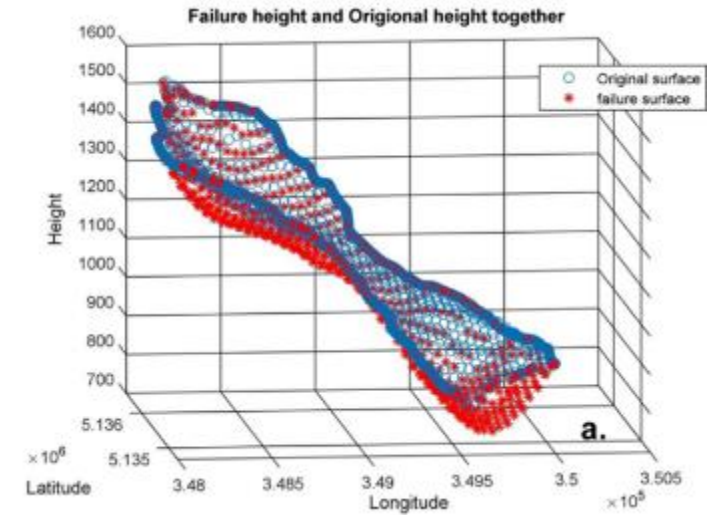
XAI Parameter ranking with time



Adding information on the type of failure mechanism



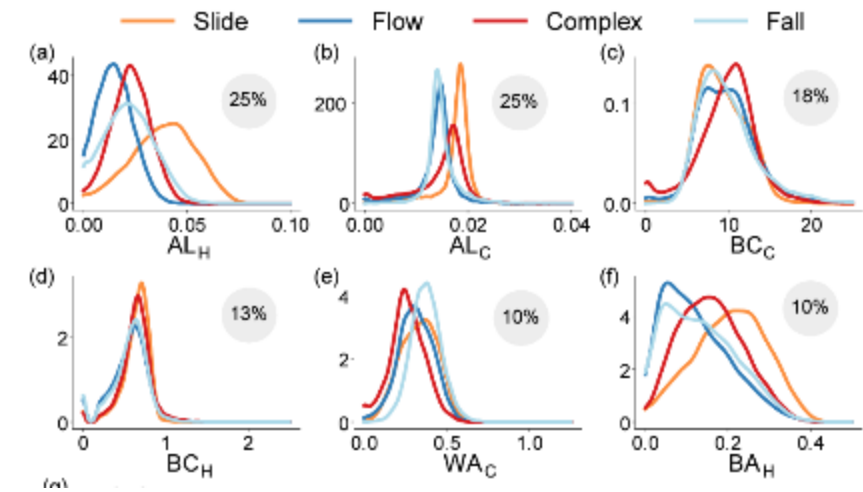
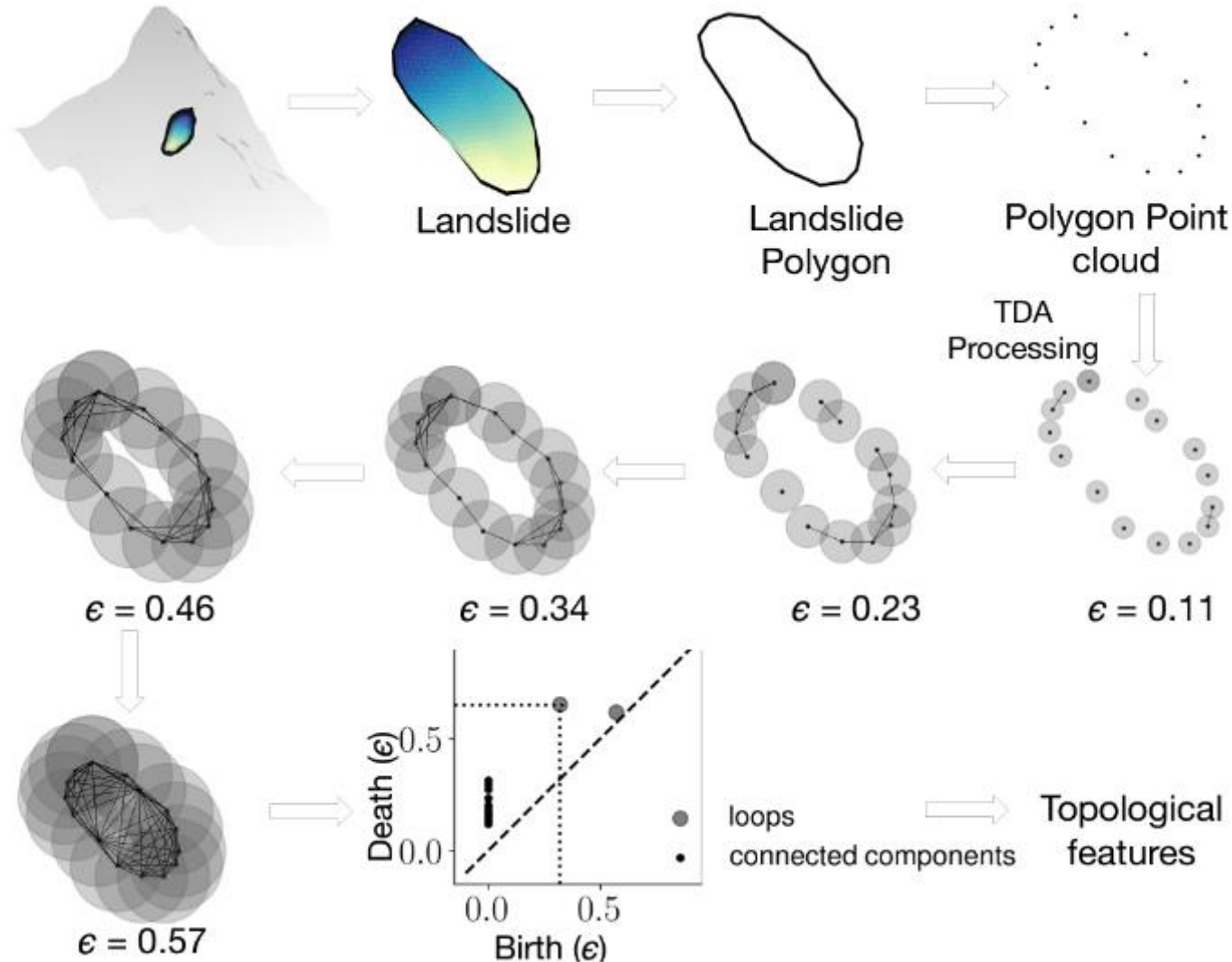
Landslide 3D shape may reveal failure mechanism



