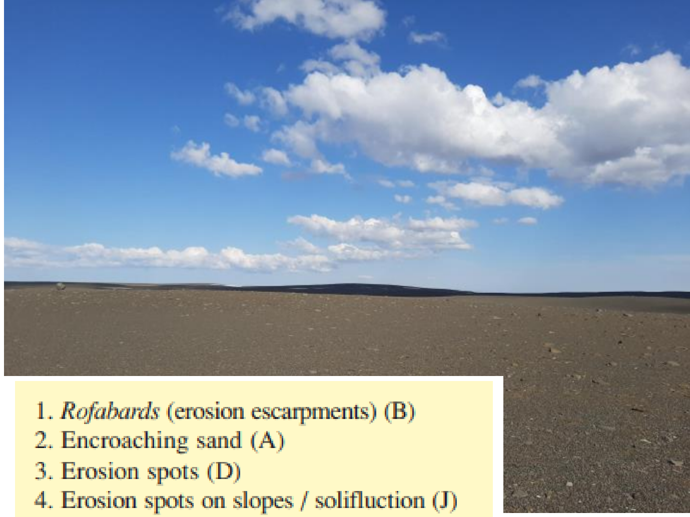
by ChatGPT

Soil erosion in Iceland

6 main erosion classes

Erosion Class
0 No erosion
1 Little erosion
2 Slight erosion
3 Considerable erosion
4 Severe erosion
5 Extremely severe erosion

Where is our effort most efficient?



1. *Rofabards* (erosion escarpments) (B)
2. Encroaching sand (A)
3. Erosion spots (D)
4. Erosion spots on slopes / solifluction (J)
5. Gullies (V)
6. Landslides (K)
7. Deserts / barren land (many classes)

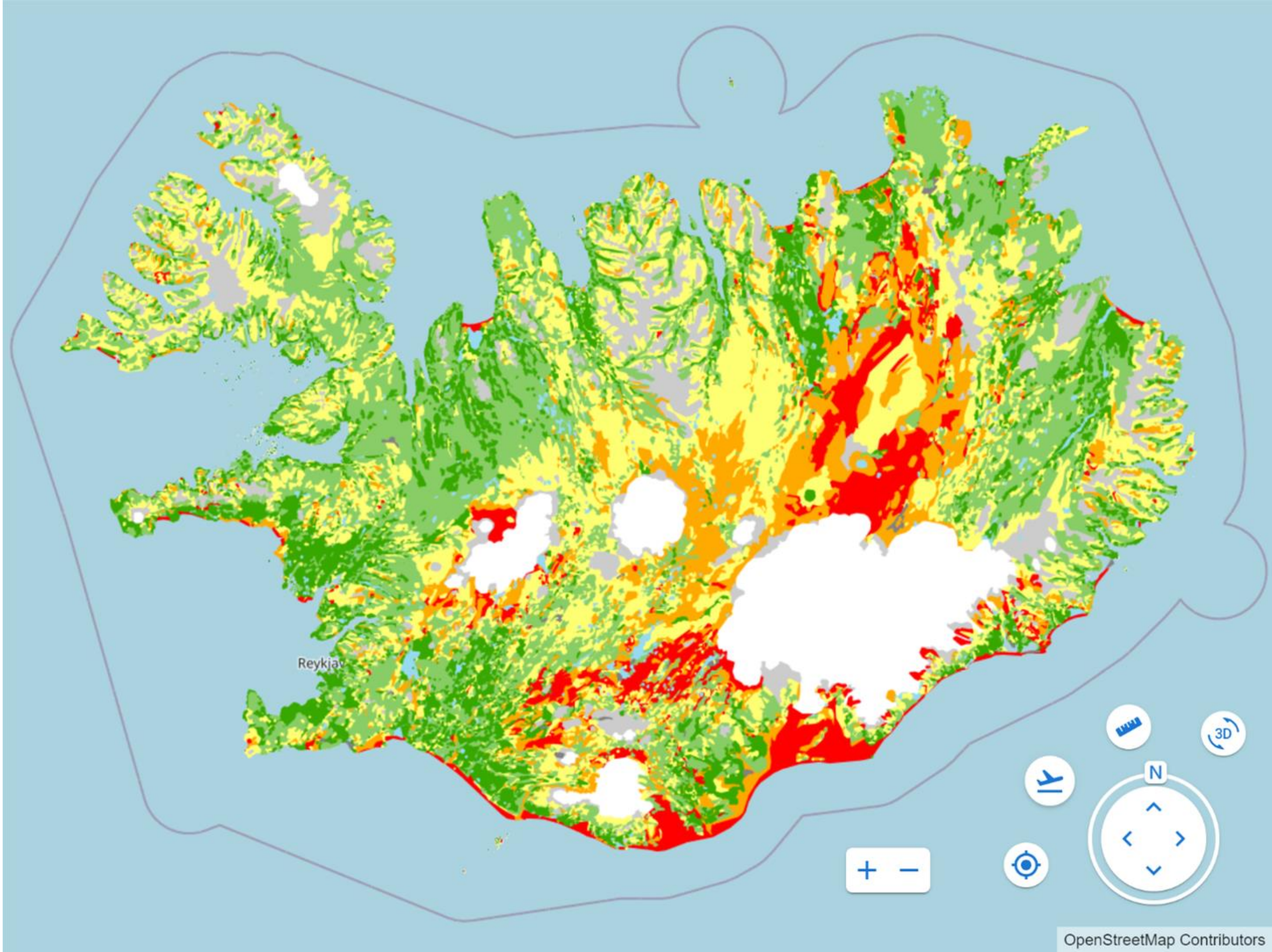
Classes from Soil erosion in Iceland – O. Arnalds et al.

