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Original Articles

Study on the urban state carrying capacity for unbalanced sustainable development regions: Evidence from the Yangtze River Economic Belt

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ABSTRACT

The Yangtze River Economic Belt (YREB) is the prior region for achieving China's strategic development with both economic and ecological goals. Since YREB covers more than 500 million people within a large area, the unbalanced urban sustainable development cannot be neglected. Different from the previous studies, this paper adopts an index of urban state carrying capacity (USCC) to assess the sustainable development in YREB. USCC can reflect the positive effects clearly, and evaluate the carrying capacity without the distortion from the opposite side. The assessment method combines the framework of Indicator-Benchmark Comparison (IBC) and the method of Analytical hieratical process (AHP), and sets up the indicator system for USCC from four perspectives. Based on the panel data for the years 2006–2014 in three scale levels, the analyses of temporal and spatial differentiation are conducted to discuss the unbalanced development in YREB. The results present that the eastern sub-UAs have much higher USCC values than the western ones significantly. The provincial cities and municipalities with higher USCC have strong impacts on their neighborhood cities around them. Further policies are suggested to support for other unbalanced sustainable development urban agglomerations like YREB.

1. Introduction

The Yangtze River Economic Belt (YREB) has been officially marked as one of China's key strategic development regions since 2016. Geographically, YREB promotes the coordination and interaction among east, central and western China, and connects the south-west border to the seacoast along the Yangtze River. With an area of two million square kilometers and over 40 percent of China's population and GDP, nine provinces and two municipalities are included in the YREB (Tian & Sun, 2018). Due to its significant location, YREB is also well-recognized to play a crucial role to drive the global cooperation on "One Belt One Road" initiative. In addition, China government has put forward the green development strategy, and promoted the YREB to develop green manufacturing and protect ecological environment (Chen et al., 2017). The YREB becomes the most important pilot region to achieve the economic and ecological win-win goals. As the urbanization process is boosted, the cities in YREB are connected and clustered. This clustering makes YREB to be evolved into an urban agglomeration (Tian & Sun, 2018). Therefore, to study the indictors of comprehensive condition for YREB should be a crucial issue for policy makers. Based on the urban development theory, this study employs the framework of carrying capacity to evaluate the indicator for the urban sustainable development.

Carrying capacity is initial a physical parameter measuring the critical loads of objects against damage. It is first cited by community ecology, and defined as the threshold of ability to withstand human activities under certain conditions (Kessler, 1994; Yu & Mao, 2002; Hui, 2015). In the further research, the meaning of carrying capacity has been extended to different aspects related to urban development. These aspects include not only ecological factors, but also economic and social factors, such as population, capital, and transportation. The carrying capacities of these factors could make joint impacts on the urban development to achieve the sustainability (Ma et al., 2017). In the latest studies, scholars propose a comprehensive evaluation index called urban comprehensive carrying capacity (UCC), which enriches the definition of carrying capacity for a synergistic urban system. UCC refers to a city's ultimate capacity to support social economic activities with a sustainable developing pattern (Wei et al., 2015), under the constrains of human resources, science, technology, infrastructural factors (Joardar, 1998) and natural resources (Onishi, 1994; Zhang et al., 2016). To summarize the previous relevant studies, we figure out that UCC is the capability to support the coordinated and sustainable development of urban systems. UCC could be evaluated by some environmental, social and economic factors, like the ecological environment, infrastructure, factor market and industrial economy (Sarma

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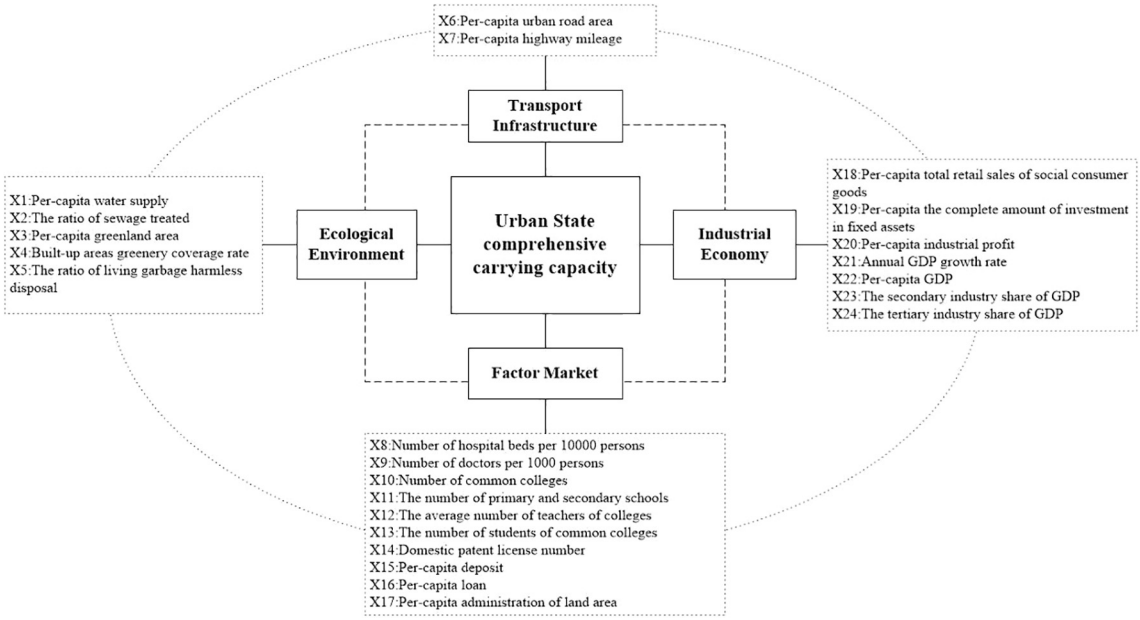

