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Methodological Pathways for Measuring Tourism Carbon Footprint: A Framework-Oriented Systematic Review

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Abstract

Tourism is increasingly acknowledged as a major driver of global greenhouse gas emissions. However, efforts to accurately assess its carbon footprint remain hindered by methodological inconsistencies and a reliance on fragmented case studies. This study undertakes a systematic review of 166 peer-reviewed research papers to critically evaluate prevailing approaches for quantifying tourism-related carbon emissions. Leveraging a structured framework encompassing four analytical dimensions and fourteen parameters, the analysis reveals that energy consumption and emission factors constitute the core elements of prevailing models. Nevertheless, only half of the papers account for indirect emissions, and the majority of studies are confined to national or subnational scales, offering limited insight into destination-specific impacts. This methodological heterogeneity undermines the comparability of results and constrains their utility in formulating coherent, evidence-based climate policies. By synthesising these diverse approaches, this review identifies critical methodological gaps, advocates for the harmonisation of best practices, and delineates a roadmap for more robust and context-sensitive carbon accounting within the tourism industry. The insights gained are practical for researchers and policymakers seeking to align tourism development with climate mitigation objectives, thereby fostering greater transparency and efficacy in carbon governance within the sector. Ultimately, such initiatives aim to fortify the sector's contribution to global decarbonisation efforts.

Keywords: carbon footprint; greenhouse gas emissions; carbon emissions; calculation methodology; climate change; carbon mitigation strategies

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1. Introduction

Drawing upon Hall's [1,2] estimate and the anticipated impact of climate change globally, it seems that tourism will contribute to 5% of the 250,000 annual deaths caused by climate change between 2030 and 2050, leading to 12,500 deaths per year and with costs exceeding USD 6 billion [3,4]. This is due to heightened occurrences of heatwaves, wildfires, or droughts, which vulnerable territories and societies are already experiencing [4,5], impacting tourism activities and businesses in these destinations [6–8]. Tourism, reliant on fossil fuels, notably contributes to climate change, generating approximately 8.8% of global greenhouse gas emissions [9]. In turn, climate change impacts tourism destinations, consumption habits, and investments in the sector [8,10–12].

UN Tourism and the European Commission have underscored the imperative of reinforcing climate action and adaptation strategies to ensure the long-term viability of the

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tourism sector [13,14]. A rigorous approach to managing the industry's carbon footprint is a pivotal step toward enhancing resilience and proactively implementing measures in response to the escalating climate emergency.

Unlike other environmental indicators, such as sea-level rise [15], the tourism carbon footprint (TCF) is a significant environmental measure that affects all ecosystems and tourism destinations. TCF comprises both the direct emissions generated by tourism-related activities—such as fuel combustion for transportation—and the indirect emissions arising from tourists' consumption of goods and services, including accommodation and food, among others [16]. Thus, the Tourism Panel on Climate Change (TPCC) indicates that the carbon footprint calculation and assessment are paramount to fostering decarbonisation strategies [12].

In this sense, tourism and climate change research has grown significantly, driven by increasing awareness, evidence, and concern about tourism's dual role in global environmental change—as both a source of emissions and a sector vulnerable to its consequences. However, the academic literature on examining and managing the impact of tourism on climate change is notably sectoral and fragmented due to the multitude of specific case studies conducted over recent decades [17]. This hinders the identification of adequate calculation methodologies and scopes [18].

Additionally, despite this expanding knowledge base, actual practices in tourism have barely shifted, as tourism destinations are increasing their climate vulnerability [19] and investments still favour carbon-intensive technologies and market segments [17]. This contradiction—"knowing more but losing more" [20]—underscores the challenge the industry faces as it attempts to adapt to an uncertain future.

This noticeable gap between theoretical frameworks and actual progress in decarbonisation calls for a closer examination of the kind of knowledge being generated and the methodological approaches applied in these investigations. It also raises questions about how scientific insights are integrated into tourism stakeholders' strategies for addressing climate-related risks and shaping effective policies [17].

Liu et al. [21] and Sun et al. [22] represent studies that have explored this research area using relatively simplified approaches, such as carbon footprint estimations based on input–output tables. In comparison, researchers like Casals-Miralles et al. [23] have adopted more comprehensive methods that better reflect the complexity inherent in this field. Nevertheless, most of these investigations primarily seek to juxtapose findings across the examined cases, often overlooking the fact that the methodological frameworks adopted in each instance constitute the principal determinants of the results obtained.

Thus, a comprehensive examination of the diverse methodologies employed to accurately calculate TCF is still missing. Consequently, this study seeks to address this gap by critically evaluating and comparing existing approaches to TCF measurement—with particular emphasis on tourism destinations and key components of the sector, including transportation, accommodation, and package holidays—in order to discern the prevailing trajectories and inherent biases within TCF research, thereby fostering more rigorous inquiry and expediting the transition of the sector toward decarbonisation.

The subsequent section outlines the employed methodological framework used throughout this study and it presents the parameters on which this state-of-the-art is developed. After elucidating the applied method, we present and evaluate the findings from the systematic review for each analysed variable. Finally, we discuss the implications of the study—paying special attention to the current deficiencies of destination TCF calculation approaches—and provide concluding remarks.

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2. Research Design and Methodology

This section describes a protocol for systematically reviewing published academic literature on calculating the TCF. A systematic literature review was conducted following the PRISMA methodology to secure transparency and completeness, as represented in Figure 1. This approach, structured around three core stages, begins by gathering all studies that may be relevant (identification). These initial findings are then refined by excluding records that do not meet the predefined eligibility criteria (screening), ultimately resulting in the final set of studies selected for analysis (inclusion) [24].

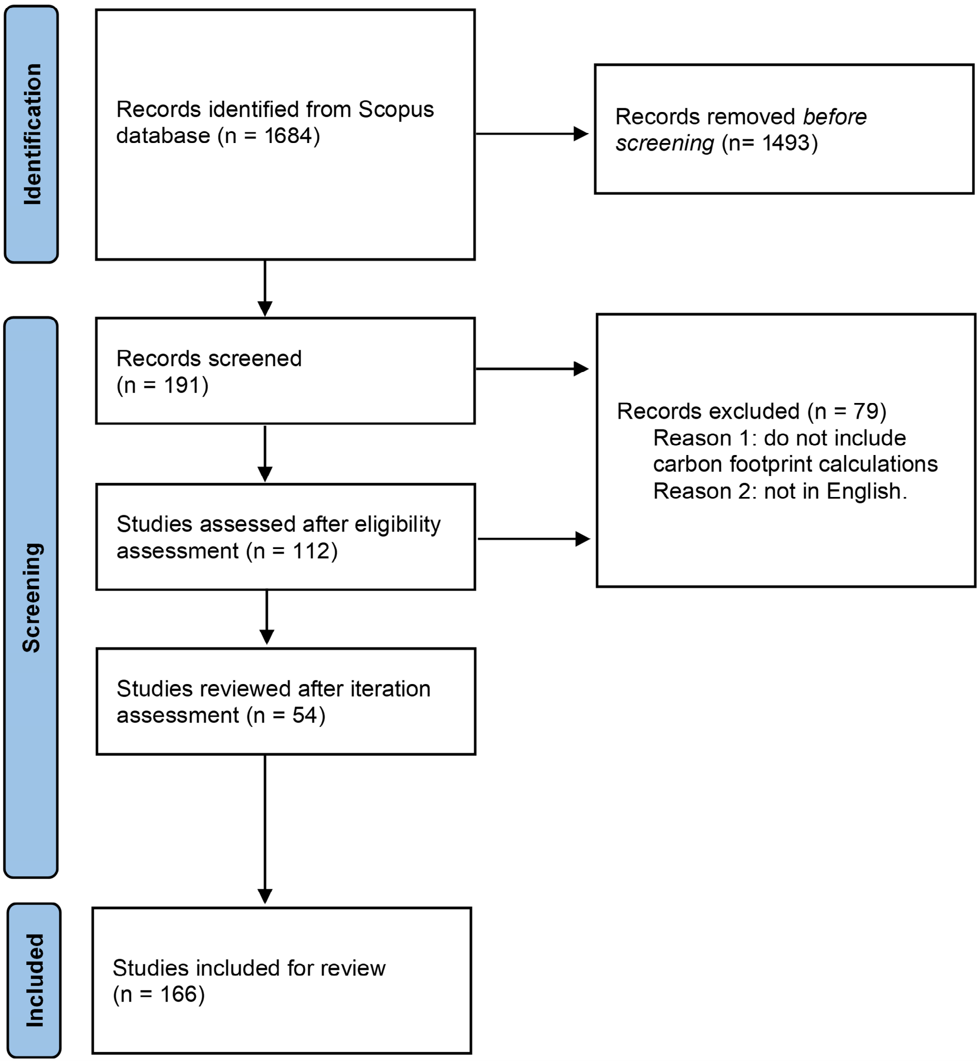

Figure 1. PRISMA diagram. Source: Page et al. [25], licenced under https://creativecommons.org/licenses/by/4.0/#ref-appropriate-credit (accessed on 11 January 2026).

