Carbon Footprint

Subjects: Environmental Sciences | Hospitality, Leisure, Sport & Tourism

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A carbon footprint is “a measure of the exclusive total amount of carbon dioxide emissions that is directly and indirectly caused by the activities of an individual or is accumulated over the life stages of a product”.

airport surface access | tourism carbon footprint | tourism sustainability | mobility | outbound tourism

1. Introduction

There is wide concern about the emissions associated with tourism and, consequently, increasing interest in reducing the carbon footprint derived from tourism activities [1], which account for 8% of global emissions [2]. These concerns are confirmed in the report released by UNWTO and the International Transport Forum [3], which puts the focus on transport related to tourism.

A tourism carbon footprint refers to the measurement of the emissions associated with a tourism activity [4][5]. Reflecting the increasing interest in this topic, a search in the Scopus database shows that the term “carbon footprint” first appeared in 2002 with just one item and has increased exponentially over the years, and in 2018, 1857 items were found. The analysis of emissions produced by tourism is a part of the literature on tourism and climate change, which, in fact, has evolved into a knowledge domain [6].

The relevance of carbon footprint comes from the increasing awareness of policymakers regarding responsible consumption resulting in the growing tendency toward environmentally friendly holidays [7][8]. This is because tourism activities make extensive use of resources (transport, lighting, air-conditioning, heating, etc.) resulting in tourism destinations producing higher emissions than other areas [9].

Calculations of tourism carbon footprint have become crucial, as they can help quantify and determine the causes of emissions [8][10], and, thus, they can support environmental policymaking. Currently, such calculations follow different approaches, particularly the production accounting principle (PAP) or the consumption accounting principle (CAP) [11][12]. However, there is a need to refine carbon footprint calculations to improve the accuracy of these measurements [13]. Ground access has also been a topic of interest from the perspective of airport management and sustainability [14]. However, in the case of leisure travel and tourism trips, it has been a somewhat neglected issue.

Land transportation of tourists to their destinations contributes 32% of the emissions associated with tourism [15]. Some studies have centred on rental cars instead of private motor vehicles [4][16]. One notable exception that did focus on analysing private vehicle emissions in tourism was based on estimations from the Tourism Satellite Account (TSA) and household consumption patterns in Australia [17]. Our research, by contrast, is focused on the emissions associated with surface access to airports as part of an outbound tourism trip (i.e., tourists' journeys from their homes to the airports and vice versa). The issue of airport access has been analysed by Budd, Ison and Ryley [18], who observed that these trips depended heavily on private transport with the corresponding concerns regarding congestion and environmental impacts. Airport ground access has also been analysed from the point of view of transport mode choice [19][20]. Sustainability policies for airport access have been discussed [21], as well as estimations of the carbon dioxide emissions of ground access to Manchester Airport [22]. Finally, the environmental implications of transport modes and the advantages of accessing airports by public transport have also been addressed [23].

2. Carbon Footprint and Its Relation to Transportation, Tourism and Airports

As one of the main worldwide economic activities, tourism has the capacity to enhance the well-being of populations [24][25]. Indeed, it contributed 10.4% to global GDP including direct, indirect and induced impacts [26]. In terms of environmental impact, overall tourism activity contributes 8% to total global CO_2 emissions [2], and of these global emissions up to 75% is estimated to be generated by transportation [15]. Tourism is generally an intensive activity in terms of resource use (e.g., transportation to long haul destinations, high consumption of resources in hotels, etc.). In fact, Koçac et al. [27] found, for a panel including the main destination countries, that tourism arrivals have an increasing effect on national CO_2 emissions because of their dependence on transportation. This issue has awakened interest among consumers, transport operators and destination managers and is changing the way tourists travel and plan their holidays, as well as the way destinations are managed and promoted.

GHG emissions are at the core of the causes of climate change and, therefore, there is increasing interest in reducing these emissions. Several methods have been used to analyse the carbon footprint related to transport [28]. However, when we deal with tourism trips, there are two main approaches to account for tourism carbon footprint: The production accounting principle (PAP) and the consumption accounting principle (CAP). Whereas PAP considers a destination responsible for the emissions derived from local production within the geographical boundaries of a destination (regardless of whether they are consumed within the region or exported), CAP considers end users' products and services consumed (regardless of whether they have been produced within the region or imported). In this regard, resulting from each of these mentioned principles, there are two main approaches to calculate tourism carbon footprints: Bottom-up analysis or top-down analysis [4], sometimes called expenditure-based or production-based, respectively [17]. Both approaches provide very useful knowledge about tourism carbon footprints and improve the tourism sector's sustainability, as they help quantify the impact of an activity [10]. These two main approaches can be extended with two additional accounting approaches [29]. These

additional approaches are the Kyoto Protocol Framework, very similar to the PAP, and the Tourism Satellite Account Protocol, which assigns emissions to the country where the tourism activities occur.

