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Review of accounting for carbon dioxide emissions from tourism at different spatial scales

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ABSTRACT

Carbon dioxide emission from tourism, as a focus of man-land relationship in tourism industry in the 21st century, is a vital index reflecting its effect on environment change. The article summarizes the contents of carbon dioxide emissions from tourism at different scales such as world, nation, region and unit. These results indicate that: (1) the accounting of the carbon dioxide emissions from tourism began from global and national scales at the end of the last century, then to regional and basic scales. (2) The Carbon dioxide emissions from tourism are mainly from high-developed countries and regions in terms of space, from the minority high-spending tourists in terms of behavior, from high-speed vehicles, high-grade accommodations and high-level tourism activities in terms of tourism element. The carbon dioxide emissions per capita of developing countries and regions are less than one tenth in developed countries and regions. As for the proportion of total emission, tourism transportation accounts for the largest, generally more than 65%, followed by accommodation, and the last is tourism activity. (3) Based on the systemic analysis of these coefficients of accounting carbon dioxide emissions in tourism, the paper indicates that there are progresses in the consistency of coefficients at global scale and diversity of coefficients at national, regional and unit scales, while the coefficients of developed countries and regions are higher than those of developing countries and regions. In addition, some recommendations including coefficients have given to China.

1. Introduction

In recent years, global warming is not only an environmental issue but also one of the biggest challenges to the international community. In the 2003 Djerba Declaration, the World Tourism Organization acknowledged the complex interactions between tourism and climate change. Tourism impacts climate change via the use of fossil fuels and greenhouse gas emissions. Carbon dioxide emissions from tourism, as a focus of man-land relationship in tourism industry in the 21st century, is a vital index reflecting its effects on environment change. Tourism is one of the largest industries in the world [1]. It is estimated to contribute about 5% of global CO_2 emissions in 2005, and if effective measures can not be taken to reduce emissions, the proportion will reach up to 7.5% in 2035 [2]. If tourism industry was a country, the rank of its percentage of total emission is No. 5 following United States, China, European Union and Russia [2]. Current tourism development is unsustainable with respect to climate change as its emissions are projected to grow at over 3% per year [3]. It is contrary for the direction of global energy saving and emission reduction in future. With the increasingly serious problem of global climate and energy, carbon reduction in tourism has become an urgent research topic to achieve sustainable tourism development in global.

Before the analysis of carbon reduction in tourism, the researchers first investigated the relationship between tourist and energy, which was quite popular in the beginning of the modern tourism research. As early as the first publication of《Annals of Tourism Research》in 1974, LeGrand [4] and Gidwani [5] respectively discussed the energy impacts on tourism from the macro and strategic level. In 1995, "Agenda 21 for the travel & tourism industry" issued by the World Travel and Tourism Council, the WTO and the Earth Council addressed energy consumption as a key focus area [6]. This indicates the start of research on energy consumption and carbon dioxide emissions from tourism. In 2000, Gössling [7] proposed the idea and framework of accounting carbon dioxide emissions for tourism industry firstly, and the author calculated emissions of a typical travel from developed to developing countries by air. Then, based on the study of energy consumption in tourism from Becken's types researches [8,9], and so on, Gössling [10] first built an integrated accounting system of carbon emissions from tourism in 2002, and the system involved in tourism transportation, accommodation and tourism activity. Over the past decade, an increasing number

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of research publications of accounting carbon emissions from tourism emerged, which had been a focus of tourism research. The analysis of emissions from tourism can facilitate to find out the source of carbon dioxide emissions, also to establish the foundation which is "from the source to the sink" such as the carbon source, carbon tax, carbon trading and carbon sink responding to global climate change.

In 2011, Wu & Shi [11] discussed the accounting system for emissions from tourism in China first. Some scholars [12,13] made some comprehensive and instructive summarization about the progress of emissions including accounting from tourism industry, but for the difficult task of energy saving and emission reduction, the key issue, accounting for emissions from tourism, need to be studied continually, systematically and thoroughly. Decomposing the emissions should be done to achieve energy saving and emission reduction of national strategic objective in tourism. To increase measuring scientificalness and achieve sustainable tourism development, this article, at the four scales including world, nation, region and unit, from the two perspectives of tourism industry and single tourism element, try to summarize the progress of accounting emissions from tourism.