- Identification process: This study focuses on peer-reviewed academic literature that estimates the carbon footprint of tourism, specifically carbon dioxide (CO_2) or greenhouse gas emissions. To ensure access to globally relevant studies and maintain reproducibility and methodological consistency, only English-language journals published up to 30 June 2025, are included. While some key works [25,26] may be excluded, their significance is acknowledged. Technical reports lacking detailed calculation methods, as noted by Loehr and Becken [17], are also excluded. Furthermore, discussions of ecological footprints and other environmental impacts are not part of this analysis.
  Before conducting the systematic search for TCF articles, common keywords were identified from an initial set of TCF-related papers. To maintain methodological rigour

and consistency, Scopus served as the primary database for compiling papers. The subsequent search has been conducted within Scopus: "tourism" AND "carbon footprint" OR "energy consumption" OR "greenhouse gas emissions" OR "GHG emissions". The time-stopping rule set for this analysis was July 2025, leading to 1684 results for the query (Table 1).

- Screening process: The abstracts of the records obtained in the first search excluded 1493 research studies that did not meet the inclusion requirements, and 191 were further analysed.
    - Eligibility assessment: 79 papers were discarded because they did not meet all the initial criteria (*n* = 112). This is primarily because the term 'calculation' was not part of the keywords used for our search, a result of a frequency analysis of the most frequently used keywords in a first selection of papers.
    - Iteration: The Scopus database search has been supplemented with a backward search. After scanning the texts and bibliographies of 112 papers, 54 additional works were identified in the final round.
- Final inclusion: This made 166 academic papers that were systematically analysed, all of which can be found in the Supplementary Materials File.

Table 1. Relevant parameters for literature identification.

Considered Parameter	Constraint
Database consulted	Scopus
Search strings	"tourism" AND "carbon footprint" OR "energy consumption" OR "greenhouse gas emissions" OR "GHG emissions"
Search fields	Title/abstract/keywords
Temporal boundaries	Published before 1 July 2025
Study types and status	Published in peer-reviewed academic journals
Content constraints	Must include self-conducted TCF calculations.

Own elaboration.

Tourism Carbon Footprint Analytical Framework (TCFAF)

The systematic literature review enabled the identification of key parameters essential for calculating the TCF. Through a comprehensive content analysis of the collected studies, critical factors influencing reported outcomes—such as methodological choices, study focus, and defined research boundaries—were examined. By systematically organising the information presented in seminal works [23–26], 14 shared parameters were identified, providing a consolidated overview of the current state of knowledge.

Building on Gössling et al.'s [27] variable grouping, these parameters are categorised into four dimensions (Ds), namely *Framing Impacts of Analysis* (D1), *Calculation Methods* (D2), *Analytical Scope and Boundaries* (D3) and *Target of Assessment* (D4). The calculation methods, research scopes, and scales are crucial to this analysis, forming its foundation and greatly influencing the results. The choice of calculation method directly affects the limitations of outcomes. By selecting the most suitable carbon impact quantification approach aligned with the paper's objectives, the outcomes can be significantly strengthened, thereby improving the overall quality and impact of the research.

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D1. Framing Impacts of Analysis

P1. Research objectives: This parameter classifies papers based on their objectives, such as calculating the tourism footprint, identifying influencing factors, analysing future implications, or studying the relationship between the footprint and economic growth [28,29]. The authors perceive these objectives, which are not mutually exclusive, as progressive, with the calculation of the carbon footprint serving as the fundamental criterion for inclusion in this paper. Consequently, items identified as influencing factors also encompass the calculation of the carbon footprint.

P2. Types of impact addressed: Assuming that sustainable tourism is understood based on the triple bottom line concept [30], it is pertinent to highlight investigations that either consider or estimate environmental, social, and economic impacts [31]. This parameter complements P1 by revealing the authors' research priorities, which may shape their interpretation of tourism's sustainable development—whether aligned with a weak or strong sustainability paradigm [32].

P3. Scope of emissions: Liu et al. [33] found that TCF studies initially emphasised the direct impacts of tourism activities or emissions. Subsequently, a shift to 'total calculation models,' encompassing direct and indirect emissions, has been observed [34]. This parameter categorises selected papers to validate this trend by examining the scope of emissions, namely direct or indirect [16,35]. Per the Greenhouse Gases (GHG) Protocol, direct emissions (Scope 1) result from controlled energy sources, while indirect emissions involve purchased energy (Scope 2) and emissions in the supply chain (Scope 3) [36–38]. Energy use in hotels is significant, so this research considers direct emissions during operational phases (Scope 1 and 2) and indirect emissions for non-operational phases (e.g., purchased materials, waste management) [37,39].

P4. Types of emissions: Contributions focusing solely on CO_2 emissions are differentiated from those encompassing other greenhouse gases [16,28,40]. As contemplated in the Kyoto Protocol, non-CO_2 emissions, including methane (CH_4) and nitrous oxide (N_2O), can be accounted for as CO_2 equivalent (CO_2eq.) values based on their global warming potential (GWP) [36].

D2. Calculation Methods

P5. Data collection procedure: Researchers use two styles to estimate the carbon footprint of tourism: top-down and bottom-up. The top-down approach begins globally, utilising sources like Tourism Satellite Accounts (TSA), and narrows down to micro issues. In contrast, the bottom-up method involves collecting microdata, like questionnaires from departing visitors, for detailed disaggregated results [41,42]. Top-down approaches use validated data but require assumptions about homogeneity and proportionality. Bottom-up studies offer disassembled analysis, which may lead to a reductionist view and sampling errors [43]. The data collection procedure determines the methods used to calculate TCF.

P6. The methodology applied: This parameter compiles existing methodologies for calculating the TCF, as shown in Table 2:

- Lifecycle analysis: Tourist products and services produce emissions throughout their entire life cycle, which encompasses raw materials extraction, manufacturing, processing, service operation, demolition, and waste management.
- Energy or fuel consumption and emission factors: These are usually accompanied by a questionnaire or on-site data collection. They focus on the energy use of a tourism service or visitor. The corresponding emission factors in each case will weigh the different types of energy used in each process.

- Input-output (I-O) and TSA: This methodology uses macroeconomic data to compute carbon emissions based on the production and consumption of tourism products and services in a specific territory. This methodology has evolved towards more sustainability-oriented perspectives, and new I-O-based calculation approaches have emerged (i.e., environmentally extended I-O).
- Scenario analysis: Using statistical data to suggest and simulate possible economic and social scenarios for which TCF and other social, environmental, and economic implications are predicted (i.e., backcasting or forecasting).
- Other methods: Methods such as Kuznets' curve, Kaya identity emission or various econometric models.

P7. Referenced standards: These standards include guidelines, boundaries, and emission factors that the authors used throughout the identified literature to standardise carbon footprint calculation. It is noteworthy that current standards predominantly endorse bottom-up calculation methodologies. Some of these standards are interconnected, as specific frameworks draw upon or inform others. For instance, the International Organisation for Standardisation (ISO) and UK's Department of Environment, Food and Rural Affairs (DEFRA) standards are derived from the GHG Protocol and share similar calculation structures and scopes [44,45]. Due to the limitations of individual frameworks [40] and the differences between different standards, researchers often combine multiple standards within specific areas of study to address these gaps:

- GHG Protocol: It provides carbon footprint estimates for various production sectors to support organisations in carbon footprint reporting [38].
- Intergovernmental Panel on Climate Change (IPCC): Based on emission factors collected from various sources (e.g., EEA), the IPCC offers guidelines for calculating the carbon footprint of territories and companies [46].
- ISO: Especially in lifecycle analysis, the ISO 14064-1 standard is a reference framework for calculating companies' carbon footprints [47].
- United Nations Framework Convention on Climate Change (UNFCCC): Instructions and methods for calculating and reporting organisational, individual, and event carbon footprints [48].
- DEFRA: Emissions conversion factors for carbon footprint accounting and reporting developed by the UK Government can also calculate indirect emissions. Lately applied in several external contexts [36,37,49].
- Publicly Available Specification (PAS) 2050: International reference framework for calculating and communicating the carbon footprint of products and services [50,51].

P8. Sources of emission factors: Fuel or energy consumption calculations rely on multipliers to quantify their impact. It is essential to trace the origin of multipliers in papers sourced from academic literature, international GHG emissions guidelines (e.g., P7), or national/regional standards. Although energy consumption calculation papers commonly use emission factors, this study also explores alternative methodologies employing multiplier coefficients or indirect emissions from the suggested sources.

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Table 2. Calculation methodologies: advantages and limitations.