1997 map

O. Arnalds, E. F. Þorarinsdóttir,

S. Metusalemsson, A. Jonsson,

E. Gretarsson, A. Arnason



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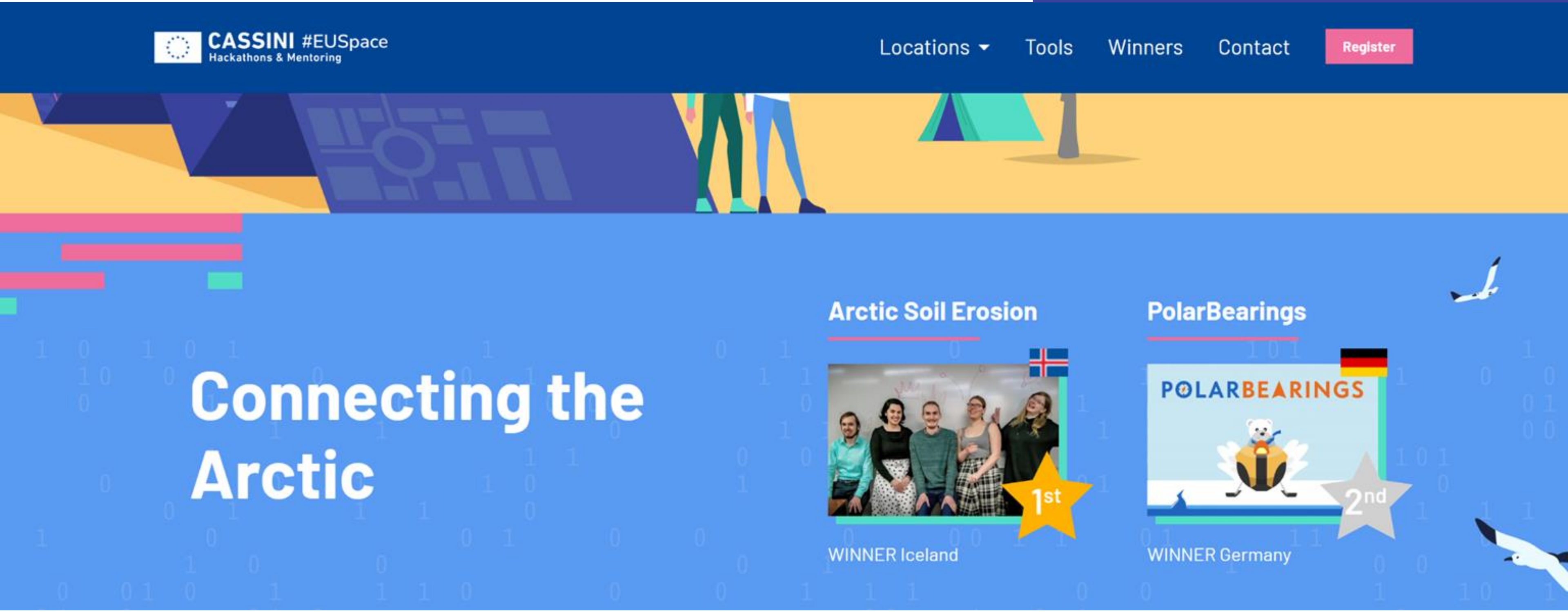
How it all started

CASSINI
Hackathons & Mentoring



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Who are we

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Research

FOSS4G
FIRENZE 2022

FOSS4G 2022 academic track

Remote mapping of soil erosion risk in Iceland

08-24, 15:25–15:30 (Europe/Rome), Room Hall 3A

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isprs
information from imagery

The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLVIII-4/W1-2022
Free and Open Source Software for Geospatial (FOSS4G) 2022 – Academic Track, 22–28 August 2022, Florence, Italy

REMOTE MAPPING OF SOIL EROSION RISK IN ICELAND

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Commission IV, WG IV/4

KEY WORDS: Soil Erosion, Iceland, Sentinel 2, Remote Sensing, Machine Learning, Support Vector Machine

ABSTRACT:

The use of remote-sensing based methods for soil erosion assessment has been increasing in recent years thanks to the availability of free access satellite data, and it has repeatedly proven to be successful. Its application to the Arctic presents a number of challenges, due to its peculiar soils with short growing periods, winter storms, wind, and frequent cloud and snow cover. However, the benefits of applying these techniques would be especially valuable in arctic areas, where ground local information can be hard to obtain due to hardly accessible roads and lands. Here we propose a solution which uses a Support Vector machine classification model and ground truth samples to calibrate the processed remote images over a specific area, in order to then automate the analysis for larger, less accessible areas. This solution is being developed for soil erosion studies of Iceland specifically, using Sentinel 2 satellite data combined with local assessment data from Iceland's Soil Conservation Services department.

