

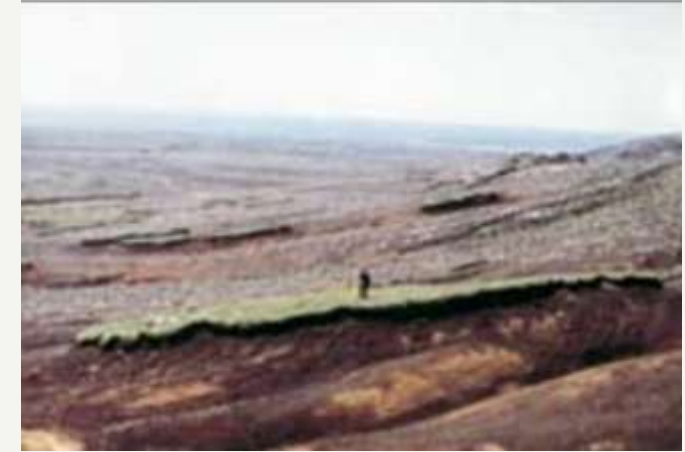


Developing a national erosion monitoring system

Jay Borchard

Why monitor erosion in Iceland?

- **A heavily degraded landscape**
 - Harsh conditions, natural disturbance, overgrazing etc.
- **Are restoration efforts working?**
 - Repeated monitoring can show where erosion is increasing, stabilising, or improving (can determine if interventions are working)
- **Supporting land use decisions**
 - E.g. Can assist in decisions surrounding grazing pressure and sheep management
- **Climate and carbon reporting**
 - Relevant for mandatory EU LULUCF reporting

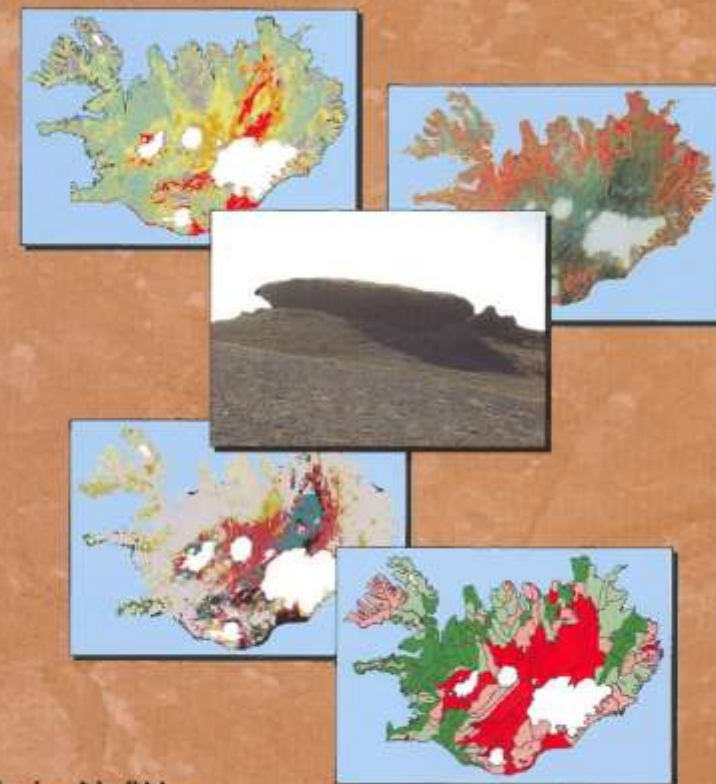


The national soil assessment program

- Initiated 1990, A collaborative project carried out by **Rannsóknastofnun landbúnaðarins (RALA)** and **Landgræðsla Ríkisins (LR)**.
- Standard erosion methods were not well suited to this landscape, requiring a locally adapted assessment approach that captured:
 - Grazing pressure
 - Wind erosion
 - Exposure of volcanic soils
 - Changes in overall land condition

JARÐVEGSROF Á ÍSLANDI

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Landgræðsla ríkisins
Rannsóknastofnun landbúnaðarins
Febrúar 1997

The erosion classification scale

- A qualitative/ordinal assessment of erosion severity
- Criteria is based not just on percent erosion but on **erosion form** (e.g. *melur*, *rofabörð*, *erosion spots*)



A rofabard. Remnants of soil and vegetation in an Icelandic desert.