Methodology	Advantages	Limitations
Lifecycle analysis (LCA): Tourist products and services produce emissions throughout their entire life cycle, which encompasses raw materials extraction, manufacturing, processing, service operation, demolition, and waste management.	Comprehensive models account for indirect impacts, particularly in the supply chain stage, and include environmental effects across sub-sectors. Though product-focused, this approach can also assess entire trips and compare itineraries within a destination.	Very detailed data inventories are required to develop lifecycle methods. The comprehensive approach to analysis poses challenges when studying large sample objects (i.e., the hotel sector).
Energy or fuel consumption and emission factors: These are usually accompanied by a questionnaire or on-site data collection. They focus on the energy uses of a tourism service or visitor. The corresponding emission factors in each case will weigh the different types of energy used in each process.	National and international emission factors are regularly updated and recalibrated. Some, such as DEFRA, also include indirect emissions like fuel production. Consumption data from surveys or audits aligns accurately with the study object.	Emission factors for some countries or regions are limited, potentially causing under- or overestimation. The quality of the survey may affect the results.
I-O and TSA: This methodology applies macroeconomic data to estimate carbon emissions from tourism product and service production and consumption within a given territory. It has evolved toward sustainability-focused approaches, introducing new environmentally extended I-O models.	No need to collect primary data. The data used has been previously validated. Indirect impacts can be calculated.	National I-O tables are not updated annually. It requires several assumptions to be made, such as linear future growth or constant prices.
Scenario analysis: Using statistical data to suggest and simulate possible economic and social scenarios for which TCF and other social, environmental, and economic implications are predicted (i.e., backcasting or forecasting).	Emission reduction strategies and actions can be planned according to expected scenarios.	The quality of scenarios relies on both the available data and the developed model.
Other methods: Methods such as Kuznets' curve, Kaya identity emission or various different econometric models.	N.A.	N.A.

Own elaboration, based on [34,35,37,40,52].

D3. Analytical Scope and Boundaries

P9. Geographical scope: Warren and Becken [53] highlight a research focus primarily at the global or national level, particularly in developed countries. This parameter assesses the territorial scope of each proposed methodology, categorising it as global, supranational, national, regional, or local/tourism destination levels [27]. Regional refers to sub-national areas, including Antarctic studies, as a supra-national territory. Local studies encompass case studies of tourism facilities or infrastructures akin to the 'unitary level' by Tao and Huang [34]. This parameter's input relies on the spatial scale defined in P13 for each paper and the corresponding analysis.

P10. Boundaries of the research: Regardless of the authors' chosen approach, the boundaries of the analyses vary considerably:

- Cradle-to-grave: It primarily pertains to lifecycle analysis studies estimating emissions from manufacturing to waste management (e.g., hotel construction to waste management). These studies are classified as cradle-to-cave when the analysis stops after the operational phase, and cradle-to-cradle when they also consider the regeneration process of the exploited resources.
- Door to door: This boundary is mainly related to work with the visitor (or the territory) as the object of study. It encompasses, at least, emissions associated with transportation, accommodation, and activities tourists consume during their stay.
- Partial: It addresses investigations that overlook the entire process or other mentioned options. For instance, a hotel facility might only calculate emissions from its operations, such as room energy consumption, restaurant food service, and spa usage [37,54,55].

D4. Target of Assessment

P11. Assessment perspective: It presents details on the approach to calculating the territory's environmental footprint, distinguishing between papers focusing on the territory as a tourism destination (covering domestic and international tourism) and those adopting a residential perspective, solely considering national production. The terms 'resident-based' and 'destination-based' are frequently employed to denote this differentiation, which arises from consumption-accounting TCF allocation principles [16]. Including this parameter in the TCFAF is compelled by the ongoing discourse on shared responsibility for carbon emissions from international activities such as tourism [56].

P12. Functional unit used: This classification pertains to both the measurement unit (e.g., kg CO_2) used for conveying calculation results and the unit to which this value is assigned (e.g., per tourist or source market) [57]. This aids in determining which party is responsible for the emissions. Qualitative parameter assessment involves an open-ended question, followed by the grouping of results for clustering.

P13. Study object: It denotes the subject of research, encompassing academic studies on TCF calculation without specifying the subsector or perspective. Following Sun's [58] proposal, contributions are organised based on the following categories:

- Tourism destinations: TCF generated by visitors and the sector in a territory is analysed, with the place being the main object of study.
- Tourism industry segments: Includes sub-sectors of the tourism industry (i.e., accommodation or transportation sector).
- Segments of travellers: Segments of visitors or specific source markets, such as British visitors.
- Complete trips: Tourism emissions are generated throughout visitors' entire trips. In this case, they focus on travelling.

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- Tourism services, facilities and events: This category includes articles focusing on an in-depth study of specific cases, such as those examining a sporting event or hotel facility [37,59,60].

P14. Constraints of the study: The parameter highlights authors' explicitly stated weaknesses in their research, specifically addressing issues in data collection or calculation execution rather than constraints of selected methodologies. The goal is to identify opportunities for improvement in future contributions [57].

Table 3 provides an overview of the potential classifications assigned to each examined dimension and parameter. In instances where a definitive response could not be determined or an estimate was unattainable through interpretative means, the designation "N.A." was applied. To streamline the extraction of results, the predominant response was selected for most questions, except when multiple valid answers were permitted (e.g., P6). Furthermore, content analysis—entailing the systematic coding of responses according to broader thematic categories—was employed to address qualitative parameters.

Table 3. Dimensions, parameters and categories for analysis.

Dimension	Parameter	Categories
D1. Framing Impacts of Analysis	P1. Research objective	Carbon footprint calculation Define influencing factor analysis and analysis of impacts or consequences Analyse the relation between economic growth and emissions
	P2. Types of impact addressed	Environmental Environmental and social Environmental and economic Environmental, social and economic
	P3. Scope of emissions	Direct emissions Indirect emissions
	P4. Types of emissions	CO_2 emissions CO_2 emissions & non-CO_2 emissions
D2. Calculation Methods	P5. Data collection procedure	Top-down procedure Bottom-up procedure Combination
	P6. Methodology applied	LCA Energy/fuel consumption and emission factors I-O/TSA Scenario analysis Others
	P7. Referenced standards	GHG Protocol IPCC ISO UNFCCC DEFRA PAS 2050
	P8. Sources of emission factors	Previous literature International guidelines National/regional standards

Table 3. *Cont.*

Dimension	Parameter	Categories
D3. Analytical Scope and Boundaries	P9. Geographical scope	Global studies Supranational studies National studies Regional studies Local studies
	P10. Boundaries of the research	Cradle-to-gate Cradle-to-cave Cradle-to-cradle Door to door Partial boundaries
D4. Target of Assessment	P11. Assessment perspective	Residents' approach Destination approach
	P12. Functional unit	(Open-ended responses)
	P13. Study object	Tourism destination Segments of tourism industry Segments of travellers Complete trips Tourism-related services, facilities and events
	P14. Constraints of the study.	(Open-ended responses)

Own elaboration.

The subsequent section presents findings from the examination of 14 parameters across 166 systematically reviewed studies (Supplementary Materials File). The categorisation of results was based on explicit information provided by the authors within the texts. Where relevant, the individual effects of multiple parameters were cross-referenced to uncover potential interrelationships.

3. Analysis of Results

This section presents the findings from a systematic review of 166 studies, organised around the four analytical dimensions, 14 parameters, and related categories outlined in Table 3. The results emphasise how methodological choices such as impact scope, calculation methods, and spatial scales shape tourism carbon footprint assessments.

3.1. Framing Impacts of Analysis (D1)

As illustrated in Figure 2, fewer than half of the reviewed studies extend beyond reporting a TCF within a given context to examine the underlying determinants or the broader implications of the calculated footprint for the destination [61,62]. This observation stresses a key limitation in nearly half of the analyses, which aim to derive a static quantitative TCF measure from an inherently dynamic reality.

Consistent with the principles of strong sustainability, where the physical environment delineates the inviolable boundaries of sustainable development, the reviewed corpus reveals a predominant emphasis on environmental impacts [63]. Papers that combine these with economic impacts are also noticeable [64,65]. As revealed in Figure 2, this is due to the calculation methodologies used in some cases. For example, Wang et al. [66] quantified both emissions and the revenue generated by the visitor segment under study, while Sun [58], in his assessment of Taiwan's carbon efficiency, integrated macroeconomic indicators such as GDP, which inherently encompass social dimensions like employment. Notably, no studies focus exclusively on environmental and social impacts. The quantification of social impacts poses considerable methodological challenges, thereby complicating efforts to integrate the core dimensions of sustainability.

