

Degree of Landscape Fragmentation in Switzerland

Quantitative analysis 1900-2002 and implications for traffic planning and regional planning

What is the degree of landscape fragmentation in Switzerland today? How much has the degree of landscape fragmentation increased over the last 100 years? What are the current trends? What are the implications for traffic planning and regional planning in the future? The project provides answers to these questions.

PROBLEM

The fragmentation of landscapes due to transportation infrastructure has a number of severe ecological effects. It contributes significantly to the alarming loss of species in Europe (e.g., due to the subdivision of populations and the isolation of habitats) and it detrimentally affects the water regime, the scenery, and the recreational quality. In spite of the planning concept of preserving large un-fragmented areas, the degree of fragmentation has continued to increase during the last twenty years. Therefore, data on the degree of landscape fragmentation and on how it has developed are needed, e.g., for use in strategic environmental impact assessments. In addition, a quantitative objective for the future degree of landscape fragmentation (as an environmental quality objective) is still missing in current environmental politics.

RESEARCH QUESTIONS

- What is the degree of landscape fragmentation in Switzerland today?
- How much and how quickly has the degree of landscape fragmentation increased since 1900 (time series)? What are the current trends?
- What differences exist among the various ecoregions, cantons, and districts?
- What recommendations for future planning and decision-making can be made?

PROJECT

The project investigates the historical development of landscape fragmentation in Switzerland since 1900 to 2002 (map of the remaining un-fragmented areas, time series, spatial comparisons) and reveals the prevailing trends for the future development. Based on the results, the project draws conclusions for traffic planning and regional planning and proposes specific measures for controlling landscape fragmentation in the future according to the principles of sustainable development.



Fig. 1: Transportation infrastructure such as roads and railroads add to the amount of noise in landscapes. They also act as barriers to the movement of many animals. Hedgehogs are among the species that are strongly affected by traffic mortality (large photo: Kantonsarchäologie Zurich, small photo: Ingo Arndt).



BENEFITS OF THE PROJECT

- Longest time series on the degree of landscape fragmentation of a region
- World-wide first historical analysis of landscape fragmentation of an entire country
- Use of the time series as an environmental indicator in the project »Monitoring Sustainable Development in Switzerland« (MONET), regular updates are intended
- Comparison of the results with results from other regions, e.g., Baden-Württemberg, Bavaria, Hesse, South Tyrol, Canada



Fig. 2: Landscape fragmentation due to traffic and settlements. The fragmenting elements (shown in red) act as barriers and as sources of disturbance (left). At the right, the corresponding effective mesh size is shown as a regular network (from Jaeger et al., in prep.). The effective mesh size corresponds with the size of the rectangles.

Method: Effective Mesh Size m_{eff}

The effective mesh size m_{eff} is proportional to the probability of two points chosen randomly in a region being connected, i.e., that they are not separated by barriers such as roads or urban development. This probability is then converted into the size of a patch – the effective mesh size m_{eff} – by multiplying it by the total size of the region investigated. The unit of m_{eff} is that of area (e.g., km²). This area corresponds to the size of the »meshes« of a regular network that has the same degree of fragmentation, and it can be compared with the values of m_{eff} from other regions. The formula for calculating m_{eff} is (Jaeger 2000):

$$m_{eff} = \frac{1}{F_{total}} (F_1^2 + F_2^2 + \dots + F_i^2 + \dots + F_n^2)$$

where n is the number of patches, F_i is the size of patch i (with $i = 1, \dots, n$) and F_{total} is the total area of the region investigated which has been fragmented into n patches.

The smaller the effective mesh size, the more fragmented the landscape.

The degree of fragmentation can also be expressed as the effective mesh density s (i.e., the effective number of patches per 100 km²).

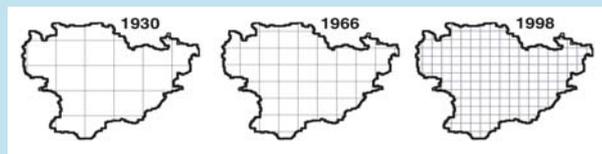


Fig. 3: The degree of landscape fragmentation in the district of Göppingen (Baden-Württemberg, Germany) expressed by the effective mesh size (indicated by the size of the boxes). Since 1930, the effective mesh size has decreased from 21.62 km² to 7.96 km² in the year 1998 (Esswein et al. 2002).

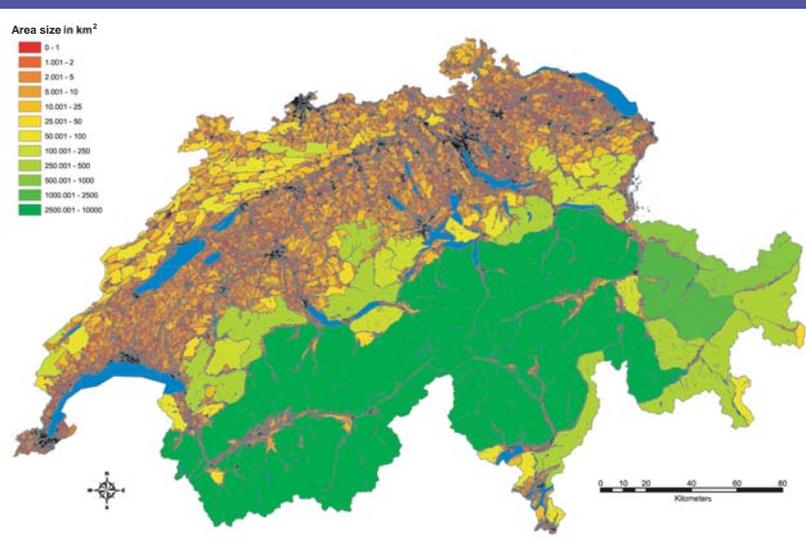


Fig. 4: Current state of landscape fragmentation in Switzerland. The colours indicate the sizes of the patches that have remained in the network created by transportation infrastructure and settlements.

ORGANISATION OF THE PROJECT

Research project on behalf of the Swiss National Road Authority ASTRA (75 %) and the Swiss Federal Agency for the Environment, Forests and Landscape BUWAL (25 %). Time frame: 5/2005 – 12/2006.

Networking: Swiss Federal Office for Spatial Development ARE; Swiss Federal Statistical Office BFS

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