

# **A review of studies on tourism and climate change from 2007-2021**

## **Abstract**

**Purpose** - The main purpose of this analysis was to review empirical studies on the relationship of climate change and tourism for a period of 15 years from 2007-2021. The main variables analyzed were research subjects, topics, and economic development levels.

**Design/methodology/approach** – Literature reviewing was used to analyze articles published on climate change and tourism from 2007 to 2021. A staged article selection process was followed using the Scopus database. Statistical comparison tests found differences among sub-groupings of articles.

**Findings** – The research articles on climate change and tourism continued their upward trajectory up until 2021. The 893 articles analyzed were published in 254 different journals with over 60% from non-tourism or cross-disciplinary journals. Significant differences were found by time period and between developed and developing countries.

**Research limitations/implications** - Gaps in the literature were detected with respect to policy analysis and it was concluded that the research for developing nations remains insufficient. More research should be encouraged to focus on the situation and solutions of climate change and tourism in developing countries. Additional research is also needed on biodiversity declines in destinations due to climate change.

**Originality/value** - This research dealt exclusively with empirical research studies in academic articles. It compared results across three different time periods and between developing and developed countries. Statistical tests supported the comparisons.

## 1. Introduction

Since the first peer-reviewed journal publications on the implications of climate change for tourism and recreation appeared in 1986 (Harrison *et al.*, 1986; Wall *et al.*, 1986), the multidisciplinary contributions on the interactions between climate change and tourism have grown (Becken, 2013; Scott *et al.*, 2012). Research has revealed that climate change is one of the “hot spots” within the more broadly framed field of tourism and sustainable development since the early 1990s (Molina-Collado *et al.*, 2022; Shahbaz *et al.*, 2021; Wang *et al.*, 2022). The body of literature on climate change and tourism has moved from stagnation in the 1980s, to emergence in the 1990s, and then to maturation after 2000 (Scott *et al.*, 2005). Therefore, reviewing these publications is worthwhile at this point for tourism scholars to better understand the current knowledge frameworks and practical interventions in dealing with climate change issues, as well as to explore the research gaps.

Several review articles have focused on issues regarding tourism and climate change. Most of these studies addressed special interests or particular perspectives to investigate the interrelationships between climate change and tourism, including reviews of the influence of climate change on international tourism (Scott *et al.*, 2012) and tourism in specific geographic regions, such as in Canada (Dawson and Scott, 2010; Hewer and Gough, 2017), Austria (Gühnemann *et al.*, 2021), Indonesia (Satyawati *et al.*, 2021), China (Wang *et al.*, 2017), the Nordic countries (Hall and Saarinen, 2021), and in small island developing states (SIDS) (Pedapalli *et al.*, 2022); the projected impacts of climate change on coastal and marine tourism (Arabadzhyan *et al.*, 2021; Moreno and Amelung, 2009) and ski tourism (Steiger *et al.*, 2019); climate change adaptation (Kaján and Saarinen, 2013; Phan *et al.*, 2021; Njoroge, 2015), destination resilience and management (Gössling and Higham, 2021; Pedapalli *et al.*, 2022; Weaver *et al.*, 2022); tourist perceptions and responses to global climate change (Gössling *et al.*, 2012); and quantitative approaches in climate change impact assessment for tourism (Rosselló-Nadal, 2014). All these works provided useful insights on the complex issues of climate change in tourism based on geographical, environmental, social, psychological, and methodological concerns. Nevertheless, these studies either probed the issues of climate change and tourism in specific regions or explored the relationship of climate change with specific tourism system components (e.g., season-based tourism, transportation, tourists, adaptation, destination management). Despite the fact that several scholars have conducted overall reviews of studies on tourism and climate change (e.g.,

Becken, 2013; Fang *et al.*, 2017; Pang *et al.*, 2013), efforts into comprehensive review of research on this topic still seems to fall short. Moreover, as these review studies were conducted in earlier years, recent research trends and knowledge accumulated thereafter are yet to be systematically addressed.

Tourism is a system where changes and feedback are continually affecting system components (Scott *et al.*, 2012), and climate change is a contemporary issue that is attracting continuing attention in the field (Becken, 2013; Fang *et al.*, 2017). Therefore, it is necessary to periodically examine the literature to reveal the underlying trends for academic scholars, stakeholders, and government agencies. An up-to-date review systematically analyzing academic articles on tourism and climate change may provide tourism researchers with a clearer view of the recent status in a research field, especially if issues are rapidly changing (Standing *et al.* 2014). This research was conducted to review empirical studies in relation to climate change and tourism for a period of 15 years from 2007-2021 in an effort to track recent trends and to provide insights into future research. In addition, we specifically examined these studies with the socio-economic approaches, in order to achieve harmony between human and nature in the tourism system and accomplish the goal of sustainable tourism. The specific research objectives were to:

1. Document the trends in numbers of publications per year, journals, study locations, subjects, and topics based on empirical studies in relation to climate change and tourism from 2007-2021.
2. Investigate how studies differed in terms of subjects, topics, as well as economic development levels from 2007 to 2021.
3. Statistically compare the subjects and topics across developing and developed countries.

In addition to achieving the three objectives, this findings on climate change and tourism are comprehensive, and offer a systematic understanding of the differences between developing and developed countries. Identifying research gaps and pointing out urgent research directions for future research are other important contributions.

In the next section, the rationale for the research objectives and the potential contributions of this review study are delineated by addressing existing knowledge (including

key knowledge gaps) of the climate change and tourism literature in the manner suggested by Huemann and Pesämaa (2022).