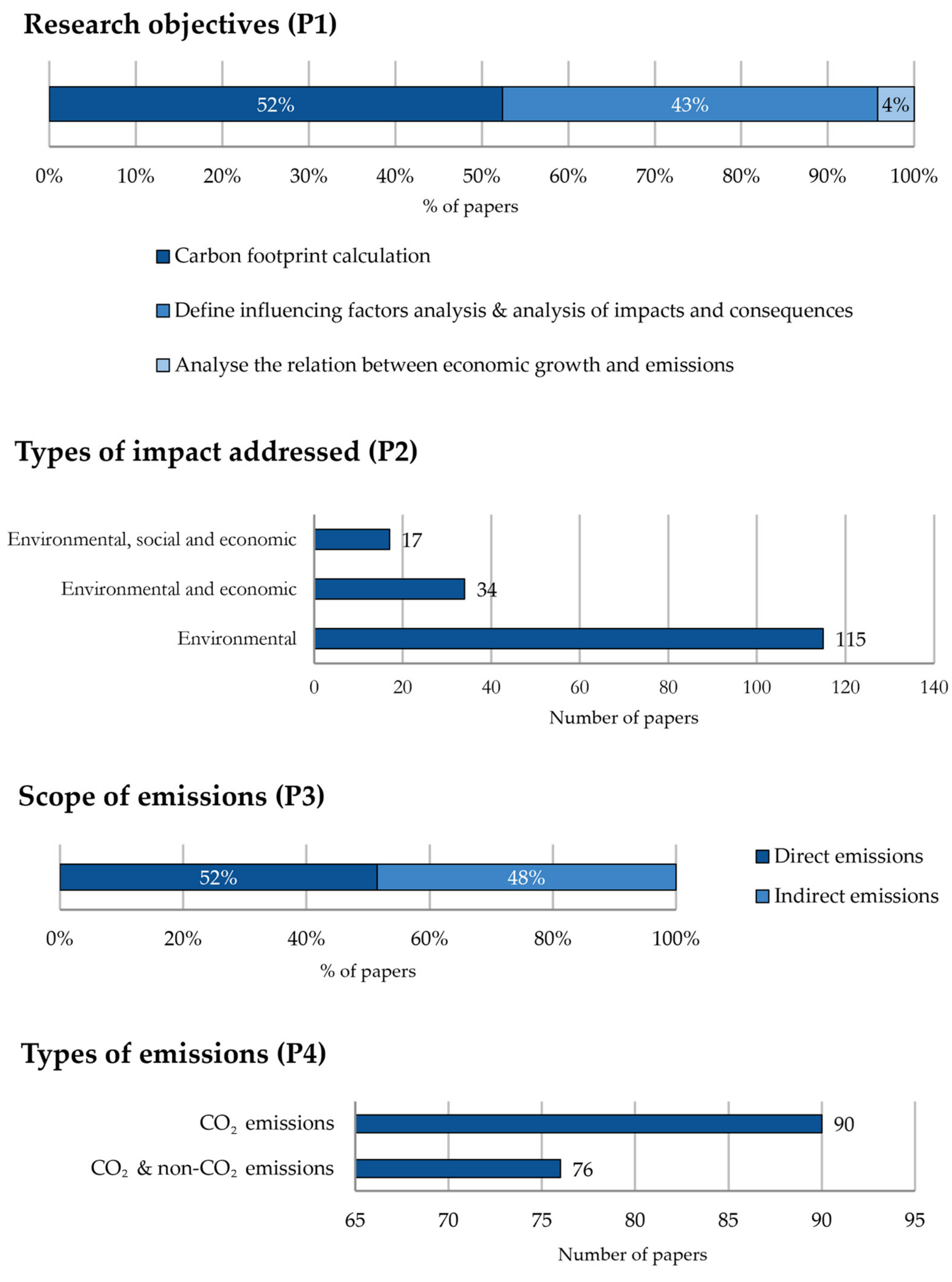

Figure 2. Framing Impacts of Analysis (D1). Own elaboration.

Among the papers, 51.20% revealed direct emissions from tourism activities, while 48.19% reported indirect emissions. For simplicity, we assumed papers on indirect emissions include direct emissions. This could be a limitation, but it is deemed appropriate given the lack of studies that focus solely on indirect emissions [29].

The outcomes associated with this parameter are closely linked to the methodological approach adopted in each case, as specific techniques are inherently more conducive to the inclusion of direct emissions. For instance, only 43% of studies employing LCA and 18% of those using IO analysis include exclusively direct emissions, whereas more than 66% of studies applying the fuel consumption method do so.

Most papers only considered CO_2 emissions, while a significant number of papers also included non-CO_2 emissions. Despite not being the gases with the highest GWP, CH_4 and N_2O were the primary non-CO_2 emissions studied.

3.2. Calculation Methods (D2)

Sun [67] uses national I-O tables and TSA statistics to exemplify the top-down approach for carbon footprint analysis. Conversely, Chan and Lam [59] used a bottom-up method, analysing energy consumption from questionnaires completed by 17 Hong Kong hotels. The two existing procedures for data collection obtained very similar counting results (Figure 3). This is related, in part, to the availability of existing data for specific contexts and the benefits that more thorough data collection can offer. Many authors have addressed the limitations of these methods by using combined methodologies based on primary and secondary data sources, for example Morfeldt et al. [68].

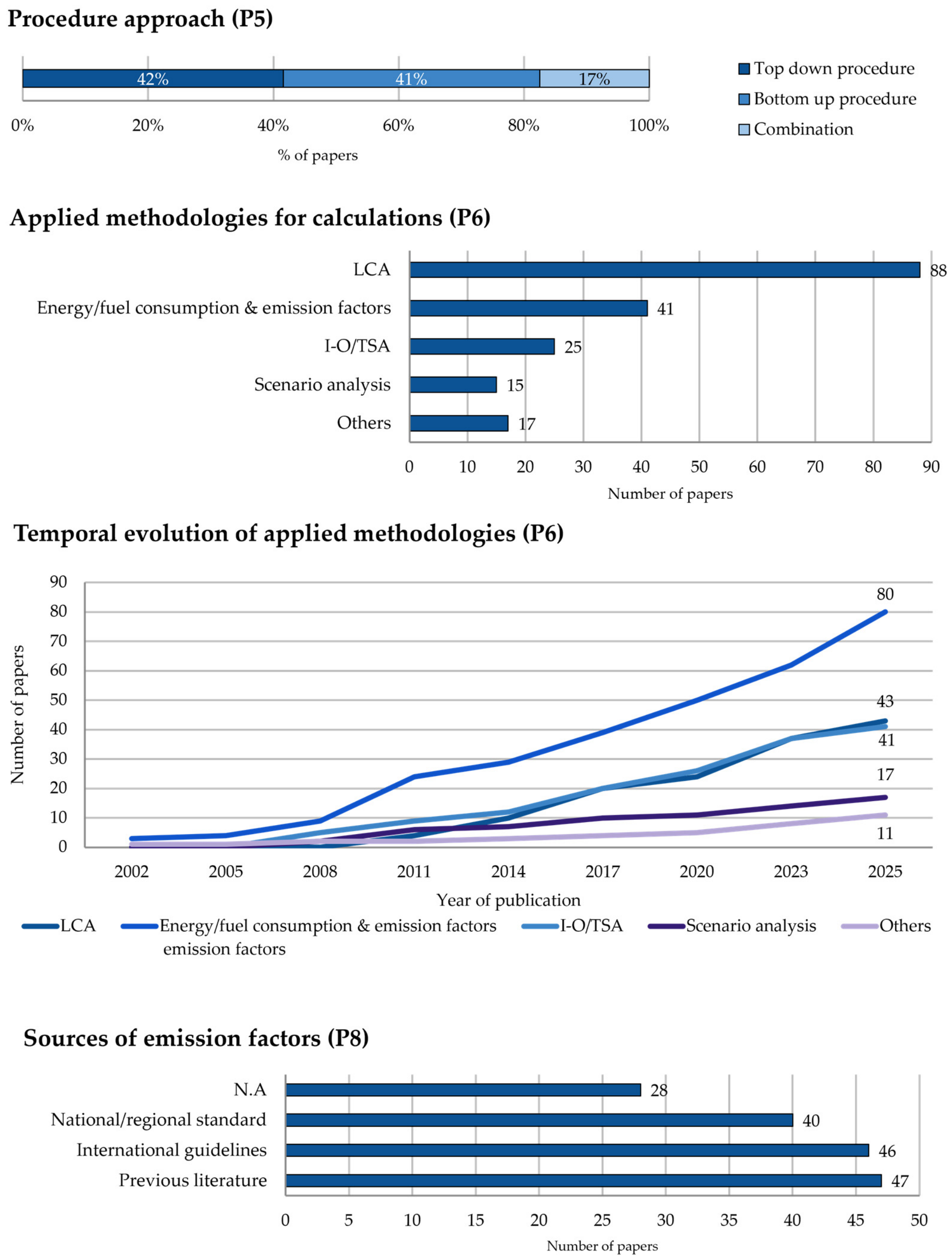

Figure 3. TCF Calculation Methods (D2). Own elaboration.

However, in accordance with the three-tier framework delineated by the IPCC, the bottom-up approach should be the primary methodology employed in this domain of research. This is due to the superior quality of results derived from locally sourced emission data [46].