1. INTRODUCTION

Soil erosion is a major global land degradation threat. Improving knowledge of the probable future rates of soil erosion, accelerated by human activity and climate change, is one of the most decisive factors when it comes to making decisions about conservation policies and for earth-system modelers seeking to reduce uncertainty on global predictions (FAO, 2015). Accurate information about it is, however, usually known only at the local scale and based on limited field campaigns (Verheijen et al., 2009).

Such is the case of Iceland, where most of the available information about its soil degradation comes solely from such campaigns, carried out by Landgræðslan, the national Soil Conservation Service[1]. The degradation of Iceland's ecosystem can be described as desertification. Due to the lack of vegetation, its wastelands have striking similarities to barren areas in arid countries. Soil erosion prediction plays a key role in mitigating the process (Arnalds et al., 2001).

Historically, pioneers include Björn Johannesson (Johannesson, 1961), who early on introduced a soil map and a book on the soils of Iceland. An attempt was made decades later to adopt the present-day FAO classification for Icelandic soils (Gudmundsson, 1994). The main work on soil science in Iceland has been undertaken by the Agricultural Research Institute of Iceland (Rala), which in 2005 became a part of the Agricultural University of Iceland (AUI). Much information about the physical and chemical properties of soils in Iceland can be drawn from the joint European COST-622 Action (Bartoli et al., 2003, Arnalds and Stahr, 2004). Research contributions in relation to the impact of man and degradation are numerous and include both Icelandic and foreign research efforts.

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[1] https://land.is/

Nowadays the Icelandic government aims at bringing soil erosion under control and achieving sustainable land use as soon as possible. Desertification is mainly caused by the interaction of grazing effects, both past and present, with sensitive soils and vegetation. The soil conservation authorities, mainly the soil conservation service, were given stronger capacities to manage and monitor grazing practices in protected areas threatened by erosion and to restore denuded land (UNEP, 2002).

The methods used to assess the evolution of soil erosion involve measurements in the field and use of aerial photographs from different time intervals. There are two techniques used with aerial photographs. One way is scanning and image analysis, the other is digitizing. The use of aerial photographs involves a certain margin of error. These are expensive tasks, especially in certain areas of the country which are very hard to access, making on-site measurement a challenge. Consequently, at the moment not all areas of interest can be explored.

In addition to the impact that climate change can have on the ecosystem of Arctic regions like Iceland, one can also wonder about the impact that soil erosion in these areas can have on the global climate. Soil in northern latitudes stores up to half of the Earth's soil carbon; about twice the amount of carbon stored in the atmosphere. The importance of this carbon sink is immeasurable. Permanently frozen ground keeps this organic carbon locked in the soil and, together with extensive peatlands, ensures that northern circumpolar soils are a significant carbon sink (Jones et al., 2009). Current estimates from the Northern Circumpolar Soil Carbon Database indicate that the northern permafrost region contains approximately 1672 Pg of organic carbon, of which approximately 1466 Pg, or 88%, occurs in perennially frozen soils and deposits (Tarnocai et al., 2009).

To improve on the above limitations, one extremely useful tool has been made available through the advancement in satellite

MDPI

remote sensing MDPI

Article

Comparative Analysis of Machine Learning Algorithms for Soil Erosion Modelling Based on Remotely Sensed Data

Daniel Fernández [1], Eromanga Adermann [1], Marco Pizzolato [1], Roman Pechenkin [1], Christina G. Rodríguez [1] and Alireza Taravat [2,*]

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Abstract: Recent years have seen an increase in the use of remote-sensing based methods to assess soil erosion, mainly due to the availability of freely accessible satellite data, with successful results on a consistent basis. There would be valuable benefits from applying these techniques to the Arctic areas, where ground local studies are typically difficult to perform due to hardly accessible roads and lands. At the same time, however, the application of remote-sensing methods comes with its own set of challenges when it comes to the peculiar features of the Arctic: short growing periods, winter storms, wind, and frequent cloud and snow cover. In this study we perform a comparative analysis of three commonly used classification algorithms: Support Vector Machine (SVM), Random Forest (RF) and Multilayer Perceptron (MLP), in combination with ground truth samples from regions all over Iceland, provided by Iceland's Soil Conservation Service department. The process can be automated to predict soil erosion risk for larger, less accessible areas from Sentinel-2 images. The analysis performed on validation data sets supports the effectiveness of both approaches for modeling soil erosion, albeit differences are highlighted.

