Concept and prototype of map of land use neighborhoods

Case study of Warsaw Metropolitan Area (WMA)

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Introduction

Land use is defined as the spatial distribution of forms of land cover patches utilized or unutilized by human within the framework of spatial and mutual relationships.
The term refers to a given terrain's functional character and is identified with a socio-economic description of the surface (Ciołkosz & Bielecka, 2005).
The observed dependency of land use and neighbouring land cover patches is discussed in many geography and spatial economy publications i.e. the economic utilization of an observed lot (or patch) has significantly less implications for its future utilisation than the existing land use in its neighborhood. Factors stimulating further land use changes include the existing neighbouring land use or the predominant land use type in a given region (Hagoort, 2006).

Goal and tasks

The advancement of GIS has facilitated simulations and geovisualizations of results of spatial analysis of land use.
The majority of analyses confronted two categories of factors influencing the observed land use changes and, at their core, involved an evaluation of spatial changes which resulted from the impact of neighbouring and consecutive forms of land use in a given area.
The types of land use classes differed depending on the aim, the scale and the area of an individual geographical study.
The changes in land use can be treated as a complex and (to an extent) random process. The research aims included the formulation of a theoretical structure of the neighborhood coefficients (Werner, 2009), analysing their operationalization and verifying their practical application.

Method
NBC – Neighborhood Coefficients

Cellular automata are mathematical models for complex natural systems containing large numbers of simple identical components with local interactions.

The concept of neighborhood coefficients is based on the combination of map algebra with two-dimensional cellular automata.

The NBC is calculated on the basis of a mathematical formula (Eq.1) which contains the numbers describing land use classes and the consecutive numbers of the cells in Moore neighborhood (3x3).

The NBC is reversible. It is therefore possible to reconstruct (recalculate) the original input land use classes in Moore neighborhood (their nominal numbers) on the basis of the value of the central cell's NBC (Eq.2).

WMA land use 2009

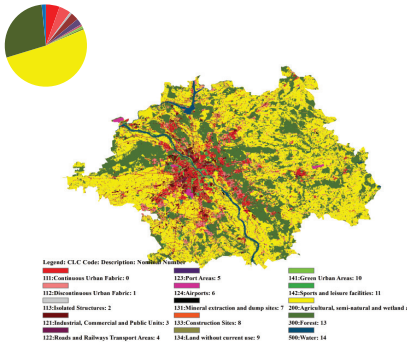

Fig. 1. Map of land use of Warsaw Metropolitan Area, 2009, source of data and map: GMES Urban Atlas, EEA, http://www.eea.europa.eu/data-and-maps/data/urban-atlas
Pie chart shows the structure of land use of whole WMA (software: ArcGIS 10)

WMA land use neighborhoods 2009

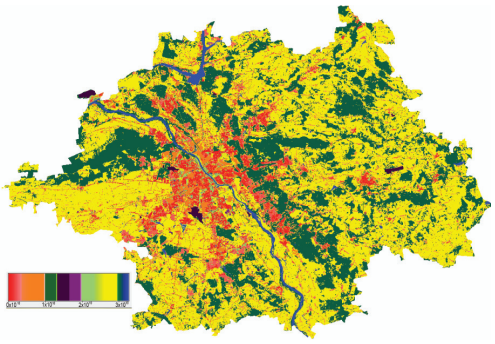

Fig. 2. Map of land use neighborhoods coefficients of Warsaw Metropolitan Area, 2009 (software: Ilwis 3.8)

WMA land use based on NBCs – 2009

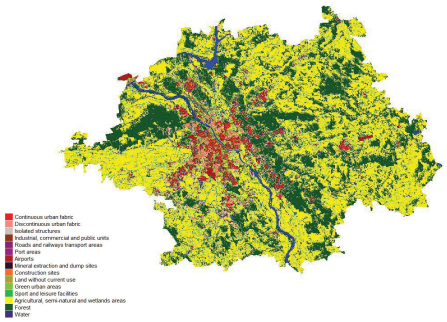

Fig. 3. Map of land use of Warsaw Metropolitan Area, 2009, based on neighborhoods coefficients. Map is based on the values of NBCs' center cells of Moore neighborhoods and presents the actual (2009) WMA land use

Potential number of neighborhoods (for 15 land use classes): 38443359375. Number of neighborhoods of WMA (for 15 land use classes, 2009): 91714. Each cell carries the information about its own nominal number and simultaneously about each of eight neighborhood cells.

Bibliography & Acknowledgments

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Neighborhood Coefficient

$$NBC_c = \sum_{i=0}^{8} k_i n^i$$

where $k \in \{0,1, \ldots, n\}$ *(Eq.1)*

Reverse Neighborhood Coefficient

$$k_i = (\text{quotient } (NBC_c / (n^i))) \bmod n$$

where $k \in \{0,1, \ldots, n\}$ *(Eq.2)*

i – the consecutive number of a cell in Moore neighborhood, k – the consecutive number describing the class of land use in an ordered nominal scale, n – the total number of land use classes, c – center of Moore neighborhood.

Common neighborhoods

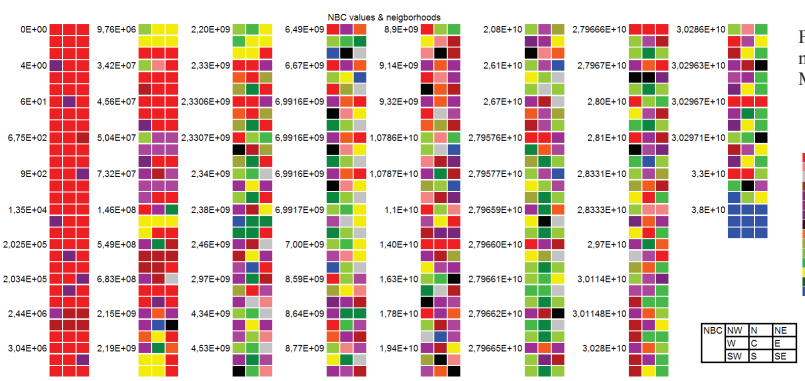

Fig.4. Most often land use neighborhoods of Warsaw Metropolitan Area, 2009