Regarding the calculation methodologies, it should be noted that, as they are not mutually exclusive, multiple answers have been allowed in those cases showing mixed methodologies (i.e., 16.27%) [69–71]. Nonetheless, fuel consumption analysis is the most commonly used calculation method in the studied papers [72–78]. It is followed by the lifecycle analysis method [79,80], complemented in 13 cases by software [81], and IO/TSA studies [82–84]. In the latter group, many cases are complemented by a factor decomposition analysis that allows for in-depth knowledge of the economic sector where the emissions originate [40].

The prevalence of these methodological approaches and the distribution of resulting outcomes are strongly influenced by the spatial scale at which studies are conducted, as certain techniques are inherently better suited to specific contexts. For instance, analyses addressing environmental and economic impacts—frequently employing I-O or TSA methodologies—are predominantly undertaken at the national level due to the macroeconomic nature of the required data. Conversely, approaches such as LCA or fuel consumption models, which demand detailed audit data, are typically applied within more localised or regional settings.

Figure 3 displays the temporal evolution of each of the analysed calculation methodologies. Research on the five identified methodologies appears concentrated within the periods of 2014–2015 and 2023–2024. While fuel consumption-based calculations remain predominant, the data also reveal a parallel rise in the adoption of LCA and IO/TSA approaches. Despite the early availability of essential data resources—such as the Ecoinvent database introduced in 2003 [85]—the popularity of these methods accelerated around 2015, likely reflecting increasing demand for more comprehensive and precise TCF assessments.

While not all papers adhere explicitly to international standards (Figure 3), almost half of the literature reviewed relies on at least one of the categorised frameworks for its calculations (Figure 4). On the one hand, the GHG Protocol, as well as other frameworks that have emerged as a result (e.g., ISO), are present, individually or in combination, in 70% of the papers. Despite their similarities in scope, methods [45] and time evolution, the application of each of these frameworks has been extended through specific calculation methodologies. For instance, these results reveal that the GHG Protocol predominantly employs the fuel consumption method [86], while the ISO standards are distinguished by the use of the lifecycle analysis method [28].

On the other hand, notwithstanding its limitations—among others in the calculation of international aviation [87]—the IPCC standard is recognised as the most frequent in the TCF literature [31]. Unlike the aforementioned group of standards, the ratio of times this framework appears independently is higher than in the first group, where these standards are significantly combined.

As it happened with the fuel consumption calculation method (Figure 3), the adoption of IPCC guidelines also began to exhibit an exponential upward trend after 2014. This may be attributed to the fact that, in the aftermath of the 2015 Paris Agreement, the imperative of a unified, comparable carbon footprint quantification methodological framework was recognised as essential to advancing the implementation of global climate action. In response, both the IPCC framework and the emission factor multiplication method effectively addressed this need.

Beyond internationally recognised frameworks such as the GHG Protocol and the IPCC guidelines, the authors also draw on national and regional standards, alongside previous academic literature, as particularly valuable resources for refining their estimates. However, the three predominant types of complementary data sources show a very even presence (Figure 3). These emission factors are shared multipliers in diverse calculation methods, as shown by research as different as Sun et al. [40] or Kelly and Williams [88].

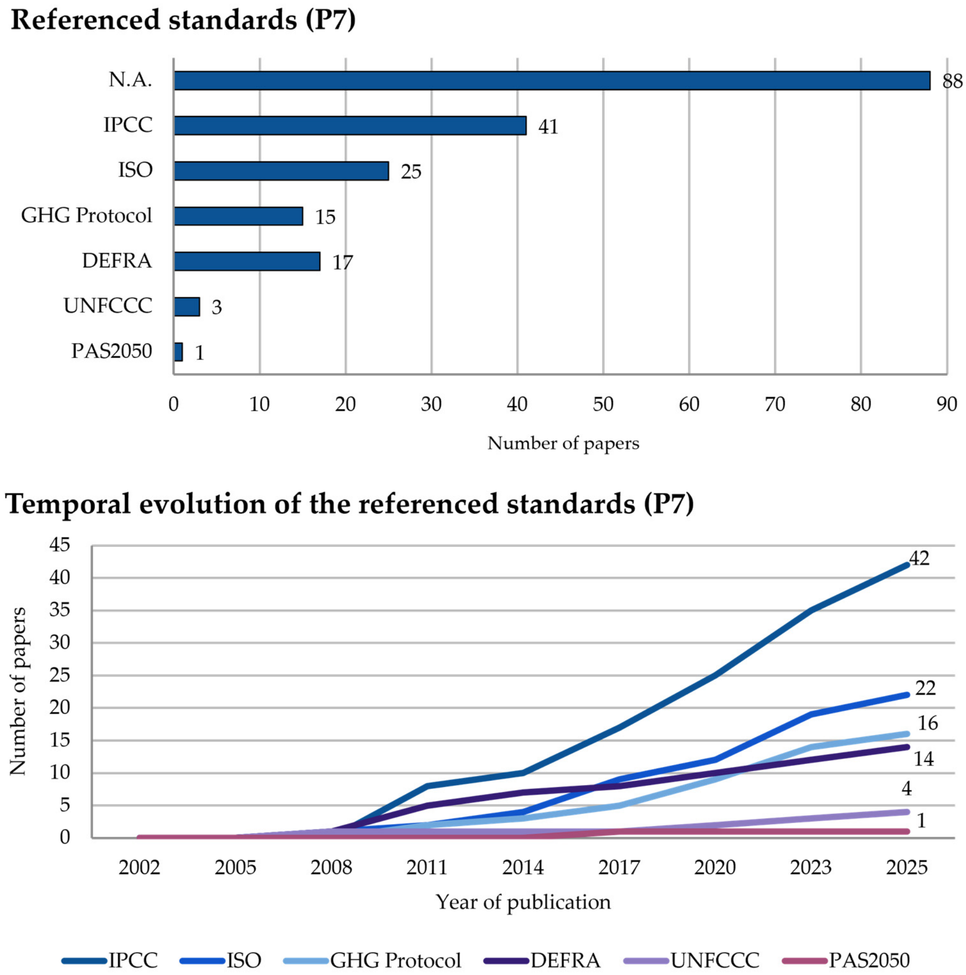

Figure 4. P7 and its temporal evolution. Own elaboration.

These parameters are not mutually exclusive, and academic sources are frequently combined with official datasets [89]. Integrating both types of information enables researchers to mitigate the limitations inherent in each approach by merging widely accepted data—such as national statistics that provide essential contextualisation—with context-specific data that closely reflect the characteristics of the studied destination.

3.3. Analytical Scope and Boundaries (D3)

Figure 5 presents the frequency of each of the P9 responses and their total percentage. Global or supranational papers [57,90–93]—despite having become reference papers in this line of research and offering the inherent cross-regional view of the environmental impacts of tourism—represent the minority of the studied papers (5.42%). This remarkable result may largely be attributed to the inherent complexities of calculations at the supranational scale—such as the inability to apply bottom-up methodologies to TCF calculation—and to the persistent challenges of acquiring up-to-date and reliable global data. On the contrary, while Scott et al. [94] advocate local actions to address climate change impacts, most studies focus on national [95–102] and regional [103–109] perspectives.

Geographical scope (P9)

P9 outcome	Number of papers	%
Global studies	9	5.42
Supranational studies	13	7.83
National studies	57	34.34
Regional studies	58	34.94
Local studies	29	17.47

Boundaries of the research (P10)

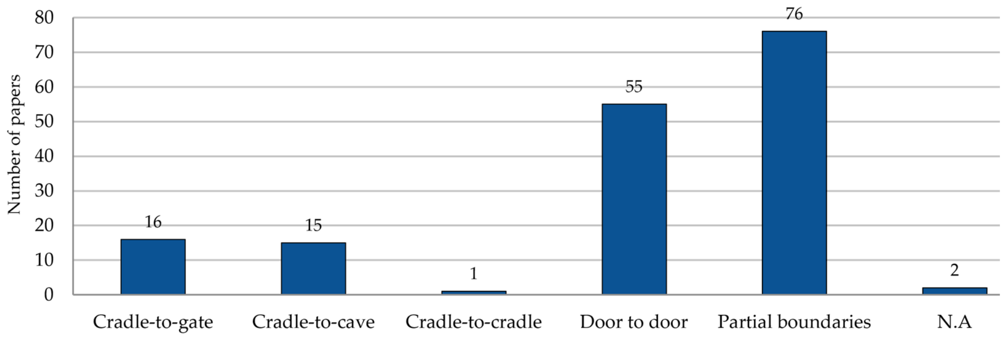

Figure 5. Analytical Scope and Boundaries (D3). Own elaboration.

Scholars from 35 countries authored the analysed papers. As shown in the density map depicted in Figure 6, studies from China (39), Spain (20), Taiwan (12), the UK (12), and Australia (12) lead this list (Supplementary Materials File). This indicates that the issue of carbon management in tourism is more frequently addressed among East Asian and Oceanian territories and, to a lesser extent, in European countries. This trend is also evident in the proportion of research papers produced in each country with public or private financial support. Except for the UK, the countries enumerated are the primary contributors to funding published research on the carbon footprint of tourism, according to the results (Appendix A).

