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Factors that Influence the Tourism Industry's Carbon Emissions: a Tourism Area Life Cycle Model Perspective

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ABSTRACT

This study proposed a factor decomposition model for analyzing carbon emissions in energy consumption of the tourism industry from the perspective of tourism area life cycle. The Wulingyuan Scenic and Historic Interest Area (WSHIA) was chosen as the study area for the analysis of the influencing factors on carbon emissions for the tourism industry over the different stages of its life cycle. The research results showed that growth in the scale of tourists and the scale of tourism output both result in the rapid growth of carbon emissions; the constant decrease in energy intensity helped inhibit carbon emissions from the stage of exploration to the stage of consolidation. However, the scale effects of tourists and the energy intensity had become the important positive factors to the growth of carbon emission, while the effects of energy structure and output scale on the growth of carbon emission had become negative factors. The inhibition of the growth of carbon emissions from optimizing the industrial structure was rapidly weakening at the stage of transformation and upgrading. Designers of policy on energy-saving and emission-reduction should focus on the differential measures, according to different influencing factors that affect carbon emissions at different life cycle stages.

1. Introduction

Tourism is one of the main contributors to energy consumption and greenhouse gas (GHG) emissions (Gössling, 2013). For many years, research on energy consumption and carbon emissions of the tourism industry has been widely carried out and discussed in hopes of promoting energy conservation and emission reduction (Tang et al., 2015). Most studies focus on accounting for carbon emissions of tourism consumption across regions (Cadarso et al., 2016; Munday et al., 2013 and Sun, 2014), sectors (Lin, 2010; Tang et al., 2015; Tsai et al., 2014; Wang and Huang, 2013) and stakeholders (Cadarso et al., 2015). In recent years, more attention has been directed at carbon emissions in particular periods at tourism destinations. However, there appears to be a general lack of understanding of the relationship between the change in carbon emissions and the life cycle of tourism destinations. This paper is an attempt to bridge this gap.

The Chinese tourism industry has experienced rapid growth and development since 1978. In 2015, China received 4.13 billion tourists, among which 4.0 billion were Chinese tourists, 133.82 million were inbound tourists, and 127.86 million were outbound tourists. The total income of tourism industry was US$662.72 billion (CNTA, 2015). For such a large industry, the amount of energy consumption resulting from its growth and development has continued to rise, and the pressure on energy-conservation and emission-reduction has also grown immensely. The need for more research on energy consumption and carbon emissions from the tourism industry has undoubtedly become of great significance from the perspective of sustainable development as well as energy-conservation and emission-reduction in China. Strategies to handle the tension between the incessant growth and development of the tourism industry and the need to curb continuous increase in carbon emissions, and methods to realize low-carbon development of the tourism industry are the top foci and concerns of Chinese tourist destinations while attempting to devise sustainable development policies.

The Wulingyuan Scenic and Historic Interest Area (WSHIA) is among the most common tourist destinations in China and its development is the epitome of the development of the tourism industry in China to a large extent. This study took the WSHIA as the research base. Adopting the top-down method, life cycle assessment method and material flow theory, coupled with determining and analyzing the total energy consumption and carbon emissions, and using the extended equation of Kaya identity and LMDI decomposition method, a factors-decomposition model was established to study carbon emission from

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energy consumption of the tourism industry in the WSHIA from 1979 to 2010. We adopt the tourism area life-cycle theory of Butler (1980) and follow the approach of Zhong et al. (2008) to delineate the life cycle of Zhangjiajie National Park, which constitutes the main part of the WSHIA, and perform analyses of the key factors influencing the growth of carbon emissions for the tourism industry over the different stages of the life-cycle in the WSHIA.

Thus, this study explored new perspectives and developed a better understanding of the influencing factors and their carbon emission contribution rate to tourism industry in its destinations at different stages of the life cycles in hopes of bridging the gaps found in previous research on the carbon emission of tourism and the tourism area life cycle. This innovative approach to analyze the environmental impact of tourism activities from the perspective of tourism area life cycle can help enrich the theories of tourism geography and green development of low carbon tourism. This research model is potentially suitable for the sustainable development of tourism destinations elsewhere. In practice, the findings from this study can provide policymakers with ideas for formulating effective policies to help promote energy-saving, emission-reduction, and low-carbon sustainable development. Examples include the adjustment of industrial sectors' structure, the optimization of energy structure in inner departments and the improvement of inner industrial energy efficiency, which are designed from broader angles based on the different growth stages of tourism destinations.

The remainder of the paper is organized as follows: The next section reviews recent literature on the logarithmic mean Divisia index decomposition approach, the tourism area life cycle, and energy consumption and carbon emissions of the tourism industry. The third section provides a brief overview of the study area. Section 4 describes the methodology used in calculating energy consumption and CO_2 emissions that are directly or indirectly linked to tourism industry, the extended Kaya identities and LMDI method for carbon emissions, and data acquisition. The penultimate section identifies the influencing factors on carbon emissions for the tourism industry in destinations from the perspective of tourism area life cycle model. Finally, we discuss some related problems, conclusions and policy recommendations, and the limitations of this paper and future research directions.

