Quantifying and spatial analysis of land use and land cover changes between 1990 and 2000 in the 440 German districts and 30 city regions

Impact Assessment of Land Use Changes
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1. Introduction about our research

- To examine **dynamics** and **structures** of **land use** and **land cover changes** between 1990 and 2000 in the **German districts** and **city regions** by using CORINE Land Cover data.

- A part of the project “Multi-scale and multidimensional Characterization of Resource-efficiency of Settlement Structures”
2. Theoretical approach

Resource-efficiency of a settlement structure (OEKO_X):
Adding to the settlement more and more utility for the human daily activities using ever fewer resources while generating less and less noise, waste and pollution.

\[
OEKO\_X \quad \overset{\text{max!}}{\Rightarrow} \quad \frac{F_U(\text{Daily activities, Economy, Ecology, Social, Culture})}{F_C(\text{Ecology, Social, Economy})}
\]

- \( F_U \) (utility function) & \( F_C \) (cost function) dependent on land use and land cover structures
- OEKO_X can be viewed from many perspectives

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OEKO_X can be viewed from the perspective of: quarters
OEKO_X can be viewed from the perspective of:

- quarters
- districts

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OEKO_X can be viewed from the perspective of:

- quarters
- districts
- federal states

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OEKO_X can be viewed from the perspective of:

- quarters
- districts
- federal states
- city regions

Circle with the midpoint in the city centre (radius = 20 km)
OEKO_X can be viewed from the perspective of:

- quarters
- districts
- federal states
- city regions

30 city regions around the most populous cities in Germany
2. Theoretical approach

- The quantitative proportions and the spatial configuration of different types of land use/cover is one variable of the cost function $F_C$ of OEKO_X.
- Our assumption: OEKO_X $\leftrightarrow$ urban form.
Overview – methods and AML programs

CORINE database

Dissolving of the coverages

Clipping of the coverages

440 Coverages (districts)

30 Coverages (20km-zone)

Proportions of LU/LC-types

Jaggedness degree

Interconnectedness degree

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Full nomenclature of the Geodata CORINE
Selected classification focus on **built-up and traffic area**
The circle with the same area as the total area of all individual settlement areas

Perimeter of this circle

\[ 2 \sqrt{\pi \sum a_i} \]
Jaggedness degree = \frac{\sum_{i=1}^{n} p_i}{2\sqrt{\pi} \sum_{i=1}^{n} a_i}

\begin{align*}
\text{perimeter} & : p_i \ (i = 1(1)n) \\
\text{area} & : a_i \ (i = 1(1)n)
\end{align*}
Interconnectedness Degree = \frac{g}{a + b + c + d + e + f + g} \times 100
3. Results

3.1 Districts
3.1 German districts
3.1 German districts

Absolute changes of artificial surfaces in administrative districts of Germany 1990 - 2000

sq.km

2. Bad Doberan (MV)
1. Emsland (NI)
3. Potsdam-Mittelmark (BB)

440. Weißenburg-Gunzenhausen (BY)
4.1 German districts

Relative changes of artificial surfaces in administrative districts of Germany 1990 - 2000

1. Bad Doberan (MV)
2. Ilm-Kreis (TH)
3. Vechta (NI)
440. Weißenburg-Gunzenhausen (BY)
3.2 German federal states (Bundesländer)

Absolute changes of artificial surfaces 1990 - 2000

<table>
<thead>
<tr>
<th>Bundesländer</th>
<th>Change (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baden-Württemberg</td>
<td>20,000</td>
</tr>
<tr>
<td>Bavaria</td>
<td>15,000</td>
</tr>
<tr>
<td>Berlin</td>
<td>10,000</td>
</tr>
<tr>
<td>Brandenburg</td>
<td>5,000</td>
</tr>
<tr>
<td>Bremen</td>
<td>2,500</td>
</tr>
<tr>
<td>Hamburg</td>
<td>2,000</td>
</tr>
<tr>
<td>Hesse</td>
<td>1,500</td>
</tr>
<tr>
<td>Lower Saxony</td>
<td>1,000</td>
</tr>
<tr>
<td>North Rhine-Westphalia</td>
<td>1,000</td>
</tr>
<tr>
<td>Rhineland-Palatinate</td>
<td>1,000</td>
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<tr>
<td>Saarland</td>
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<tr>
<td>Saxony</td>
<td>1,000</td>
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<tr>
<td>Saxony-Anhalt</td>
<td>1,000</td>
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<tr>
<td>Schleswig-Holstein</td>
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</tr>
<tr>
<td>Thuringia</td>
<td>1,000</td>
</tr>
</tbody>
</table>
3.2 German federal states (Bundesländer)

Relative changes of artificial surfaces 1990 - 2000

[Bar chart showing relative changes for various states.]

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3.3 City regions

Expansion of artificial surfaces
in annulus zones around the city centre of Dresden
1990 - 2000

Artificial surfaces *
- Estate 1990
- Growth 1990 - 2000
* without mining sites

Annulus zones of 1 km are presented.

Data sources:
Umweltbundesamt und Deutsches Zentrum für Luft- und Raumfahrt (CORINE Land Cover 1990 / 2000)

Project manager: N. X. Thinh
GIS analysis: N. X. Thinh / K. Geier
Cartography: U. Schumacher
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3.3 City regions

Expansion of artificial surfaces
in annulus zones around
the city centre of
München
(Munich)
1990 - 2000

Artificial surfaces *
- Estate 1990
- Growth 1990 - 2000
- * without mining sites

Annulus zones of 1 km are presented.

Data sources:
Project manager: N. X. Thinh
GIS analysis: N. X. Thinh / K. Geier
Cartography: U. Schumacher
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Umweltbundesamt und
Deutsches Zentrum für Luft- und Raumfahrt
(CORINE Land Cover 1990 / 2000)
Density Gradient of Artificial Surfaces
Berlin 2000

3.3 City regions
3.3 City regions

Density Gradient of Artificial Surfaces
Dortmund 2000

Density [%]

Distance to city centre [km]

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4. Conclusion

- The highest increase of built-up and traffic area between 1990 and 2000 is reached northwest of Mecklenburg, the Emsland, the green belt to the south of Berlin, the Leipzig north, some Thuringian districts, Westwald and Eifel.
- Berlin city region most compact, Dortmund city region most dispersed.
- Berlin city region has also the maximal interconnectedness between urban fabric and industrial, commercial and transport units (20%), Bremen the minimal values (6% in 1990 & 7% in 2000).
- For spatial analysis of settlement patterns more detailed vector data should be used in the future (e.g. ATKIS Basis-DLM).
- But currently CLC the best available European wide data set on land cover and land use for environmental evaluation.
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Thank you very much for your attention!