## **2. Literature review**

### *2.1 General contour of review studies on tourism and climate change*

Review studies on tourism and climate change can be traced back to the mid-2000s, with most of the studies in early years being published in books or book chapters. Hall and Higham's (2005) edited book represents the first synthesis work exclusively on this topic, in which a series of literature-based studies are presented by experts exploring the development of climate change research in tourism, the effects of climate change on tourism in different geographical regions, and climate change adaptation. This was followed by Gössling and Hall's (2006) edited book on tourism and global environment change, and Becken and Hay's (2007) book discussing risks and opportunities of tourism in the context of climate change. For journal articles, Moreno and Amelung's (2009) review of studies on climate change and coastal and marine tourism, which was published in the *Journal of Coastal Research*, contributed to the earliest work exclusively on this topic. Dawson and Scott's (2010) review on the impacts of climate change on tourism activities in the Great Lakes region represented the first review study published in a tourism-specific journal (i.e., *Tourism in Marine Environments*). As the editorial for a special issue of the *Journal of Sustainable Tourism* on this topic, Scott and Becken (2010) offered a brief yet critical overview regarding the progress in and key knowledge gaps for climate change and tourism research. It is in this commentary that the issue of the geographically uneven distribution of research between developed and developing countries was first highlighted. They also noticed a shortage of research into tourism's contribution to climate change and mitigation. From 2011 onwards, a slow yet steady increase was witnessed in the number of review studies on tourism and climate change, sporadically distributed in tourism-specific journals.

Methodologically, most scholars conducted narrative reviews of specific aspects or within specific regions. Only a small portion of the studies involved a systematic review examining research trends and existing knowledge of studies on this topic. A well-known and also one of the earliest systematic review studies was Becken's (2013) comprehensive review of 459 publications on tourism and climate change from 1986 to 2012. Her analysis concluded that research from multi-dimensional perspectives makes the field more integrative

and critical. Through a co-authorship network analysis, she highlighted the centrality of a small number of authors and suggested there might be a risk that the field looks more significant than it is. During the same period, Pang *et al.* (2013) did an overview of 440 studies on climate change and tourism from 1990 to 2010. They examined existing knowledge concerning the impact of climate change on tourism and tourism's contribution to climate change. As a review method, the systematic review gained more attention and is more frequently applied in recent years. Fang *et al.* (2017) conducted a scientometric analysis of 976 publications between 1990 and 2015 related to tourism and climate change through CiteSpace to identify and visualize the evolution of the collaboration and co-citation networks, and emerging trends. This review method was also adopted by Wang *et al.* (2017) who focused on the impact of climate change on tourism in the Qinghai-Tibetan Plateau of China, by Steiger *et al.* (2019) who examined climate change risk for ski tourism, by Arabadzhyan *et al.* (2020) with particular attention to coastal tourism, and by Lopes *et al.* (2021) who examined trends in research in relation to climate change and tourism.

These reviews used different criteria for inclusion into their bibliographical collections. For example, Arabadzhyan *et al.* (2020) contained several types of publications, including peer-reviewed journal articles, policy papers, and official reports. Although all the other reviews only included peer-reviewed outputs, Pang *et al.* (2013), Fang *et al.* (2017), and Lopes *et al.* (2021) selected journal articles while Becken (2013) and Steiger *et al.* (2019) included journal articles as well as book chapters and books. It should be noted that the choice of publications deemed relevant for bibliographical analysis is somewhat subjective (Scott *et al.*, 2005). Thus, inclusion of different types of publications in these reviews may have influenced their results and interpretation in relation to the trends in climate change and tourism.

## *2.1 Analytical frameworks of review studies*

Generally, several indicators (i.e., numbers of publications per year, journals, study locations, and research topics) are used to show the trends of studies in relation to climate change and tourism (Becken, 2013; Fang *et al.*, 2018; Pang *et al.*, 2013; Scott *et al.*, 2005). However, the analytical frameworks that were used to guide the discussion of research topics were case-specific and subjectively determined to fit with the specific research objectives. Pang *et al.* (2013) discussed existing knowledge of studies on tourism and climate change from two basic aspects, i.e., impacts of climate change on tourism and tourism's contribution

to climate change. Becken's (2013) analytical framework was more problem-solving oriented. She synthesized key themes of past studies on this topic into three components, including impacts and adaptation, mitigation, and policy. Policy highlighted top-down approaches to climate change whereas adaptation and mitigation emphasized bottom-up initiatives and actions. Fang *et al.* (2017) also included impacts of climate change and adaptation and contribution of tourism to climate change and mitigation in their framework, but treated climate and tourism as an independent theme. Other scholars included more specific themes in their reviews. Steiger *et al.* (2019) and Lopes *et al.* (2021) paid particular attention to methodology in their thematic analyses. For example, besides climate change impacts, mitigation, and policy, Lopes *et al.* (2021) differentiated another five themes, including thermal comfort, modelling, climate and tourism assessment, multidisciplinary climate assessment, and expert-based climate and tourism assessment. Differing from aforementioned studies, a more combined perspective was used by Nickson *et al.* (2011). They identified three specific themes in association with climate and tourism, which included climate change, weather change, and season change; some other themes including transportation, policy, social concern/initiative, consumer attitudes, destination preference and choice, and winter activities were categorized according to tourism sectors.

In summary, the association of climate change and tourism is shaped by different physical conditions related to tourism, stakeholders, and climate determinants (Dawson and Scott, 2010; Rosselló-Nadal, 2014; Scott and Becken, 2010). Thus, research investigations, including the current one, report on the subjects, which can encompass tourism decision-makers such as visitors, residents, enterprises, government agencies, other stakeholders, as well as determinants and outcomes of climate change and tourism including carbon (e.g., carbon emissions), types of destination, and measurement scales (e.g., tourism climate indexes).

### *2.3 Trends in review studies by research topics*

The body of literature on climate change and tourism has been growing rapidly since the mid-2000s, with the majority focused on the impact of climate change on tourism (Becken, 2013; Fang *et al.*, 2017; Phan *et al.*, 2021). Similarly, past review studies focused predominantly on the impacts of climate change on different tourism sectors and related adaptation strategies. The trend continued in recent years of articles reviewing the literature about climate change and its impacts on coastal areas and islands with Arabadzhyan *et al.*

(2021) considering coastal tourism and Pedapalli *et al.* (2022) looking at impacts on SIDS; and on specific geographic regions such as the Nordic countries (Hall and Saarinen, 2021). Moreover, resilience in tourism is receiving much greater research attention as a result of the COVID-19 pandemic and climate change began to enter this recent discussion (e.g., Gössling and Higham, 2021; Wang *et al.*, 2022). Also emerging are conversations about roadblocks to climate change adaption in tourism due to intractable policies and systems, inadequate creativity, and other human factors (Phan *et al.*, 2021; Weaver *et al.*, 2022).

