



Research Paper

Linking ecosystem services and landscape patterns to assess urban ecosystem health: A case study in Shenzhen City, China



Jian Peng^{a,b,*}, Yanxu Liu^a, Jiansheng Wu^{a,b}, Huiling Lv^b, Xiaoxu Hu^a

^a College of Urban and Environmental Sciences, Peking University, Laboratory for Earth Surface Processes of the Ministry of Education, Beijing 100871, China

^b Key Laboratory for Environmental and Urban Sciences, Shenzhen Graduate School, Peking University, Shenzhen 518055, China

HIGHLIGHTS

- Urban ecosystem health is assessed by landscape patterns and ecosystem services.
- CSNE is used to quantify the impact of landscape patterns on ecosystem services.
- There is significant deterioration of urban ecosystem health during 2000–2005.

ARTICLE INFO

Article history:

Received 9 November 2014

Received in revised form 26 May 2015

Accepted 21 June 2015

Keywords:

Regional ecosystem health assessment
Urban landscapes
Ecosystem services
Landscape patterns
Shenzhen City
China

ABSTRACT

Ecosystem health assessment is always one of the key topics of ecosystem management. However, few studies have focused on assessing ecosystem health of landscapes, which are geo-spatial units composed of different kinds of ecosystem mosaics. Healthy ecosystems should sustainably provide a range of ecosystem services to meet human needs, and such a concept often cannot be expressed using the traditional ecosystem health assessment. Using Shenzhen City in China as a case study area, this research aims to assess the ecosystem health of urban landscapes based on ecosystem services. Results showed a distinct deterioration of urban ecosystem health for all of the 30 units assessed in Shenzhen City during 1978–2005. Five levels were classified with respect to health using fixed thresholds. There were 12 towns appearing with the worst level and 4 towns disappearing with the best level in 2005 compared with the status in 1978. Although there was no significant decrease in the level of health during 1978–2000, by 2005 more than 70% of towns belonged to the top two levels, classifying them as unhealthy. Among all the assessing indicators, the indicators of ecosystem organization contributed least to ecosystem health, except in 1986, and ecosystem services were found to be the most contributive indicator during 1978–2005. It was also suggested that land use patterns provided an integrating bridge among regional ecosystem health, economic development, and environmental performances.

© 2015 Elsevier B.V. All rights reserved.

1. Introduction

Natural ecosystems provide both the material basis and ecological services for the subsistence and development of human society, and healthy ecosystem can ensure the sustainability of human development (Peng, Wang, Wu, Shen, & Pan, 2011). However, the health of the Earth's ecosystems is in a downward spiral, and monitoring the health of ecosystems is thus necessary

to achieve sustainability (Rapport & Hildén, 2013; Rapport & Maffi, 2011). In the 1980s, a concept known as Ecosystem Health emerged in relation to the need for sustainable development of ecosystems (Rapport, 1989), offering a new idea and a method for environmental management (Costanza, 1992; Guidotti, 1995). In this respect, Rapport (2007) pointed out that achieving ecosystem health should become the cornerstone of sustainability policy. The primary goal of any study relating to ecosystem health is to provide conceptual and methodological foundations for assessing the conditions of the Earth's ecosystems (Rapport et al., 1999), and a healthy ecosystem is considered to be the desired endpoint of environmental management (Costanza, 2012). With this connotation and goal, ecosystem health is regarded as being one of the most important issues for ecosystem management and at the core position of integrated ecosystem assessment.

* Corresponding author at: College of Urban and Environmental Sciences, Peking University, Beijing 100871, China. Tel.: +86 10 62750926.

E-mail addresses: jianpeng@urban.pku.edu.cn (J. Peng), liyuanxu@pku.edu.cn (Y. Liu), wujs@pku.edu.cn (J. Wu), tle_1475@qq.com (H. Lv), huxx@pku.edu.cn (X. Hu).

A healthy ecosystem can be classically defined in terms of three main features: vigor, resilience, and organization (Costanza, 1992). Vigor describes the activity, metabolism or primary productivity of a system; organization refers to the number and diversity of interactions between the system's components; and resilience focuses on the system's ability to maintain its structure and pattern of behavior in the presence of stress (Costanza, 2012). In recent years, the methods for ecosystem health assessment (EHA) were notably expanded. Hong et al. (2009) built three submodels by social accounting matrix, binary logistic regression and ecosystem condition data to assess stream ecosystem health. Bunn et al. (2010) recommended five indicators of water quality, ecosystem processes, nutrient processes, macro-invertebrates and fishes to monitor the ambient ecosystem health. Styers, Chappelka, Marzen, and Somers (2010) selected landscape metrics to describe forest ecosystem health in an urbanizing landscape. Van Niekerk et al. (2013) integrated five indicators in relation to ecosystem pressure and response to assess estuary ecosystem health. In addition to the diversified indicators, the conceptual structure on EHA has also gradually progressed. Connell (2010) proposed that there was an important methodological link between sustainable livelihoods and ecosystem health, and that the two concepts were in synergy. Sarkar, Patil, Hugar, and vanLoon (2011) analyzed the sustainability of agricultural practices and community perception, and their effect on ecosystem health. Sandin and Sala (2012) discussed ecosystem succession, and looked at measuring marine ecosystem health with the application of successional theory. Nevertheless, in the recent years many EHA studies still have continued to use the most widely accepted classic framework of vigor-organization-resilience (Xue, Wang, & Niu, 2013; Yu et al., 2013), which is most widely accepted. It is therefore necessary to consider whether it is necessary to incorporate one or more new indicators in the traditional EHA framework when using EHA for various targets on different scales?

