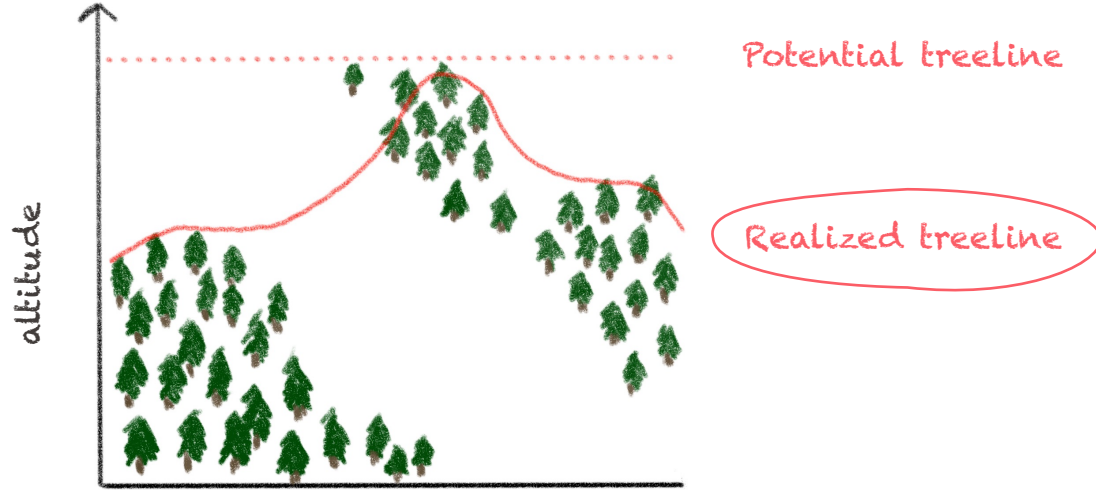




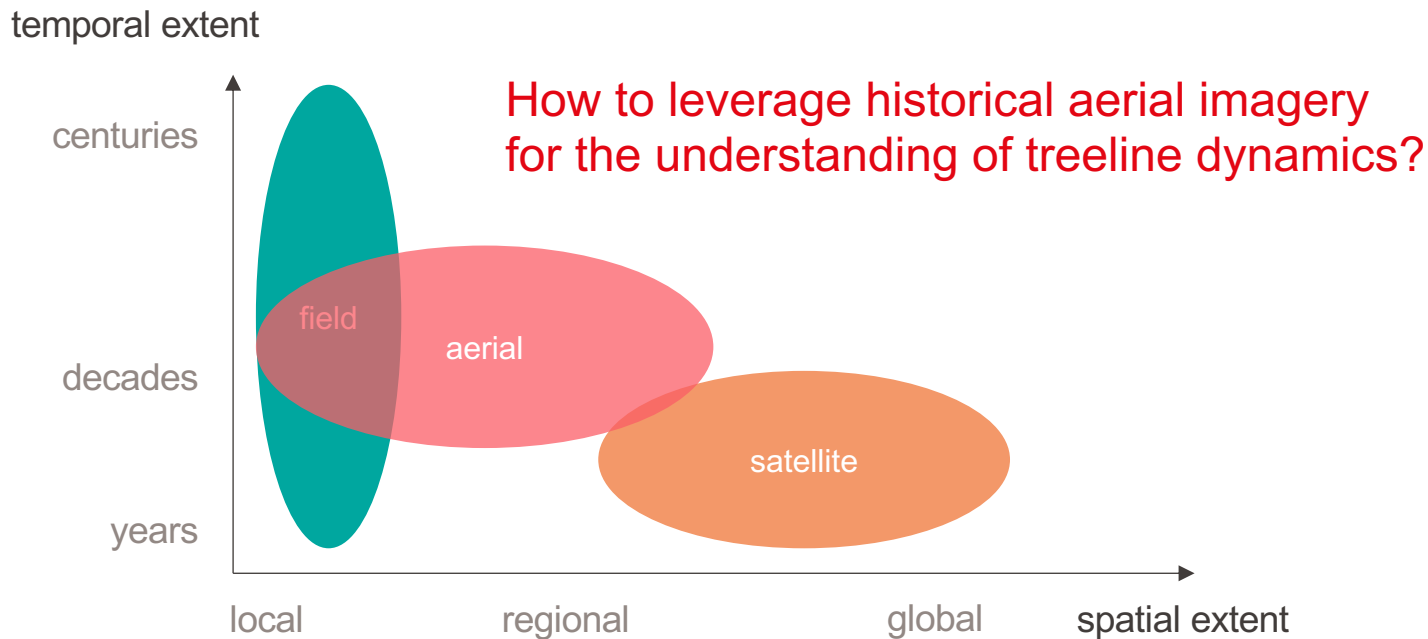
**Linking deep learning-
based forest cover maps
to treeline spatio-
temporal patterns**