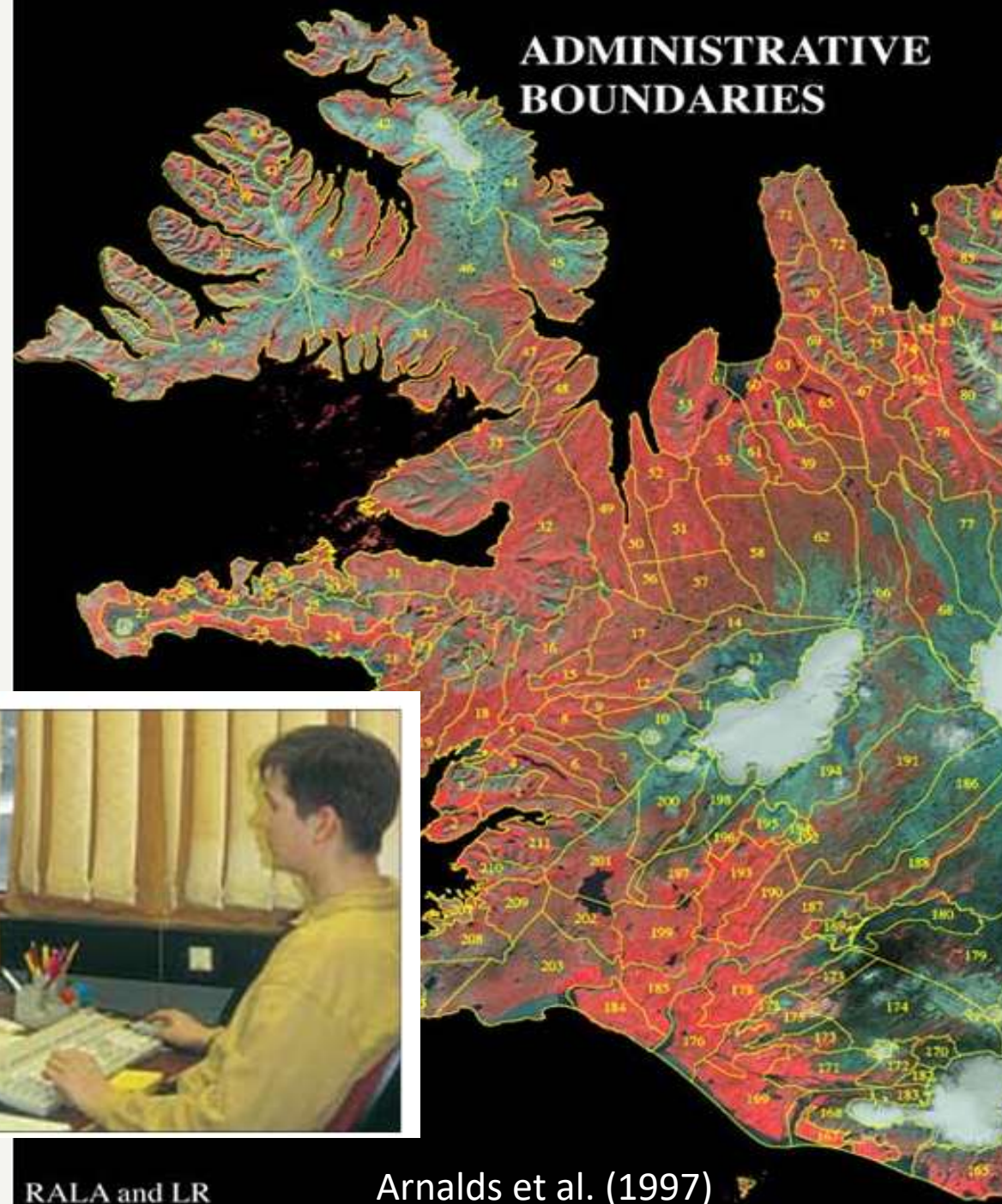


Dyngjusandur, north of Vatnajökull glacier.

