



## Conceptualization of Publications on "Sustainable Winter Tourism And Climate Change": A Bibliometric Analysis Using R Programming

### *Sürdürülebilir Kış Turizmi ve İklim Değişikliği" Üzerine Yayınların Kavramsallaştırılması: R Programı ile Bibliyometrik Analiz*

Fatma BAŞAR<sup>1</sup>

#### ABSTRACT

The International Ski and Snowboard Federation (FIS) and the World Meteorological Organization (WMO) have initiated a new collaboration to draw attention to the threats posed by climate change to winter sports and tourism. The Memorandum of Understanding signed within this scope includes the development of joint initiatives aimed at highlighting the effects of global temperature increases on snow and ice cover and strengthening scientific-sports dialogue. This collaboration is considered an important step as it represents the first time that WMO, one of the specialized agencies of the United Nations, has collaborated with an international sports federation. This study examines the academic literature on sustainable winter tourism and climate change using bibliometric analysis. The analysis, which is conducted using publication data obtained from academic databases such as Web of Science, reveals research trends in this field. The results show that academic interest in sustainable winter tourism and climate change has increased significantly in recent years. The majority of studies evaluate the effects of climate change on winter tourism destinations and focus on sustainable solutions and strategies. In addition, the analysis identifies the main trends in the literature by examining the geographical distribution of the studies, the most frequently used concepts and keywords, the types of publications and the most cited studies. The findings provide an important basis for future studies by comprehensively evaluating the existing research on sustainable winter tourism and climate change. In this context, the study is a valuable guide that can contribute to the development of sustainable tourism policies. In the bibliometric analysis process, the R programming language and its relevant packages were utilized for data processing and visualization.

**Keywords:** Sustainable winter tourism, Climate Change, Bibliometric analysis

#### Öz

Uluslararası Kayak ve Snowboard Federasyonu (FIS) ile Dünya Meteoroloji Örgütü (WMO), iklim değişikliğinin kış sporları ve turizme yönelik tehditlerine dikkat çekmek amacıyla yeni bir iş birliği başlatmıştır. Bu kapsamda imzalanan Mutabakat Zaptı, küresel sıcaklık artışlarının kar ve buz örtüsü üzerindeki etkilerini vurgulamayı ve bilimsel-sportif diyalogu güçlendirmeyi hedefleyen ortak girişimlerin geliştirilmesini içermektedir. Bu iş birliği, Birleşmiş Milletlerin uzman kuruluşlarından biri olan WMO'nun ilk kez uluslararası bir spor federasyonu ile ortak çalışmasını temsil etmesi bakımından önemli bir adım olarak değerlendirilmektedir. Bu çalışma, sürdürülebilir kış turizmi ve iklim değişikliği konularındaki akademik literatürü bibliyometrik analiz yöntemiyle incelemektedir. Web of Science gibi akademik veri tabanlarından elde edilen yayın verileri kullanılarak gerçekleştirilen analiz, bu alandaki araştırma eğilimlerini ortaya koymaktadır. Sonuçlar, sürdürülebilir kış turizmi ve iklim değişikliği konularına yönelik akademik ilginin son yıllarda önemli ölçüde arttığını göstermektedir. Çalışmaların büyük bir kısmı, iklim değişikliğinin kış turizmi destinasyonlarına etkilerini değerlendirirken, sürdürülebilir çözümler ve stratejiler üzerine odaklanmaktadır. Bununla birlikte analiz, araştırmaların coğrafi dağılımını, en sık kullanılan kavramları ve anahtar kelimeleri, yayın türlerini ve en çok atıf alan çalışmaları inceleyerek literatürdeki temel eğilimleri belirlemektedir. Elde edilen bulgular, sürdürülebilir kış turizmi ve iklim değişikliği konularında mevcut araştırmaları kapsamlı bir şekilde değerlendirerek, gelecekteki çalışmalar için önemli bir temel sunmaktadır. Bu bağlamda, çalışma sürdürülebilir turizm politikalarının geliştirilmesine katkı sağlayabilecek değerli bir rehber niteliğindedir. Bibliyometrik analiz sürecinde, verilerin işlenmesi ve görselleştirilmesinde R programı ve ilgili paketlerinden yararlanılmıştır.