**Thiên-Anh Nguyen
Marc Rußwurm
Gaston Lenczner
Devis Tuia**

16.04.24

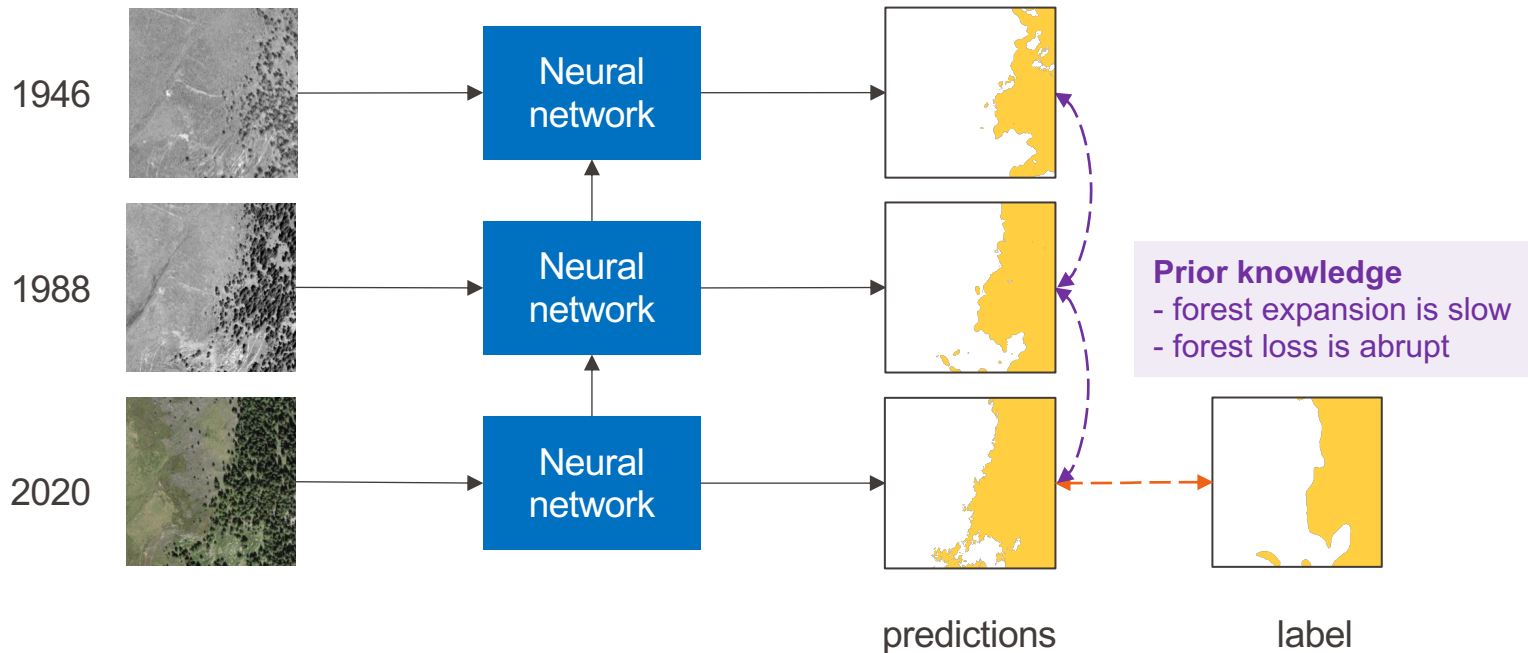


Monitoring treeline dynamics



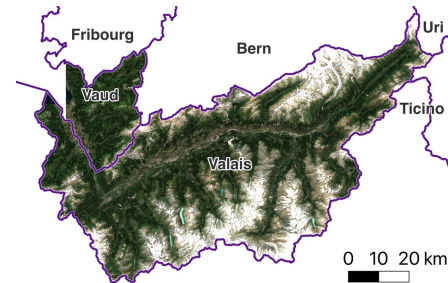
1. **Mapping forest cover over time** with aerial imagery and deep learning
2. **Extracting treeline dynamics** (ongoing work)