Class	Erosion severity	What the class reflects
0	No erosion	No identifiable soil erosion
1	Little erosion	Minor erosion; land is largely stable and erosion is limited
2	Slight erosion	Noticeable erosion, but generally limited; vegetation/soil cover remains largely intact
3	Considerable erosion	Clearly established erosion with substantial effects on soil/vegetation; erosion is significant enough to require management
4	Severe erosion	Extensive or advanced erosion; substantial loss/degradation of soil and/or vegetation
5	Extremely severe erosion	Very extensive/advanced erosion; highly degraded or actively eroding land, often associated with bare/sandy surfaces

Early GIS methods for mapping erosion

- They used landsat imagery to identify homogenous landscape units (*e.g. Survey units*).
- Surveyors to examine each survey unit, assess, and assign an erosion severity grade (0 -5).



RALA and LR
1997

Arnalds et al. (1997)

The first national-scale erosion map



Foreign desertification scientists in a recently formed Icelandic desert.

Arnalds et al. (1997)



The GroLind project



Aims and Goals

- Program started in 2017
- To Assess and monitor the state of Icelandic vegetation and soil resources
- Develop cost-effective large-scale monitoring systems using field data.

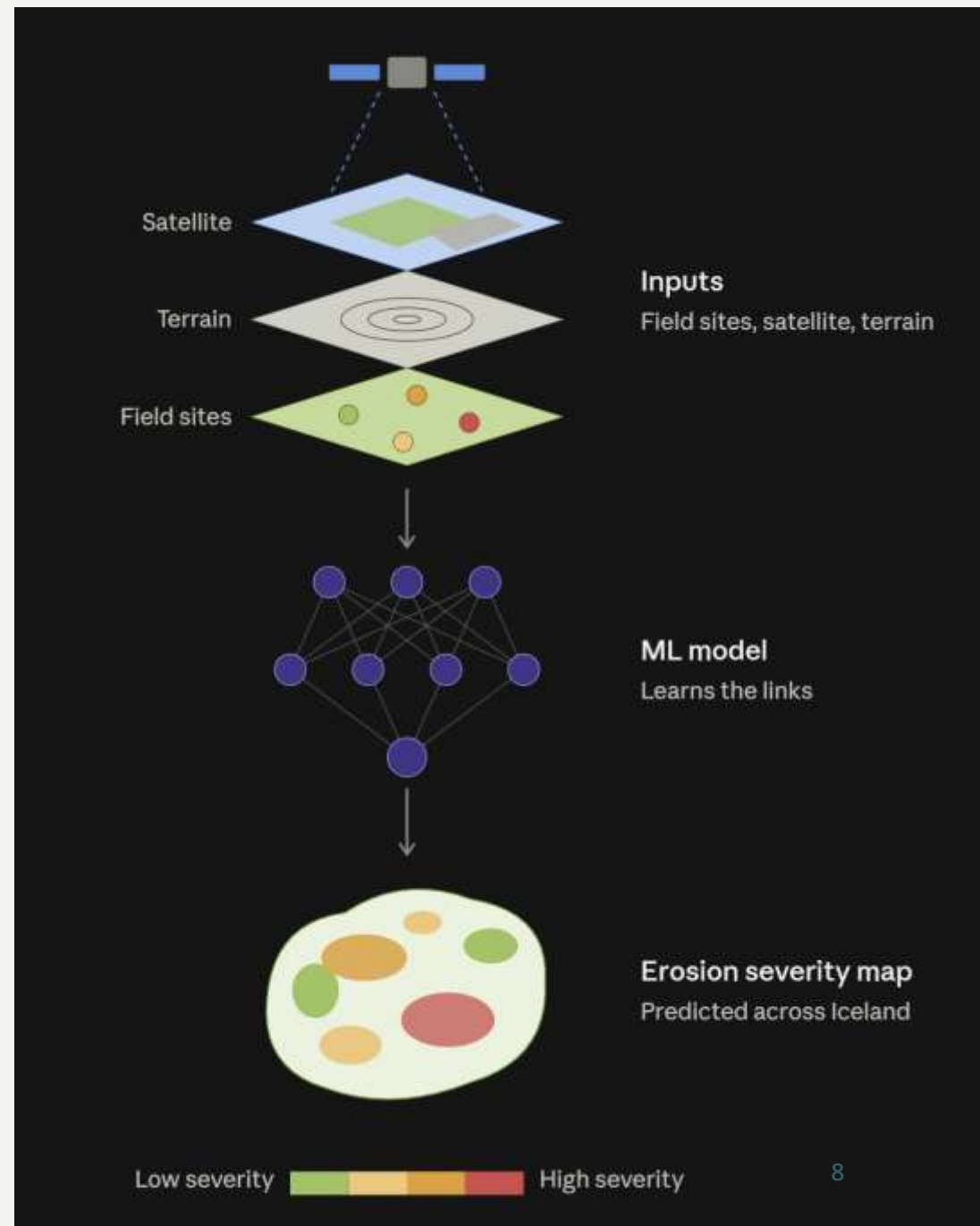
Survey data

- *Field surveys*: ~1500 sites across Iceland
- Collected from 2019
- Field plot size: 50m by 50m
- Each site assessed for erosion severity using the 5-point scale.