The PAP approach used for the study of carbon footprints considers a region responsible for the emissions derived from local production within its geographical boundaries [4]. This is the principle that underlies the Kyoto Protocol in order to reduce nations' emissions. From the PAP point of view, importance is placed on the production of goods and services regardless of whether they are consumed within the region or exported. With regards to the tourism carbon footprint of a given tourism destination, the PAP measure considers emissions associated with domestic tourism (i.e., residents of a given tourism destination visiting that same tourism destination), inbound tourism (i.e., non-residents of a given tourism destination visiting that tourism destination) and transactions of outbound tourism that take place before departing (i.e., residents of a given tourism destination buying package tours in travel agencies to visit foreign tourism destinations). PAP does not take into consideration emissions related to the rest of activities associated with outbound tourism and imports. This top-down (or production-based) analysis allows the assessment of tourism as a sector within the wider economy [4].

Alternatively, the CAP places the responsibility of emissions on consumers' consumption patterns without considering the origin of goods and services consumed [29]. In this sense, the tourism carbon footprint of a region using the CAP measure considers emissions associated with domestic tourism (i.e., residents of a given tourism destination visiting that tourism destination) and outbound tourism (i.e., residents of a given tourism destination visiting another tourism destination). Under the CAP measure, all emissions associated with inbound tourism that are considered imports are excluded. CAP provides detailed information on energy end-uses and the main drivers of emissions. Thus, CAP focuses on tourists' behaviour patterns when they travel [10]. It considers emissions associated with expenditure in a country by foreign and domestic tourists, emissions from air travel by tourists and emissions by outbound residents within their own country prior to or following flights (e.g., internal transport, hotels, etc.). It excludes emissions of outbound flights and outbound tourists outside their country.

Regardless of the approach chosen, there is no universal and accepted method to be followed when calculating the tourism carbon footprint. Moreover, researchers are still refining proposals to improve this measure. For example, Cadarso et al. [13] identified the importance of the emissions associated with tourism investments and refine the calculation of the tourism carbon footprint by incorporating investment emissions. Consequently, there is an explicit call for improving the accuracy of the measurement of the emissions derived from tourism transport, excluding accommodation. As a result, the focus is placed in this study on a specific part of tourists' trips, which has often been neglected in studies to date.

Most of tourism's carbon footprint comes from transportation, and specifically from aircraft modes of transportation [30]. Indeed, 75% of tourism emissions are connected to means of transportation [15]. However, there has been much attention placed on the fact that about 40% of total tourism emissions comes from air transportation yet neglects the fact that 32% of this amount comes from car modes of transport. Indeed, one of the main recommendations in order to mitigate emissions suggests a shift from both aircrafts and cars to other modes of transportation [15]. However, in the case of remote islands, it is difficult from an eco-efficiency point of view to

reduce impacts concerning the use of aeroplanes. The main reason is that, geographically speaking, potential markets need to access the destination using air transport, and it would be unrealistic to switch to other transportation modes. In addition, tourists also generate CO_2 emissions when travelling to the airport, thus strategies can be implemented to try to reduce these emissions. Therefore, the focus of this study is on the estimation of the carbon footprint generated by different means of transport to arrive at the airports of origin.

Fuel consumption by land transport used by tourists during their trips (at destination and origin) produces CO_2 emissions. In fact, it generates 32% of total transportation CO_2 emissions according to UNWTO, UNEP and WMO [15], while all kinds of transportation generate 23% of total CO_2 emissions [3]. The focus on the calculation of the carbon footprint derived from the use of land transportation has often been placed on rental cars used within tourism destinations [4][16], and the access to destinations by car [31]. Nevertheless, little attention has been given to tourism-related domestic mobility to airports in intermodal land–air traffic, as we show in this paper. In this sense, Dwyer et al. [17] calculated the GHG emissions of motor vehicles, other than rental cars, with estimations from the TSA derived from household consumption. Their analysis considered emissions of Australian travel agencies and tour operators, accommodation, restaurants, private car use, transport to the destination and other connected industries to calculate the tourism carbon footprint of Australia from a PAP and a CAP point of view. They considered emissions from tourism-related private motor vehicle use to be 20% of the production-based total tourism carbon footprint, but in this case, the private car was the main mode of tourist transport.

To develop a more accurate measure of tourism GHG emissions from private motor vehicle use for tourism purposes, there is still a need for estimations regarding the use of these vehicles in tourists' places of residence. Specifically, the impact of tourists' journeys from their homes to the airports should be analysed. This study argues that this specific part of people's holidays also contributes to the emissions of the tourism industry and, therefore, its assessment is necessary in order to increase the accuracy of the measurement of tourism carbon footprints.

