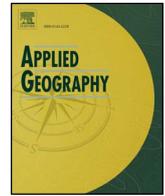




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Natural topographic controls on the spatial distribution of poverty-stricken counties in China

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ABSTRACT

The spatial distribution pattern of the economic development among counties is an important external representation of a balanced and sustainable regional development in China. The natural topography has been regarded as one of the most important factors that controls the economic development of a county. Moreover, natural topography determines land availability and regional accessibility and further influences the objective environment of wealth creation. On the basis of the digital elevation model (DEM) data and geographic information science (GIS) spatial analysis method, this study utilizes the poverty-stricken counties in China to explore the influential factors of the spatial distribution of county's wealth by considering the natural topographic environment. The indexes of slope gradient, terrain relief, river length and river density are calculated to investigate the spatial relationship between the wealth distribution of counties and their natural topographic condition. Results show that the poverty-stricken counties in China are mainly located on the second Gradient Terrain of the Three Gradient Terrains in the country and are particularly concentrated in the Loess Plateau, Qinling-Daba Mountains, and Yunnan–Guizhou Plateau. These areas are also located near both sides of the traditional Hu Huanyong Population Line of China. Results also show that the complex conditions of the natural topography have a positive driving effect on the spatial distribution of the poverty-stricken counties. By contrast, non-poverty-stricken counties are mainly located in areas with good topographic conditions. A total of 70% of the poverty-stricken counties are characterized by severe topographic condition with an average slope gradient of over 10° calculated from the 90 m cell size DEM. However, only 32% of the non-poverty-stricken counties are characterized by severe topographic condition. In addition, 72% of the poverty-stricken counties have an average terrain relief of over 50 m in a local 3 × 3 cell size (270 m × 270 m), whereas non-poverty-stricken counties accounted for only 34%. Furthermore, the scale effect of the topographical feature derivation from DEM makes the actual topographic condition of the poverty-stricken counties even worse, and the land should be considerably difficult to cultivate. Finally, the primary industry seems to experience difficulty in addressing poverty in poverty-stricken counties. The sheep-flock effect of government-led industries that enter the poverty-stricken counties is expected to be an important policy direction for a balanced regional development. This study provides a reference to the driving force of the natural topographic conditions on the wealth accumulation among counties for a balanced and sustainable regional development.

1. Introduction

The county is the most basic administrative unit in China and around the world. The economic development level and spatial distribution pattern of this unit are the visual performances of the status quo of the regional economic development in China. This specific pattern could be regarded as an important reference factor to promote a

balanced and sustainable regional development, as well as formulate the macro-control policy of the government (Cao, Xu, Xie, Liu, & Liu, 2016; Jin & Lu, 2009; Liao and Wei, 2012; Mao, 1991; Wang, Wang, & Lin, 2016; Ward, 2016). The investigation of the spatial distribution characteristics and influencing factors of county's economic development can externally deepen the understanding of the spatial status quo and evolutionary process of China's county development. Moreover,

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these investigation and factors provide an improved understanding of the developmental mechanism of counties under varied natural and social driving factors. The current study is also of immense theoretical and practical significance to serve strategic policy making for a balanced and sustainable regional development in China.

Multiple and complex influential factors could be determined to shape the economic developmental level among counties (Chen et al., 2015; Rupasingha & Goetz, 2007). These factors could be summarized into two categories, namely, social and natural factors. For social factors, many scholars explored the driving mechanisms of counties' economic development with social entry points, such as the structure, distribution and migration of population (Bennett, Probst, & Pumkam, 2011; Le Goff & Singh, 2014; Wang, Feng, & Yang, 2014; Yang, 2014; Maguire-Jack, Lanier, Johnson-Motoyama, Welch, & Dineen, 2015; Wei et al., 2015; Chen, Wang, Wen, Fang, & Song, 2016; Iceland and Hernandez, 2017), characteristics of various industries (Gamau, Le Billon, & Spiegel, 2015; Li, Chen, & Sun, 2014; Loayza & Rigolini, 2016; Wang & Li, 2016; Zuo & Bao, 2008), construction of the infrastructure, and macro-control policy making of the government (Chen, Lu, & Liu, 2010; Ellen, Horn, & O'Regan, 2016; He, Liu, & Wu, 2010; Liu & Zeng, 2011; Lü, 2015; Rogers, 2014; Wang, Huang, & Cao, 2016). Among these factors, humans are the creators of economic developmental level. The characteristics of population (i.e., amount, distribution, and migration) play a significant role in the economic developmental level of counties. For example, a significant positive relationship between population change and economic development has been determined among counties in China in 2000–2010 (Wang et al., 2014). In addition, the characteristics of industries (i.e., type, distribution, and accumulation) among counties should be another important factor to control the economic development. Such as the economic output of the Chinese tourism industry plays significant role in counties' economic development, particularly in a tourism-focused county (Zuo & Bao, 2008). A significant effect has been determined from the characteristics of the industrial structure on the development level of counties' economy and the spatial differentiation of counties' urbanization (Wang & Li, 2016). Lastly, the infrastructure construction and macro-control policy making of the government also guides the economic development of county. To illustrate, Chen et al. (2010) used China's urbanization strategy as basis to investigate the urbanization level of each province and explore its relationship with the economic development level. Liu and Zeng (2011) explored the relationship between traffic accessibility and developmental level of counties' economy by measuring the accessibility of the road network constructed by the government.

