SIMULATION OF THE CHANGES OF LAND USE IN POLAND USING CELLULAR AUTOMATA AND MAP ALGEBRA

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Abstract
Introduction

One can observe a more and more frequent application of cellular automata to spatial research. Cellular automata are mathematical models for complex natural systems containing large numbers of simple identical components with local interactions. They consist of a lattice of sites, each with a finite set of possible values. The value of the sites evolves synchronously in discrete time steps according to identical rules. The value of a particular site is determined by the previous values of a neighborhood of sites around it.

Objectives

The aim of the research is to verify the hypothesis stating that existing spatial pattern and the range of area with different classes of land use show defined tendencies for further spatial development according to the geographical model (Hagoort, 2006, Tobler 1979). The theory results from adopting a realistic assumption that the neighborhoods of different areas, which constitute the actual borders is a potential frontier of spatial expansion.
The idea of using of the neighborhood indicator in analysis of land use changes is combination the method of map algebra and two-dimensional cellular automata. The aims of research are formulating the theoretical structure of the neighborhood indicator and checking its usability in practice.

Methodology

During the process of simulation, socio-economic and physico-geographic factors are not taken into consideration. According to Foteringham (et al., 2000), one of the purposes of cartographical analysis is indirect understanding of the phenomena by analyzing spatial patterns and inferring spatio-temporal processes recognizing local hot-spots. To this purpose the maps of the extents of the different research areas in Poland were used. On the basis of a statistical analysis of the neighborhood indicators the transition rules for cellular automata were formulated to the purpose of the simulation of the state of the extent of these areas in the future. The EU CORINE land cover database for different time points with extended coverage was used as the verification of the simulation results.

Results

As Wolfram stated (2002) „Three possible mechanisms that can be responsible for randomness (…) there is random input from the environment at every step (…) there is random input only in initial conditions. And in the third case, there is effectively no random input at all (…)" The first mechanism is captured in the so-called stochastic models. The second is suggested by chaos theory. The third mechanism is suggested by the behavior of simple programs (op. cit.). The sets of the transition rules derived from the calculated neighborhood coefficients will be just these simple programs. All simulations processes consist not only of computed transition rules but of all the neighborhood coefficients and simulation steps which are also (geo)visualized and statistically verified for the past.

Conclusions

The probable maps of the future extents of land use of chosen research areas in Poland will be the results of the whole project.