The sustainability of any ecosystem needs to be defined in relation to its spatial and temporal scale (Costanza & Patten, 1995). As a healthy ecosystem consists of macro ecological function, its realization and maintenance are also scale-dependent. EHA, which includes a great quantity of specially designated indicators, always focuses on a certain kind of ecosystem and can be conducted at the ecosystem, regional or global scale (Table 1), and the results of EHAs thus vary significantly when different scales are considered (Guidotti, 1995). According to Peng, Wang, Wu, and Zhang (2007), the regional scale is the core scale in EHA research, and research on the influence of spatial patterns on ecological processes is crucial for regional environmental management. In relation to this core scale, the concept of regional ecosystem health has emerged. Regional ecosystem health means that in a certain spatial and temporal range, the stability and sustainability of ecosystem services are offered by the spatial entity, which is the matrix of various kinds of ecosystems, under the condition of ecosystem health self-maintenance (Peng et al., 2007). In other words, regional ecosystem health expresses the ability of the spatial unit to maintain spatial patterns and ecological processes, to adjust and recover from external disturbances, and to ensure the sustainability and satisfactory provision of ecosystem services.

Ecosystem services have always been important in providing an indication of ecosystem health on human–nature coupled view (Rapport, 1995). Costanza (2012) proposed that a healthy ecosystem provide a range of valuable ecosystem services sustainably, which is a primary design goal for ecological engineering, and thus to benefit both humans and the entire natural world. However, it is often not possible to express the concept of ecosystem services when conducting a traditional ecosystem health assessment as

such an assessment focuses more on the integrity and sustainability of the actual ecosystem itself. It is therefore considered necessary to enable a link between ecosystem health and the provision of ecosystem services, and determining how any ecosystem dysfunction relates to these services when making an EHA (Rapport, Costanza, & McMichael, 1998). At a regional scale, landscapes generate a wide range of valuable ecosystem services (Bateman et al., 2013), but the composition and configuration of landscapes are being substantially changed by humankind (Li, Li, Zhu, Song, & Wu, 2013). When research on regional ecosystem health at the landscape scale, the simple analysis on ecosystem structure should be incomplete. It is thus considered important to focus on how the changes in ecosystem services interact with various land use types, in addition to the effect of human activities, in order to gain a more comprehensive understanding of the ecosystem health of a region.

Extending the notion of ecosystem health to a regional level is not a completely new idea as it was firstly proposed in the 1990s (Rapport et al., 1998). However, few researchers showed interest in the exact meaning of regional ecosystem health assessment (REHA), and no methodological paradigms have been proposed. Although the REHA is an extension of the EHA, there are slight differences in their research objects. Generally speaking, the traditional EHA is a quality assessment of a certain kind of ecosystem, such as an aquatic ecosystem, marine ecosystem, or forest ecosystem. When conducted at a macro scale, the REHA pays more attention to spatial dimensions and usually focuses on ecosystem services, thereby emphasizing the effect of spatial mosaic patterns of different ecosystems in relation to the health status of each ecosystem. Thus, REHA therefore represents an integration of the quality assessment, quantitative structure assessment, and the spatial pattern assessment (Peng et al., 2007).

Besides the widely accepted vigor-organization-resilience system indicators, some studies have expanded the assessment framework by using new methods (Su, Fath, & Yang, 2010). Su, Yang, and Chen (2009) adopted a set pair analysis to assess urban ecosystem health. Yu et al. (2013) built a pressure–state–response framework using land use database. Furthermore, a large number of researchers have recently accepted the use of the energy analysis method within the REHA (Jing, Yuan, Guo, & Wang, 2010; Liu et al., 2009; Su, 2010; Su et al., 2011; Zeng, Zhao, & Yang, 2010). However, the human demands for natural ecosystems, such as the indicators related to ecosystem services, has rarely been clarified, and the spatial adjacency effect of landscape patterns on ecosystem health has also not yet been taken into account within REHAs.

In relation to the significance of ecosystem services at a regional scale, the REHA considers four factors: ecosystem vigor, organization, resilience, and services. The determination of ecosystem vigor clarifies the function of regional ecosystems, and it is generally measured by the metabolic capacity or primary productivity. Organization is evaluated by the overall stability of the landscape structure and the connectivity of each component, and resilience refers to the ability of the landscape mosaic to maintain its original structure and to function under human and natural disturbances. In addition to determining services however, it is necessary to consider the effects of the adjacent spatial relationships of various ecosystems on their services. These four factors are discussed in greater detail later in the study.

In this respect, we use Shenzhen City in China as a case study area, and consider ecosystem services and landscape patterns in an assessment of the urban ecosystem health. The aims of this study are to put forward an approach for assessing urban ecosystem health with the framework of ecosystem vigor, organization, resilience, and services. In doing so, we analyze the changes in urban ecosystem health using time series land use data from 1978 to 1986, 1990, 1995, 2000, and 2005, and discuss the contribution of REHA indicators.

Download English Version:

<https://daneshyari.com/en/article/7460966>

Download Persian Version:

<https://daneshyari.com/article/7460966>

[Daneshyari.com](https://daneshyari.com)