

*Proceedings of the 19th International Conference
Informatics for Environmental Protection*

Enviro*Info*

Brno 2005

Networking Environmental Information

**Jiří Hřebíček,
Jaroslav Ráček
(Eds.)**

Networking



**Masaryk University in Brno
September 7–9, 2005
Brno, Czech Republic**

Landscape Fragmentation in the Free State of Saxony and the Surrounding Border Areas

Ulrich Walz and Ulrich Schumacher¹

Abstract

This article shows the results of an analysis of landscape fragmentation in Saxony and adjoining regions with special attention to Saxony's borders. The investigation uses GIS-methods in order to model the landscape fragmentation and to evaluate with spatial-statistical parameters. One result is that environmental analysis of landscape fragmentation should be based on areas defined by natural borders instead of political frontiers as large unfragmented areas still exist in cross border regions. These unfragmented areas should be taken into consideration in regional planning and planning of infrastructure.

On the example of Saxon-Bohemian Switzerland problems of cross-border investigations of fragmentation and their development since 1900 are pointed out in detail. Thus it's possible to show the development of landscape fragmentation in the region of this cross-border national park (D – CZ) during the last one hundred years. The regional study shows that the coherent consideration of large unfragmented areas across the political frontiers is necessary for further protection and development of nature.

1. Analysis of Landscape Fragmentation

The landscape fragmentation due to traffic lines and settlement areas represents the cumulation of different anthropogenic impacts on the landscape in a spatial and temporal sense (e.g. settlement expansion, motorway and road system densification, development of rail routes and channels). Thereby it is an important indicator for the condition of the landscape with close references to the suitability for recreation like hiking (Lassen 1990), to the noisiness and to the quality of habitats for certain animal species (European Commission 2000; Forman et al. 2003). In the meantime large unfragmented open space is recognized by the planning authorities in Germany as a limited available conservation resource. This shows for example the designation of large unfragmented space as "priority areas for nature and landscape" into newer planning instruments like the Regional Development Plan of Saxony (SMI 2003).

1.1 Database and GIS Methods

After the creation of a nationwide overview map (Schumacher & Walz 2000) currently at the IOER¹ a comprehensive geographical database for the analysis and documentation of unfragmented open space in Saxony is developed: In addition to the present state both the historical situation before the beginning of the motorway construction (about 1930) and the future development (scenario to approximately 2020) are regarded. Methodically selected tools of geoinformatics are used for spatial analysis, particularly in the fields of vector data processing. Geostatistic tools are necessary for the quantification and evaluation of unfragmented open space by indicators.

¹ Leibniz Institute of Ecological and Regional Development (IOER), Weberplatz 1, D-01217 Dresden
email: u.walz@ioer.de, Internet: <http://www.ioer.de>

The integration of heterogeneous data from various countries and times (with different geodetic reference parameters, accuracies as well as classifications of traffic lines) into a consistent geographical information system represented a time consuming and challenging step. So the first task was to integrate numerous heterogeneous databases of the Federal Republic of Germany (Federal States Saxony, Brandenburg, Saxony-Anhalt Thuringia and Bavaria), the Czech Republic and the Republic of Poland. A problem for example was the harmonisation of different nomenclatures of the biotope and land use mappings of the individual federal states.

For the retrospective view historical maps were scanned, georeferenced and evaluated concerning the traffic infrastructure. For the scenario geodata of the Digital Regional Planning Register of Saxony (DIGROK) and appropriate special plannings are included.

1.2 Measurement of Landscape Fragmentation

For the quantification of landscape fragmentation the number and the area of unfragmented open space as well as the effective mesh size (m_{eff}) (Jaeger 2000, 2002) are commonly used as indicators to describe the state and to compare the changes over the time. The parameter „Area of the unfragmented open space“ is in use for 25 years (Gawlak 2001); the parameter “Effective mesh size“ is proposed for the use in all federal states of Germany (Schupp 2005) while it is also used by the European Environment Agency (EEA). None of these parameters gives any information about the shape of the open space. Small, but long features or a dead-end road within are not considered adequately. By calculation of the largest inner circle of the open space it is possible to quantify the “depth” of the minimal undisturbed area. Because of this, the authors propose the evaluation of such open space by a combination of the area and the largest inner circle classified values (Fig. 1 and 2).