As shown in Figure 6, the temporal trajectory of scientific output exhibits notable disparities across these regions. Whereas scholars in countries such as the United Kingdom, Taiwan, and Australia reached their zenith in the mid-2010s, the leading nations in the current ranking achieved peak productivity closer to the present decade. In Spain, this outcome aligns with the interpretation offered by Osorio et al. [110], who attribute the shift to the nation's progressive commitment to climate action—evidenced by substantial recent investments in renewable energy and the establishment of regulatory frameworks that promote decarbonisation, developments that have likely stimulated research on tourism's carbon footprint through enhanced funding opportunities.

Furthermore, almost half of the papers present partial boundaries, meaning that they do not fit any of the proposed options [55,111–117] (Figure 5). The components most frequently omitted from these calculations are detailed in the findings associated with parameter P14. Due to its directness, the door-to-door approach is the second-most commonly chosen category among researchers [54,118–124]. Predominantly, door-to-door papers employ energy use and fuel consumption methodologies.

Cradle-to-gate [125–129] and cradle-to-cave [130–135] papers hold similar relevance, constituting the minority of the literature corpus. The limited representation of these boundaries is not due to a lack of researcher capability but to the methodological challenges frequently cited by numerous authors [63]. These challenges arise particularly in contexts such as input-output analysis, where accounting for emissions from foreign transport companies is difficult. In the case of two papers, boundaries could not be identified due to insufficient information [69]. Equally noteworthy is that only a single paper adheres to the cradle-to-cradle framework, which encompasses a regenerative perspective on both the processes and objects under examination [136].

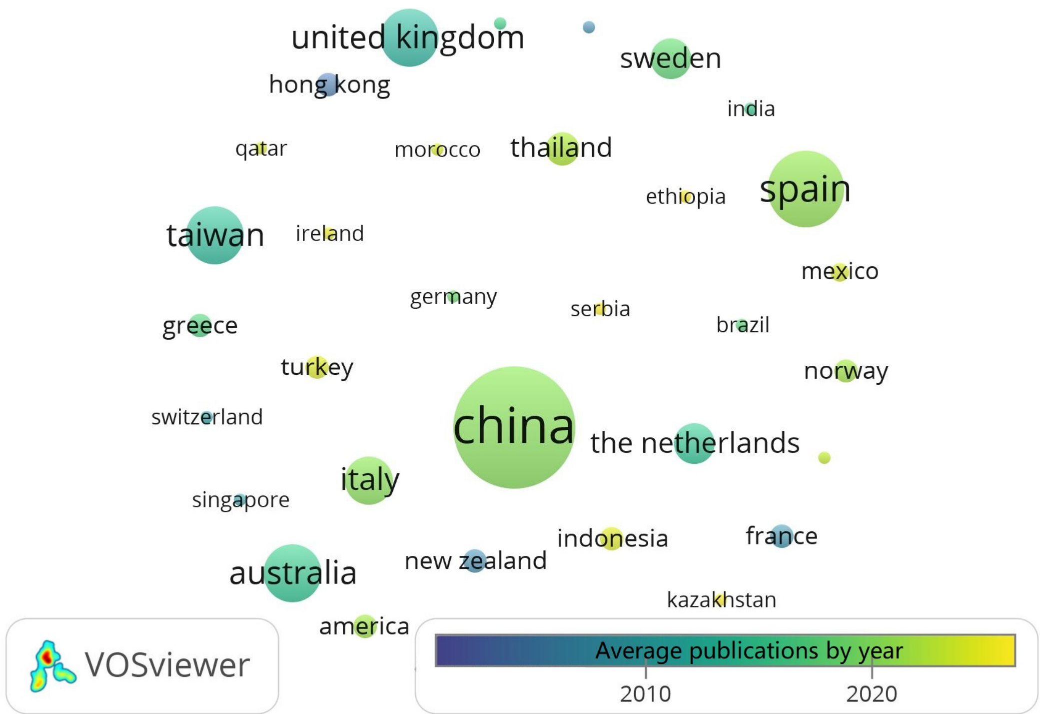

Figure 6. Density map by country based on main authors' affiliations. Own elaboration with Vosviewer 1.6.19.

3.4. *Target of Assessment (D4)*

Regarding the allocation principle used for the TCF calculation, most of the research reviewed adopted a destination perspective in their study [43], which implies that they examined the TCF of visitors and locals. The residential perspective prevails at the national level [110], while the destination approach is more noticeable at the regional and local levels [137–141]. This disparity may arise due to the greater accessibility of national data on production, imports, and exports.

At the same time, such information may not be as readily available for regional or municipal contexts. The case of Lenzen et al. [16] is remarkable, as it included both residents' and destination perspectives. To avoid double-counting, the table in Figure 7 categorises this paper once, focusing on residents.

After analysing the units of measurement used in the papers included in the review, functional unit results are grouped based on whether they measure visitor emissions, total industry or sector emissions, or assign emissions to a specific facility or building. Most papers allocate the results on the tourism industry [142–149] or visitors [150–157], using the functional units of reference presented in Figure 7. Due to the complex nature of these studies, research on tourism facilities/services [158–160]—exhibits diverse units of measurement, including kg CO_2 (eq.)/m^2, by room, guest, overnight, or year.

Displaying a comparable level of prevalence, tourism destinations [161–168] and segments of the tourism industry [169–175] are the main objects of study of the TCF. Half of the papers on the tourism sub-sectors exclusively analyse tourism transport [176–188]. Most studies examining tourism-related facilities [189–193] have mainly studied different types of accommodation [194,195] or events [196,197].

Assessment perspective (P11) by geographical scope (P9)

		Geographical scope					Total
		Global	Supranational	National	Regional	Local	
Allocation principle for calculation	Residents	1	1	6	1	1	10
	Destination	8	12	51	57	28	156
Total		9	13	57	58	29	166

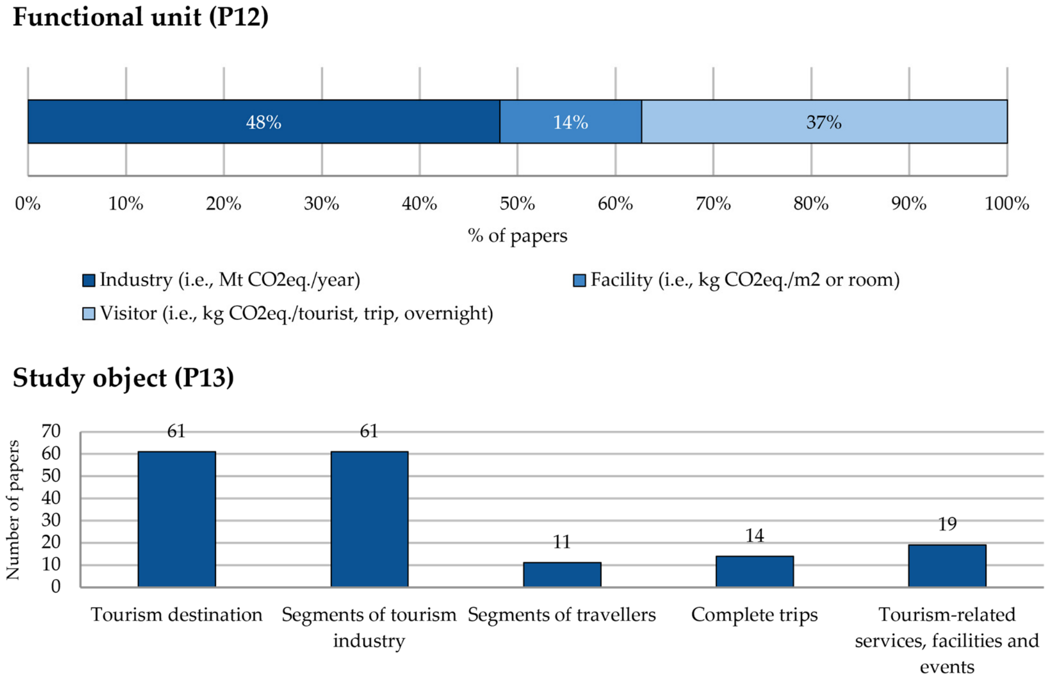

Figure 7. Target of Assessment (D4). Own elaboration.

The dominance of the main subjects of study may be shaped by the priorities or research agendas of the funding agencies supporting the authors (Table 4). So much so that more than 70% of research on a specific segment of travellers has received financial support for its development.

Table 4. Study objects and received funding.

Study Object	Received Funding	%
Tourism destination	35	57.38
Segments of tourism industry	36	59.02
Segments of travellers	8	72.73
Complete trips	7	53.85
Tourism-related services, facilities and events	8	50

Own elaboration.

An examination of the specific cases of the countries receiving the highest levels of funding—namely China and Spain—reveals that, although tourism destinations and tourism segments remain the predominant focus of academic investigations, the research projects that have secured financial support for their execution exhibit a broader thematic scope compared to those that have not obtained such funding (Table 5).