Keywords: soil erosion; Sentinel-2; remote sensing; machine learning; support vector machine; random forest; multilayer perceptron; image classification; arctic

check for updates

Citation: Fernández, D.; Adermann, E.; Pizzolato, M.; Pechenkin, R.; Rodríguez, C.G.; Taravat, A. Comparative Analysis of Machine Learning Algorithms for Soil Erosion Modelling Based on Remotely Sensed Data. *Remote Sens.* **2023**, *15*, 482. https://doi.org/10.3390/rs15020482

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1. Introduction

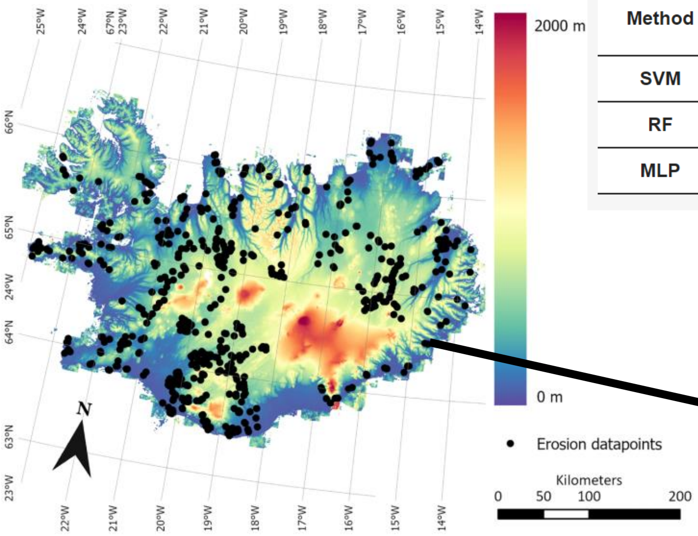
Soil erosion is becoming a major land deterioration hazard worldwide. Making strides in our understanding of the likely future rates of soil erosion, quickened by human activity and climate alterations, is one of the foremost conclusive components when it comes to making choices on preservation arrangements and for Earth ecosystem modelers looking to diminish the unreliability of global expectations [1]. Despite this, detailed information is typically based on limited field campaigns and is typically only known locally [2].

This is the situation in Iceland, where Landgræðslan, the country's Soil Conservation Service, is the sole source of the majority of information about soil degradation in the land [3]. The deterioration of Iceland's ecosystem can be considered as a form of desertification. Due to their lack of vegetation, its badlands have prominent similitudes to desolate zones in dry weathered nations. Soil erosion forecast plays a key part in relieving such progression [4].

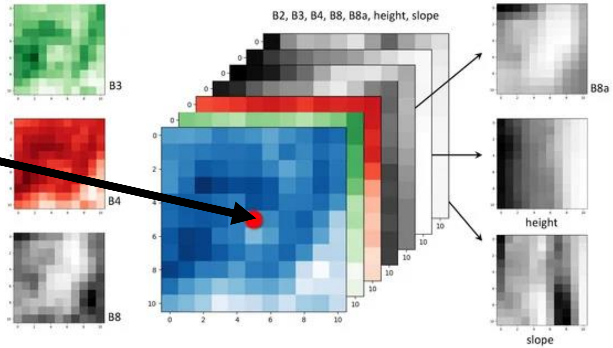
From a historical perspective, pioneers include Björn Johannesson [5], who first published a soil erosion map in his book on the soils of Iceland. The current FAO classification for Icelandic soils was attempted decades later [6]. The Agricultural Research Institute of Iceland (Rala), which became a part of the Agricultural University of Iceland (AUI) in 2005, has done the majority of the work on Icelandic soil science. The joint European COST-622 Action [7,8] provides a wealth of information regarding the chemical and physical properties of Iceland's soils. Numerous Icelandic and international research efforts have contributed to our understanding of the effects of both man-caused and natural degradation.

