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The Research of China Urban Efficiency Based on Suomi-NPP Night-time Light Data

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Abstract

China is the fastest urbanizing area in the world. Nowadays, increasingly complex urban systems not only create more socioeconomic output (such as GDP), but also bring more infrastructural costs, which intensifies the contradiction between large populations and relatively scarce resources. Thus, urban research has to focus on urban efficiency toward efficient, inclusive, and sustainable urbanization instead of urban size. Aiming at "land" in man-land relationship, urban size research mainly explores location factors. However, proposed by Michael Batty, social interaction is the driving force for urban efficiency, stressing on "man" in man-land relationship. Recently, our increasing ability to collect and share data on many aspects of urban life has begun to supply us with better clues to the properties of cities. Human activity can be effectively reflected using night-time light imageries. Making use of Suomi-NPP night-time light data, the Night Light Urban Efficiency Index (NLUEI) was proposed to quantitatively evaluate the urban efficiency, then this index was applied to 282 cities in China to calculate their urban efficiency. Results showed that 60.5% of these cities obtained the same result via NLUEI and social-tie density model from MIT. Compared to "2013 urban competitiveness blue book" published by CASS (Chinese Academy of Social Sciences), seven cities in top ten cities published by CASS also emerged in top ten cities according to NLUEI, and other three cities were all energy cities with low NLUEI. It is demonstrated that (1) NLUEI is a straightforward and objective index for evaluating the urban efficiency and (2) NLUEI works well in China and has great potential in urban management.

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1. Introduction

A larger percentage of people live in cities than at any point in human society [1], while China is the fastest urbanizing area in the world. According to UN forecasts, global population will increase to over 8 billion by 2025, with much of this anticipated population growth expected in urban areas. In China, the percentage of Chinese living in urban areas increased from 18% to over 50% since the late 1970s [2], as much as 53.73% by 2013.

The increasing urbanization in China presents both opportunities and challenges [3] toward future scenarios of sustainable development. Increasingly complex urban systems not only create more socioeconomic output (such as GDP), but also bring more infrastructural costs, which intensifies the contradiction between large populations and relatively scarce resources. As for China, there is the necessity for a sustainability transition toward a stable total human population, together with a rise in living standards and the establishment of long-term balances between human development needs and the planet's environmental limits [6]. Thus, China's urbanization must be transformed from urban expansion period to smart growth period, accordingly, urban research has to focus on urban efficiency toward efficient, inclusive, and sustainable urbanization instead of urban size. Thus, a major challenge worldwide is to build the quantitative measures of urban efficiency capturing the balance between socioeconomic outputs and infrastructural costs scientifically and providing appropriate information and decision-making support for urbanization.

Recently, the development of the Quantitative Urbanism [5] and our increasing ability to collect and share data on many aspects of urban life [4] have begun to supply us with better clues to the properties of cities. To evaluate urban efficiency quantitatively and scientifically, a straightforward and objective index, termed as the Night Light Urban Efficiency Index (NLUEI), was proposed making use of mainly Suomi-NPP night-time light data and statistical yearbook data, moreover, conformation of this index was observed of 282 cities at different levels of development in China in 2012 and the results were compared with the social-tie density model from MIT [7] and the "urban competitiveness blue book" published by CASS (Chinese Academy of Social Sciences)[8], from which it is concluded that (1) NLUEI is a straightforward and objective index for evaluating the urban efficiency and (2) NLUEI works well in China and has great potential in urban management.

The contributions of this paper are three-fold. First, a major contribution of this paper lies in proposing the key question in China's urbanization should shift from "how we can make our cities more urbanized" to "how we can make cities more efficiency?", which focus on the urban efficiency considering balance between socioeconomic outputs and infrastructural costs. Secondly, different from aiming at "land" in man-land relationship before, our research view stresses on "man" in man-land relationship. Furthermore, instead of analyzing population distribution as a direct proxy of urbanization in China, we takes literally the idea that interactions and information exchange on social networks are often the driving force for idea-creation and productivity [7]. Based on this speculation, we further conjecture that the quantitative evaluation of social interaction should be a direct proxy of urbanization instead of the former population distribution. Thirdly, based on the Quantitative Urbanism, the Night Light Urban Efficiency Index (NLUEI) is proposed, and this index is simple, objective and easy to use.

The structure of the paper is as follows. The research starts in section 2 with notion of urban efficiency and quantitative measures of urban efficiency, termed as the Night Light Urban Efficiency Index (NLUEI). Furthermore, we introduce the methodology to obtain the natural city area reflected the social interaction, as a direct proxy of socioeconomic outputs in NLUEI, making use of Suomi-NPP night-time light data. This index was further in section 3 applied to 282 cities in China in 2012 to calculate their urban efficiency and the results were compared with the social-tie density model from MIT [7] and the "urban competitiveness blue book" published by CASS [8] in section 4. Finally, the paper draws a conclusion and points to the future work.

2. Methodology

2.1. Measures of Urban Efficiency

We live in an age of cities [9].By the end of this century, it is likely that most of the world's population will be living in one type of city or another, as urbanization and globalization become norm. This fast urbanization appears to promote large production and innovation, and is related with higher levels of per capita income and creativity [10][11][12]. However, an issue that has received less attention in the literature (exceptions are [4] and [6]) is that the