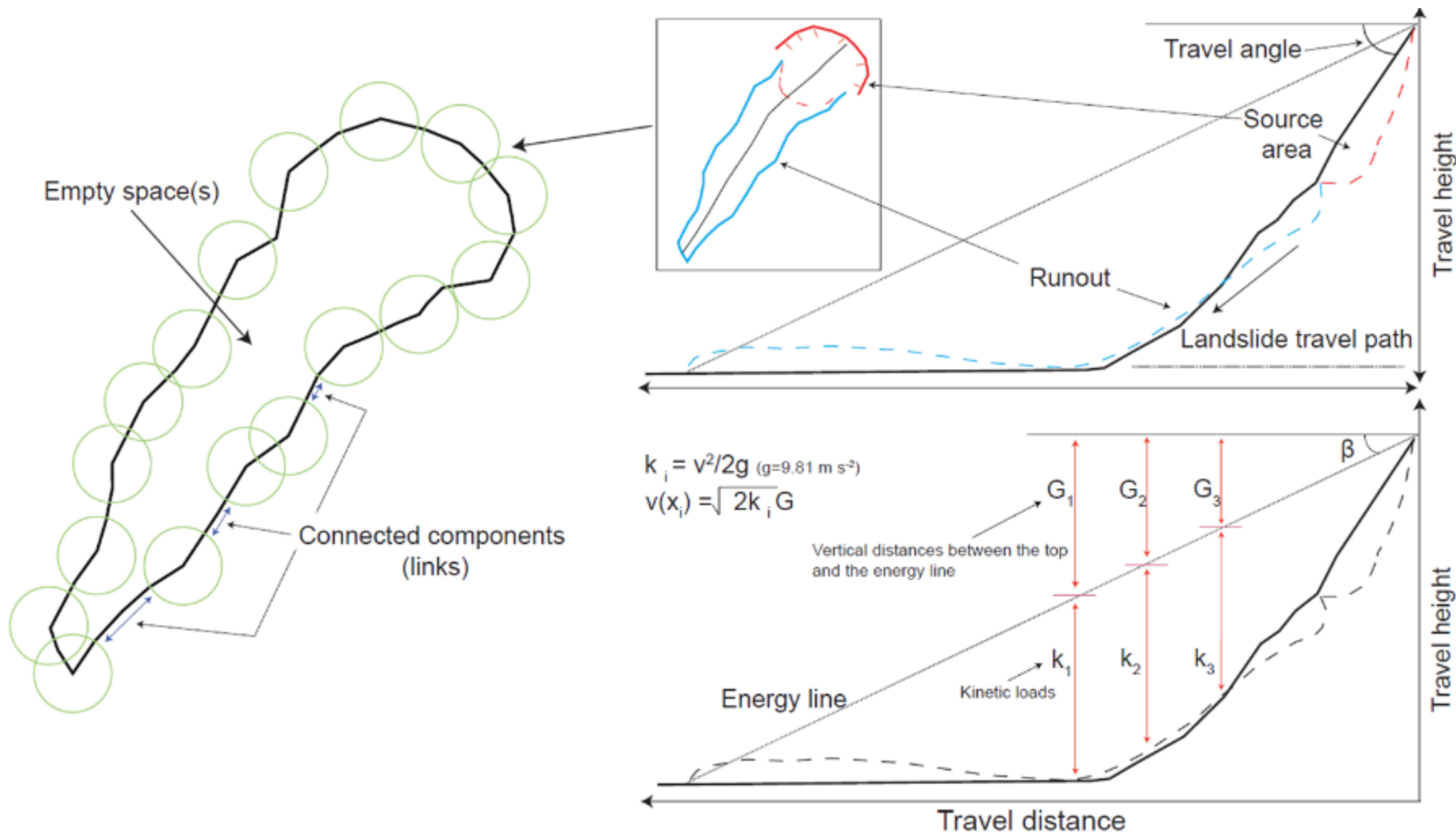
Prajapati and Jaboyedoff, 2022

Adding information on the type of failure mechanism

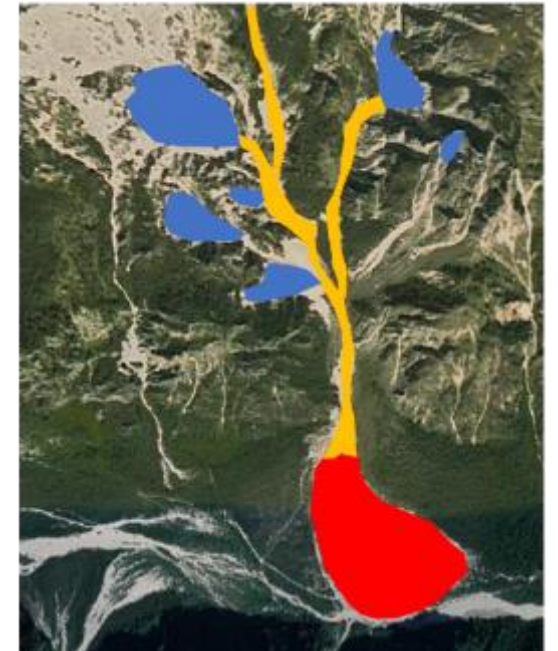
Detection of Failure Mechanism with AI-driven Topological Analysis (AIDTA)