		Largest Inner Circle (radius in meters)				
		0-500	> 500-1000	> 1000-1500	> 1500-2000	> 2000
Area in km ²	0-10	1	1	1	2	3
	> 10-20	1	2	2	3	4
	> 20-30	1	2	3	4	5
	> 30-40	2	3	4	4	5
	> 50	3	4	5	5	5

Fig. 1: Assessment of unfragmented open space by a matrix of Area and Inner Circle. Values between 1(very high fragmentation) and 5 (very low fragmentation).

2. Current situation of Landscape Fragmentation in Saxony

In numerous studies, the administrative borders were regarded as the boundary of the area studied. Because large unfragmented open space particularly exist in the border region between the Free State of Saxony and the Czech Republic, in the present work of the IOER special attention is dedicated to a border spreading view (Walz 2005). Another reason is that the recent EU enlargement to Eastern Central Europe leads to a strong pressure on the development of the traffic infrastructure with possible negative effects on the landscape fragmentation.

The investigation shows as one result that the landscape fragmentation is not only very distinctive in the urban sprawl of Leipzig, Dresden, Chemnitz and Zwickau, but also in intensively used rural areas. As the map show (Fig. 2), the largest unfragmented space are located in the cross-border area of the „Ore Mountains“, the “Saxon Switzerland” and the “Lusatia Mountains”. This can be explained with the relief, the

cross-border situation for centuries and the political events as a consequence of World War II. In contrast large unfragmented open space still exist in the northeast of Leipzig and in the northeast of Saxony („Upper Lusatia and Lower Silesia“) because of unfertile sandy soils. They didn't allow a dense human settlement in former times. In the Upper Lusatia region and in the south of Leipzig existent unfragmented open space are stamped by large former brown-coal open minings. Highly fragmented areas are partially located in the national park „Saxon Switzerland“, in the biosphere reserve „Upper Lusatia Heath and Pond Landscape“, in some nature protection areas and NATURA-2000 regions.