Table 5. Distribution of study objects analysed in China and Spain, respectively.

Study Object	Share of Papers with Funding	Share of Papers Without Funding
Tourism destination	70% and 40%	67% and 40%
Segments of tourism industry	20% and 13%	33% and 60%
Segments of travellers	7% and 7%	0% and 0%
Complete trips	3% and 27%	0% and 0%
Tourism-related services, facilities and events	0% and 13%	0% and 0%

Own elaboration.

Beyond the primary object of study, the funding allocated to authors appears to have exerted a notable influence on both the methodological approach adopted and the geographical scope selected for analysis. As illustrated in Tables 6 and 7, studies conducted without financial support demonstrate a greater propensity to employ complex calculation techniques, such as lifecycle assessment or scenario-based modelling.

Table 6. Distribution of calculation methods based on funding.

Applied Calculation Method	Share of Papers with Funding	Share of Papers Without Funding
LCA	23%	29%
Energy/fuel consumption and emission factors	49%	46%
I-O/TSA	26%	24%
Scenario analysis	9%	14%
Others	6%	7%

Own elaboration.

Table 7. Distribution of geographical scales based on funding.

Geographical Scale	Share of Papers with Funding	Share of Papers Without Funding
Global studies	3%	8%
Supranational studies	9%	6%
National studies	39%	29%
Regional studies	34%	38%
Local studies	15%	19%

Own elaboration.

With respect to geographical coverage, the data reveal that funded research predominantly concentrates on national-level analyses—approximately 10% more than their unfunded counterparts—whereas the inverse pattern emerges for global-scale studies, where unfunded projects account for more than twice the proportion observed among funded investigations.

A qualitative constraints analysis was conducted to categorise limitations into three groups: excluded emissions, assumed statements, and other shortcomings, utilising coding techniques [198]. The analysis identified excluded items, with transportation emissions comprising 16.70% of the omissions as the most significant concern, followed by accommodation emissions at 7.56% (Table 8). Emissions associated with food, catering, and indirect effects accounted for 6.82% of the excluded items. Likewise, certain indirect emissions associated with the studied objects are among the principal factors systematically excluded from TCF calculations (Supplementary Materials File).

Table 8. Main excluded items related to transportation and accommodation.

Excluded Items: Transportation	Example
Different transportation modes	Rosselló-Batlé et al. [81]
Journey-related emissions	Jones [158]
International air travel	Becken and Patterson [43]
Excluded Items: Accommodation	**Example**
Accommodation-related emissions: laundry, cooling, etc.	Puig et al. [199]
Emissions from certain types of accommodations	Campos-Herrrero et al. [31]
Hotel building, equipment and refurbishment	Filimonau et al. [200]

Own elaboration.

The extensive nature of the exclusion list is a primary factor contributing to the prevalence of partial boundary applications in over half of the studies reviewed in P10. This suggests that, while researchers aim to incorporate indirect emissions from tourism activities—thereby aligning with the TCF definition [16]—methodological constraints hinder the achievement of a comprehensive and accurate TCF estimation.

Researchers also made several assumptions to meet their research objectives. Commonly referenced assumptions included details about visitor transportation, major access points, and consistent transport patterns. Additionally, analysing macroeconomic data often relies on assumptions of homogeneity, proportionality, and domestic technology to aid in data processing and interpretation (Table 9).

Table 9. Main assumptions identified in the analysed literature.

Assumptions	No. Reps	Example
Segment of visitors coming by certain means of transport	11	Wang et al. [201]
Data homogeneity and proportionality	6	Cadarso et al. [63]
Departures from largest gateways	4	Farreny et al. [202]
Domestic technology assumption (DTA)	4	Sun et al. [40]
Other Shortcomings	**No. Reps**	**Example**
Lack of detailed/accurate data	30	Jiang et al. [203]
Limited scale of calculation	11	Cao et al. [204]
Temporal inconsistencies	10	Lundie et al. [205]
Small sample size	3	Filimonau et al. [44]
Survey data quality	3	Chan and Lam [61]
Use of third-party methodologies/data	3	Xu et al. [206]

Own elaboration.

Constraints of a different nature have also been identified. Papers on fuel, energy consumption, and I-O methodologies often exhibit notable weaknesses. These limitations are crucial, especially given the data-intensive nature of the lifecycle methodology. Nonetheless, some authors have encountered fewer challenges in this regard, thanks to the advanced development of the lifecycle methodology and the availability of global databases used as sources (e.g., SimaPro 8).

4. Theoretical Discussion

This paper systematically scrutinised the existing methodological approaches employed within the academic literature to measure the tourism carbon footprint. The objective was to evaluate and compare current methods for calculating TCF, identifying convergent and divergent elements in research. To this end, we reviewed the published TCF calculations to identify critical steps and common flaws and improve calculation precision.

The findings of this study underscore the pivotal role that selecting a specific calculation methodology—e.g., lifecycle analysis—plays in shaping the broader set of variables that determine the TCF. As the results reveal, not only does the choice of method yield differing outcomes, but it also profoundly influences the geographical scope, the types of emissions considered, and the definable boundaries, all of which are contingent upon the resources—primarily data—available for the analysis.

Only half of the analysed articles address indirect carbon emissions and non-CO_2 impacts. The predominant approach for quantifying the carbon footprint involves estimating energy consumption. A considerable body of researchers seeks to mitigate the limitations inherent in individual calculation methods by integrating multiple approaches [11]. Nevertheless, despite employing such combined methodologies, as proven here, numerous studies fall short of achieving a comprehensive analysis that is free from partial boundaries or the exclusion of critical elements, such as international aviation.

Although IPCC standards are the most frequently cited in the literature, this review also evidences the variety of existing standards and categories to address a TCF calculation. The coexistence of similar international standards needing more official recognition makes it difficult to establish a unified foundation. This fragmentation—which also stems from research focused on highly specific contexts—makes it hard to compare mitigation and adaptation strategies across tourism destinations and attractions, complicating efforts to establish cohesive, actionable insights.

Most research focuses on the emissions of national and subnational territories. Chinese and Spanish scholars have made the most significant contributions to this body of scientific work, likely due to the substantial funding these countries have received to advance this knowledge. Tourism destinations and subsectors of the tourism industry, such as transport, are the main objects of study observed in this analysis. Thanks to these contributions, this paper fills a notable research gap, as the results present a more comprehensive and profound contribution compared to prior literature.

Several authors have systematically approached the wide academic literature on the relationship between tourism and climate change, such as Loehr and Becken [17]. Beyond the breadth of their research approach, these authors offered a comprehensive climate change knowledge framework that served as a starting point for the research.

From a more specific standpoint concerning TCF and the quantification of associated emissions, bibliometric investigations such as that conducted by Liu et al. [21] underscore the relevance of the present study. These analyses emphasise the imperative for a more coherent and structured research framework—one that delineates the boundaries of inquiry and furnishes scholars with a comprehensive understanding of the principal challenges and priorities inherent in TCF measurement. Among the main systematic reviews of the literature on TCF are those listed in Table 10.

The focus of prior studies, such as those by Casals-Miralles et al. [23] and Tao and Huang [33]—which examine 27 and 46 TCF papers, respectively—lies primarily on TCF calculation outcomes, without fully considering the methodological constraints underlying these results. In these cases, many of the dimensions and parameters that comprise the analytical framework of our research (i.e., TCFAF) were not deeply explored (e.g., P1, P4 or P5).

Authors such as De Camillis et al. [57] concentrate their reviews on methodological attributes. Their research focused on a single methodological approach—e.g., LCA—whereas the present paper encompasses the full spectrum of methodologies extant in the current body of literature.

Table 10. TCF systematic literature review papers.

Authors	No. Papers Studied	Applied Databases	Temporal Scope	Goal/Focus of the Research	Studied Parameters
De Camillis et al. [57]	12	N.A.	1994–2009	"To identify LCA approaches that may be used as a basis for the subsequent development of sectorial lice cycle thinking guidelines" (p. 1)	Type of LCA methodology, study object, purpose and functional unit
Tao and Huang [34]	46	N.A.	2000–2014	"The content of carbon dioxide emissions from tourism at different scales" (p. 1)	Applied coefficients and geographical scale
Casals-Miralles et al. [23]	54 (out of which 27 were about TCF)	Google Scholar	2000–2023	"Pressure exerted by visitors and the local population" (p. 1), measured through "units [of emissions] per tourist" (p. 2)	Location, scope, type of data, methodology and approach
Gössling et al. [27]	62	Google Scholar, EBSCO (secondary data), Web of Science	1986–2022	To validate the 4s model: "the paper provides a systematic review of these dimensions and their interrelationship, with a focus on emission inventory comprehensiveness, allocation principles, clearly defined responsibilities for decarbonisation and the identification of significant mitigation strategies" (p. 1)	Geographical scope, involved stakeholder, scope and strategy

Own elaboration.