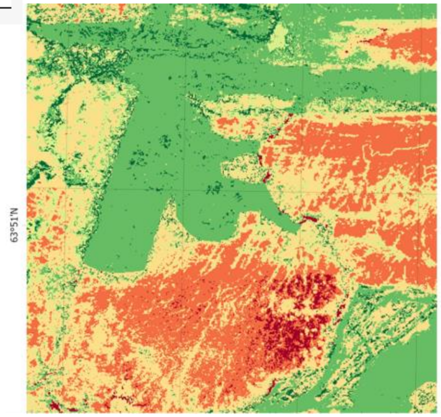
What we do – Generalize and Classify

Preprocessing → Dataset building → Training → Testing → Classify

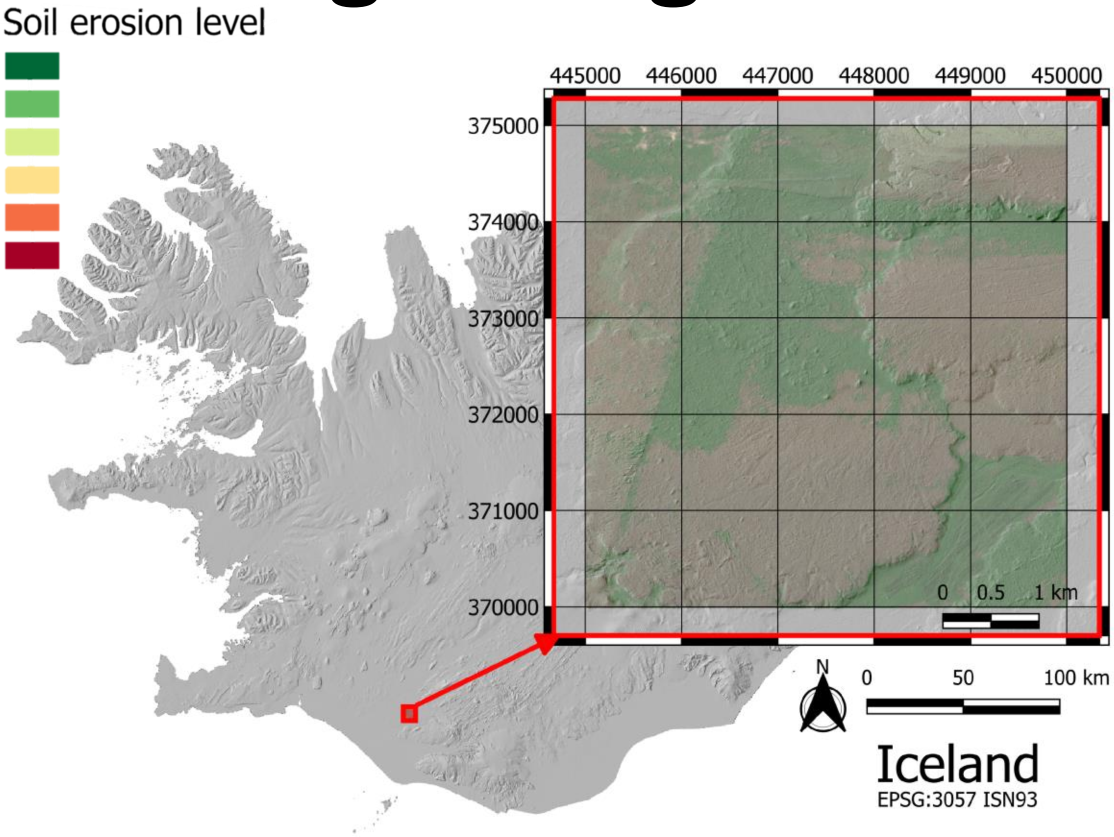


Method	Accuracy	*k*-Fold Accuracy	Precision	Recall	Macro F1-Score
SVM	0.92	0.919 ± 0.002	0.92	0.92	0.92
RF	**0.93**	**0.932 ± 0.002**	**0.93**	**0.93**	**0.93**
MLP	0.74	0.739 ± 0.005	0.73	0.74	0.73