Only two review studies concentrated on assessment in relation to the interaction between climate change and tourism (Rosselló-Nadal, 2014; Filimonau *et al.*, 2011). To the best knowledge of the authors, there was no review study exclusively on mitigation, though tourism's contribution to climate change and/or mitigation emerged as distinctive themes in several review works (Becken, 2013; Gössling *et al.*, 2012; Gühnemann *et al.*, 2021; Pang *et al.*, 2013; Scott *et al.*, 2012). Past research mainly examined the impacts of transportation (especially aviation sector) and accommodation on climate change, with tourists' influence on climate change been insufficiently examined. Scholars (Becken, 2013; Scott *et al.*, 2012) also pointed out that mitigation policies as well as their effectiveness in carbon emission reduction in the long run were scarcely addressed, and hence needed more scholarly attention.

It should also be noted that increasing attention has been paid to the relationship between climate change and tourism in developing countries (Hoogendoorn and Fitchett, 2018; Pedapalli *et al.*, 2022; Satyawati *et al.*, 2020; Wang *et al.*, 2017) since the issue of geographically uneven distribution of research between developed and developing countries was highlighted in early 2010s (Scott and Becken, 2010; Becken, 2013; Fang *et al.*, 2017). With greater vulnerabilities, developing countries in Africa, Asia, and Oceania look to tourism as a key strategy for future development, yet tend to overlook security risks and adaptive capacity (Scott *et al.*, 2012). Therefore, it is of particular significance to compare differences in research subjects and topics between developed and developing countries.

### 3. Methods

#### 3.1 Identification of research articles

The source of candidate manuscripts on climate change and tourism was the first critical decision for this research. Several steps were followed to ensure the coverage and representativeness of these publications. First, Scopus, was used as the main database for searching for relevant articles due to its broader coverage of tourism journals than the Web of Science (Hall, 2011). However, Scopus covers articles in English and that is a limitation of this research. Second, as the research focus was on climate change and tourism, several keywords were used in combination to collect all the relevant research from the database. The researchers used “tour\*(keyword) OR trip (keyword) OR travel\* (keyword) OR hotel (keyword) OR hospitality (keyword) AND climate\* change (keyword) OR global warm\*(keyword) OR greenhouse\*(keyword)” for article identification. The star sign (\*) enlarged the article pool with different naming conventions. For example, the term ‘tour\*’ allowed different variations of the words to be included, such as ‘tour’, ‘tourism’, ‘tourist’, ‘tourism industry’ and so on. Kaján and Saarinen (2013) also systematically used predetermined keywords in Scopus for searching related peer-reviewed articles in tourism, climate change, and adaptation. However, the current research did not select the ‘social science and humanities’ category in Scopus as Kaján and Saarinen (2013) did. This was because that Becken (2013) found most of the studies on tourism and climate change were published in non-tourism journals, including environmental science and engineering. Thus, without such pre-selection, this research enlarged the candidate pool to include more multidisciplinary journals as Becken (2013) suggested.

Since the purpose of this review was to identify the trends in articles on climate change and tourism in empirical, peer-reviewed journals, other publications such as conference papers, book chapters, reviews, notes, and non-English articles were excluded. The investigation was conducted at the end of January 2021 and generated 2,422 articles in 2007-2021 in Scopus. The period (2007-2021) was selected for two major reasons. First, the 1997 Kyoto Protocol was one of the most significant initiatives that united global forces to reduce greenhouse gas emissions. Even a decade later, the Protocol still had a significant impact on international negotiations related to global warming, such as the Bali Road Map in 2007 and the Paris agreement in 2016. Moreover, since the Second International Conference on



Climate Change and Tourism in 2007, climate change has been regarded as the most serious threat to tourism sustainability, and tourism adaptation has become one of the most significant concerns in the international tourism community (Fang *et al.*, 2017). As a response from the academic community, a major increase occurred in the literature on climate change and tourism from 2007 onwards (Fang *et al.*, 2017; Steiger *et al.*, 2019). Thus, this research used 2007 as the starting year to summarize the scholarship in relation to climate change and tourism after a decade of the Protocol. Second, for the purpose of periodically examining the trend in relation to climate change and tourism, this research used 15 years of publications for the analysis.

### 3.2 Article review procedures

The review process was conducted in two stages. During the first stage, the authors read the full-texts of all 2,422 articles and systematically screened them to identify those to be further analyzed by applying four criteria:

- Both concepts of climate change and tourism had to be the critical variables in the research articles. Those studies examining only one of the variables were excluded.
- Based on the concept of tourism defined by Hall and Lew (2009), examinations of non-tourism-related mobility (daily travel for working purposes) were removed from consideration. For example, Stanley *et al.* (2018) examined the policy options for the reduction of greenhouse gas emissions from urban road transport. The study focused on daily commuting instead of tourism; therefore, it was excluded from the review process.
- The research must have empirical data (with clear procedure of data collection and analysis) concerning climate change and tourism to meet the requirements of this study. For example, Njoroge's (2015) study of climate change and tourism adaptation focused on literature reviewing while Fang *et al.*'s (2017) study of climate change and tourism was a review paper, both of which were excluded.
- The articles had to be in English; non-English articles were excluded.

The authors with doctoral degrees or professorships in recreation or tourism conducted the screening tasks and had constant discussions based on the above criteria. Finally, 893 articles out of 2,422 were selected for further analysis.