Knowledge-based model training



Results

- 1m resolution forest cover maps 1946 to 2020

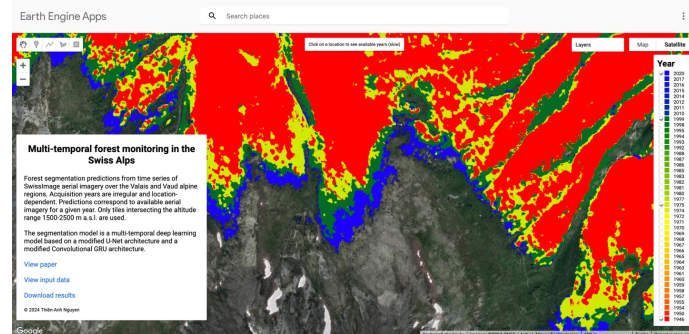


Multi-temporal forest monitoring in the Swiss Alps with knowledge-guided deep learning

Thiên-Anh Nguyen^{a,*}, Marc Rußwurm^b, Gaston Lenczner^a, Devis Tuia^a

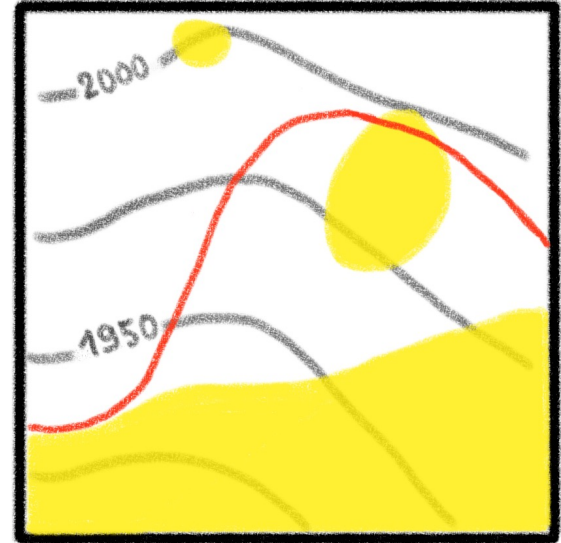


<https://www.sciencedirect.com/science/article/pii/S0034425724001202>

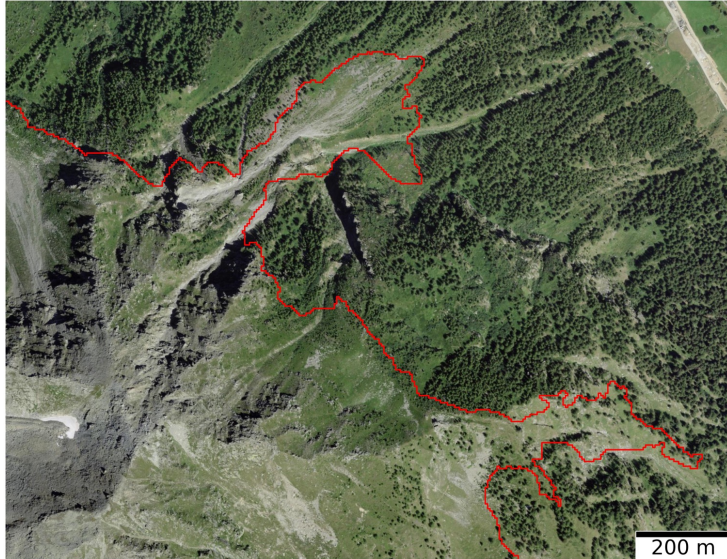


<https://temp-forest-mapping.projects.earthengine.app/view/multitempforestmap>

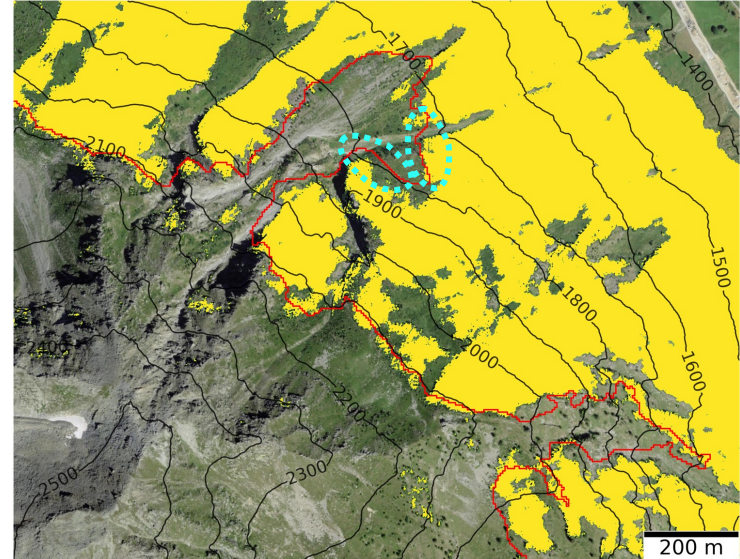
- Using the DEM and the forest cover map:
 - a. Find elevation e_n of p^{th} percentile highest forested pixel in neighborhood of n meters
 - b. Delineate the line $e = e_n$
 - c. Remove lines due to inner holes