**Anahtar Kelimeler:** Bibliyometrik Analiz, İklim Değişikliği, Sürdürülebilir Kış Turizmi.

<sup>1</sup> Corresponding Author: Ataturk Universty, Fatma.basar@atauni.edu.tr, ORCID: 0000-0002-3358-1011



## INTRODUCTION

Climate change poses significant risks for the international ski tourism industry, as winter tourism is highly influenced by climate variability. Ski resorts are increasingly aware of the existential threat posed by the climate crisis, and many have started developing environmentally sensitive adaptation strategies to reduce negative impacts and ensure the sustainability of winter tourism.

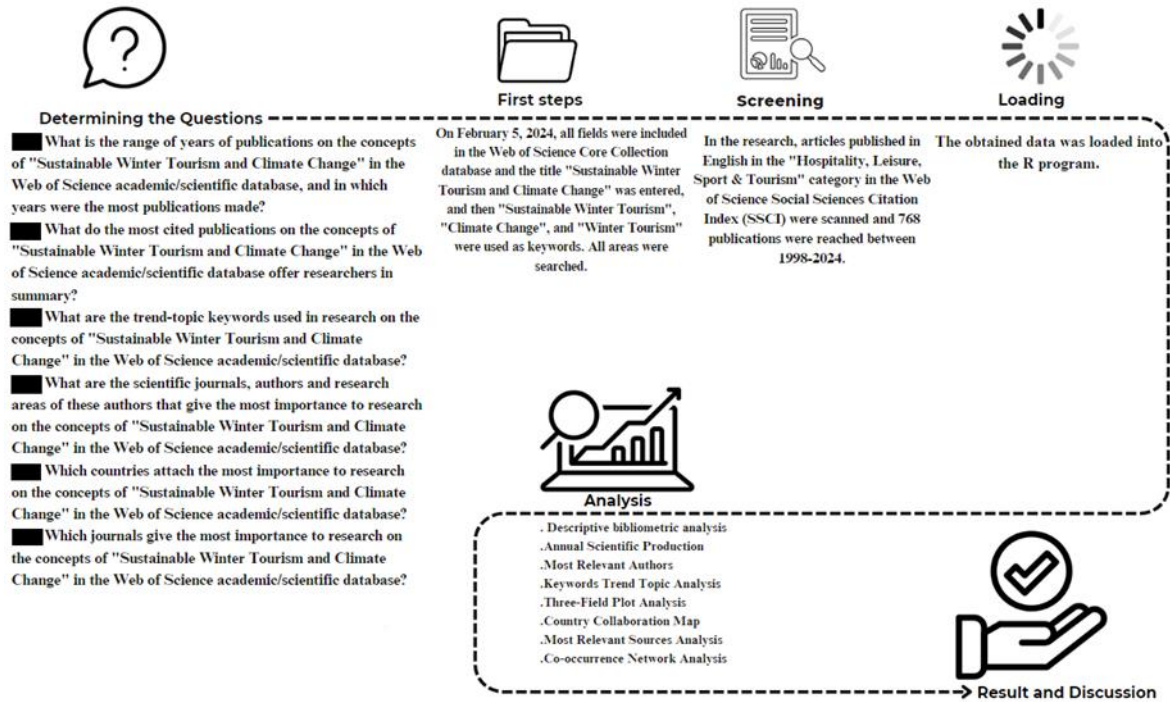
Although most ski resorts are not located in urban areas, ski resort towns face similar challenges as cities, such as heavy traffic congestion and high energy demand, especially during the peak season. In this context, it is important to utilize renewable energy sources and smart technologies to ensure the sustainable management of ski resorts. "Smart Altitude" projects represent an intersection between ski resorts and smart city concepts, particularly through the use of innovative strategies such as real-time energy monitoring, renewable energy integration, and smart energy usage. These approaches aim to manage energy more efficiently and support long-term climate resilience.

Ski resorts in the lower Alps are an example of those affected by climate change. Many resorts in this region are implementing systemic and local green initiatives in the hope of achieving a more sustainable future. However, for these initiatives to be truly effective and long-lasting, they must be supported by comprehensive policy frameworks and adaptive strategies tailored to the specific characteristics of each region. Low-carbon policies and adaptation strategies should therefore be based on regionally and locally grounded assessments of strengths and weaknesses in areas such as energy management, renewable energy potential, climate change adaptation and mitigation, and investment in governance structures (Polderman et al., 2020).