### 3.3 Coding scheme

In the second stage, the coding scheme was established. It consisted of four categories, and each category was coded into binary data, being numerically represented by zeros or ones. The first category was the study locations in which countries were used as the coding units. For study locations across different countries (e.g., Austria and Switzerland), both countries were coded. Some articles had a global perspective (e.g., global sea level rises and changes in tourism), so ‘global’ was used for coding to highlight the worldwide coverage of these studies. Then, countries were further categorized into developing and developed nations based on the report of world economic outlook published by the International Monetary Fund (IMF, 2019). IMF classification is recognized worldwide to measure the economic development in every country. According to the IMF (2019), there are 39 economies classified as ‘advanced’. The ‘developing’ and ‘developed’ countries were coded for the 893 articles based on IMF’s classifications. However, some studies, for example, conducted in the Arctic and Antarctica, or across both developing and developed regions, were not classified in either one so they were excluded from the analysis. The results yielded 741 articles in either developing or developed countries.

The third category was for research subjects, representing the main people, agencies or institutions that articles addressed. Nine sub-categories were generated through content analysis, including: (1) visitors, (2) residents, (3) enterprises, (4) stakeholders, (5) carbon, (6) destination, (7) index (e.g., Tourism Climate Index and Thermal Climate Index), and (8) other. If a study included more than one research subject, only the principal subject was coded.

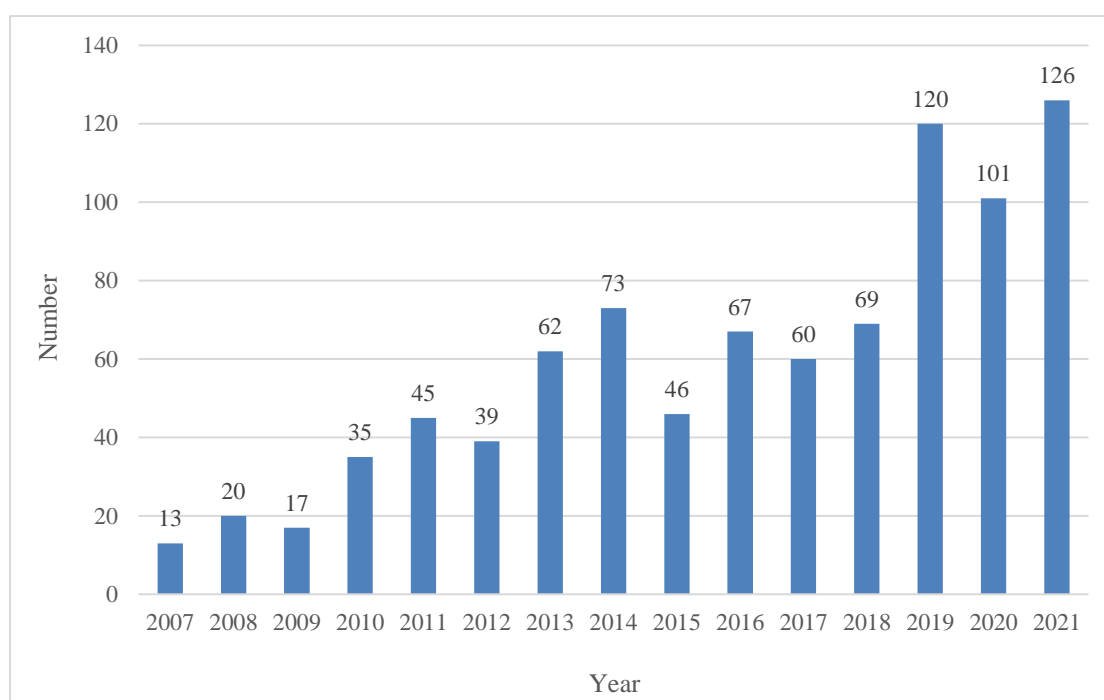
The fourth coding category represented the main topics covered. Based on climate change and tourism literature reviews (Nickerson *et al.*, 2011), the main topics were grouped into ten sub-categories: (1) transportation, (2) social concerns/attitudes/behavior, (3) policy, (4) measurement and modelling, (5) winter activities/tourism, (6) destination preference and choice, (7) natural resources and biodiversity, (8) weather change and its effects/season changes/seasonality, (9) mitigation and adaptation, and (10) others. Since most of the articles in relation to climate change and tourism covered more than one main topic (Becken, 2013), absolute counting was applied (Ma and Law, 2009), where each topic appearing in an article was marked “1” in that category.

The authors performed the coding of articles, and several steps were followed to increase inter-coder reliability. First, the coders discussed the contents and details of the coding scheme. Second, all coded the first 30 articles and discussed inconsistencies to reach greater consensus. Third, another 50 articles were coded by the researchers, and multi-coder reliability tests were conducted based on the results for all coding items. The Fleiss Kappa reliability was used to calculate multi-coder reliability. The average Fleiss Kappa reliability was 0.66, reaching the substantial agreement level ( $k = 0.61-0.80$ ) (Landis and Koch, 1977). Finally, each coder was equally assigned articles for coding, and all the coding results were aggregated for further analysis.