In the case of airports, there are a number of studies on ground access and/or sustainability, but none are related specifically to tourism. In the systematic literature review on airport sustainability conducted by Greer et al. [32], after analysing 108 contributions from 2009 to 2019, they showed that the topic of ground access has not been a central concern in studies on airport sustainability. However, there are specific contributions on ground access to airports that have been reviewed by Pasha and Hickman [33], who concluded that there is a need for research on passengers' mode choice to improve sustainable transport planning. There are also several papers that include surveys on airport access aimed at developing multinomial models to understand passenger choices. The contribution of Pasha [20] provides a model of transport mode choice for Brisbane airport. Moreover, interest in access to airports has been recognized within transport studies, and even the National Academies of Sciences, Engineering and Medicine of the United States has published a report on worldwide access to airports [34] that provides a global review of the topic.

The methodological challenges related to measuring airport ground access and footprints have also been addressed by several papers. Postorino and Mantecchini [35] consider that access to the airport must be considered as a piece in a larger puzzle. In fact, the methodology proposed by these authors is focused on the

carbon footprint of a transport node, the airport, considering ground access, terminal and landing and take-off operations. Other authors, such as Bud et al. [36], Ryley et al. [21] or Miyoshi and Mason [22] provide very insightful methodological and empirical approaches to airport access and sustainability. This literature mainly focuses on a production accounting approach, based on the airport. Nevertheless, there is still a gap in the literature related to tourist mobility and airport ground access following a consumer accounting perspective, where the research focus is on the tourist throughout the travel cycle, beyond just a transport node, like an airport. The literature shows that aeroplane emissions seem to have taken precedence over those derived from ground access, but there is an opportunity for managing tourism emissions by better measuring, managing and planning of ground access to airports [36].

References

1. Sun, Y.-Y. Global Value Chains and National Tourism Carbon Competitiveness. J. Travel Res. 2018, 58, 808–823.
2. Lenzen, M.; Sun, Y.-Y.; Faturay, F.; Ting, Y.-P.; Geschke, A.; Malik, A. The Carbon Footprint of Global Tourism. Nat. Clim. Chang. 2018, 8, 522–528.
3. World Tourism Organization; International Transport Forum. Transport-Related CO2 Emissions of the Tourism Sector: Modelling Results; UNWTO: Madrid, Spain, 2019; ISBN 978-92-844-1666-0.
4. Sun, Y.-Y. A Framework to Account for the Tourism Carbon Footprint at Island Destinations. Tour. Manag. 2014, 45, 16–27.
5. Tang, M.; Ge, S. Accounting for Carbon Emissions Associated with Tourism-Related Consumption —Meiwei Tang, Shouzhong Ge, 2018. Tour. Econ. 2018, 24, 510–525.
6. Becken, S. A Review of Tourism and Climate Change as an Evolving Knowledge Domain. Tour. Manag. Perspect. 2013, 6, 53–62.
7. Mehmetoglu, M. Accurately Identifying and Comparing Sustainable Tourists, Nature-Based Tourists, and Ecotourists on the Basis of Their Environmental Concerns. Int. J. Hosp. Tour. Adm. 2010, 11, 171–199.
8. Sun, Y.-Y.; Pratt, S. The Economic, Carbon Emission, and Water Impacts of Chinese Visitors to Taiwan: Eco-Efficiency and Impact Evaluation. J. Travel Res. 2014, 53, 733–746.
9. Kelly, J.; Williams, P.W. Modelling Tourism Destination Energy Consumption and Greenhouse Gas Emissions: Whistler, BC, Canada. J. Sustain. Tour. 2007, 15, 67–90.
10. Becken, S.; Patterson, M. Measuring National Carbon Dioxide Emissions from Tourism as a Key Step Towards Achieving Sustainable Tourism. J. Sustain. Tour. 2006, 14, 323–338.
11. Turner, K.; Munday, M.; McGregor, P.; Swales, K. How Responsible Is a Region for Its Carbon Emissions? An Empirical General Equilibrium Analysis. Ecol. Econ. 2012, 76, 70–78.