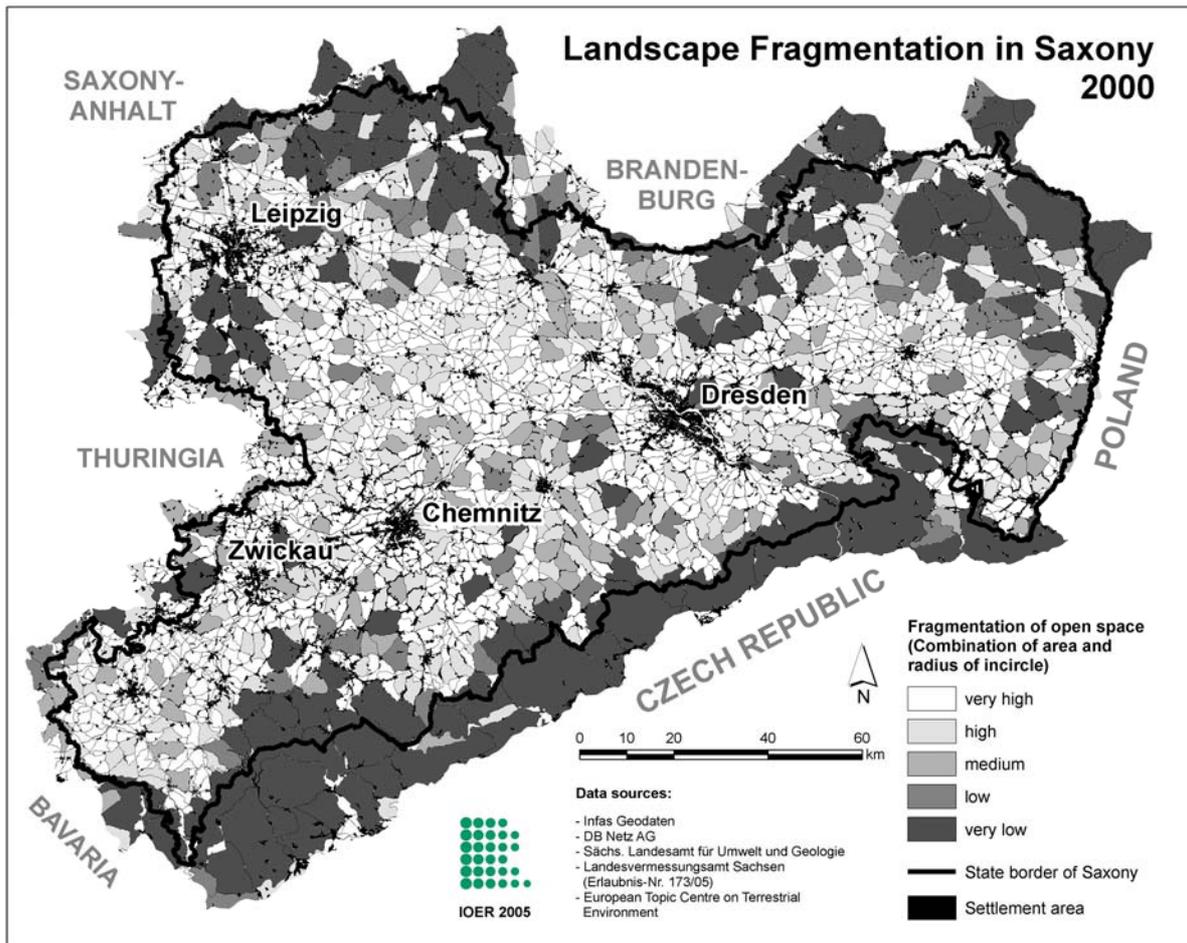


Fig. 2: Landscape fragmentation in Saxony and border regions. Calculated on basis of motorways, main and countryside roads and railroads. Processing: U. Walz und G. Raschke. Cartography: U. Schumacher.

3. Development of Landscape Fragmentation since 1900 – Cross-border case study

The increasing landscape fragmentation within the last one hundred years can be documented by the analyse of the state in landscape in former times. In a cross-border case study of the Saxon-Bohemian Switzerland the historical development of these space and the effects of fragmentation on individual environmental subjects of protection are particularly examined (Fig. 3).

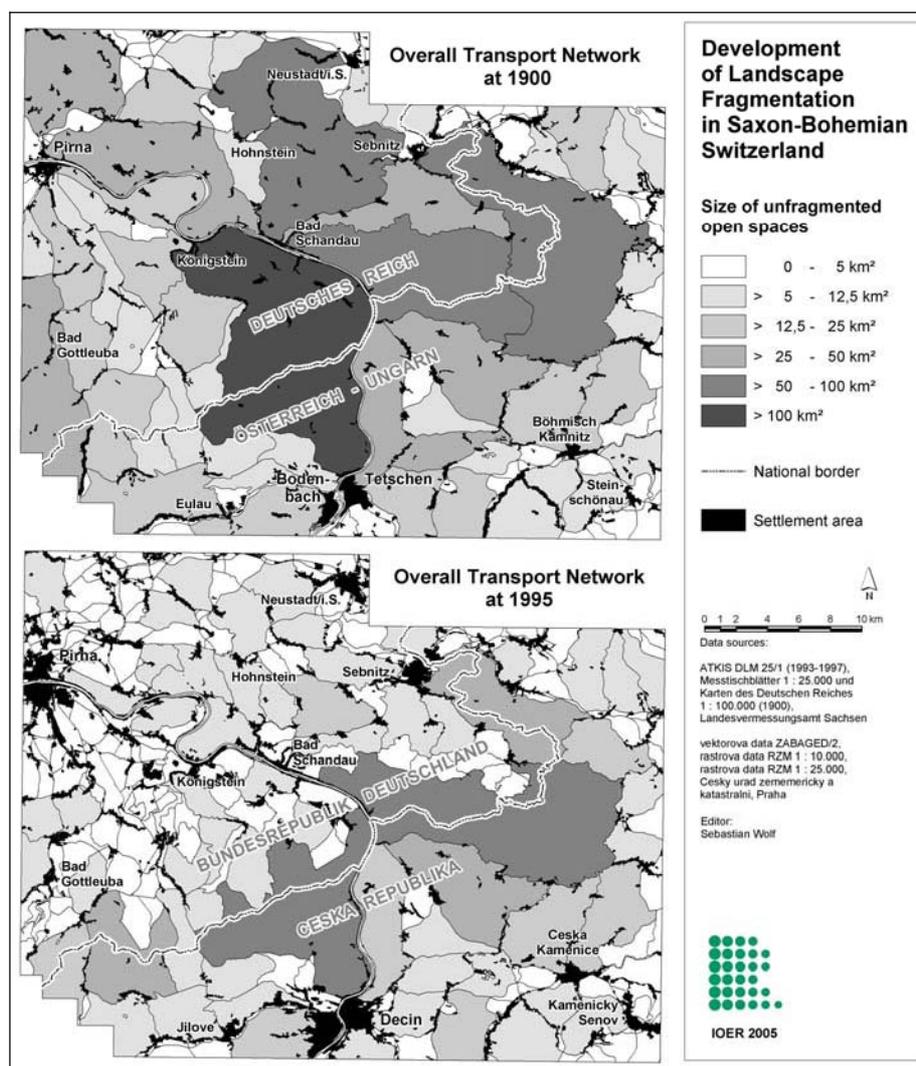


Fig. 3: Cross-border development of unfragmented open space in the national park region of Saxon-Bohemian Switzerland during the 20th century