## **4. Results and discussion**

### *4.1 Numbers of articles per year*

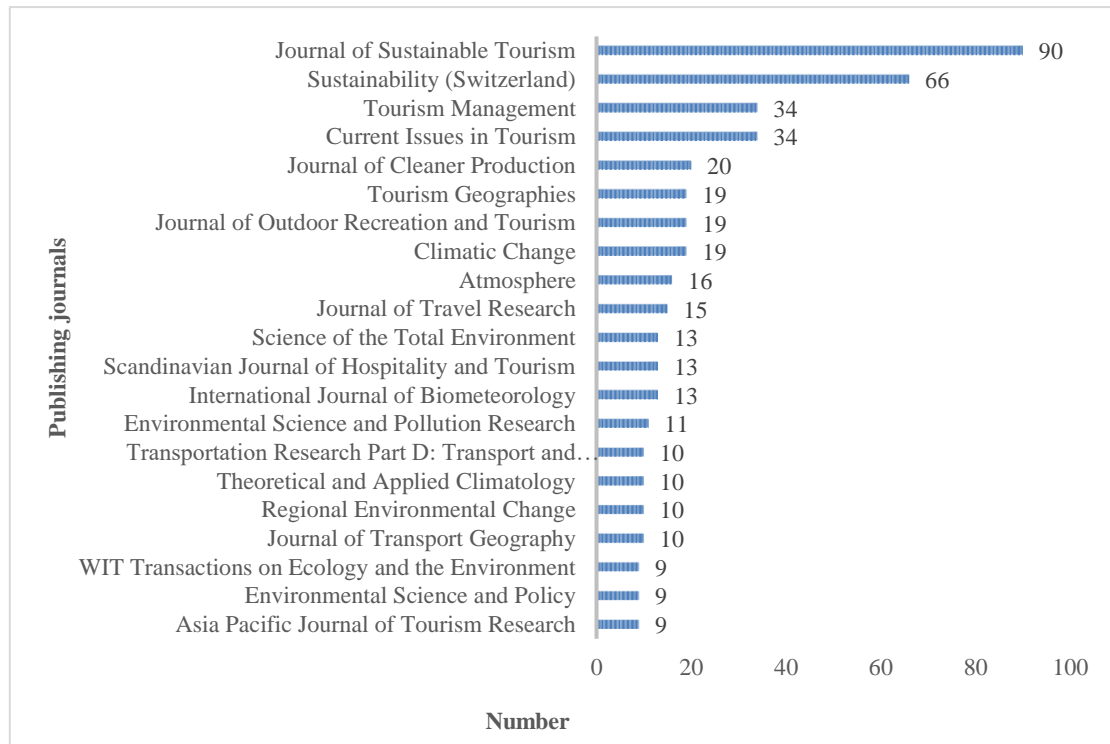
Figure 1 shows the numbers of empirical articles related to tourism and climate change published per year during 2007-2021 based on the analysis of 893 publications. Overall, significant increases in the annual averages were identified for the three different periods. The total number was 169 (18.9%) for 2007-2012, 377 (42.2%) for 2013-2018, and 347 (38.9%) for 2019-2021. This finding is consistent with previous research (Becken, 2013; Pang *et al.*, 2013; Scott *et al.*, 2005), indicating an upward trend in publications in relation to climate change and tourism. However, it also should be noted that, among the 2,422 articles generated in Scopus during 2007-2021, only a total of 893 were categorized as being based upon empirical studies. It seems that less than 40% of research had a combined focus on climate change and tourism and addressed the actual effects of one construct on others.



**Figure 1.** Number of articles per year in 2007-2021

#### 4.2 Publishing journals

The 893 articles were published in 254 different journals. Of these, 21 journals contributed 50% of the publications (Figure 2). The *Journal of Sustainable Tourism* contributed 10.0% of articles and was the journal most frequently publishing tourism and climate change articles ( $n = 90$ ), consistent with previous findings (Becken, 2013; Fang *et al.*, 2018). *Sustainability* ( $n = 66$ ), *Current Issues in Tourism* ( $n = 34$ ), *Tourism Management* ( $n = 34$ ), and *Journal of Cleaner Production* ( $n = 20$ ) were the other top five journals with the largest number of publications. Only 313 articles (35.1%) were published in tourism, hospitality or leisure-related journals (44 journals), with the remaining 580 (64.9%) published in non-tourism or cross-disciplinary journals (210 journals), such as *Sustainability*, *Journal of Cleaner Production*, *Climatic Change* ( $n = 19$ ), and *Atmosphere* ( $n = 16$ ).



**Figure 2.** Number of publishing journals with articles on climate change and tourism in 2007-2021

### 4.3 Study locations

Overall, 741 out of 893 articles (83.0%) specified their study locations were within one country, indicating the majority of the studies preferred a local perspective on the topic of tourism and climate change. Only a small portion of the articles was identified as regional research ( $n = 105$ , 11.8%) or with a global focus ( $n = 47$ , 5.2%). The studies with a local focus covered 92 different countries, with the majority of developed country studies in Europe and the majority of the developing country studies in Asia. The top eight countries with most articles jointly contributed 50.2% of the publications, whereas the other 84 countries contributed the remaining half of the publications. The top eight countries included the United States ( $n = 69$ ), China ( $n = 67$ ), the United Kingdom ( $n = 52$ ), Spain ( $n = 51$ ), Australia ( $n = 43$ ), Canada ( $n = 35$ ), Austria ( $n = 28$ ), and Finland ( $n = 27$ ). China was the only developing country on this list, and it had considerably more studies in comparison with the other developing countries. If the two developed regions of China (i.e., Taiwan and Hong Kong) were taken into consideration, China would be the country with most articles ( $n = 94$ ). In general, studies conducted in developed countries/regions ( $n = 552$ , 74.5%) were much more than those for developing countries/regions ( $n = 189$ , 25.5%). However, an increasing

trend was identified in terms of the portion of the developing country studies across the three different periods, i.e., 13.2% (n = 25), 35.4% (n = 67), and 51.3% (n = 97) in 2007-2012, 2013-2018, and 2019-2021, respectively. The number of articles for developing countries was much higher than in Becken's (2013) review with only eight studies in 1986-2012.

For the developed countries, a sharp decrease of research was found in the United Kingdom, Australia, and Finland during the latest period of 2019-2021. Although these countries were among the top eight during the entire period of 2007-2021, they were excluded from the list in 2019-2021. Similarly, research in Canada decreased in the recent decade. Although it was identified as a leading country with most articles on climate change and tourism during 1986-2012 (Becken, 2013), its rank dropped out of the top five countries during 2013-2021 in this review. In contrast, Spain emerged as one of the top five countries during both periods of 2013-2018 and 2019-2021, becoming a leading country for research on tourism and climate change in the Mediterranean area.

#### *4.4 Descriptive data for content analysis*

Figure 1 showed a growth trend starting at an intermediate low point in 2012. After a high point in 2014, it declined again in 2015-2018, then jumped in 2019. Therefore, the 15 years were divided into three periods: 2007-2012, 2013-2018, 2019-2021, and chi-square tests were used to detect any significant differences in research subjects, topics, and economic development levels.