2. Literature review

It is not the purpose of this section to provide a comprehensive review of literature, rather this section is to provide a foundation for what our study seeks to accomplish.

2.1. Logarithmic mean Divisia index decomposition approach

Decomposition analyses are techniques that analyze historical changes in economic, environmental, and other socio-economic indicators to trace the underlying factors that contribute to such changes (Sun, 2016). Various decomposition methods have been used to examine the underlying factors that affect the change of energy consumption, although none have been agreed on as the "best" since applications vary case by case (Liu and Li, 2007; Zhang et al., 2011). Two types of decomposition techniques are well developed and have widely been used: structural decomposition analysis (SDA) and index decomposition analysis (IDA) (Ang, 2004; Hoekstra and van den Bergh, 2003; Rose and Casler, 1996). SDA is an extension of the input-output (I-O) model based on the analytic framework of Leontief (1966). Rose and Casler (1996) review the development of SDA and its relationship with the fundamental principles of other alternative approaches.

IDA has also enjoyed much popularity. The IDA method can be further divided into two branches: one that uses the Laspeyres index and the other that is linked to the Divisia index. Ang (2004) compares various index decomposition analyses and suggests the logarithmic mean Divisia index (LMDI) method (Ang et al., 1998) as the preferred method due to its practical advantages. The decomposition formula is chosen in this study based on its ease of interpretation and properties of completeness, time reversal, and zero-value robustness (Ang, 2004; Hoekstra and van den Bergh, 2003).

The LMDI has been widely used in energy efficiency and environmental impact decomposition (Ang, 2005; Ang, and Zhang, 2000) and the study of the effects of decomposition of emission of CO_2 (Wang et al., 2005; Liu et al., 2007). It has been demonstrated to be the preferred choice based on its mature technology, numerous different forms, ease of calculation and absence of residual decomposition. Lin and Long (2016) employ the LMDI to explore the driving factors of carbon emission changes in China's chemical industry. LMDI method is applied to industrial CO_2 emissions and employment in 5 European Union countries (Kopidou et al., 2016). The LMDI method is also used to identify the factors that contribute to changes in CO_2 emissions for the Turkish economy (Tunç et al., 2009). Yang et al. (2016) analyze several measurement possibilities, present and develop a number of approaches based on the LMDI methodology to decompose changes in aggregate CO_2 emissions. Achour and Belloumi (2016) identify the driving factors and measure the corresponding contributions in transportation energy consumption over the period 1985–2014 for Tunisia using LMDI.

After a comprehensive comparison of different IDA methods, Ang (2004) recommends the multiplicative and additive LMDI-I method due to its theoretical foundation, adaptability, ease of use and result interpretations, and other desirable properties (Ang, 2004). This method has since been widely applied to the factor decomposition on carbon emissions in various industries (Ang, 2015; Cansino, et al., 2015) and different regions (Chong, et al., 2015; Robaina-Alves and Moutinho, 2014; Tan, et al., 2016). Liu et al., (2011) used LMDI to analyze the five factors affecting energy consumption and carbon dioxide emissions of the tourism industry over 1999–2004 in Chengdu city, China. They found that energy intensity, expenditure size and industry size are the most important drivers of emissions growth in tourism while the two other factors (energy share and consumption structure) do not have any substantial influence. Dai and Gao (2016) used LMDI to analyze the key factors that drove the chronicle changes in logistics energy consumption in China. Cansino et al. (2015) carried out a multisector analysis based on the LMDI-I method.

Some scholars have improved the method of LMDI to meet the research demand of energy consumption and carbon emissions. Chong et al. (2017) put forward an improved LMDI method to decompose regional energy consumption growth. Shao et al. (2016) extended the LMDI decomposition model by introducing three novel factors (R & D intensity, investment intensity, and R & D efficiency). Jiang et al., (2017) combined two-layer LMDI decomposition with Q-type hierarchical clustering to systematically evaluate the contributions of related drivers from 30 provinces to the growth of China's national carbon emissions.

2.2. The tourism area life cycle

The conceptual framework of the Tourism Area Life Cycle (TALC) has been frequently examined since it was first proposed by Butler in 1980. The TALC consists of a six-stage evolution of tourism, namely exploration, involvement, development, consolidation, stagnation, and post-stagnation (Butler, 1980). During the consolidation stage, the local economy will be dominated by tourism (Butler, 1980) and a few large-scale, corporate enterprises become the dominant economic participants (Tooman, 1997). Dibenedetto and Bojanic (1993) investigated the effects of both strategic and environmental factors on the TALC for Cypress Gardens. The application of the destination life cycle model adopts a case study approach to evaluate social welfare changes as tourism evolves over time (Tooman, 1997). Bao et al., (2006) discussed the application of the TALC model to tourism planning and development in China, particularly in the rejuvenation of tourism in the Danxia