In this region, the landscape fragmentation increased since the end of the 19th century, especially in the time after World War II as a result of the increasing mobility and the growth of settlements. In many places drives were paved and the road network enlarged. Because of this, the value of the parameter „Effective mesh size” was more than halved (from 174 sqkm in 1900 to 71,3 sqkm in 2000). If one compares the Saxonian and the Czech areas, there are noticeable differences: The remaining unfragmented space in the Czech Republic is significant larger than these space in the German part. A cross-border management and the cohesive assessment of impacts is in consideration of this fact a must.

4. Results and further steps

If the analysis of large unfragmented open space is restricted to the individual national territories, there is the danger not to recognize all cohesive unfragmented space. Therefore they can't be considered in case of

future planning and possible impacts. Especially in case of long-term planning of road corridors it is necessary to pay attention to the environmental subject of protection of unfragmented open space. They should be included in the regional plans, like it's the case in Saxony.

Information about indicators like landscape fragmentation should be made public. They should be used to make people in general and especially the actors aware of this problem. It's a problem which affects not only animals and nature, but also the quality of life and health of our society, especially in the issues of noise, air pollution and recreation potential. Modern information technologies like the Internet and especially the interactive Web-mapping tools provide effective possibilities for public information².

At present, substantial research needs to be done for the cumulative effects of structural spatial changes. Increasing fragmentation of open space by infrastructure routes is just one aspect. In addition, significant changes of the landscape structures arise as consequence of growing residential and industrial areas as well as changes of property and intensified farming. Also the changes of the relation between public and private transport systems push the expansion of the motorway and railway network. The cumulative effect of numerous small impacts into the landscape (regarded individually) can exceed the sum of all particular effects.

Bibliography

- European Commission (2000): COST 341. Habitat Fragmentation due to Transportation Infrastructure. State of the Art Report. Luxemburg: 125 p.
- Forman, R.T.T. et al. (2003): Road ecology. science and solutions. Washington, Covelo, London: 481 p.
- Gawlak, C. (2001): Unzerschnittene verkehrsarme Räume in Deutschland 1999. - In: Natur und Landschaft 76(11): 481–484.
- Jaeger, J. (2000): Landscape division, splitting index, and effective mesh size: new measures of land-scape fragmentation. - In: Landscape Ecology 15(2): 115-130.
- Jaeger, J. (2002): Landschaftszerschneidung – Eine transdisziplinäre Studie gemäß dem Konzept der Umweltgefährdung. Stuttgart: 448 p.
- Lassen, D. (1990): Unzerschnittene verkehrsarme Räume über 100 km² - eine Ressource für die ruhige Erholung. - In: Natur und Landschaft 65(6): 326-327.
- Schumacher, U. & Walz, U. (2000): Landschaftszerschneidung durch Infrastrukturtrassen. - In: Nationalatlas Bundesrepublik Deutschland. Band 10: Freizeit und Tourismus. Heidelberg - Berlin: 132-135.
- Schupp, D. (2005): Umweltindikator Landschaftszerschneidung – Ein zentrales Element zur Verknüpfung von Wissenschaft und Politik. - In: GAIA 14(2): 101–106.
- SMI Sächs. Staatsministerium des Innern (2003): Landesentwicklungsplan Sachsen. Dresden, 111 p.
- Walz, U. (2005): Landschaftszerschneidung in Grenzräumen Sachsen und die Sächsisch-Böhmische Schweiz. – In: GAIA 14(2): 171-174.

² s.a. <http://www.ioer.de/langzeitmonitoring>

Informatics for Environmental Protection
Networking Environmental Information

Proceedings of the 19th Conference “Informatics for Environmental Protection” September 7-9, 2005, Brno, Czech Republic

Editors

Jiří Hřebíček, Jaroslav Ráček

Published by Masaryk University in Brno, 2005

Cover Design: Tomáš Staudek

1st edition, 2005 Number of copies 500

55-966A-2005 02/58 8/Př

ISBN 80-210-3780-6