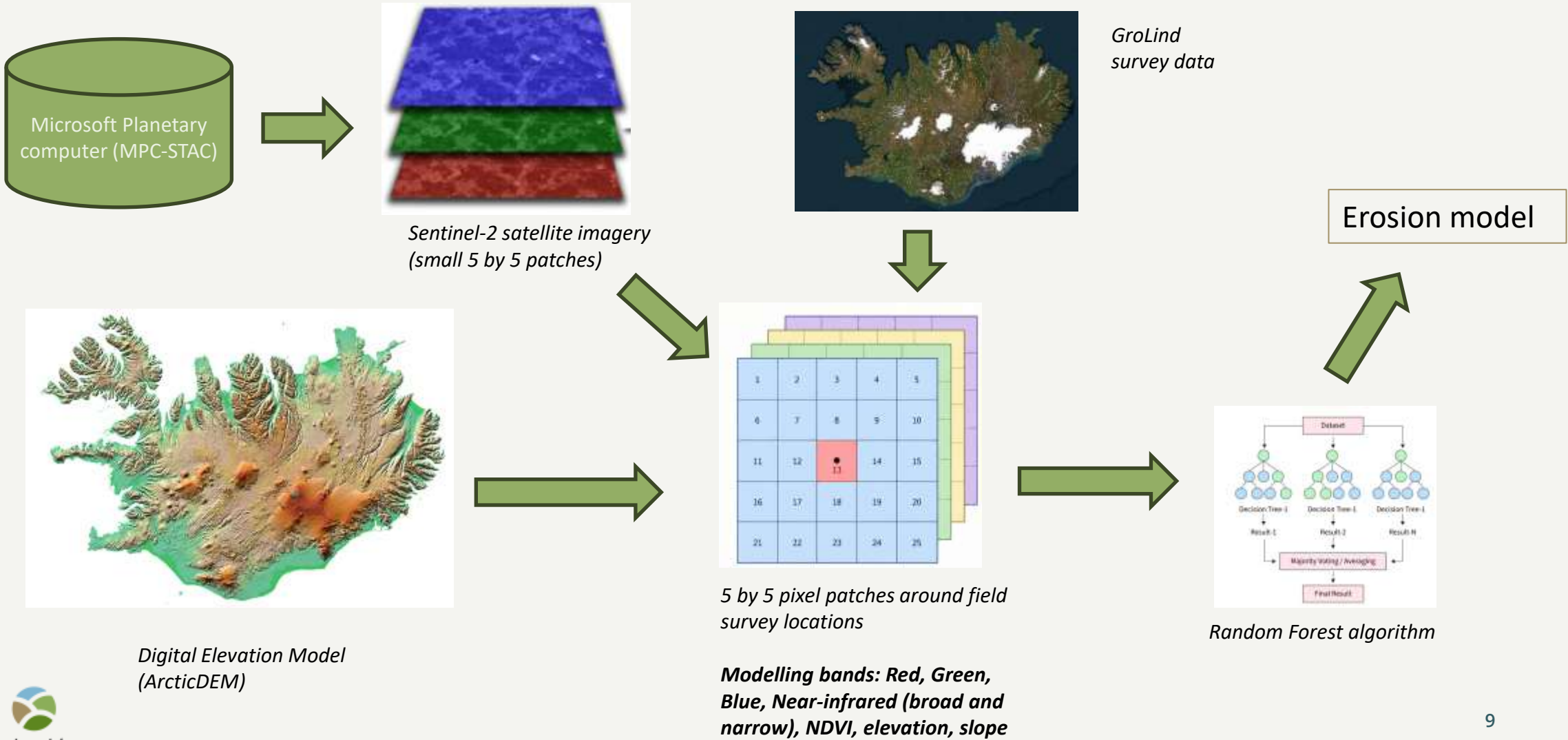


A remote-sensing ML framework for estimating erosion severity

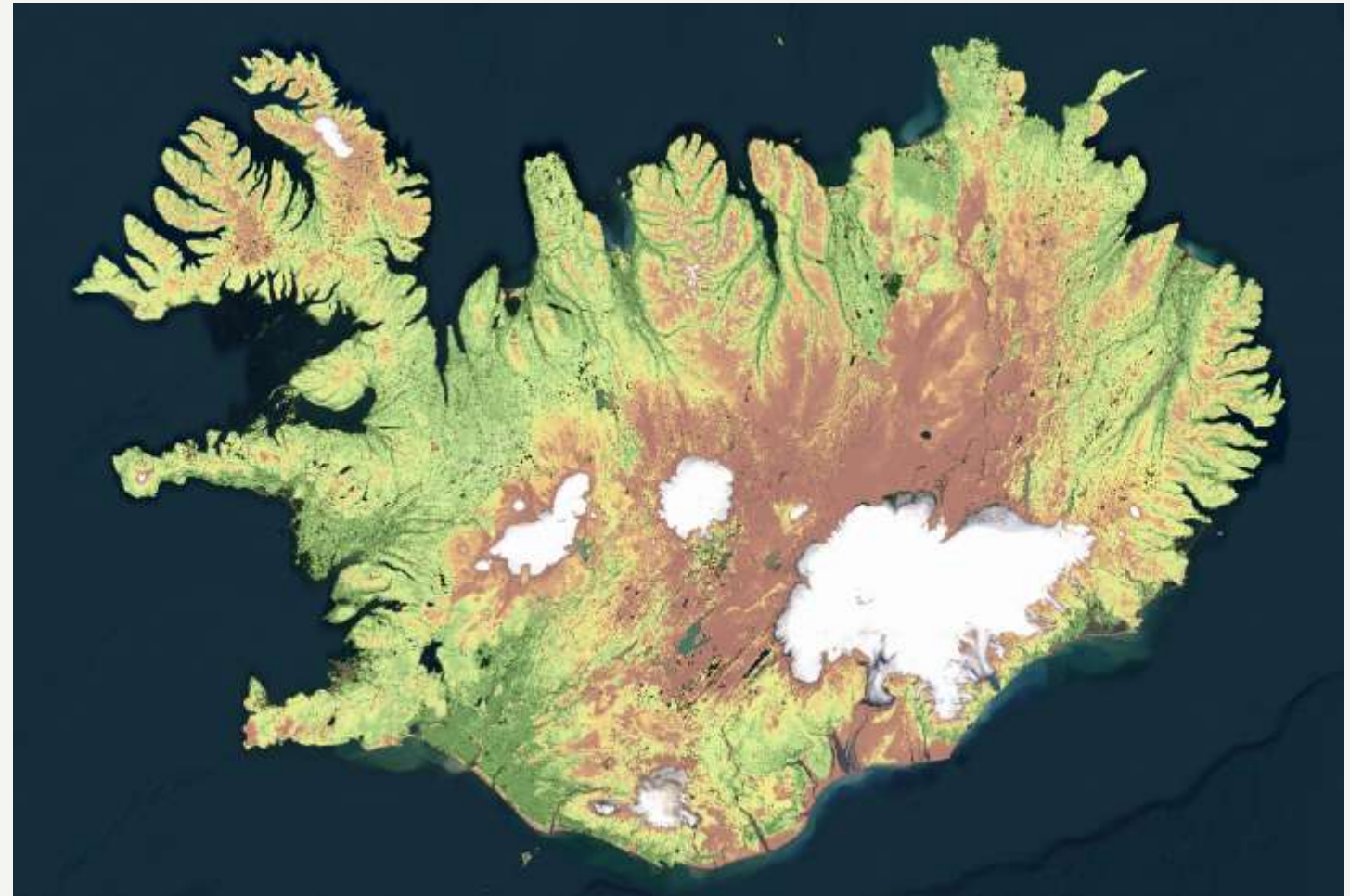
