



## Full length article

## Spatio-temporal changes in ecosystem service value in response to land-use/cover changes in the Pearl River Delta

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## ABSTRACT

Urban development and human activities threaten ecosystem structures and ecological processes. Since 1995, the gross domestic product (GDP) of the Pearl River Delta (PRD) has increased by more than thirteen fold. However, our understanding of how the ecosystem service value (ESV) has responded to land-use/cover changes (LUCC) in the PRD remains limited. In this paper, we use a multi-source data approach to assess the patterns of ESV in the PRD from 1995 to 2015. The hot/cool-spot mapping method is used to analyse the spatial differences in ESV at a 1 km scale. The results revealed the following: (a) the proportion of increase in built-up land area is 6.3% in the PRD; this change occurred mainly through the occupation of farmland and forest land. (b) The area of hot spots increased from 37% in 1995 to 41% in 2015, while the area of cool spots increased from 34.6% to 36.3%. The ESV hot spots are mainly distributed in Zhaoqing and Huizhou. (c) The ESV has changed due to a combination of natural and anthropogenic factors in the PRD. Furthermore, corresponding management measures are identified according to the results of the exploratory spatial data analysis. The findings of this study have practical significance for establishing mathematical models to reveal the patterns of ESV in urban agglomerations.

## 1. Introduction

Gross domestic product (GDP) is used as the criterion to assess economic development. However, this measure neglects not only the ecological perspective but also the social perspective and has aroused widespread global academic controversy. There is an urgent need for measures that outperform GDP in comprehensively reflecting the various impacts of economic development; thus, research on ecosystem services (ES) has gained widespread attention. The measurement of ES seeks to address the question, “How much are nature's services worth?” (Westman, 1977). The term “natural services” was first used academically by Westman, and its synonym “ecosystem services” first appeared in 1981 (Ehrlich and Ehrlich, 1981) and was officially introduced in 1983 (Ehrlich and Mooney, 1983). Two pioneering studies were published in 1997: one by Daily et al. (1997), titled “Nature's Services: Societal Dependence on Natural Ecosystems”, and the other by Costanza et al. (1997) in the journal *Nature* under the title, “The Value of the World's Ecosystem Service and Natural Capital”. The publication of these studies sparked a discussion and an upsurge in research on ecological capital in ecosystems, ES and related policies (Bockstael et al., 2000; Sutton and Costanza, 2002). Subsequently, the *Millennium*

*Ecosystem Assessment* (2005) was announced by the United Nations, The Economics of Ecosystems and Biodiversity (TEEB) Foundations were created by Germany, and European countries attempted to build a complete system of monetary accounting methods (TEEB Foundations, 2010), but the methodology was complex and characterized by considerable uncertainty.

ES are defined as the benefits people directly or indirectly obtain from ecosystems. The *Millennium Ecosystem Assessment* (2005) divided ES into four categories—supporting, provisioning, regulating and cultural services. More recently, the European Environment Agency (EEA) published the Common International Classification of Ecosystem Services (CICES, V5.1) and reclassified the ES into three categories—provisioning, regulating & maintenance, and cultural services. This classification has been adopted in the present study. What is the definition of “ecosystem service value (ESV)”? Ecosystem valuation is an economic process that assigns value to an ecosystem and its ecosystem services. This value is defined as the ESV. The TEEB report (2010) proposed 22 ES, of which only half were selected in this paper based on the result of a social survey in this region from previous studies (Bryan et al., 2018; Xie et al., 2017).

With the sustained growth of the global economy and the

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