NFP 48 Landschaften und Lebensräume der Alpen
PNR 48 Paysages et habitats de l'arc alpin
NRP 48 Landscapes and Habitats of the Alps

WSL

Land abandonment and natural regeneration of forest in the Swiss mountains: A spatial econometric analysis

(The project is part of the Swiss National Research Program NRP 48 "Landscapes and Habitats of the Alps")

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Aim: The aim of this study is to investigate patterns and causes of forest regeneration on abandoned agricultural land in the Swiss mountainous area.

Main hypothesis: Agricultural land is abandoned if cultivation costs are not covered by yields.

Methods: Two statistical models on different spatial and temporal scales are estimated to investigate the pattern and causes of natural regeneration of forest (i) in the Swiss mountainous area and (ii) in a selected case study area.

Logistic regression is used to investigate the relationships between the covariates and the binary dependent variable (presence /absence of forest regeneration on former agricultural areas).

Data: The *binary dependent* variable contains the information, whether the cultivation of agricultural land was abandoned or maintained between two points in time. Land abandonment is measured via natural regeneration of forest.

The *covariates* used in the *logistic regression* models are spatially explicit proxies for cultivation costs and yields of agricultural parcels.

Within the **Swiss mountainous area,** we investigate the broad-scale pattern of forest regeneration between the 1980s and 1990s (based on data from the Swiss land-use statistics)

Study areas
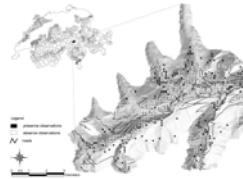
Within a selected **case study area,** we investigate the local pattern of forest regeneration between 1959 and 2000 (based on land-use classifications of aerial photos).

The case study area is located below the (estimated) climatic treeline within the political community *Tujetsch*.

Maps of selected spatially explicit covariates used as proxies for cultivation costs and yields of parcels to explain forest regeneration in the:
(i) Swiss mountainous area   **(ii) case study area**.
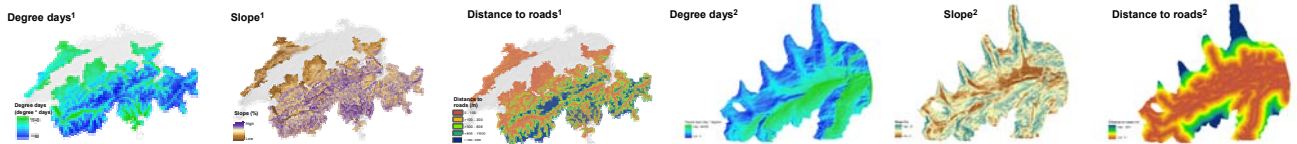
[1] The evaluation level of the covariates used for the broad-scale model (whole Swiss mountains) is 100m; [2] The evaluation level of the covariates used for the case study model is 25m

Results: Swiss-mountainous area:

The **Swiss mountainous area model** shows that the probability of areas in agricultural use to convert to forest is high at locations, where the *heat sum* is low (at high altitudes, on north-facing slopes).

It confirms our hypothesis that land abandonment takes place, where yields are low.

The probability of conversion to forest is also high, where the *soil stoniness* and the *steepness* have intermediate values (squared relationship to the response).

It shows that agricultural land-use is often maintained, where cultivation costs are low (either favorable topography or extensive land-use such as alpine pasturing).

The model predicts 64% of an independent sample of observations correctly.

For details of model calculation and results see the submitted conference-paper.

Case study area:

The **case study model** shows that the probability of areas in agricultural use to convert to forest is high at locations, where the *steepness* is high and where the *precipitation* and *radiation* are low (on north-facing steep slopes).

It confirms our hypothesis that land abandonment takes place, where the costs of cultivation are high and yields are low.

The probability of forest regeneration also peaks at a certain distance interval from roads and at locations, where the *heat sum* has intermediate values.

It indicates that the cultivation is mostly maintained, where parcels are accessible by agricultural vehicles and have a higher *heat sum*. The cultivation is also maintained, where accessibility by vehicles is not necessary and where the *heat sum* is lower. Thus it shows that the cultivation was mostly maintained (i) on meadows and favourabale pastures in and near the valley bottom and (ii) on alpine pastures. Forest regeneration mostly takes place between these areas.

The model predicts 91% of an independent sample of observations correctly.

A discussion of possible underlying causes of forest regeneration is given in the submitted conference-paper.
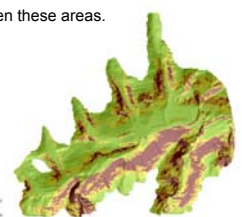
Conclusions:

The results partially confirm our hypothesis that forest regeneration takes place, where the cultivation costs of parcels are high and yields are low. The results indicate that linear assumtions about the relationships between proxies for costs and yields and land abandonment are often not sufficient. This can partially be explained by the different land-use systems within both study areas, i.e. cultivation of both meadows and pastures in the valleys and mountain and alpine areas.

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