Gössling et al. [27] recently conducted a systematic review validating their 4S model (scope, scale, strategy, stakeholder). Their analysis includes non-academic sources, but both studies share structural similarities in parameters (e.g., 'Purpose' parallels P1; 'GHG considerations' parallels P4). However, our framework offers broader categorisation and deeper granularity, enabling rich insights into research attributes and detailed aggregated results. Key examples include 'Spatial focus' (P9), 'Assessment method' (P6), and 'Assessment standard' (P7), where our approach provides clarity (Table 11). Similarly, our proposal includes additional parameters, such as P8 (Sources of emission factors) and P14 (Constraints of the studies), which have helped us understand the results of many other parameters.

Table 11. Main differences between this study and Gössling et al. [27].

Parameter	Gössling et al. [27]	TCFAF
Spatial focus/P9	Global; National; Subnational; Business	Global; Supranational; National; Regional; Local (including business-level)
Assessment method/P6	I-O; Multiplication; LCA	LCA; Energy/fuel consumption and emission factors; I-O/TSA; Scenario analysis; Others
Assessment standard/P7	GHG Protocol; ISO/PAS2050	GHG Protocol; IPCC; ISO; UNFCCC; DEFRA PAS 2050

Own elaboration.

In essence, this research offers a more detailed view of computational methods, addressing a broader range of specific parameters, such as emission types, study objects, data procedures, and calculation methodologies in TCF calculations. Such comprehensiveness is crucial for advancing the rigour of TCF calculation processes—as well as for fostering more effective research that drives faster progress towards tourism decarbonisation [17]—as it offers a more far-reaching depiction of the critical parameters in TCF quantification.

5. Conclusions and Practical Recommendations

Measurement, decarbonisation, regeneration, collaboration and finance are the five actions delineated by the industry in the Glasgow Declaration on Climate Action in Tourism [207]. Addressing climate change necessitates proactive actions, including innovation and robust knowledge management [62]. Hence, supranational policymakers should exert significant effort to standardise carbon footprint metrics across the tourism industry, including destinations, sectors, and facilities. Creating the TPCC is a step towards this goal. However, developing policies that facilitate the normalisation of these calculation processes and promote their regulated use could enhance their raison d'être. In pursuit of uniformity and precision in the computation of carbon footprints for tourism destinations and stakeholders, adopting a common standard reference framework would ensure consistency and accuracy. This could promote the inclusion of concepts commonly excluded, thus providing a consolidated methodological improvement for the sector.

The diversity of the results obtained in this research underscores the absence of standardisation and cohesion that has characterised TCF research. As has historically happened in tourism [208,209], the international standards employed in the examined papers were initially intended for sectors other than tourism. Despite the substantial global carbon footprint impact of industries like manufacturing, policymakers in international tourism have yet to promote specific carbon footprint calculation standards.

It is anticipated that enhanced standardisation of these calculations—and, consequently, a higher degree of comparability in the resulting data—could significantly mitigate the issue identified by Loehr and Becken [17] of misalignment between academic research and practical decarbonisation efforts within the tourism sector.

In this regard, Gössling et al. [210] (p. 3) express concern about the improvement opportunities of organisations in terms of carbon management due to the "inconsistency and inadequacy of international, regional, and national policy approaches". Tourism data needs to catch up to other economic and environmental statistics. Limited investment in surveys and complex modelling hinders our understanding of the connections between tourists' behaviour, policies, and decarbonisation. The commitments articulated at the Conference of Parties (COP29) in Baku in November 2024 represent a pivotal advancement in this domain. These commitments confer legitimacy upon the carbon footprint calculation methodologies advocated by the scientific community. Consequently, they bolster the adoption of top–down macroeconomic approaches as the preferred paradigm for national tourism destinations. This decision is also consonant with the findings of this research, as we have demonstrated a notable predominance of national-scale papers within the extant literature.

Nevertheless, this emerging scenario continues to exhibit deficiencies in the standardisation of processes at local destination and sub-national levels. The resources and information available for the development of these inventories are comparatively limited, while the imperative to decarbonise the activities of local tourism stakeholders remains equally pressing. It should also be noted that, despite adherence to carbon footprint measurement standards, the macro scale often allows system actors to overlook their impact. Conversely, the micro-scale—or local scale in the context of tourism destinations—emerges as a more persuasive option as it enables tourism system actors to grasp more clearly their share of the climate change problem. Despite the recommendations put forth at COP29 to advocate for the use of scientific methodologies in the calculation of these inventories—and considering the general challenges countries face in meeting environmental commitments—

national tourism destinations remain excessively vast areas for implementing specific decarbonisation actions among tourism stakeholders.

The future investigation of tourism carbon management and climate change should also be realistic about the "perhaps never-ending growth" [211] (p. 832) in the tourism sector and its ongoing dependence on carbon fuel sources. Achieving a paradigm shift—such as degrowth [212], global decarbonisation and slow travel—remains challenging. Despite the inevitable consequences of surpassing environmental limits [213], even meeting the 2015 Paris Agreement goal of limiting global temperature rise to below 2 °C above pre-industrial levels would be unattainable if current growth trends persist [209].

Forthcoming research on the tourism carbon footprint should also focus on local problems. The impact of climate change is mainly at the destination scale, which calls for adaptation and efforts to fight this problem. Tourism researchers aiming to mitigate the effects of climate change should adopt a holistic perspective by 'thinking globally and acting locally'.

Besides the accuracy of impact measurement, it is more relevant that an increasing number of tourism destinations have access to such calculations and results. This would accelerate the move towards the key action outlined by the Glasgow Declaration on Climate Action in Tourism, namely, the decarbonisation of the sector [207].

Limitations of the Study and Future Research Lines

This study acknowledges certain limitations. First, given the proven robustness and extensive coverage of Scopus [214], this study exclusively considers scientific articles indexed within this database. To minimise the risk of duplicate records and maintain methodological consistency, publications from alternative sources such as Web of Science were systematically omitted from the analysis. Nonetheless, the iterative phase of the PRISMA protocol facilitated the inclusion of additional sources, ultimately expanding the dataset to 166 studies. Research on TCF calculations published in other languages besides English and the latter half of 2025 was not incorporated; however, the selected scope is considered sufficiently representative of prevailing trends in this domain. Furthermore, assumptions were applied during the systematic review to classify studies within the proposed framework, such as distinguishing between direct and indirect emissions. While these assumptions are appropriate for the current context, they may warrant refinement under alternative research conditions.

Building on the considerations outlined in previous sections regarding the future direction of research on tourism carbon footprint, this study also proposes avenues for further investigation to deepen the insights derived from the present study. Foremost, future research should expand the scope to include additional records—such as those gathered in alternative databases such as Web of Science, those published in additional languages like Chinese or those published after the completion of this research—to provide a more comprehensive perspective on the broader academic context. Following this, it is recommended to examine correlations, causal relationships, and potential effects among key variables, including the influence of funding distribution and possible biases in prominent cases such as Spain. Likewise, further exploration of the factors underlying the temporal evolution of results would be valuable, particularly regarding the prevalence of specific methodologies and calculation approaches during distinct periods.

Finally, given prospective trends in TCF calculation and the advancement of standardisation processes, the proposed 14-parameter analytical framework may necessitate targeted refinements—particularly in its categorical structure—to safeguard its relevance and operational utility. Such adjustments would be contingent on the evolving global orientation of TCF measurement, whether it leans toward privileging tourism destinations as the primary units of analysis or toward endorsing specific methodological paradigms, such as top-down approaches.

Supplementary Materials: The complete dataset of the studies analysed in this review can be found online in https://www.mdpi.com/article/10.3390/cli14020028/s1.

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Conflicts of Interest: The authors declare no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

COP	Conference of Parties
DEFRA	UK's Department of Environment, Food and Rural Affairs
DTA	Domestic technology assumption (DTA)
GDP	Gross domestic product
GHG	Greenhouse gases
GWP	Global warming potential
I-O	Input-output
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
LCA	Lifecycle analysis
TCF	Tourism carbon footprint
TCFAF	Tourism Carbon Footprint Analytical Framework
TPCC	Tourism Panel on Climate Change
TSA	Tourism satellite accounts
UNFCCC	United Nations Framework Convention on Climate Change

Appendix A

Table A1. Number of analysed papers and percentage of funded contributions.

Country	Number of Papers	% Papers That Received Funding
China	39	76.92%
Spain	20	75%
Taiwan	12	50%
UK	12	33.33%
Australia	12	75%
Italy	9	33.33%
The Netherlands	7	57.14%
Sweden	7	42.86%
Japan	4	60%
Thailand	5	25%

Table A1. *Cont.*

Country	Number of Papers	% Papers That Received Funding
Greece	3	0%
France	3	0%
Hong Kong	3	66.67%
New Zealand	3	33.33%
USA	3	33.33%
Turkey	3	33.33%
Norway	3	33.33%
Austria	2	66.67%
Indonesia	3	50%

Own elaboration.

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