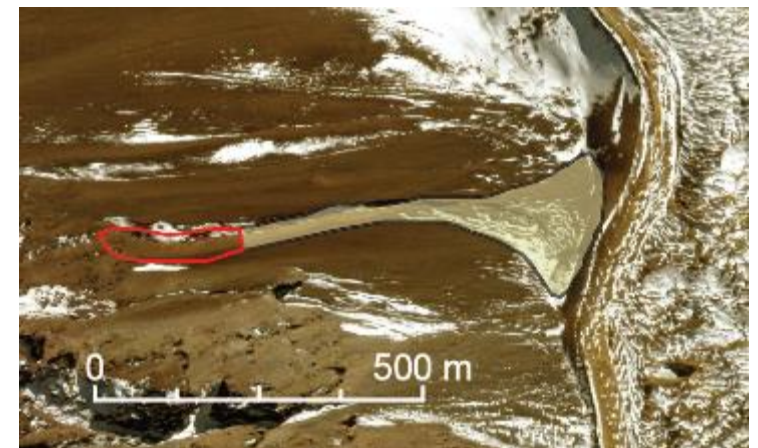
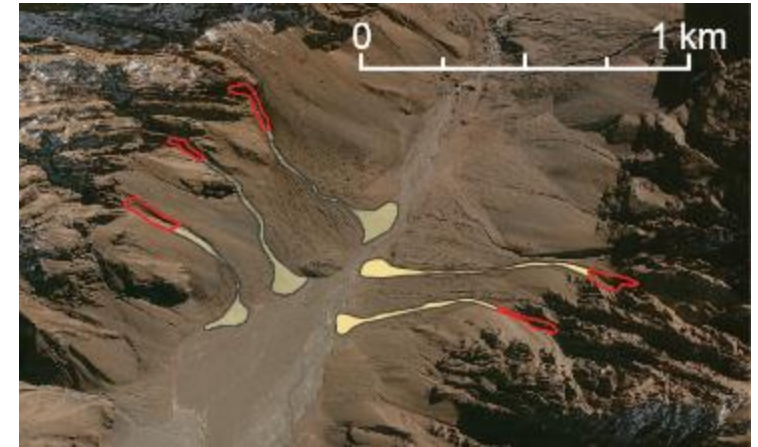
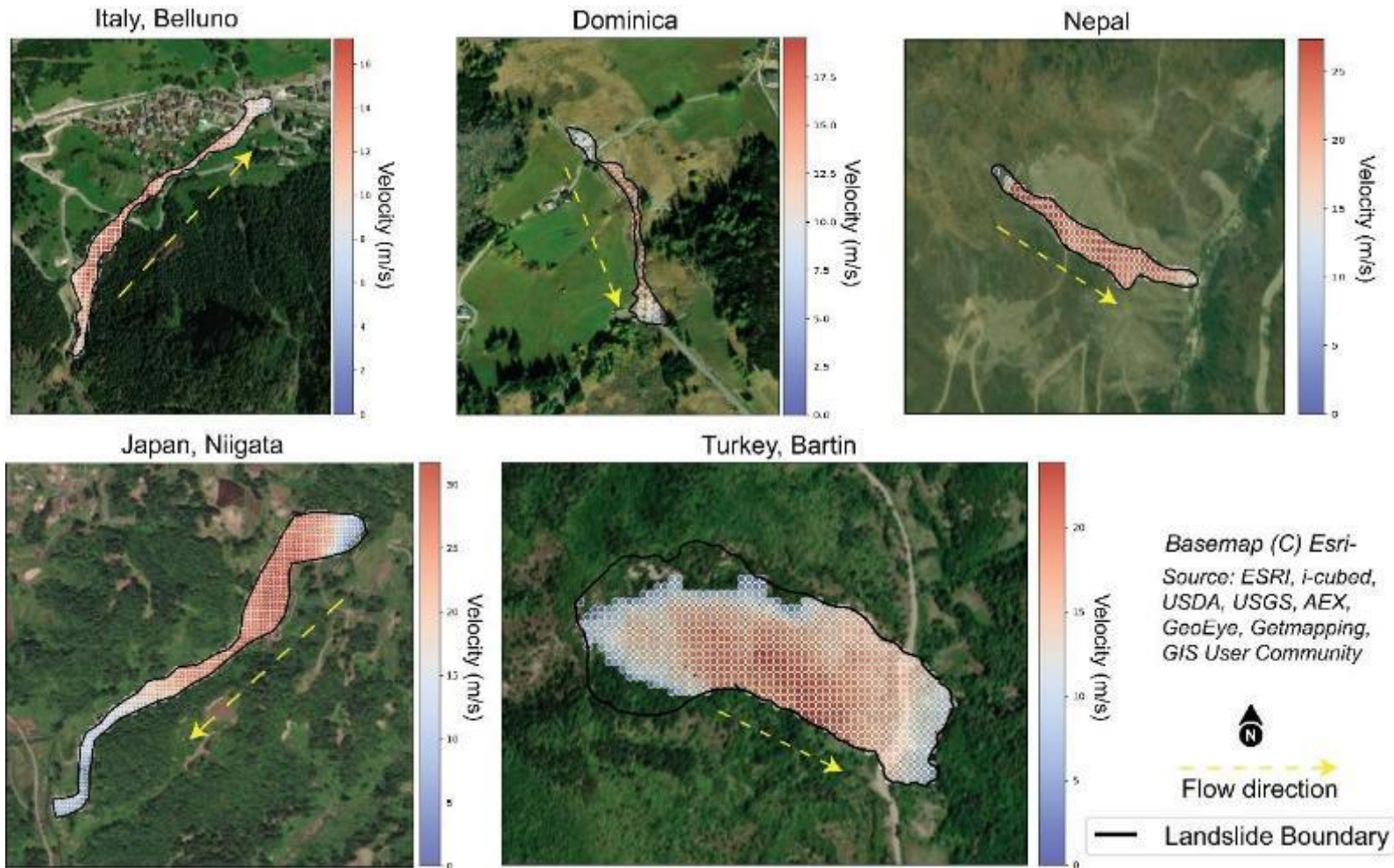
Separating kinematic zones



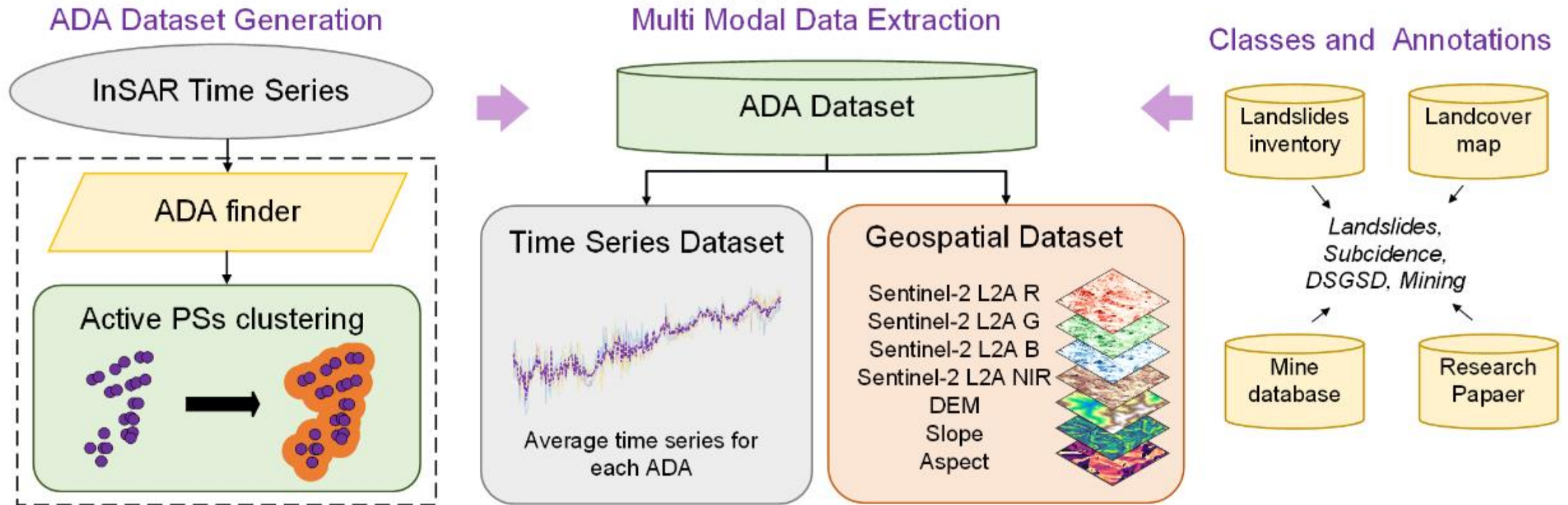
Separation of Kinematic Zones with Physics-Informed Machine Learning (PIML) and Topological 3D Analysis