12. Zhong, Y.; Shi, S.; Li, S.; Luo, F.; Luo, W.; Xiao, Q. Empirical Research on Construction of a Measurement Framework for Tourism Carbon Emission in China. Chin. J. Popul. Resour. Environ. 2015, 13, 240–249.
13. Cadarso, M.Á.; Gómez, N.; López, L.A.; Tobarra, M.Á. Calculating Tourism's Carbon Footprint: Measuring the Impact of Investments. J. Clean. Prod. 2016, 111, 529–537.
14. National Academies of Sciences, Engineering, and Medicine. Airport Ground Access Mode Choice Models; The National Academies Press: Washington, DC, USA, 2008; p. 23106. ISBN 978-0-309-42034-1.
15. World Tourism Organization; UNEP. Climate Change and Tourism: Responding to Global Challenges; World Tourism Organization: Madrid, Spain, 2008; ISBN 978-92-844-1234-1.
16. Gössling, S.; Buckley, R. Carbon Labels in Tourism: Persuasive Communication? J. Clean. Prod. 2016, 111, 358–369.
17. Dwyer, L.; Forsyth, P.; Spurr, R.; Hoque, S. Estimating the Carbon Footprint of Australian Tourism. J. Sustain. Tour. 2010, 18, 355–376.
18. Budd, T.; Ison, S.; Ryley, T. Airport Surface Access in the UK: A Management Perspective. Res. Transp. Bus. Manag. 2011, 1, 109–117.
19. Akar, G. Ground Access to Airports, Case Study: Port Columbus International Airport. J. Air Transp. Manag. 2013, 30, 25–31.
20. Pasha, M.M.; Hickman, M.D.; Prato, C.G. Modeling Mode Choice of Air Passengers' Ground Access to Brisbane Airport. Transp. Res. Rec. 2020, 2674, 756–767.
21. Ryley, T.; Elmirghani, J.; Budd, T.; Miyoshi, C.; Mason, K.; Moxon, R.; Ahmed, I.; Qazi, B.; Zanni, A. Sustainable Development and Airport Surface Access: The Role of Technological Innovation and Behavioral Change. Sustainability 2013, 5, 1617–1631.
22. Miyoshi, C.; Mason, K.J. The Damage Cost of Carbon Dioxide Emissions Produced by Passengers on Airport Surface Access: The Case of Manchester Airport. J. Transp. Geogr. 2013, 28, 137–143.
23. Budd, L.; Ison, S.; Budd, T. Improving the Environmental Performance of Airport Surface Access in the UK: The Role of Public Transport. Res. Transp. Econ. 2016, 59, 185–195.
24. Buhalis, D. Marketing the Competitive Destination of the Future. Tour. Manag. 2000, 21, 97–116.
25. Dwyer, L.; Kim, C. Destination Competitiveness: Determinants and Indicators. Curr. Issues Tour. 2003, 6, 369–414.
26. World Travel & Tourism Council. Benchmarking Research Trends 2019. How Does Travel & Tourism Compare to Other Sectors? World Travel & Tourism Council: London, UK, 2019.

27. Koçak, E.; Ulucak, R.; Ulucak, Z.Ş. The Impact of Tourism Developments on CO2 Emissions: An Advanced Panel Data Estimation. Tour. Manag. Perspect. 2020, 33, 100611.
28. Auvinen, H.; Clausen, U.; Davydenko, I.; Diekmann, D.; Ehrler, V.; Lewis, A. Calculating Emissions along Supply Chains—Towards the Global Methodological Harmonisation. Res. Transp. Bus. Manag. 2014, 12, 41–46.
29. Sun, Y.-Y.; Lenzen, M.; Liu, B.-J. The National Tourism Carbon Emission Inventory: Its Importance, Applications and Allocation Frameworks. J. Sustain. Tour. 2019, 27, 360–379.
30. Peeters, P.; Schouten, F. Reducing the Ecological Footprint of Inbound Tourism and Transport to Amsterdam. J. Sustain. Tour. 2006, 14, 157–171.
31. UNWTO. International Tourism Highlights, 2020 ed.; UNWTO: Madrid, Spain, 2021; ISBN 978-92-844-2245-6.
32. Greer, F.; Rakas, J.; Horvath, A. Airports and Environmental Sustainability: A Comprehensive Review. Environ. Res. Lett. 2020, 15, 103007.
33. Pasha, M.M.; Hickman, M. Airport Ground Accessibility: Review and Assessment. In Proceedings of the 38th Australasian Transport Research Forum (ATRF), Melbourne, VIC, Australia, 16–18 November 2016.
34. National Academies of Sciences, Engineering, and Medicine. Ground Access to Major Airports by Public Transportation; ACRP report; Transportation Research Board: Washington, DC, USA, 2008; ISBN 978-0-309-09941-7.
35. Postorino, M.N.; Mantecchini, L. A Transport Carbon Footprint Methodology to Assess Airport Carbon Emissions. J. Air Transp. Manag. 2014, 37, 76–86.
36. Budd, T.; Ryley, T.; Ison, S. Airport Ground Access and Private Car Use: A Segmentation Analysis. J. Transp. Geogr. 2014, 36, 106–115.