From aforementioned studies we can summarize that social factors considerably influence and determine the developmental level and spatial distribution of counties' economy. However, on the one hand, from the stability of Hu Huanyong's population distribution line (Qi, Liu, & Zhao, 2015), the overall spatial distribution pattern of China's population has not changed, particularly the spatial pattern that is calculated by a county, even though a segment of the population migrated to several individual supercities or big cities during the urbanization process (The specific Hu Huanyong line, also known internationally as the “Hu Line”, was proposed by Prof. Hu Huanyong in 1934. The line marked a striking difference in the distribution of China's population.). This finding demonstrates that the current population distribution pattern will exist for a long time with the statistical unit of a county. In addition, different types of industry have specific location selection and accumulation characteristics. All industries have different preconditions for counties. In particular, the distribution of secondary and tertiary industries is characterized by the contingency of location selection and inevitability of capital profitability. In terms of the primary industry, the 2012 China Statistical Yearbook show that the poverty-stricken counties still have less arable land, and a high proportion of their GDP is actually from primary industry. Therefore, the primary industry is still the leading factor that influences the development of poverty-stricken counties in China.

On the other hand, geographical background, such as the natural controlling factors of climate and geomorphology, significantly controls the economic development of counties. Thus, the natural environment should be the most basic factor. Economic development and social history are restricted to and formed on the natural environment. Hence, the natural environmental factors are the external objective conditions of wealth creation, thereby significantly and geographically controlling the economic development of counties. Natural factors (i.e., climate adaptability, sufficiency of water resources, availability of land, and accessibility of an area) determine the creativity of counties' wealth in varying degrees (Deng & Tang, 2013; Deng, Fang, & Tang, 2013; Fang, 2009; Fang, Ouyang, & Zheng, 2012; Husmann, 2016; Liu & Xu, 2016; Wang, 1996; Wishitemi, Momanyi, Ombati, & Okello, 2015; Zhang et al., 2015). In the poverty-stricken areas or counties in China, the available land is still the foundation of human survival and further economic development. Such land should be regarded as the core source of wealth creation in these poverty-stricken counties. The accessibility of different areas and availability of land are profoundly influenced by the natural topographical environment. Moreover, the natural topographical environment fundamentally determines the overall topographical characteristics of China's Three Gradient Terrains. These Three Gradient Terrains also affect their corresponding climate and water resources (Jiang & Yang, 2009).

Several scholars have also attempted to explore the effect of the natural topographical environment on the economic development of counties (Chen & Ge, 2015; Feng, Tang, & Yang, 2007; Liu, Deng, & Song, 2015; Zhou, Li, & Ren, 2012). However, the terrain features derived from the considerably coarse digital elevation model (DEM) resolution or statistical DEM data with a certain window size could inevitably result in the inaccurate expression of the natural topography in a certain area. The reasons are due to lack of high-resolution DEM data in the national scale, difficulty of calculation using the national big data volume of DEM, and limitation of digital terrain analysis (DTA). For example, the terrain relief is calculated under a statistical window of 10 km × 10 km on the national scale (Feng et al., 2007). This result could inevitably lead to the inaccurate expression of land availability on the local scale (i.e., below 10 km). With the development of the DEM data acquisition and DEM-based DTA methods (Tang, 2014), the DEM and DTA methods have been successfully applied in different fields (Tang, 2014). Moreover, implementing the detailed scale of terrain analysis in the entire China is possible. The natural topographic factors derived from DEM on the national scale provide the data and methodological basis to explore the spatial relationship between the natural topographical environment and counties' wealth.

The purpose of this paper should be twofold: (1) identify the spatial patterns of economic development in China by county level of geography, especially the poverty-stricken counties; and (2) examine and account for the associations/relations between the spatial patterns of poverty-stricken counties and the characteristics of their topographical environment. First, the current study investigates the economic development level of all counties in China on the basis of the 2012 China Statistical Yearbook issued by the National Bureau of Statistics of China. Second, 592 poverty-stricken counties that were recognized by the Poverty Relief Office of the State Council of China in 2012 have been marked. Third, the topographical derivatives of terrain relief and slope gradient were calculated from the digital elevation model (DEM), and the water resource indexes of river length and river density were calculated from digital line graph (DLG) data. Lastly, the controlling effect of the natural topographical environment on the spatial distribution of poverty-stricken counties in China was discussed using the marked poverty-stricken counties and calculated terrain derivatives.

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