Separating kinematic zones



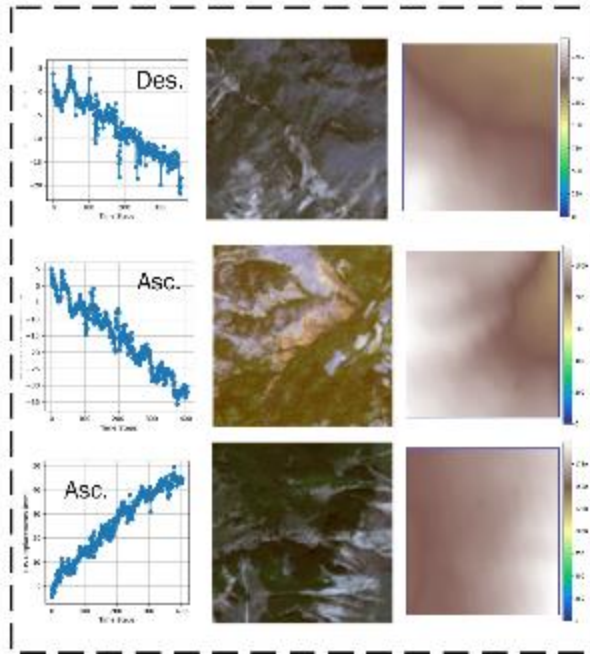
Exploiting displacement time series



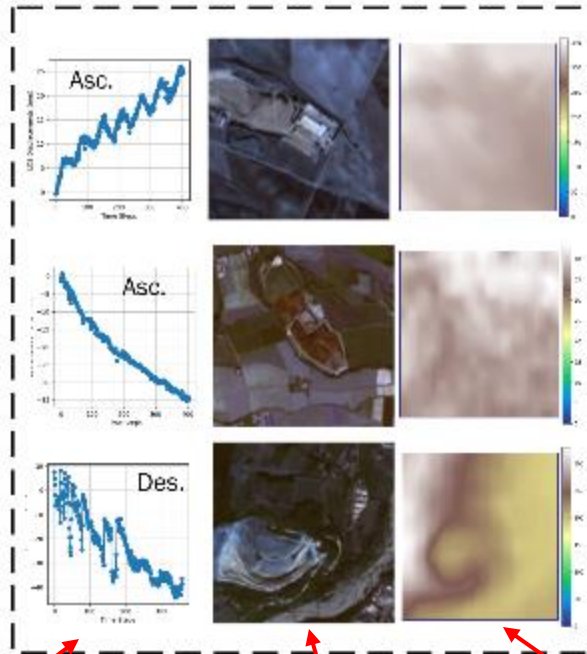
ADA Tools and ADA detection method from Barra et al. 2017 and Navarro et al. 2020.