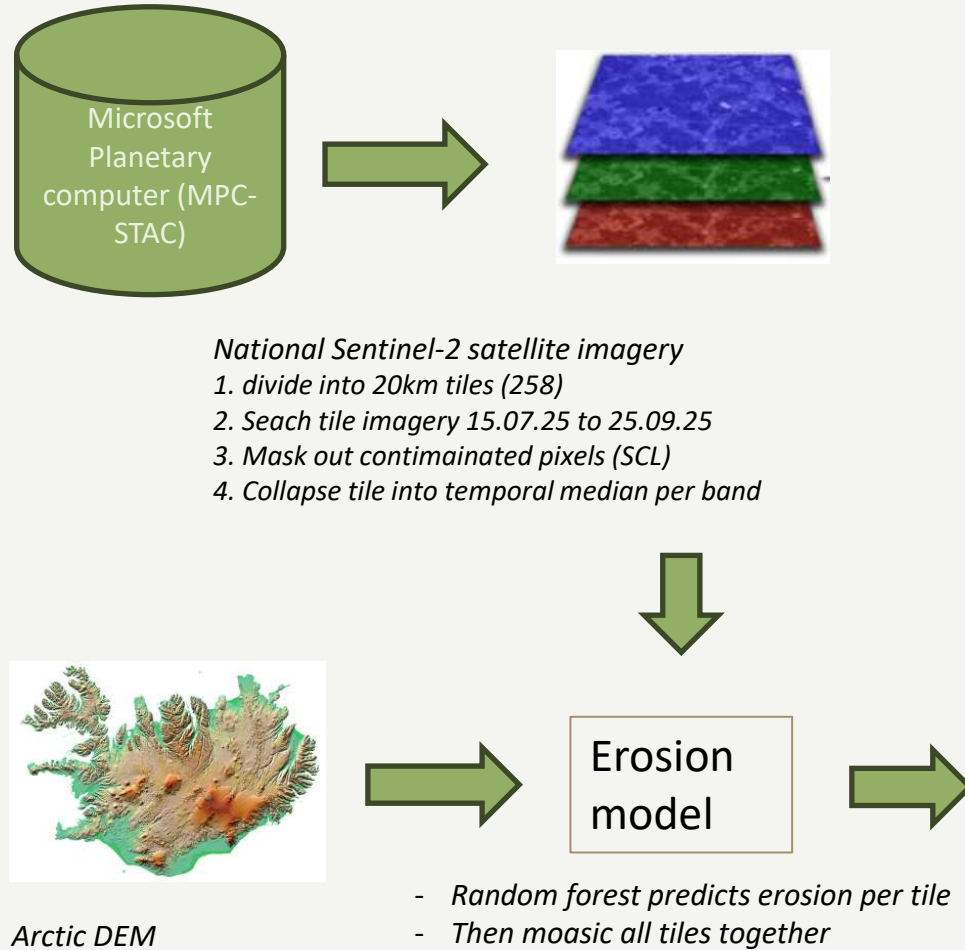
- Erosion site assessments provide observed erosion severity to train a model.
- Satellite imagery and terrain data provide environmental information across Iceland.
- A machine-learning (ML) model links the field observations to landscape characteristics and predicts erosion severity across the country.