Spatial analysis pipeline



aerial image

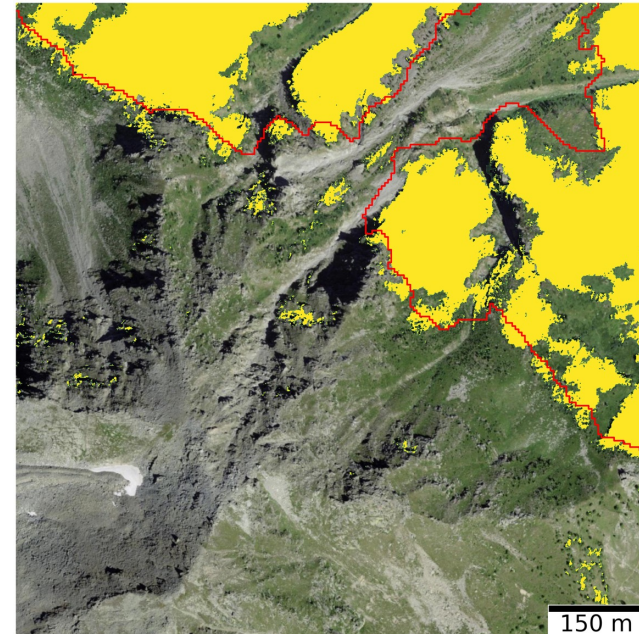
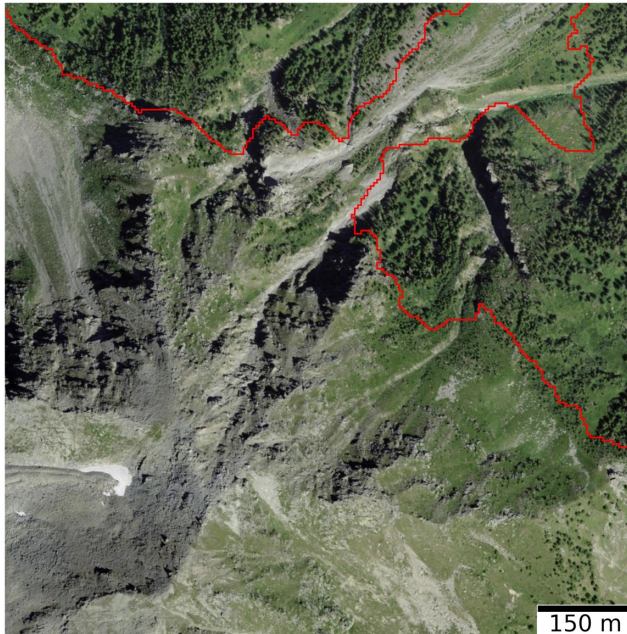