Typologies considered in the model

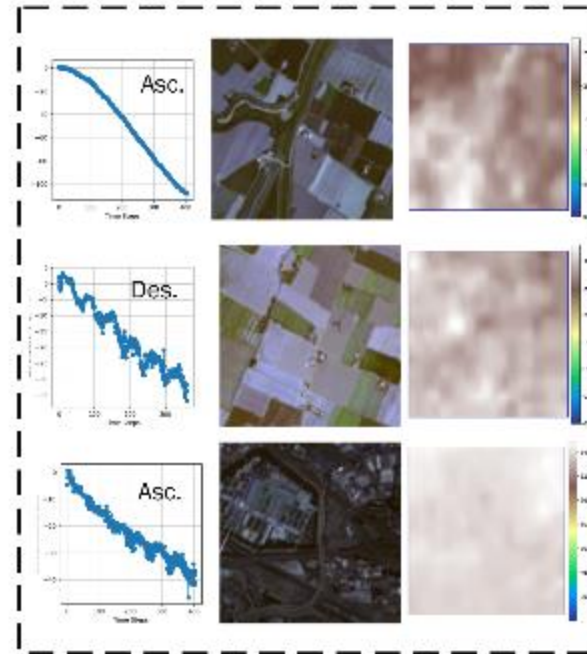
Landslide



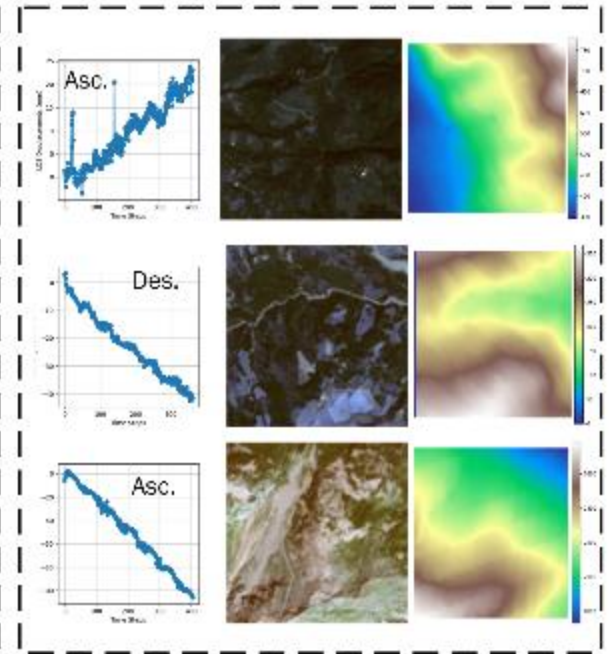
Mining



Subsidence



DSGSD

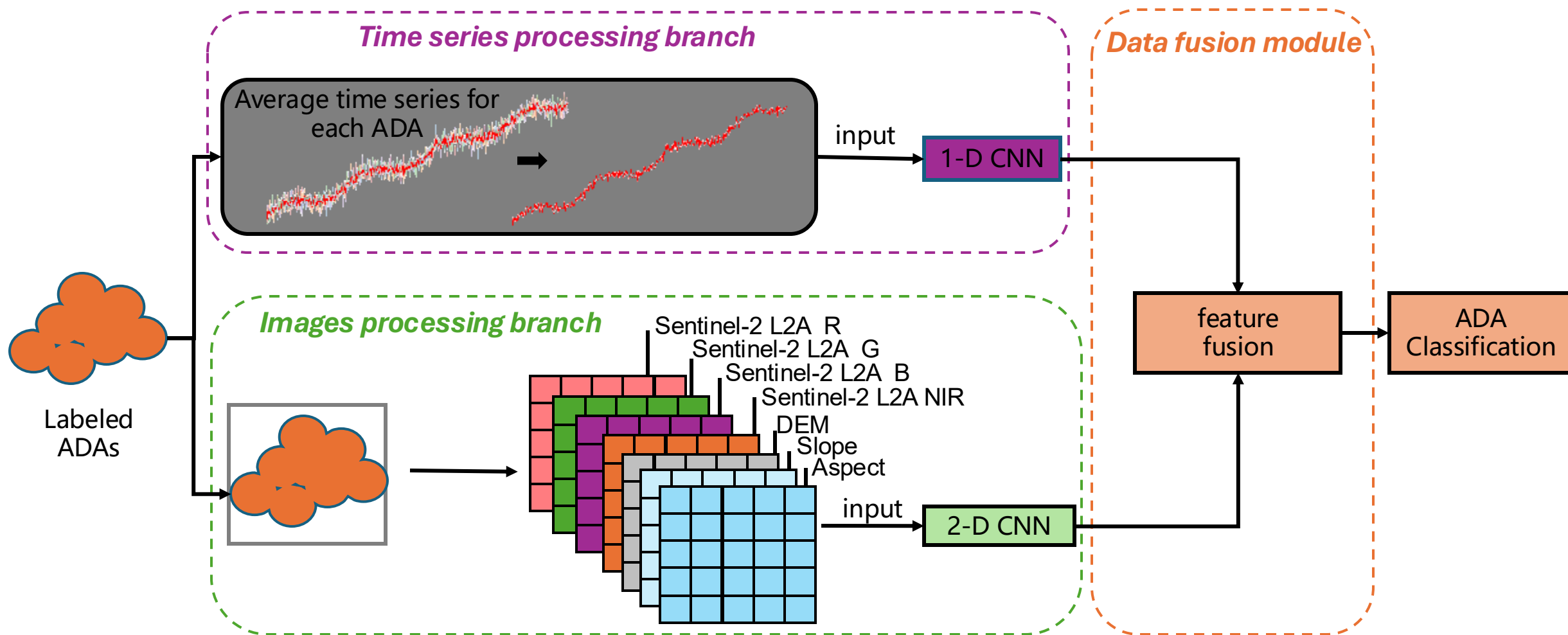


LOS Ground displacements
time series

Sentinel-2 optical remote
sensing images

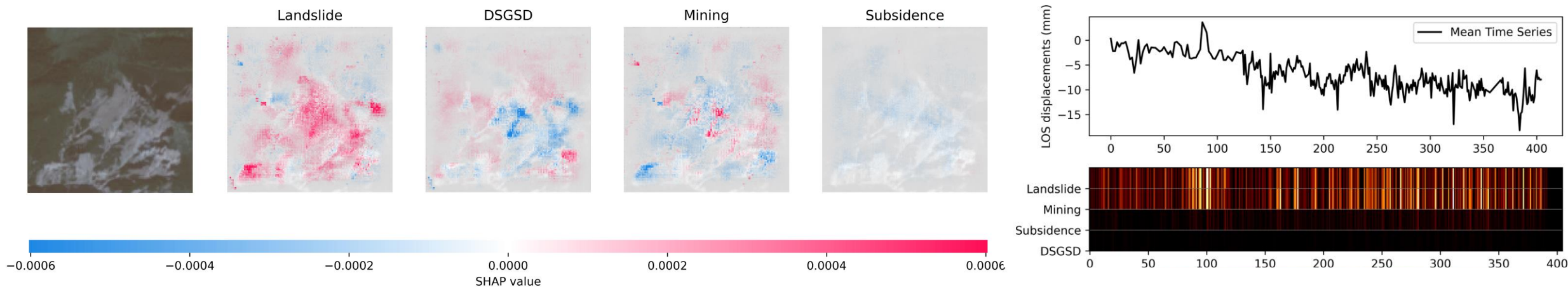
terrain products

Time-Series/Image AI Processing

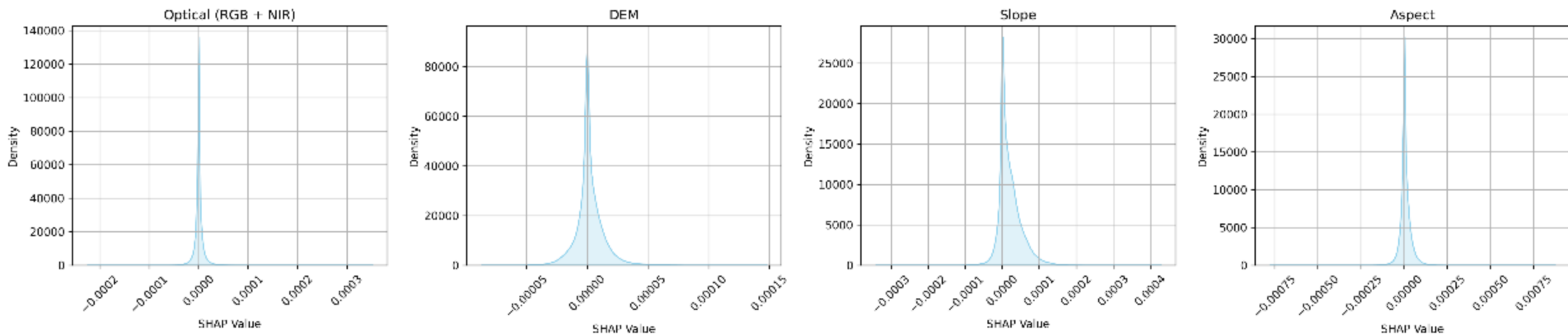


Explainability Analysis with 2D SHAP Plots

ADA_GLB_ID:11479 Ture Label: Landslide Predicted Label:Landslide Probability:0.9108

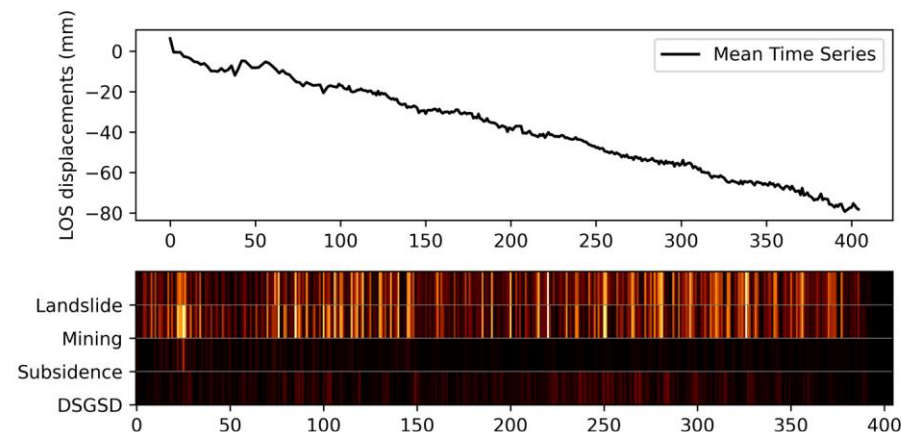
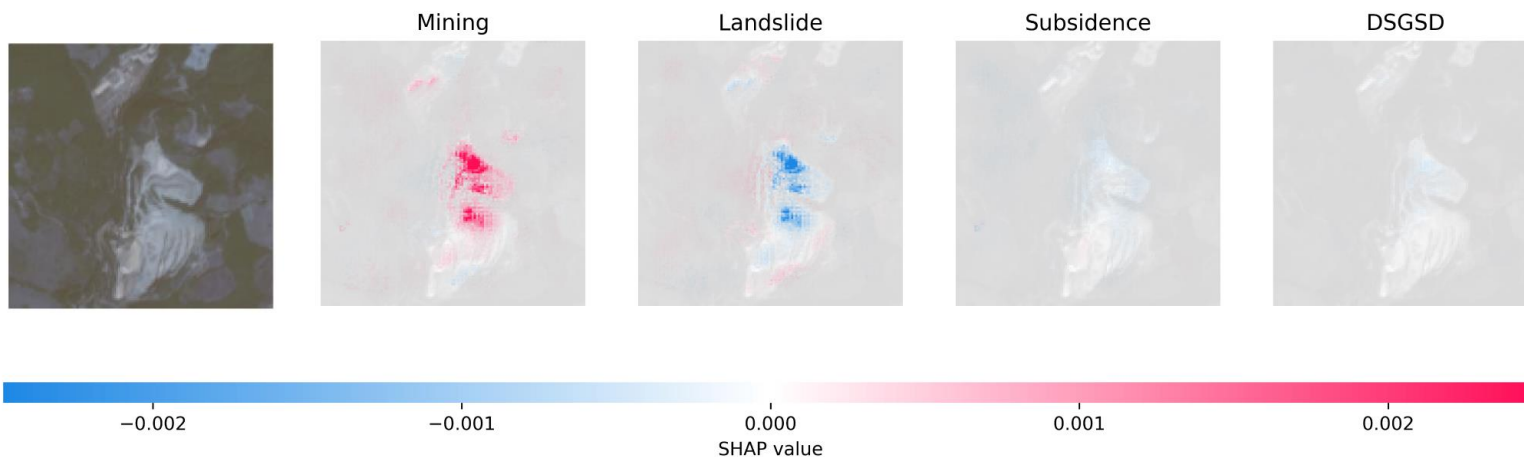


