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Mapping spatial variations of land cover in a coastal landscape using pattern metrics

Hakan Alphan*, Nil Çelik

Çukurova University, Department of Landscape Architecture, Balcali Campus, Saricam, Adana, 01330, Turkey

Abstract

The aim of this study is to analyze spatial variations of land cover using pattern metrics in the case of a Mediterranean coastal area. Various composition and configuration metrics were used to analyze characteristics of land cover and its spatial heterogeneity. Satellite images (i.e., SPOT) were used to classify land cover. Pattern analyses were conducted in Erdemli district of Mersin, Turkey, from coastline to about 200m ASL. Landscape patterns were quantified and mapped on the basis of number of patches (NP), edge density (ED), largest patch index (LPI), aggregation index (AI), Shannon's and Simpson's diversity and evenness indices (SHDI, SIDI, SHEI, SIEI). A relationship between observed patterns/calculated indices and current land uses were investigated. Results showed that many of the pattern features differed between the coast and upper lands due to varying composition and configuration characteristics of land cover types under investigation.

Keywords: Pattern metrics; landscape change; Mediterranean; Erdemli; spatial diversity

1. Introduction

Landscape patterns are formed by a mixture of natural and human-managed patches that vary in size, shape, and arrangement in space; the patterns are also correlated with landscape-scale ecological processes (Turner, 1990; Hulshoff, 1995; Han et al., 2005). Spatial pattern of landscapes exhibits different characteristics, depending on the

* Corresponding author. Tel.: +90-505-812-43-95; fax: +90-322-338-61-89
E-mail address: alphan@cu.edu.tr

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scale of observation and analysis (Wu et al., 2002). Landscape pattern analysis studies the composition of landscape components and their spatial arrangements (Cao et al., 2004), and depicts them using certain methods, such as characters, graphs and landscape indices (Liding et al., 2008).

Pattern index is an overall description of the structural characteristic of the landscape type. Different landscape types might possess the same or similar pattern characteristics, so the landscape pattern information only is not enough to fully explain the vulnerability of the eco-environment (Penghua et al., 2007). A plethora of metrics has been developed to quantify landscape patterns on categorical maps. Such metrics fall into two general categories: those that quantify the composition of the map without reference to spatial attributes, and those that quantify the spatial configuration of the map, requiring spatial information for their calculation (Gustafson, 1998; McGarigal and Marks, 1995).

A number of different approaches in representing spatial concepts have resulted in the development of various spatial metrics or metric categories as descriptive statistical measurements of spatial structures and patterns. Commonly applied metrics are patch size, dominance, number of patches and density, edge length and density, nearest neighbor distance, fractal dimension, contagion, etc. (Herold, 2005; McGarigal et al., 2002).

The aim of this study is to analyze spatial heterogeneity of landscape pattern using landscape-pattern metrics in the case of a Mediterranean-type coastal area. Various indices of composition, configuration such as number of patches (NP), edge density (ED), largest patch index (LPI), aggregation index (AI), Shannon's and Simpson's diversity and evenness indices (SHDI, SIDI, SHEI, SIEI) were used to analyze characteristics of land cover and its spatial heterogeneity in Erdemli (Turkey).

1.1. Study Area

The study area is Erdemli town (Turkey) and its surroundings, located in the Mediterranean region of Turkey. It extends from coastal plain to the foothills of the Taurus Mountains (Fig. 1). Coastal zone of the area is mainly occupied by coastal plain, while northern fringe represent areas with undulated terrain and steep slopes. The study area and its vicinity have a complex network of streams that flow into the Mediterranean Sea. The climate is typical Mediterranean with mild and rainy winters and hot and humid summers. In general terms, areas with lower altitudes, mainly characterized by a mixture of agricultural patches, pine forests, maquis and shrubs have undergone extensive changes due to agricultural expansion.

The invasive nature of agriculture was also evident in upper lands. Coastline and coastal alluvial plain, on the other hand witnessed rapid urbanization. The town expanded and the coastline was occupied by high multistory buildings serving for domestic tourism (Alphan and Derse, 2013).

2. Methodology

The methodology included three main steps: (1) land cover classification, (2) metric selection and calculations and (3) mapping spatial diversity using pattern metrics.

One of the most important requirements of analyzing landscape patterns is to provide accurate spatial and thematic representations of landscapes. Spatial resolution or scales of this representation also affect analyses (Pascual-Hortal and Saura, 2007). Landscapes in the study area were characterized using CORINE Land Cover (CLC) classification scheme. The CLC is a three-level hierarchical scheme, which comprises three levels of thematic detail. The first level indicates 5 major categories of land cover on a global scale. Second level includes 15 classes, while the third level has 44 classes. A fourth level could also be added for some or all of the items, for studies on national or regional scales.

A Land use/cover map was produced using digital image classification techniques applied to SPOT (Satellite Probatoire d'Observation de la Terre) image of 2007. Five land cover categories used in image classification were derived from the CLC categories.

Built-up areas in the classification comprised urban fabric (code: 1.1) and industrial, commercial and transport units (code: 1.2) of the CLC. Therefore, continuous urban fabric (1.1.1.), discontinuous urban fabric (1.1.2.), industrial or commercial units (1.2.1), road and rail networks and associated land (1.2.2) and port areas (1.2.3) that were described at the third level were considered in a single "built-up" class. Other classes in the classification (i.e.,