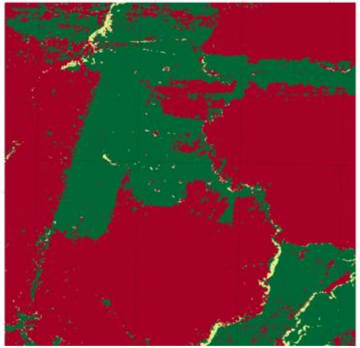




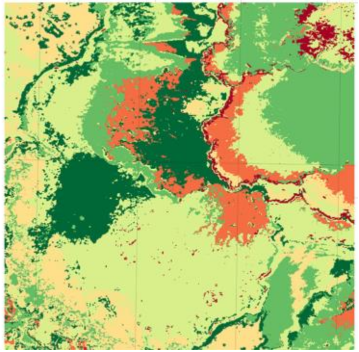
Finding the right model



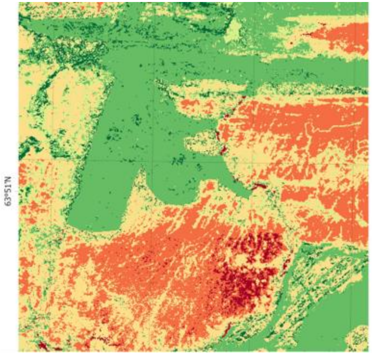
MLP

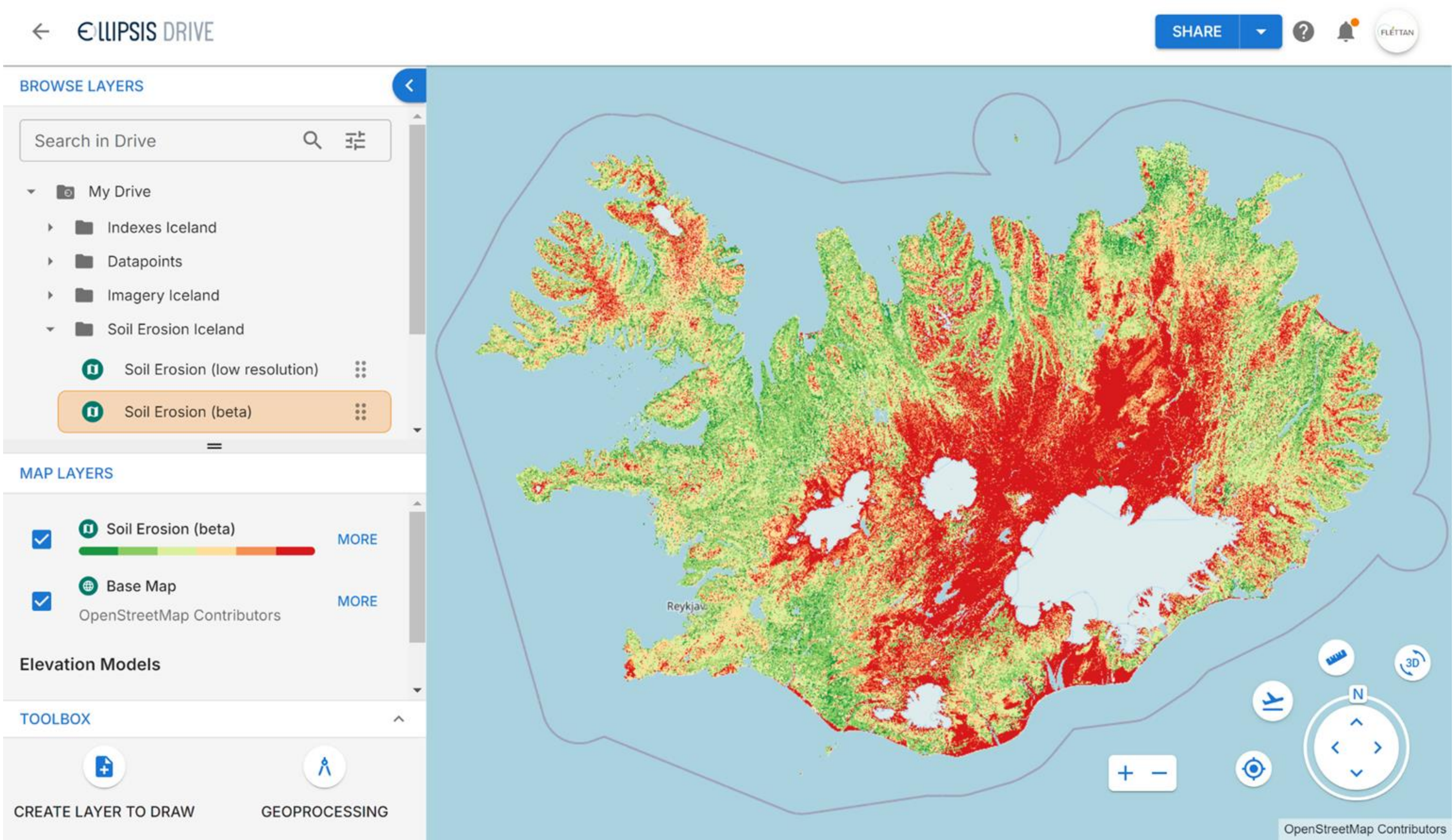


SVM



RF

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Soil Erosion (beta)
MORE
Base Map
OpenStreetMap Contributors
MORE
Elevation Models
TOOLBOX
CREATE LAYER TO DRAW
GEOPROCESSING
Reykjav
3D
N
OpenStreetMap Contributors