Various methodologies have been applied in the academic literature to assess the supply and demand side impacts of climate change on the ski tourism sector, as well as the sector's capacity to adapt. However, before diving into these technical aspects, it is important to present a brief conceptual framework to improve the accessibility and comprehension of the topic, especially for readers less familiar with it (Steiger, 2010).

The aim of this study is to examine the bibliometric characteristics of academic publications on the concepts of "Sustainable Winter Tourism and Climate Change" within the WoS database and to create network maps based on these characteristics. WoS was chosen as it is a reliable database encompassing comprehensive and high-impact academic publications. Furthermore, its rigorous indexing criteria ensure access to significant and high-quality studies, thereby enhancing the scientific credibility of this research. To facilitate understanding of the study, a bibliometric workflow diagram is presented in Figure 1.

## Bibliometric Workflow



**Figure.1.** Bibliometric Workflow Diagram

The research seeks to answer the following questions:

Q.1. What is the year range of the publications on the concepts of "Sustainable Winter Tourism and Climate Change" in the WoS academic/scientific database, in which years were the most publications made?

Q.2. What do the most cited publications on the concepts of "Sustainable Winter Tourism and Climate Change" in the WoS academic/scientific database offer to researchers in summary?

Q.3. What is the trend-topic keywords used in the researches on the concepts of "Sustainable Winter Tourism and Climate Change" in the WoS academic/scientific database?

Q.4. What are the scientific journals, authors and their research fields that give the most importance to the research on the concepts of "Sustainable Winter Tourism and Climate Change" in the WoS academic/scientific database?

Q.5. Which countries give the most importance to the research on the concepts of "Sustainable Winter Tourism and Climate Change" in the WoS academic/scientific database?

Q.6. Which journals in the WoS academic/scientific database give the most importance to research on the concepts of "Sustainable Winter Tourism and Climate Change"?

### 1. Literature Review

As sustainable tourism research has developed over the decades, it has embraced cognate concepts and has remained the umbrella concept for appraising the development of tourism (Niewiadomski & Brouder, 2024). Sustainable tourism is defined as "the use and development of environmental resources to meet the needs and preferences of today's tourists, while at the same time preserving these resources for the benefit of future tourists and the local community (Hughes, 1995). Climate change is a multifaceted issue that will

affect people through various mechanisms. In particular, tourism is a multi-sectoral industry that depends heavily on the natural environment and climatic conditions, and is therefore especially vulnerable to the impacts of climate change (Gössling & Scott, 2025). Winter tourism destinations are characterized by unique natural landscapes and climatic conditions that shape their appeal. As the impacts of climate change accelerate, winter tourism resorts are expected to undergo a profound transformation. In response to these challenges, researchers have increasingly focused on understanding how climate change affects the winter tourism sector and how destinations can adapt (Beyazit & Koc, 2010). Various methodologies have been used to assess both the supply and demand side impacts of climate change and the capacity of the ski industry to adapt to climate change. It is necessary to provide an overview of the geographically and methodologically diverse literature on this topic (Steiger, 2010).

One of the most common adaptation strategy plans implemented by ski resorts is the artificial snowmaking technique. The artificial snowmaking technique creates different costs for ski resorts (Steiger & Mayer, 2008). Hopkins (Hopkins, 2014), in his research in Queenstown, New Zealand, concluded that snowmaking technology as a medium/long-term climate change adaptation strategy may be constrained by atmospheric conditions, resource access, financial cost and public perceptions, therefore, more research is needed to critically examine the long-term sustainability of snowmaking for climate change adaptation.

The leading impacts of climate change on winter tourism include rising winter temperatures, shorter snow seasons and reduced snow cover depth. Especially since 2000, there has been a growing body of research on climate changes affecting winter destination activities (Burakowski et al., 2008).

The World Meteorological Organization (WMO) published an announcement on its official website on October 3, 2024, stating that the partnership with the International Ski and Snowboard Federation (FIS) draws attention to the negative effects of climate change on winter sports and tourism. This collaboration is considered an important step in terms of WMO's first joint initiative with an international sports federation. The cancellation of 26 of the 616 World Cup races organized by FIS in the 2023/24 season due to weather conditions reveals the concrete effects of climate change on winter sports. Within the scope of this agreement, which will enter into force as of the 2024/25 winter season, WMO and the National Meteorological and Hydrological Services aim to combat the increasingly evident effects of climate change by making their science based data and expertise available in the field of (FIS) winter sports and mountain tourism.

