Landscape Fragmentation in Europe

Jochen A.G. Jaeger,¹ Christian Schwick,² Tomas Soukup,³ Luis F. Madriñan,¹ Hans-Georg Schwarz-von Raumer,⁴ and Felix Kienast⁵

Problem
Landscape fragmentation caused by transportation infrastructure has a number of detrimental effects like reduction in size and persistence of wildlife populations, changes of local climate, and increases in pollution and noise from traffic. Therefore, data on the degree of landscape fragmentation are needed for assessing the sustainability of human land uses. In addition, quantitative objectives for the future degree of landscape fragmentation (as an environmental quality objective) are still missing in current environmental politics. In order to compare different regions, their degree of fragmentation needs to be interpreted in terms of socio-economic measures such as population density and GDP.

Project Objectives
1. Quantitative analysis of landscape fragmentation in Europe at three spatial scales for two points in time (2002 and 2008)
2. Determination of the relative importance of socio-economic factors as drivers of landscape fragmentation

Methods: Effective Mesh Size $m_{\text{eff}}$ and statistical analysis
The currently available data on the road and railroad network in Europe are a reliable basis for defining a fragmentation geometry that is comparable among the different European countries. We are using the effective mesh size $m_{\text{eff}}$, which is proportional to the probability of two points chosen randomly in a region being connected. This probability is then converted into the size of a patch – the effective mesh size $m_{\text{eff}}$ – by multiplying it by the total size of the region investigated. The unit of $m_{\text{eff}}$ 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 $m_{\text{eff}}$ from other regions (Fig. 2):

$$m_{\text{eff}} = \frac{1}{A_{\text{total}}} \left( A_1^2 + A_2^2 + A_3^2 + \cdots + A_n^2 \right)$$

where $n$ is the number of patches, $A_i$ is the size of patch $i$ (with $i = 1, \ldots, n$) and $A_{\text{total}}$ is the total area of the region investigated which has been fragmented into $n$ patches (Jaeger 2000). 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).

The statistical analysis applies general linear modeling (GLM).

Benefits of the project
• World-wide first analysis of landscape fragmentation of an entire continent
• Assessing the degree of landscape fragmentation based on socio-economic and physical factors
• Estimate of the current rate of fragmentation increase in Europe

Funding and Organization of the project

Affiliations
¹ Concordia University, Montreal, Canada, jaeger@alcor.concordia.ca, madrinan@alcor.concordia.ca
² Dietgeschicht, Schwick & Spichiger, Zürich, Switzerland, schwick@hastspeed.ch
³ GISAT, Prague, Czech Republic, as member of the European Topic Center of Land Use and Spatial Information (ETC-LUSI) of the European Environment Agency (EEA), Copenhagen, tomas.soukup@gisat.cz
⁴ University of Stuttgart, Germany, soukup@gisat.uni-stuttgart.de
⁵ Swiss Federal Research Institute WSL, Birmensdorf & ETH Zürich, Switzerland, felix.kienast@wsl.ch

References