10 Correctly Classified Landslide Examples - SHAP Value Density

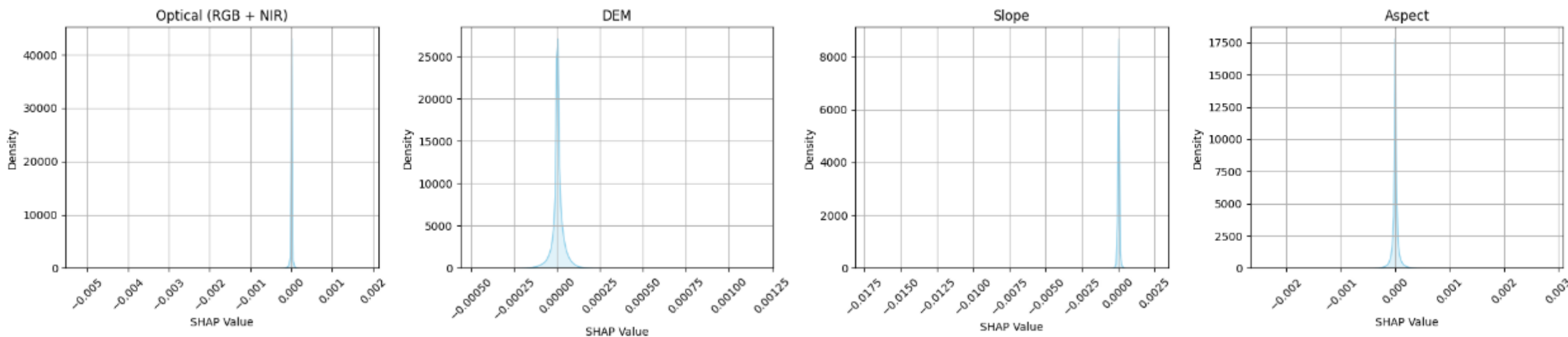


Explainability Analysis with 2D SHAP Plots

ADA_GLB_ID:81139 True Label: Mining Predicted Label: Mining Probability:0.9536

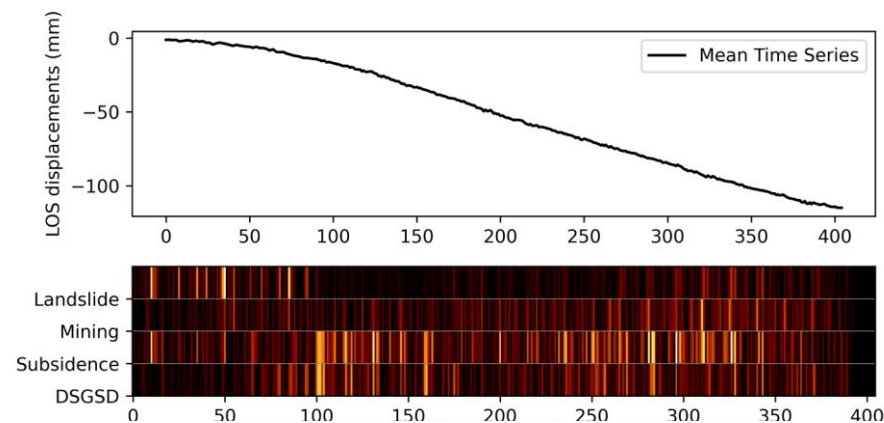
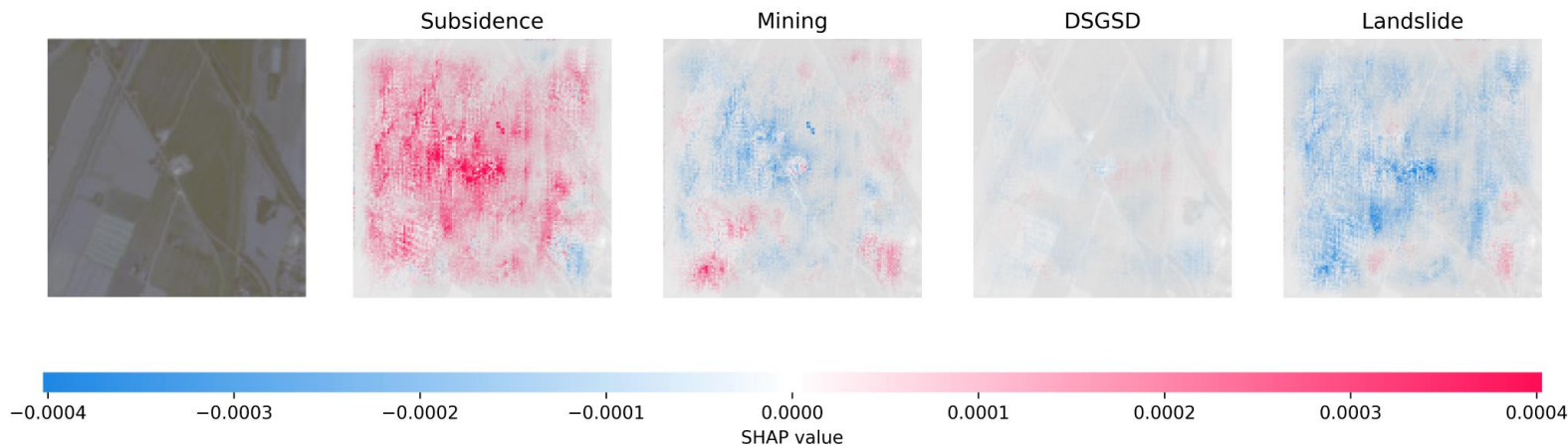


10 Correctly Classified Mining Examples - SHAP Value Density

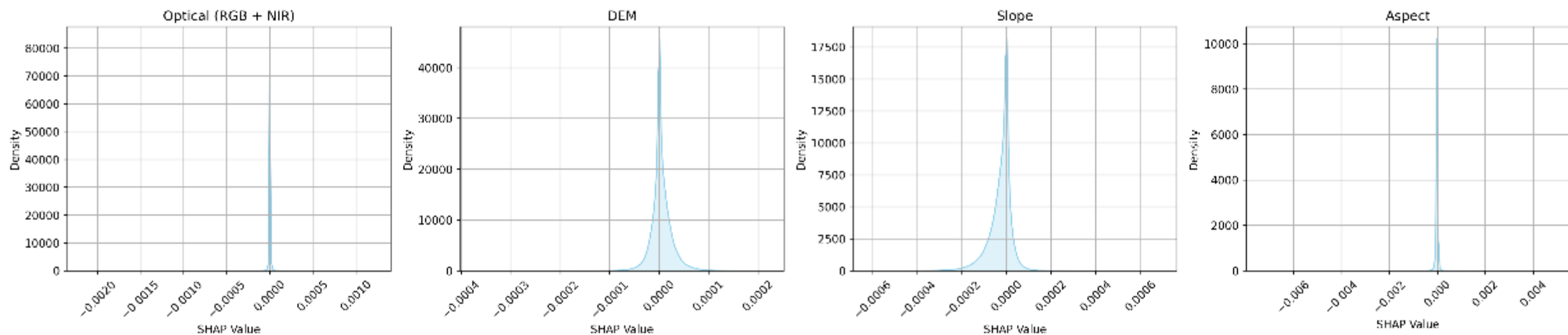


Explainability Analysis with 2D SHAP Plots

ADA_GLB_ID:18056 True Label: Subsidence Predicted Label:Subsidence Probability:0.9986