2. Content

2.1. Global scale

Tourism was not a traditional sector in the System of National Accounts and as a result no country possesses comprehensive national statistics on the energy demand or emissions specifically resulting from tourism [14]. This will increase the difficulty of accounting emissions for tourism. At the beginning of this century, the study of accounting emissions for global tourism industry stepped into the start-up phase, and some achievements had been made. According to Gössling's results, tourism might be responsible for the emissions of 1400 Mt of CO_{2-e} (in 2001), and it may contribute 5.3% to global CO_{2-e} emissions [10]. Tourism might be responsible for the emissions of 1307 Mt of CO_2, indicating that tourism's contribution to global CO_2 emissions was estimated range between 5% and 14% (in 2005) [2]. Peeters found that total 2005 CO_2 emissions for tourism (thus including same-day visitors) was estimated at 1302 Mt, which was almost 4.95% of global emissions [3]. The amounts of total emission and the proportions in the three preceding articles are consistent, which means that the accounting research has made great consensus. Some relevant research objects are continents, for example, Antarctic tourism accounted for 1.5% of the global tourism emissions [15]. Besides the evaluation of the status quo, some studies also simulated and predicted the future scenario of the global tourism carbon emissions [2,16–18].

The accounting of single element confined only to aviation tourism, and other forms of transportation, accommodations and tourism activities were almost involved in. The worldwide tourism emissions were distributed mainly to international air travel [7,19,20]. Aviation was responsible for 1.6–2.2% of global anthropogenic emissions of CO_2, in other words, air traffic was responsible for 13% of the CO_2 emissions associated with global transportation, with tourism accounting for at least half of this value (6.5%) [7]. The industrialized countries, which constituted only 15% of the world's population, accounted for 82% of the global leisure-related transport [10]. In developing countries, about 24% of the fossil fuels could be attributed to the destination's share, and a typical journey to a developing country might entail per caput emissions of 3385 kg CO_{2-e}, which was not far short of the global average of 4000 kg of CO_2 emitted annually per capita [7]. To solve the issue that the traditional travel carbon emissions do not include same-day visitors, by merging European passenger transport demand data with international tourism data, created a new MuSTT (Multi-Stakeholder for Sustainable Tourism & Transport) model, Peeters estimated the aviation tourism greenhouse gas accounting for 7% of all European emissions in 2000, and forecasted that the proportion would increase to 15% by 2020 [21,22].

2.2. National scale

Over the past decade, the research of accounting emissions at national scale have yielded fruitful results through many researchers' efforts, but the cases are mainly developed countries within Europe and the United States, rarely referring to developing countries. Based on the authors' a series of previous researches [8,9,23,24], Becken estimated 1549 kilotonnes of carbon dioxide emitted for the tourism sector for the reference year of 2000 within New Zealand using the bottom-up analysis, and the top-down analysis demonstrated the direct CO_2 emissions and indirect effects were 1438 kilotonnes and 1251 kilotonnes severally in 1997/98 for the tourism sector [14]. The two methods were also applied for Switzerland [25]. Because the system boundaries of the two methods are different, their results are also diverse. Using the production approach, total (direct plus indirect) GHG emissions in 2003–2004 were estimated to be 54.4 Mt within Australia (total direct GHG emissions were 26.3 Mt, and total indirect GHG emissions were 28.1 Mt), but using expenditure-based approach, the results were 61.5 Mt (total direct GHG emissions to be 29.5 Mt and total indirect GHG emissions to be 32.0 Mt) [26]. In Seychelles, more than 97% of the energy footprint was a result of air travel (2002) [27]. In Germany, the 14% of the longer vacation journeys to destinations outside Europe were responsible for almost 55% of the emission [10], just as Dubois says: "Very long distance trips and air transport are identified as major problems, caused by a small group of frequent travelers" [28]. Wu & Shi [11] estimated the total amount of carbon emissions for the tourism sector within China in 2008, and the conclusion was deduced that leisure travel emissions was 3.3 times sight-seeing.

The single element measuring focused on the tourist traffic, but accommodation and tourism activities were few because of the complexities of themselves. In 2002, the research of analyzing international tourist flows to estimate carbon dioxide emissions associated with air travel appeared [23], then many scholars tended to choose island countries as their research objects. The CO_{2-e} emissions produced by the air travel of international visitors to New Zealand and for New Zealand residents traveling overseas in 2005 were calculated to be 7893 Gg and 3948 Gg respectively, and the authors also showed that no single offsetting scheme targeted inside the country appeared physically and/or politically realistic [29]. The emission factor for individual journeys by cruise ships to or from New Zealand in 2007 weighted mean of 390 g CO_2 per pkm [30]. After accounting emissions from intra-European cross-nation traffic holidays, Dickinson highlighted "While slow travelers are readily able to embrace the benefits of a lower carbon footprint this is not necessarily the main motivation. Non-slow travelers and a large proportion of those engaging with slow travel are keen to justify further tourist travel" [31]. In Fiji, resorts accounted for 86% of the total emission of the lodging industry [32]. Where tourists engage in air-based recreational activities, such activities could be expected to be relatively significant as a total proportion of the emissions resulting from a trip, except trips involved in intercontinental travel [20].

2.3. Regional scale

Between national and unitary scale, regional scale is equivalent to China's province and city and large areas such as the Yangtze River Delta. The comprehensive studies were lesser at this scale, but, after the appearance of the report "Climate change and tourism, Responding to global challenges" issued by UNWTO–UNEP–WMO