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Yearly NIR Mosaics 10m

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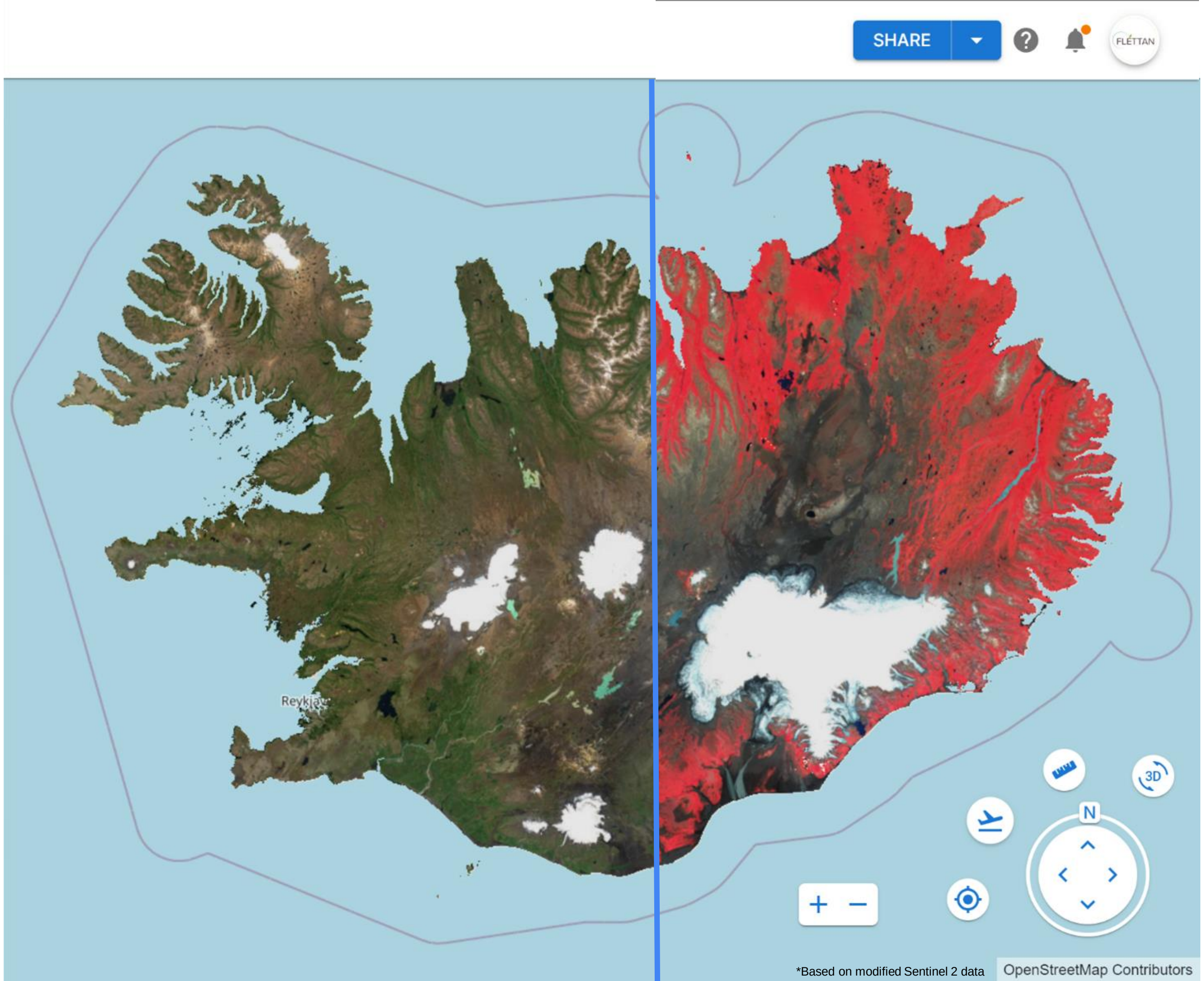
Integrated in our services



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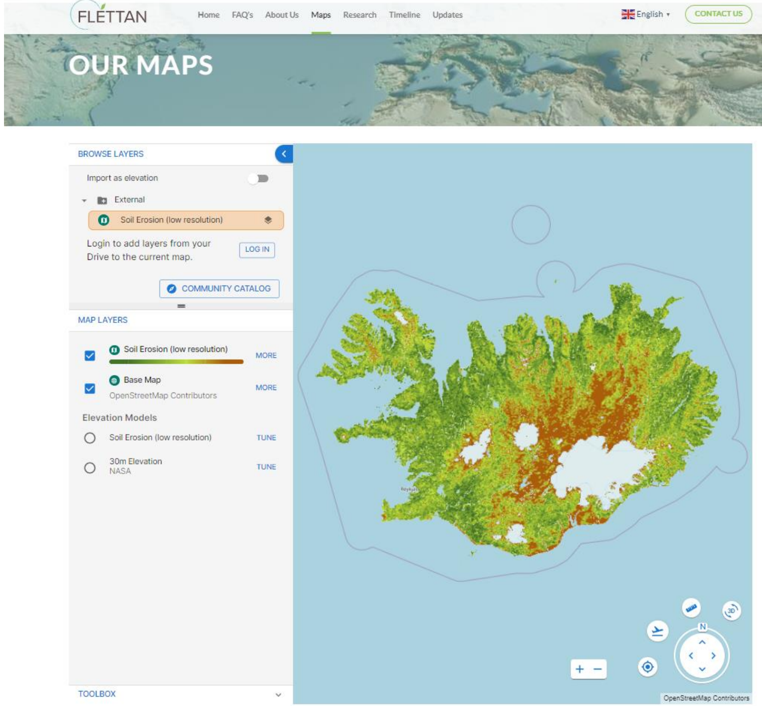