#### *4.5 Research subjects across time periods*

Table 1 shows the results with both descriptive and comparative analysis data. It also indicates that the most studied research subjects were visitors (23.6%), followed by stakeholders (13.2%), enterprises (12.8%), carbon (12.7%), and destinations (12.1%) for the empirical articles published in 2007-2021. Residents were the least studied research subjects in all time periods. The chi-square analysis indicated a significant difference for research subjects for 2007-2012, 2013-2018, and 2019-2021 ( $\chi^2 = 57.5$ ,  $p < 0.001$ ). The value of Cramer's V was 0.18 ( $p < 0.001$ ) and showed time period was weakly related to subjects.

[Table 1 about here]

In 2007-2018, research studies focused on visitors (28.4% and 27.9%), but in 2019-2021, there was a significant decline (16.7%). Compared with these three periods, research

380 subjects on destinations increased significantly (4.1% to 17.6%). On the contrary, research  
381 subjects on indexes significantly declined (16.0% to 8.4%).  
382

#### 4.6 Research topics across time periods

Table 2 shows that the most popular research topics were measurement and modelling (26.8%), followed by social concerns/attitudes/behavior (17.6%), mitigation and adaptation (15.1%), and weather change and its effects (8.7%) for the empirical articles published in 2007-2021. Natural resources and biodiversity (4.9%), policy (3.4%), and others (1.1%) were the topics on which researchers least focused on in 2007-2021. Chi-square analysis produced a significant difference in research topics for the three time periods ( $\chi^2 = 106.6$ ,  $p < 0.001$ ). The value of Cramer's V was 0.180 ( $p < 0.001$ ) and showed the time period was weakly related to topics.

The earlier (2007-2018) researchers focused more on winter activities and tourism (11.4%, 10.4%). There was less interest in winter activities and tourism in 2019-2021 (5.7%), but more interest in weather change and its effects (12.8%) and natural resources and biodiversity (7.4%). Many early studies on climate change and tourism explored the impact of global warming on winter activities (e.g., skiing), but recent research was more about the impact of global warming on tourism, not only on winter activities, but also on natural resources or biodiversity, and cold or hot weather effects on tourists' willingness to travel. There were more tourists choosing establishments to match their sustainable ideas and who were looking to enjoy authentic experiences and biodiversity resources (Kiatkawsin and Han, 2017; Han, 2021; Molina-Collado *et al.*, 2022).

[Table 2 about here]

#### 4.7 Comparative analysis by economic development level

Several researchers have claimed that one of the major gaps in climate change and tourism studies is an uneven geographic distribution of assessments, with more focus on developed countries but little on developing nations which have more risk and vulnerability in tourism (Becken, 2013; Scott and Becken, 2010; Scott *et al.*, 2012). Therefore, this research compared the studies on developed and developing countries.

Table 3 shows that research of developing countries accounted for approximately 20% to 34% from 2007-2018 to 2019-2021. The studies on developed countries dropped from about 80% to 66%. The issues of climate change and tourism in developing countries are gradually being taken more seriously. However, the attention to developing nations and



regions is not yet sufficient. Becken (2013) and Scott et al. (2012) said that developing countries are weak in adapting to and mitigating climate change, and rely on tourism as an important source of GDP. More research should be encouraged to focus on the situation and solutions of climate change and tourism in developing countries.

[Table 3 about here]

#### *4.7.1 Research subjects and economic development levels*

The most popular research subject in the developed country studies was visitors, almost twice as for developing countries (27%, 14.3%), as shown in Table 4. The top three subjects for developing countries were stakeholders, carbon, and destination: significantly higher than for developed countries. Most of the developed countries were in Europe and the Americas. They paid more attention to people, and so tourists tended to be the focus.

[Table 4 about here]

#### *4.7.2 Research topics and economic development levels*

Comparing the research topics of developed and developing countries, it was found that developed countries paid more attention to winter activities and tourism (10.3% vs 1.7%), social concerns, attitudes, behavior (18.8% vs 12.6%) and transportation (8.0% vs 4.9%) than developing countries. However, the topics for developing countries were significantly higher than those of developed countries for policy (5.4% vs 2.3%), natural resources and biodiversity (7.1% vs 4.0%), and measurement and modelling (28.9% vs 22.9%), as shown in Table 5.

[Table 5 about here]

Scott et al. (2012) asserted that tourism in developing regions was more vulnerable because of potential shifts in demand favoring higher latitude countries, significant impacts on natural tourism assets, heightened security risks, relatively lower adaptive capacity, and greater distances to major markets. Therefore, it is likely for research conducted in developing countries to respond to these risks through research on mitigation and adaptation policies and strategies and natural resource conservation. Although the research on policies in developing countries is higher than that in developed countries, it is still not sufficient. The lack of research on tourism and climate change policy remains obvious (Becken, 2013).

The developed country studies tended to focus more on the topics of winter tourism, social and psychological impacts, and transportation. The ski industry was the first and the most studied aspect of climate change impacts on tourism, mostly in developed regions such as Canada, the United States, and the European Alps (Scott *et al.*, 2012). Winter tourism was an important aspect for evaluating the effect of climate change in the developed nations. As climate change may lead to a gradual shift in tourism destinations toward higher latitudes and altitudes, it is likely to cause a relatively small decrease in total international tourist arrivals and total distance traveled (Hamilton *et al.*, 2005). Understanding tourist perceptions and reactions to the impacts of climate change is essential to anticipating the potential shifts in tourism demand and markets (Gössling *et al.*, 2012). Moreover, climate change and the shift of tourism destinations also have direct and indirect effects on transportation in Western wealthy countries that are major international tourism outbound markets (Arabadzhyan *et al.*, 2021; Gössling *et al.*, 2008). Thus, it is reasonable to expect the research in developed regions to focus more on social and psychological impacts and transportation.

#### *4.8 Research trend and discussion*

##### *4.8.1 Broader disciplines and countries*

Reviewed 15 years empirical studies, we found the result reflects a broader pool of disciplines where research related to tourism and climate change originates and it is consistent with Becken's (2013) findings. It is an exciting trend for more interdisciplinary scholars to invest in the study of tourism and climate change.