In addition, a 2023 study conducted by French and Austrian scientists and published in the journal *Nature Climate Change* reveals the potential impacts of global temperature increases on ski resorts. According to the study, if global temperature increases reach 2°C, 53% of the 2,234 ski resorts in Europe would be at serious risk of snow supply without artificial snow production, and 98% if they reach 4°C. These findings emphasize the need to limit global warming by reducing greenhouse gas emissions.

Furthermore, Switzerland, where both the FIS and the WMO are headquartered, has recorded a marked upward shift in the zero-degree isotherm level, increasing from roughly 600 meters above sea level fifty years ago to nearly 850 meters today, reflecting the tangible consequences of climate warming in alpine regions. According to ((SCNAT), 2018)report, if current emission levels continue, this level will reach 1,300–1,500 meters by 2060. These predictions pose significant risks to the future of winter tourism and snow sports and reveal the need for policies and strategies to mitigate the effects of climate change.

In light of these challenges, the theoretical framework of this study is grounded in Sustainable Tourism Development and Climate Change Adaptation Theories. Sustainable tourism emphasizes the balance between environmental conservation, economic viability, and social responsibility, which is particularly relevant for ski resorts facing climate induced vulnerabilities (Elsasser & Bürki, 2002). Climate change adaptation theories, on the other hand, provide a structured approach to understanding how tourism-dependent regions can enhance their resilience through proactive mitigation strategies. Integrating these perspectives allows for a comprehensive analysis of how ski resorts can transition towards low-carbon, climate-resilient operations while maintaining their economic viability and visitor appeal (Scott et al., 2012). Future research should further explore innovative adaptation measures, policy implications, and stakeholder collaboration to ensure the long-term sustainability of winter tourism in the face of accelerating climate change.

## 2. Methodology

This study is based on data retrieved from the Web of Science (WoS) database. WoS is one of the most widely utilized academic platforms, enabling researchers to access peer-reviewed publications across a wide range of disciplines (Fang et al., 2018). It offers comprehensive bibliographic records, including citation data, abstracts, keywords, and full publication details.

To examine the academic landscape surrounding the concepts of Sustainable Winter Tourism and Climate Change, this study employs bibliometric analysis a quantitative method used to assess the productivity, evolution, and intellectual structure of scholarly literature. Bibliometric analysis provides valuable insights into the development of a specific research field and helps identify emerging trends (Andrés, 2009).

Researchers frequently apply bibliometric techniques to analyze article and journal performance, track patterns of scholarly collaboration, and explore thematic networks and conceptual frameworks within the literature. By systematically organizing and interpreting large scale, often unstructured datasets, bibliometric analysis serves as a powerful tool for mapping the knowledge structure of a field. Well-designed bibliometric studies thus contribute significantly to identifying knowledge gaps, gaining new insights, and positioning academic work within the broader scientific context (Donthu et al., 2021).

In this study, data analysis and visualization were carried out using R programming language and the bibliometrix package, an open-source software environment specifically designed for bibliometric research (Aria & Cuccurullo, 2017). A workflow diagram was constructed to provide a clear representation of the methodological steps undertaken in the analysis.

R is a widely adopted statistical programming language developed by the R Core Team and distributed under the GNU General Public License. It includes a broad spectrum of statistical and analytical tools such as linear regression, hypothesis testing, time series analysis, clustering, and categorical data analysis. Due to its robust capabilities in data mining, statistical computing, and graphical representation, R is commonly used in scientific research across disciplines (Dalgaard, 2008).

In alignment with the research objectives, the Co-word Analysis method was applied to examine conceptual relationships and thematic structures within the literature. This technique identifies the co-occurrence patterns of keywords and terms in academic publications, thus revealing how key concepts such as “Sustainable Winter Tourism” and “Climate Change” are interconnected and in what academic contexts they have been studied.

The dataset was collected from the WoS Core Collection on February 5, 2024. Initially, a search was conducted using the phrase "Sustainable Winter Tourism and Climate Change" in all fields. Subsequently, a broader query was executed using the keywords "Sustainable Winter Tourism", "Climate Change", and "Winter Tourism". The search was limited to English-language articles classified under the "Hospitality, Leisure, Sport & Tourism" category within the Social Sciences Citation Index (SSCI).