Fig. 1. The framework and indicators of USCC in YREB.

et al., 2012; Wei et al., 2016; Tian and Sun, 2018).

Most of studies use both state and stress factors to indicate positive and negative effects on the UCC system, and make their relatively comprehensive assessment results (Carey, 1993; Sarma et al., 2012; Wei et al., 2015). However, due to the different processes of urban development, the dominant effect on the capacity could change from state factors to stress factors. For example, in the takeoff period of urbanization, the state factors (like capital investments, natural resource supply) exert positive effects on the carrier and make a great contribution to UCC (Button, 2002). But in the period after rapid growth, many stress factors arise and become dominant, such as the intensification of environment pollution, huge resources demand and overcrowded effects. These stress factors oppositely provide a lot of pressure on the urban sustainable development (Heikkila and Xu, 2014). Therefore, using opposite indicators in one system at the same time, to some extent, may confuse capacity with stress (Liu and Borthwick, 2011) and cannot get the clearly conclusion about the value of UCC. In particular, in the UA like YREB which covers both fast-developing and well-developed cities, the state and stress factors could affect the UCC simultaneous. Some indicators of state factors contribute to the carrying capacity, but some others of stress factors exert opposite pressure on UCC. In this paper, we employ an urban state carrying capacity (USCC) to explore a clear evaluation index system. USCC could reveal the carrying capacity from the perspective of state factors. Different from the previous studies (Wei et al., 2015), these state indicators of only positive effects can clearly assess the carrying capacity without the distortion from the opposite side (Liu and Borthwick, 2011). USCC could reflects the real state of carrying capacity and provide a straightforward basis for the assessment of USCC, which supports an unbalanced sustainable development UA like YREB.

Compared with previous study, this paper has three informative and innovative points. First, since the process of urbanization is rapid in YREB, this paper uses USCC which is concentrated on the objective supporting ability instead of the traditional UCC to evaluated its sustainable development. The framework of USCC could figure out the potential state carrying capacity more directly. Second, to analyze the temporal and spatial variability of USCC, this paper adopts a dynamic successive assessment method, which combines the framework of Indicator-Benchmark Comparison (IBC) and the method of Analytical hieratical process (AHP), to set up the indicator system for USCC from four perspectives. Third, in this paper, both the geostatistics (Francky, 2016) method and geographical information system-based method (You et al., 2017) are employed to analyze the USCC differentiation for the YREB cities in three scale levels.

The remainder parts are organized as follow: Section 2 shows the methodology and the data. The empirical results are provided in Section 3. Section 4 is the conclusion and policy recommendation.

2. Urban state comprehensive carrying capacity

2.1. USCC evaluation index system

The framework of Indicator-Benchmark Comparison (IBC)[1] and the method of Analytical hieratical process (AHP)[2] are both introduced to set up the indicator system for USCC (Fig. 1). According to the indicator selection principle[3], 24 basic indicators (See Table 1) are selected referred to the previous literature (Feng et al., 2009). All these indicators reflect the state of carrying capacity, and make positive contribution to the value of USCC. According to the attribution of each indicator, we use the AHP method to classify the 24 basic indicators into four subsystems, such as ecological environment (EE), transportation infrastructure (TI), factor market (FM), and industrial economy (IE)[4]. After the classification, the state factors and synergistic effects could be concentrated on different perspectives, and the framework of the USCC in YREB is set up. The details of the USCC's framework are shown in Fig. 1 and Table 1.

[1] The Indicator-Benchmark Comparison (IBC) is one of the conventional assessment models for carrying capacities (Graymore et al., 2010; Liu, 2012; Oh et al., 2005; Shi et al., 2013; Yu & Mao, 2002). As the assessment is based on individual indicators, the carrying capacities values can be compared in threshold, quantifiable criteria or recommended standards (Joardar, 1998; Liu & Borthwick, 2011).

[2] The Analytical hieratical process(AHP) system is structured hierarchically at different levels, with each level consisting of a finite number of decision elements (Singh et al., 2007; Hosseini & Kaneko, 2011). The top level of the hierarchy represents the overall goal, whereas the lowest level is composed of all possible alternatives (Aguaron et al., 2003). This method combines the qualitative and quantitative analyses and it can provide a multi-dimensional and multi-criterion analysis.

[3] The indicator selection principle includes scientificity, feasibility, completeness and gradation.

[4] In this paper, the EE, TI, FM and IE are the abbreviations of these four subsystems.