Spatiotemporal Analysis of Land Use Transition Process:
A Case Study of Central Tsukuba

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Abstract

Land use transitions are directly influenced by human activities. Polygonal representation is an important technique for understanding land use and the relationships among them, where each polygon represents a space of homogeneous land use. The advantage of vector-based polygon representation lies in representing the shape of geographical features in a way that makes micro-scale analysis possible. This study aims to establish and investigate analytical frameworks for polygon-based land use data sets to understand the transition processes of change regarding types of land use and their shapes. Firstly, this study develops *polygon event* and *polygon state* to clarify the land use transition process. The *polygon event* and *polygon state* help to reveal continuity, both spatially and temporally. A *polygon event* represents a combination of changes in both the type of land use and its shape through a transition process. A *polygon state* reflects homogeneity during the transition process. Two indices – the stability index and compactness – were used to enhance the understanding of the transition process. The stability index evaluates the succession of an attribute, while compactness recognizes the geometrical characteristics of a polygon.

Secondly, the lifetime of land use is investigated to analyze the continuity of the land use attribute through the transition process. This study shows the execution of multi-temporal analysis of land use transition processes. Using a data set with high temporal resolution, survival analysis was conducted. As the results show, polygons adjacent to those that have changed frequently indicated frequent change of land use type themselves. Conversely, the surroundings of polygons with a low frequency of change in land use have not experienced change in land use at all, or have changed once or twice at most. This indicates the existence of local variability in the frequency of land use change.

A case study in Tsukuba City, Japan, demonstrates the feasibility of the approach that is presented here. All of the polygons constructed in the study area show the existence of land use types that is different from their surrounding polygons. For this case, the proposed approach helps to understand continuity both spatially and temporally. These findings represent fundamental examples of transition processes that employ polygon-based data. The patterns and processes that are identified are location specific; thus, the results provide a reference for other sites that have been developed by planning, such as in the study area. The approaches based on the results of the intersection operation, and the measurement of the geometric features which are included in standard GIS software, can be adapted for many uses. The proposed analytical framework supports the clarification of land use transition patterns and is effective in explaining the spatiotemporal land use transition process.

Key words: land use transition process, polygon event, polygon state, stability index, compactness, lifetime, survival analysis, Tsukuba.

Contents

List of Tables

List of Figures