In 2007-2012, more than 80% of relevant research was invested in developed countries. However, the number of studies on developing countries increased nearly four times (from 25 to 97) in these three years (2007-2012, 2013-2018, 2019-2021). The number of articles for developing countries was much higher than in Becken's (2013) review with only eight studies in 1986-2012. These findings are consistent with previous research, indicating an increase of research in how climate change affects developing countries (Becken, 2013; Peeters, 2009). Many developing countries are located in Asia, Africa and Latin America. Their economic and research capabilities are inferior to those of developed countries. We hope that more research can focus on the difficulties, challenges and solutions of developing countries of tourism and climate change. As recommended by Phan *et al.*, (2021), we should

support the scientific research and data from developed countries toward developing countries in order to solve the imbalance in the geographical distribution of the literature.

#### 4.8.2 *The changes of research subjects*

By Table 1, visitors as the most studied research subjects, this appears to reflect an emphasis on the demand side of tourism in these studies. Scott *et al.* (2012) also stressed that understanding the implications of climatic change for tourist demand patterns is a research priority, especially for international tourism. However, the low involvement of residents in the studies also echoed Kaján and Saarinen's (2013) suggestion about the lack of enough community engagement in tourism and climate change studies. More investigations with local citizens and communities should be encouraged. In addition, the results indicated that researchers focused less on enterprises but more on destinations in 2019-2021. Enterprises and destinations represent the supply side of tourism. Although business adaptation for climate change is critical to the sustainability of tourism (Njoroge, 2015), the theme of destinations as 'victims, winners, losers' is becoming more popular (Pang *et al.*, 2013). Studies related to winter, coastal, and last-chance tourism (e.g., Eijgelaar *et al.*, 2010; Lemelin *et al.*, 2010) emerged more often in 2013-2021. These findings suggest that the demand side of tourism related to climate change has shifted from an emphasis on enterprises to more of a focus on destinations.

IPCC (2008) declared that the global economy should fully reduce carbon emissions in the coming 30 years. The tourism system is an important contributor to global carbon emissions, and the tourism industry must pay attention to the issue of carbon emissions (Lenzen *et al.*, 2018). Tourism destinations play a key role in reducing carbon emissions, and destination managers have to find solutions to achieve the goal of decarbonizing, improving profitability and resilience (Gössling and Higham, 2021). It can be seen from the research subjects in 2019-2021 that destinations have attracted more researchers.

Table 4 shows that the top three research subjects in the developed country studies were visitors, enterprise and stakeholder, but the top three subjects for developing countries were stakeholders, carbon, and destination. The reason why studies conducted in developing countries tended to focus more on stakeholders but less on visitors is likely to be that climate change and tourism affects GDP and salaries of employees, and contribute to poverty alleviation (Gössling *et al.*, 2008). The poverty impacts of tourism include a wide range of

influences on the livelihoods of the poor, not just jobs or incomes, but differential costs and benefits (Ashley *et al.*, 2000). Therefore, it is possible that stakeholders were a higher priority to be assessed in the studies related to climate change and tourism in developing countries. In addition, the research conducted in developing countries focused more on carbon. This result is similar to Becken's (2013) finding, suggesting the research in developing countries is more limited to aspects of energy and greenhouse gas emissions, but ignores other serious issues such as water constraints and extreme weather events.

#### 4.8.3 *The changes of research topics*

According to Table 2, the topic of measurement and modelling attracting the most researchers was consistent to Becken's (2013) finding, reflecting that the positivist as opposed to constructivist, interpretive and critical theories, was the research paradigm that most scholars adopted. In addition, fewer researchers focused on natural resources and biodiversity and policy in relation to climate change and tourism. As an example of the former, Coombes, Jones, and Sutherland (2008) found vegetation diversity was likely to decline in coastal areas when visitor numbers increased due to warmer and drier weather conditions. Becken (2013) also concluded that a lack of research on tourism and climate change policy was evident. More research should be encouraged to focus on these two topics in the future.

The topic of social concerns, attitudes and behavior was valued by many researchers in 2007-2021. Gössling *et al.* (2012) claimed there was an increasing body of literature on the impacts of climate change on tourist behavior and demand, but some were flawed because the motives for travel were interlinked with perceptions of destination attributes, which can be affected by climate change. The trend may also reflect a shift from a focus on the demand side to greater emphasis on supply in climate change and tourism studies. Finally, topics on mitigation and adaptation had greater recent attention, indicating that adaptation is being emphasized as urgent in tourism and climate change studies (Kaján and Saarinen, 2013, Phan *et al.*, 2021).

The researches targeted to developing countries paid more attention than those of developed countries in the topics of policy, natural resources and biodiversity, and measurement and modelling (Table 5). Scott *et al.* (2012) asserted that tourism in developing regions was more vulnerable because of potential shifts in demand favoring higher latitude

countries, significant impacts on natural tourism assets, heightened security risks, relatively lower adaptive capacity, and greater distances to major markets. Therefore, it is likely for research conducted in developing countries to respond to these risks through research on mitigation and adaptation policies and strategies and natural resource conservation. Although the research on policies in developing countries is higher than that in developed countries, it is still not sufficient. The lack of research on tourism and climate change policy remains obvious (Becken, 2013). Molina-Collado *et al.* (2022) pointed out that appropriate policies can guide the development of tourism and hospitality industry towards sustainable tourism. It was found that the topics of developed countries were higher than those of developing countries for winter activities and tourism, social concerns, attitudes, behavior and transportation. The ski industry was the first and the most studied aspect of climate change impacts on tourism, mostly in developed regions such as Canada, the United States, and the European Alps (Scott *et al.*, 2012). Winter tourism was an important aspect for evaluating the effect of climate change in the developed nations. As climate change may lead to a gradual shift in tourism destinations toward higher latitudes and altitudes, it is likely to cause a relatively small decrease in total international tourist arrivals and total distance traveled (Hamilton *et al.*, 2005). Understanding tourist perceptions and reactions to the impacts of climate change is essential to anticipating the potential shifts in tourism demand and markets (Gössling *et al.*, 2012). Moreover, climate change and the shift of tourism destinations also have direct and indirect effects on transportation in Western wealthy countries that are major international tourism outbound markets (Arabadzhyan *et al.*, 2021; Gössling *et al.*, 2008). Thus, it is reasonable to expect the research in developed regions to focus more on social and psychological impacts and transportation.

