

5 Mapping Swiss Ecosystems from Aerial Images and Environmental Variables

Task. This project aims to develop a deep learning framework for predicting ecosystem categories in Switzerland by jointly leveraging remote sensing imagery and environmental variables.

The goal of this study is to evaluate the contribution of remote sensing images to ecosystem classification, compare their predictive performance with environmental variables, and investigate how to combine both data sources effectively. The aim is also to identify information provided by environmental variables that is not captured by remote sensing, but is relevant for ecosystem mapping.

Data. The data spread across Switzerland and comprises 16'925 locations with:

- One aerial image of 100x100m at a 50cm spatial resolution with RGB bands from the swisstopo product swissIMAGE [1].
- 48 numerical variables from SWECO25 [2], a raster database for ecological research in Switzerland, covering 6 thematic: land use/land cover, bioclimatic and edaphic (soil) properties, population, geology, hydrology and vegetation. The variables have been standardised (mean=0, std=1).
- Ecosystem label extracted from the EUNIS (European Nature Information System)[3] framework, spanning 17 categories.

The dataset is already split into training (60%), validation (10%) and test (30%) sets following a geographic split to avoid spatial autocorrelation. Results are expected to be computed on the test set. Data are available [here](#) [4] .

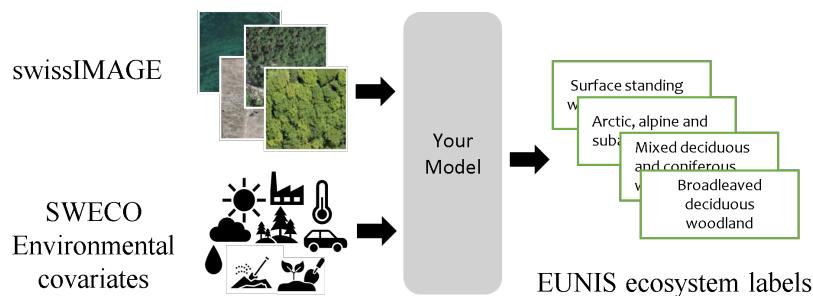


Figure 6: General pipeline for predicting ecosystems from aerial images and environmental variables.

Expected Outcome.

- Build a training pipeline with the appropriate model architecture: i.e. starting from an appropriate pretrained backbone, choosing a loss function, searching for the best hyperparameters, etc. Compute and discuss appropriate performance metrics on EUNIS ecosystem predictions.
- Compare the performance of models trained on the different subsets of variables (ablation study by thematic group of variables: impact of bioclimatic variables, of geology, etc.) and critically analyse which variables are useful for predicting the ecosystem. Discuss an effective combination of input (images, sweco variables) to reach the best performance.
- Highlight and interpret interesting results to support your analysis, for example, with figures or maps.

References.

- [1] swissIMAGE orthophotos : <https://www.swisstopo.admin.ch/en/orthoimage-swissimage-10>
- [2] Külling, N., et al., (2024). *SWECO25: a cross-thematic raster database for ecological research in Switzerland*. Scientific Data, 11(1), 21.
- [3] Chytrý, M., et al., (2020). *EUNIS Habitat Classification: Expert system, characteristic species combinations and distribution maps of European habitats*. Applied Vegetation Science, 23(4), 648-675.
- [4] Drive to dataset : <https://filesender.switch.ch/filesender2/?s=download&token=cf23c578-fdae-443f-aba4-c05b819b79d5>