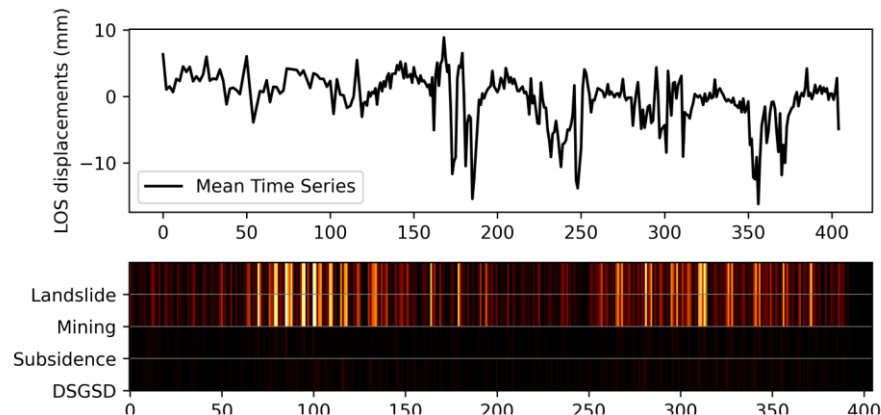
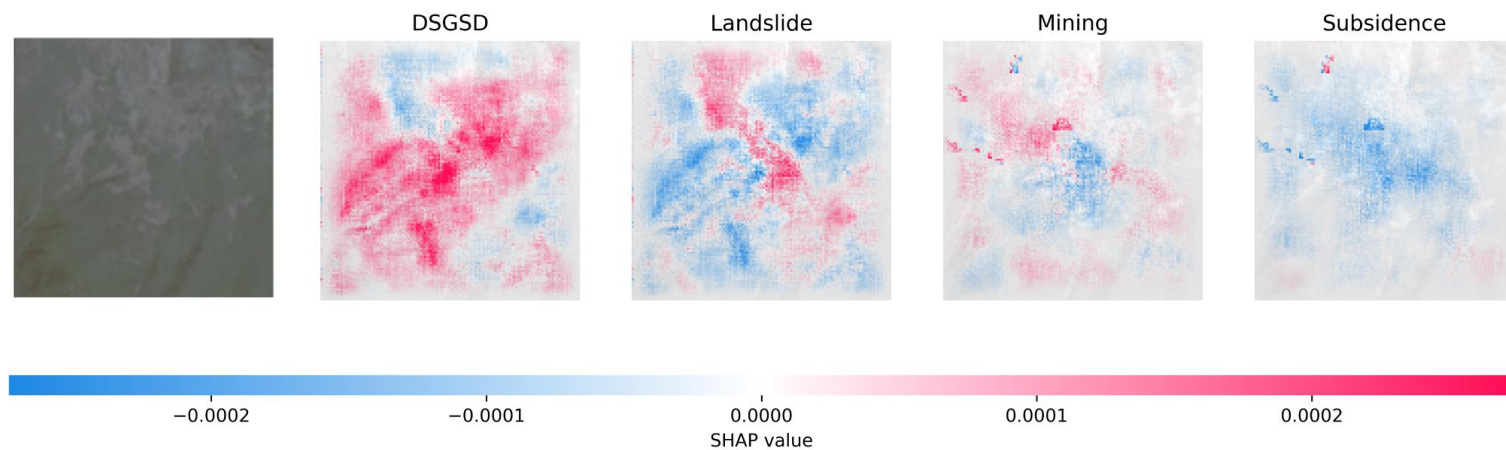