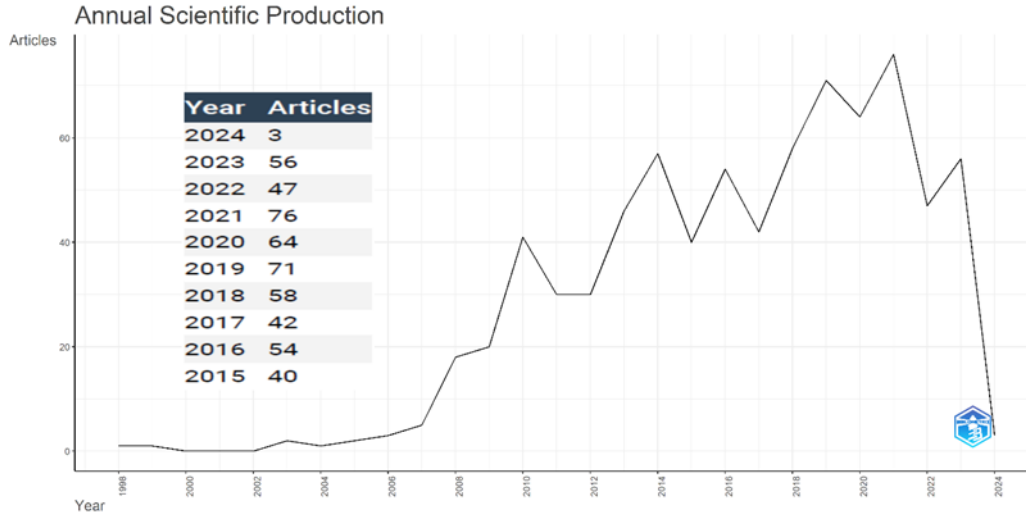
As a result of the search process, 768 publications published between 1998 and 2024 were identified. Bibliographic data including article titles, abstracts, author keywords, and citation counts were extracted for further analysis. A summary of the general characteristics of the dataset is presented in Table 1.

Table.1. General Characteristics of the Research

Description	Results
<b>MAIN INFORMATION ABOUT DATA</b>	
Timespan	1998:2024
Documents	768
Annual Growth Rate	%4.32
Document Average Age	7.42
Average citations per doc	34.35
<b>DOCUMENT CONTENTS</b>	
Keywords Plus (ID)	1197
Author's Keywords (DE)	2217
<b>AUTHORS</b>	
Authors	1406
Authors of single-authored docs	98
<b>AUTHORS COLLABORATION</b>	
Single-authored docs	129
Co-Authors per Doc	2.77
International co-authorships %	37.37
<b>DOCUMENT TYPES</b>	
Article	768

According to the data obtained, it is seen that the first publication was made in 1998 according to the related searches. According to the related search titles, a total of 868 publications were reached and among these publications, books, book chapters and papers were excluded and only articles were included in the research. There are 768 articles included in the study. In the analysis of the obtained article data, interpretations were made on the last ten years of data in the relevant studies years draws attention. In particular, the highest number of publications was reached in 2019-2020-2021. According to the years, the annual growth rate of authors' studies on this subject is 4.32%. Global measures against climate change have started to be taken rapidly. The first global meeting on this issue was formalized in 1997 with the Kyoto Protocol. Within the scope of this protocol, 37 developed countries and the European Community took joint decisions on reducing greenhouse