Step 1. Developing an Erosion severity model



Step 2. Estimating erosion severity at a national-scale



Erosion severity map (50m resolution) – (2025)

Moving beyond a single classification map

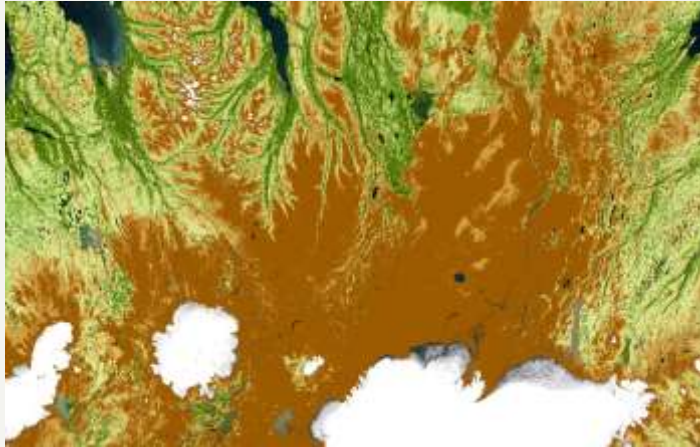
Four national map products from erosion model:

- (a) Erosion severity class
- (b) Expected erosion severity score
- (c) Quality assurance (QA) layer
- (d) Model uncertainty map

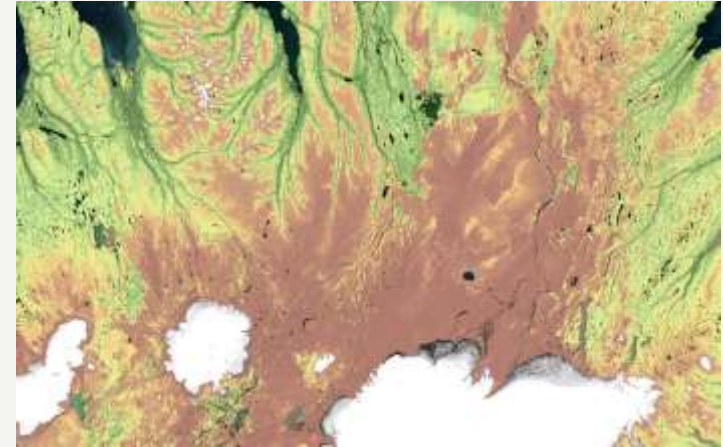
Publication:

- 4 map products
- Technical report

(a) Erosion severity class (0,1,2,3,4,5)



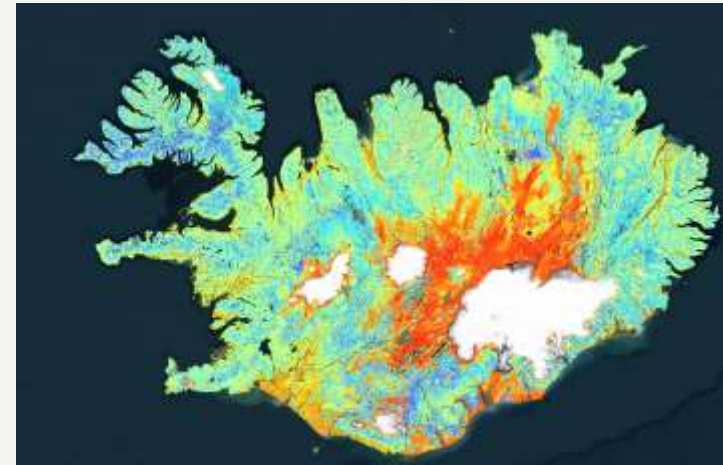
(b) Expected erosion severity score (0 – 5)



(c) QA layer



Model prediction uncertainty (red is highly confident)



Model performance

Overall performance

- Modest model performance with exact accuracy = 55%
- Off-by-one tolerance accuracy = 85%

Performance by erosion class

- *No erosion (0)*: Model detects most areas with no erosion
- *Slight erosion (1)*: Many slight-erosion cases are missed
- *Moderate and considerable (2,3)*: hardest classes for the model to distinguish
- *Severe (4)*: moderate classification performance
- *Extremely severely (5)*: model identifies almost all of the extremely severe cases

Developing a monitoring system: A statistical-ML hybrid approach