forest cover

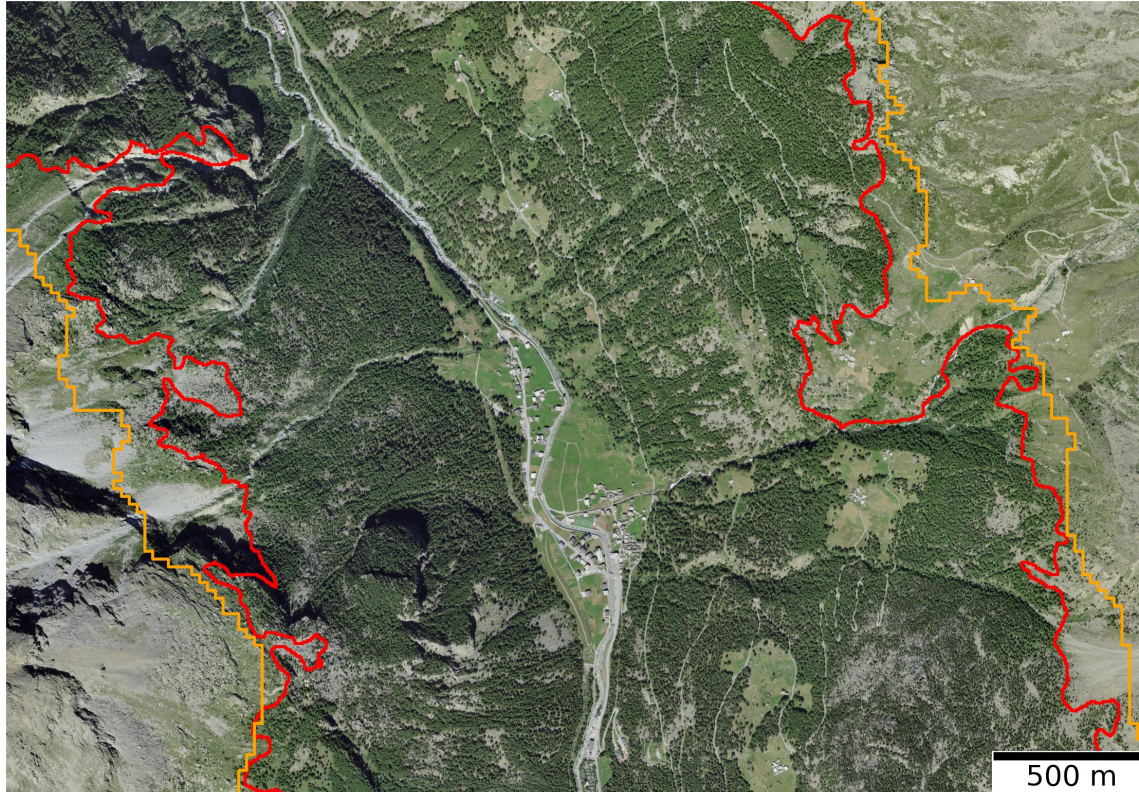
$$n = 50 \text{ m},$$
$$a_{\min} = 800 \text{ m}^2 \Rightarrow p = 89.8$$

Robustness

- Percentile:
 - removes small forest patches and outpost trees
 - **robustness to mapping errors**



Spatial scale

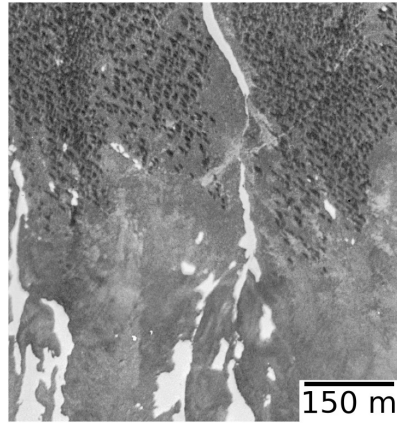


$n = 50 \text{ m}, p = 89.8$

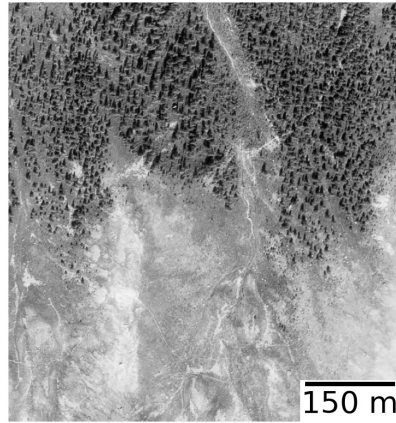
$n = 250 \text{ m}, p = 99.6$

How to choose n ?

Treeline shifts



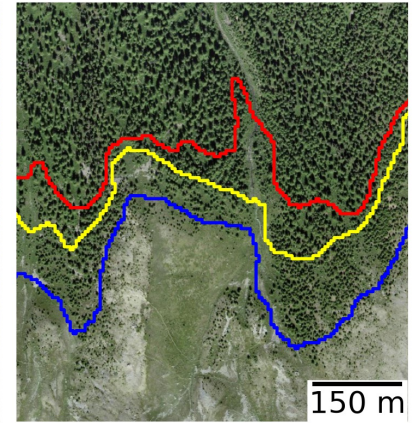
1946



1981



2020



How to measure treeline shift?

1. Mapping forest cover over time
2. Extracting treeline dynamics
3. **Uncertainty estimation**
4. **Identifying local drivers**



Extension to entire Swiss Alps

- Realized treeline can be mapped automatically from historical aerial imagery, over large regions
- Attention to forest/treeline definition, robustness, uncertainty
- Potential for identifying drivers at various spatio-temporal scales



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Bundesamt für Landestopografie swisstopo
Office fédéral de topographie swisstopo
Ufficio federale di topografia swisstopo
Uffizi federal da topografia swisstopo



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