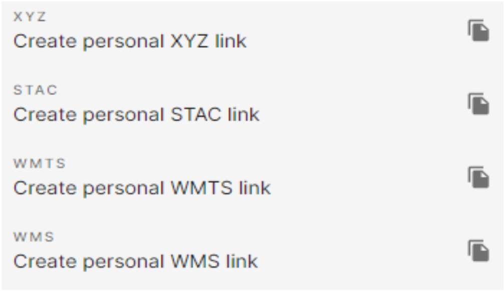

Let's dive in → https://app.ellipsis-drive.com/search

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Roadmap

- Nov 2021 - Winner Cassini Iceland
- Dec 2021 - Winner Cassini EU
- Jun 2022 - Rannis Fræ
- Aug 2022 - FOSS4G 2022
- Jan 2023 - MDPI paper
- Jun 2024 - Rannis Sproti
- **Sept 2024 - Beta testing**
- Nov 2024 - Historic data
- 2025 - Model improvement

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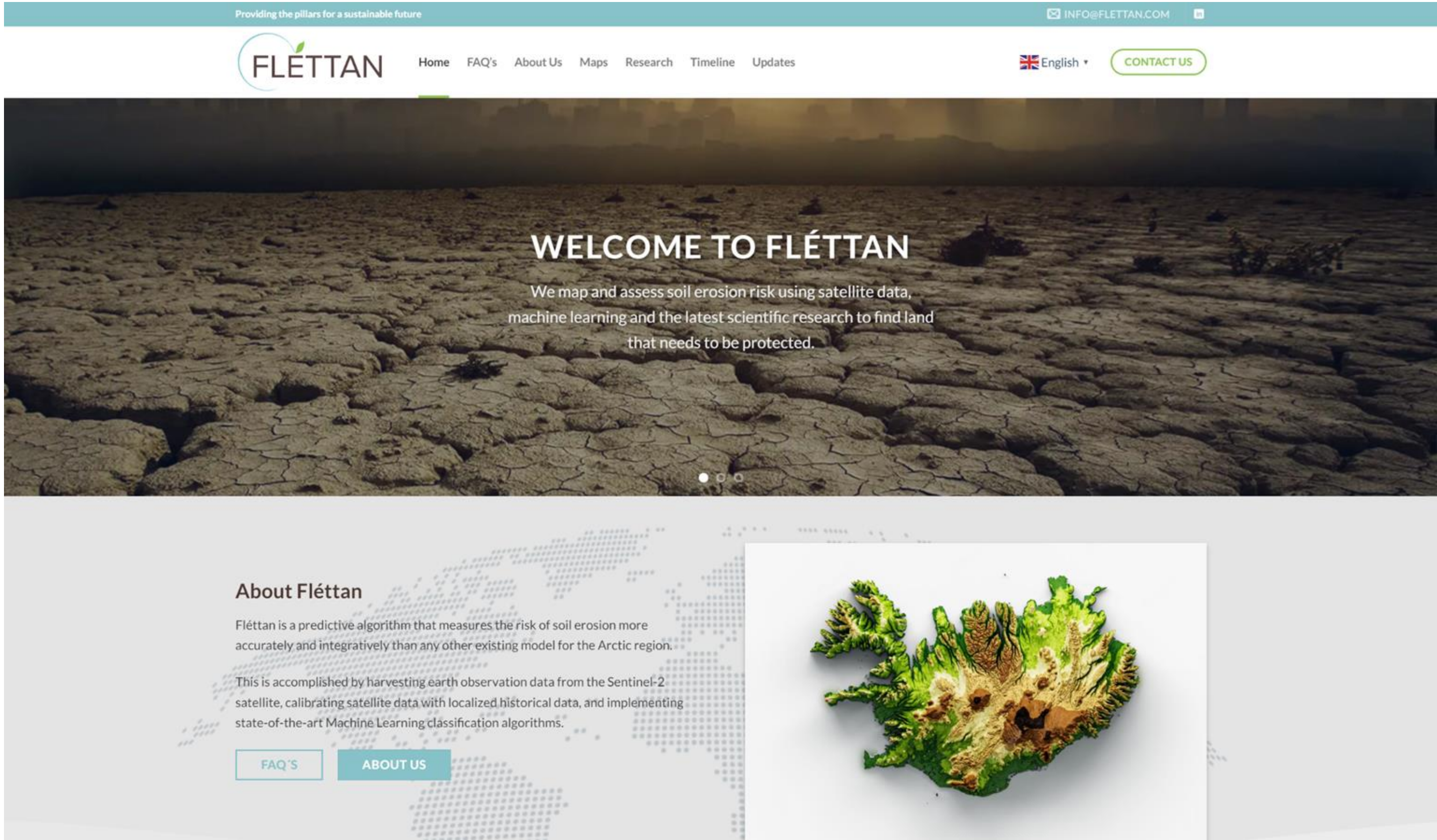
Website https://flettan.com/



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Thank you!

We look forward to a greener future together!

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