10 Correctly Classified Subsidence Examples - SHAP Value Density

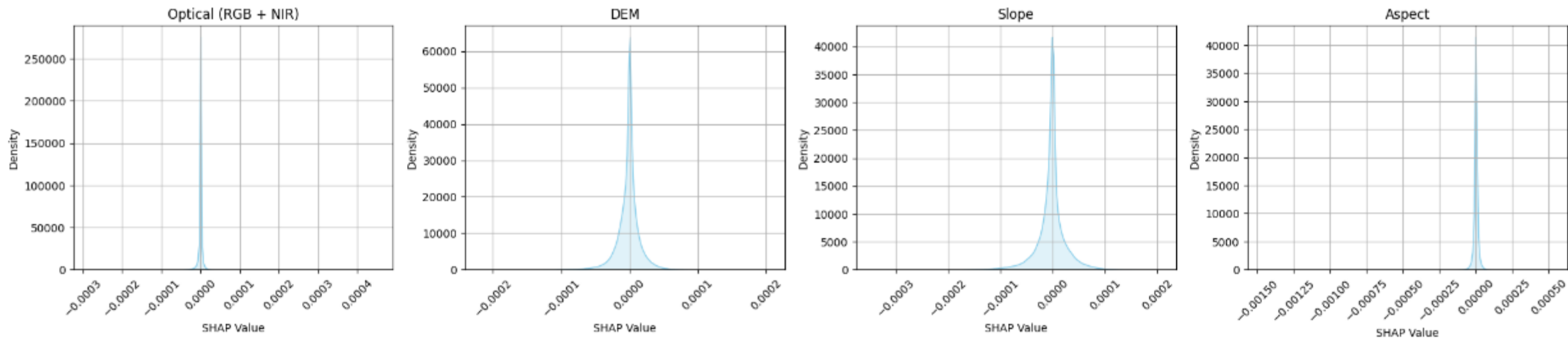


Explainability Analysis with 2D SHAP Plots

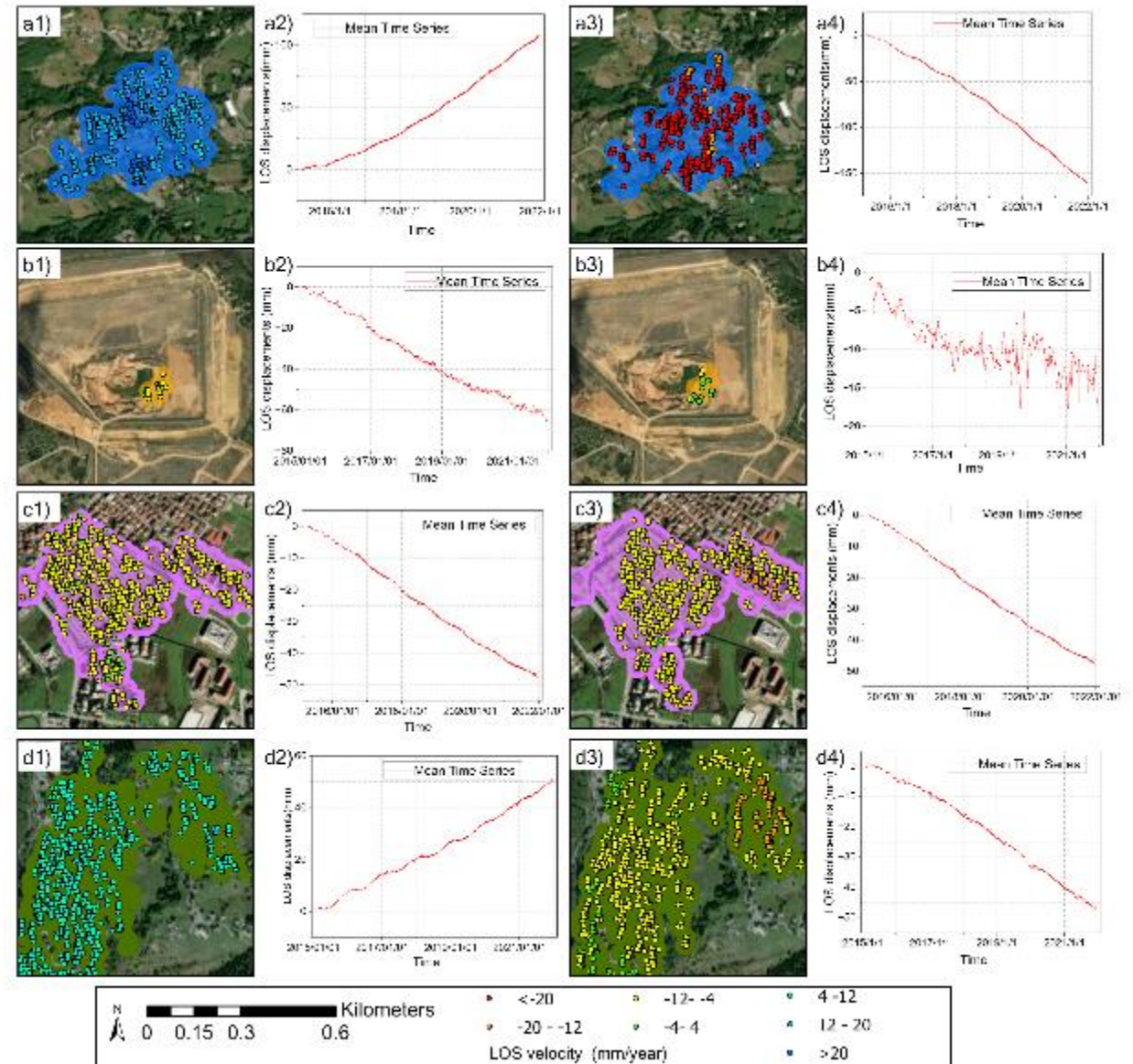
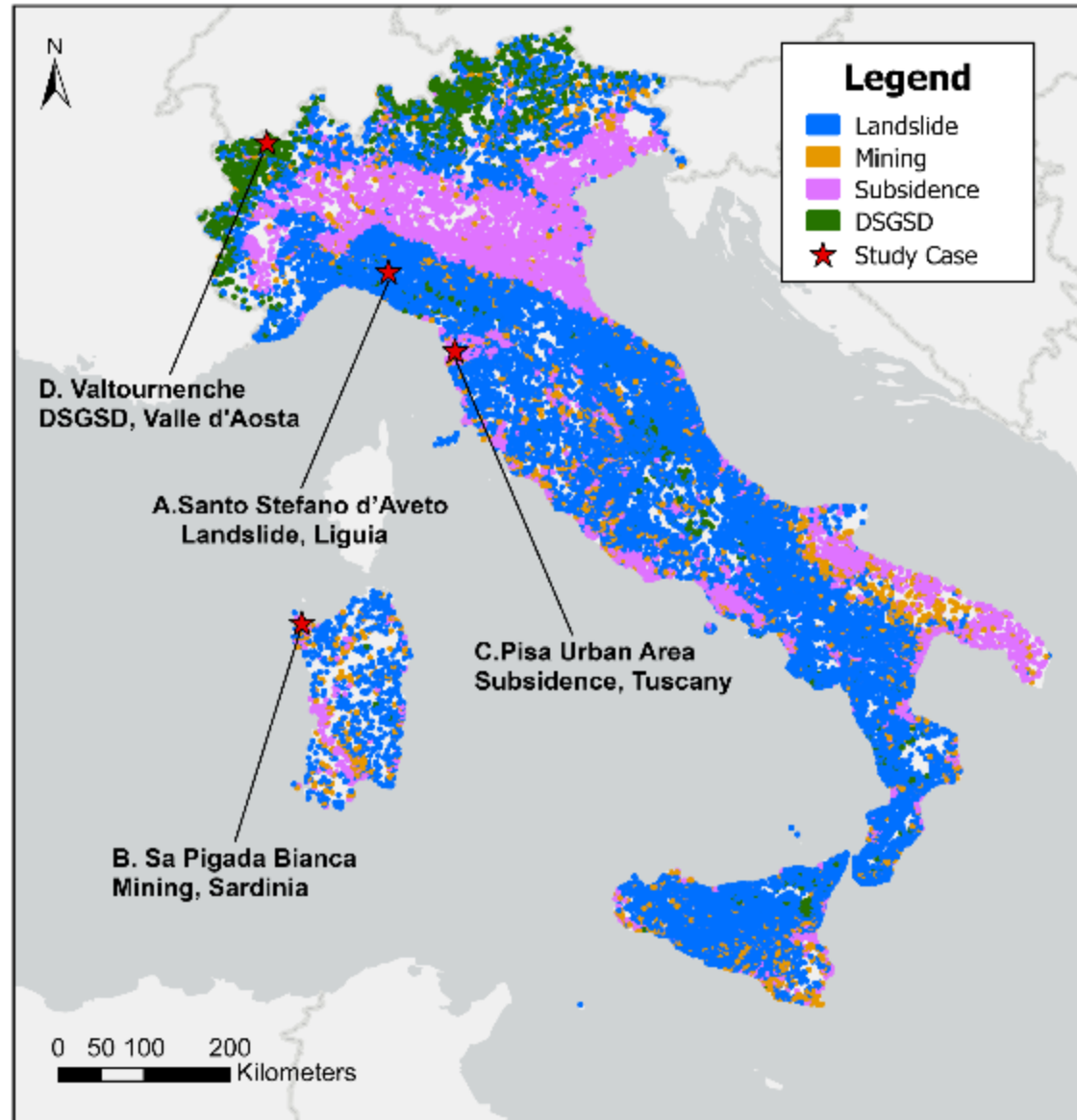
ADA_GLB_ID:12417 True Label: DSGSD Predicted Label:DSGSD Probability:0.9710



10 Correctly Classified DSGSD Examples - SHAP Value Density



Deployment on Unseen Datasets at Large Scale



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Thanks for the
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