EFFECTS OF CHINA'S URBAN FORM ON URBAN ENERGY CONSUMPTION

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Overview

Since the Reforming and Openning-up in 1979, China has experienced a booming development of urbanization. China's urbanization level was less than 20% in 1979, then exceeded 50% in 2011 and reached 56.10% by the end of 2015. The number of cities has increased from 193 in 1978 to 655 in 2015. The built-up urban area increased 6-fold between 1981 and 2015. Urbanization has been reshaping both the physical environment and the energy consumption pattern. It has been argued that urban form can significantly affect urban energy consumption. Some researches have focused on individual cities by modelling transportation and residential energy usage of various urban forms (Banister et al., 1997; Ko, 2013). Some empirical stuies attempted to reveal the relationship between urban form of cities and energy consumption in developed countries (Marshall, 2008; Ko and Radke, 2014). Also, in China, which is a typical developing country under a rapid urbanization process, some reseachers began to pay attention to the relationship between urban structure and energy use (Zhang J., 2013; Chen, Y. et al., 2015). This paper aims to explore the correlation between urban form and urban energy consumption in China, Compared with the previous studies which focused on one city or a few cities, this paper studies the relationship between urban form and urban energy consumption of a large number of cities which are 287 provincial-level and prefecture-level cities in China. Moreover, this paper analyses temporal characteristics of China's urban form, urban energy consumption and the relationship between both from 2000 to 2010.

The paper is organised as follows: in the introduction section the research background and literature review will be introduced. The second section gives an overview about methods for measuring urban form indicies and geographically weighted regression (GWR) model. Data sources will also be introduced in the second section. The third section shows the results and some key findings. We conclude the paper and put forward some suggections on future urban development and energy development in the fouth section.

Methods

Spatial analysis by Geographic Information System (GIS) will be applied to quantify two urban form indices in different cities, i.e., compact ratio index and fractal dimension index.

Geographic weighted regression (GWR) model is used to test the statistical significance between the urban form indices and the urban energy consumption. Moreover, a comaprison of results from geographic weighted regression(GWR) and ordinary least square(OLS) regression will also be implemented to show how the GWR model deal with the spatial heterogeneity of the impacts of urban form on energy consumption.

This study is carried out in China's four provincial-level cities and 283 prefecture-level cities in 2000, 2005 and 2010. The data source used to compute the urban form is from a reliable previous GIS research named "A normalized urban areas composite index (nuaci) based on combination of dmsp-ols and modis for mapping impervious surface area" (Liu, X. et al.,2015) . And the data for urban energy consumption and other urban characteristics comes from CEIC Data's China Premium Database, which offers us a wealth of information on the performance of various industries in every city.

In the OLS and GWR model, we adopt electricity consumption per capita to measure the urban energy consumption. And urban form is quantified by the compact ratio and fractal dimension index. Meanwhile, we include some control variables which may affect the electricity use for production and buildings. GDP pre capita is considered firstly as energy is one of the inputs for production, likewise, share of secondary sector production is adopted as control variable since secondary sector is more energy intensive than others. As for buildings electricity use, the average annual temperature matters since the electricity used for heating or cooling the space may be various across different types of climates. In addition, construction land per capita and population density are included because larger construction and population density may increase the efficiency of energy use.

Results

First, the compact ratio indices in general decreased from 2000 to 2010, which implies the trendency of urban sprawl in China has enhanced. The fractal dimension index increased generally.

Second, the GWR model resulted that compact urban form can reduce urban energy consumption per capita. However, there existed large spatial difference in the effects of compact urban form on urban energy consumption per capita.

Third, the fractal dimension index had non-significant relationship with urban energy consumption. Compared with these two indices of urban form, the development stage of urbanization of one city had a larger impact on urban energy consumption.

Conclusions

The paper makes several contributions to the literature and the policy-making of urban and energy development. Firstly, this study conducts a macro-analysis of urban form and urban energy consumption with a large number of cities. Secondly, this study fills up the research gap in exploring the relationship between urban form and urban energy consumption in a developing country under a rapid urbanization process. Thirdly, the findings of this study will help policy-makers in developing a sustainable urban development strategy and urban energy use strategy.

References

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