## **5. Conclusions and Implications**

### *5.1 Conclusions*

Although several scholars have conducted analyses to present general trends in research on climate change and tourism (e.g., Becken, 2013; Fang *et al.*, 2018; Scott *et al.*, 2005; Wang, 2022), most of these studies included multiple peer-reviewed sources (i.e., book chapters, reports, conference papers, and journal articles). Also, they analyzed the literature over continuous time periods, and none addressed the key knowledge gap on the uneven geographic distribution of existing assessments identified by several previous investigations

(Becken, 2013; Scott and Becken, 2010; Scott *et al.*, 2012). Therefore, this research provided a periodic trend in studies related to climate change and tourism through systematically analyzing empirical research in the Scopus database during 2007-2021. In addition, the analysis revealed the trend in studies conducted in developing and developed countries.

Overall, there was an increase in the number of published journal articles related to tourism and climate change from 2007 to 2021. Among 2,422 articles derived through Scopus, only 893 were identified as empirical studies with the dual focus on tourism and climate change. The 893 articles were published in a total of 254 different journals with over 60% from non-tourism or cross-disciplinary journals. This reflects the multidisciplinary nature of studies of tourism and climate change. Locally focused research covered 92 different countries, with the majority of developed country studies in Europe and most of developing country studies in Asia. The studies on developed countries dropped from 2007 to 2021. The issues for developing countries are gradually deepening. However, the attention to developing nations and regions is not yet adequate.

Most research targeted visitors as research subjects, while residents had the least focus. However, the research subject focus on tourists has gradually declined over the three periods (2007-2012, 2013-2018, 2019-2021). On the contrary, the research subject focus on destinations is gradually increasing. The findings showed that the supply side of tourism related to climate change has shifted from an emphasis on enterprises to more on destinations.

The most popular research topic was measurement and modelling, revealing positivist as the most popular paradigm in tourism and climate change research. The least research topic was policy. There were significant differences in research topics in three periods. In 2019-2021, the research topics of weather change, its effects, season changes, seasonality, and natural resources and biodiversity increased, but the research topic on winter activities and tourism received lesser attention.

Comparing the research subjects for developed countries and developing countries, the findings revealed that the developed country studies paid more attention on visitors, enterprise and stakeholder, but the top three subjects for developing countries were stakeholders, carbon, and destination. The economy of some developing countries depends deeply on the tourism industry. Climate change leads to the reduction of tourism revenues,

which affects not only tourism enterprises, but also stakeholders. Therefore, the researchers targeting developing countries were more concerned about the understandings, dilemmas, and solutions among stakeholders.

Comparing the research topics for developed countries and developing countries, the findings showed that developed countries were concerned more with winter activities, social and psychological impacts, and transportation than developing countries. However, the research of developing countries focused more on policy, natural resources, measurement and modelling. Scott et al. (2012) stated that tourism in developing regions was more vulnerable because of they are higher latitude or island countries with lower adaptive capacity. Effective mitigation and adaptation policies and natural resource conservation can reduce the negative impact of climate change on tourism, which is a major topic for developing countries.

## *5.2 Theoretical and practical implications*

Climate change has deeply impact on tourism industry worldwide and greenhouse gas emissions from tourism also accelerate climate change. Tourism is considered one of the least prepared industries for the risks and opportunities of climate change (Scott, 2011). Academic research can help us understand the current situation between tourism and climate change (Molina-Collado *et al.*, 2022). Then the study systematically analyse 15-year researches from which we learned the theoretical and practical implications and gaps of tourism and climate change. It can be summarized as follows:

- In sum, there are more studies on tourism and climate change, indicating that this issue has received more attention in 2007-2021. By economic level, research targeted in developed countries accounts for three quarters. Although research in developing countries is gradually increasing, it is still insufficient. It is recommended that more scholars should invest in tourism and climate change in developing countries to help solve the difficulties and challenges faced by low economic level countries.
- Visitors and stakeholders are the top two research subjects concerned by scholars. Researchers paid the most attention on the issue of tourists of developed countries, while scholars invested in stakeholders targeted in developing world. The impact of climate change on tourism is not only on visitors, but also on residents, tourism

industry staff, local governments, etc. It is suggested that future research should be more involved in stakeholder.

- Measurement and modelling and social concerns, attitudes and behavior are the top two topics most concerned by researchers. It shows that most scholars use measurement and modelling to understand and predict the relationship and interaction between tourism and climate change. Compared with developed world, there are more research to invest in policies of developing countries. In order to achieve the sustainable tourism goal, the research on the mitigation and adaptation or natural resource conservation policies should be more urgent than other researches of developing countries.

## **6. Limitations and future research directions**

It needs to be acknowledged that the interpretation of these results should be made with care. This research excluded book chapters, reports, conference proceedings, and non-English journal articles and non-empirical data. Also, it is acknowledged that while Scopus is one of the major databases, there are many other electronic databases and different combinations of keywords that can be used by researchers to search for and collect more articles for future research. Thus, a more complete picture regarding trends in tourism and climate change can be provided.

Given the complexity of the relationships between tourism and climate change, researchers should explore more features of their interactions and apply a more diverse set of analysis techniques. The results provide some directions for scholars to fill gaps with future research strategies and designs. For example, the results showed the topic of policy was relatively more frequent in the research conducted for the developing countries than for developed nations. Future researchers can examine the difference in the content of policy between developing and developed areas using qualitative analysis. Also, linking theory and practice needs to have greater priority to deliver more effective applications and strategies in tourism.



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