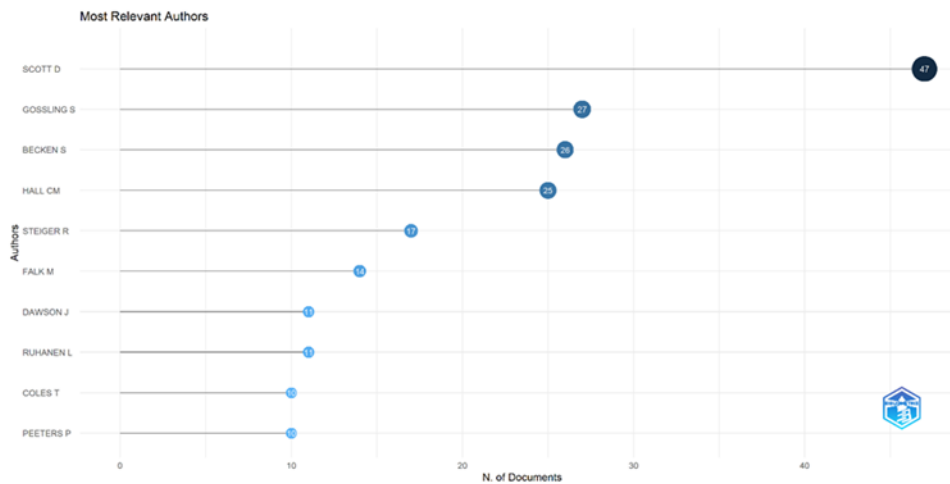
gases. However, no emission reduction was achieved in line with the decisions taken, on the contrary, the increase in greenhouse gases continued. In the following years, in 2011, the United National Framework Convention on Climate Change (UNFCCC) became a legally binding agreement for countries (Pang et al., 2013). With the Paris Agreement signed in 2015, road maps were drawn to keep global warming below 20 degrees, and countries were encouraged to limit greenhouse gases after 2020 (Scott, 2021). The number of studies on sustainable winter tourism and climate change by years is given in Figure 2.



**Figure.2.** Annual Scientific Production

#### 4.2. Most cited authors (Most Relevant Authors Analysis)

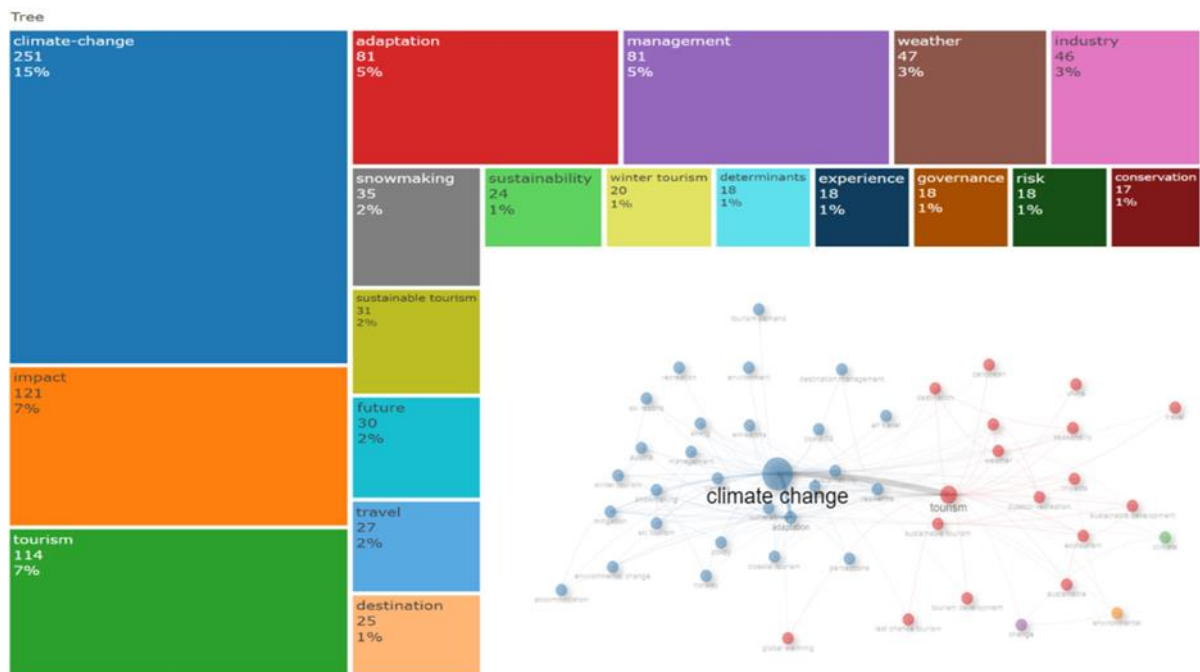
The researcher with the most publications on sustainable winter tourism and climate change is Daniel Scoot. Daniel Scoot's expertise is in the fields of Global Change and Tourism. He has worked on the humanitarian aspects of climate change and contributed to the Third and Fourth Assessment Reports of the United Nations Intergovernmental Panel on Climate Change (Scott, 2011). Stefan Gosling is one of the important researchers who contributed to the field with his studies on climate change and tourism. The studies of the researcher, who generally deals with climate change and international tourism issues in his studies, serve as a source for researchers who will study sustainable winter tourism and climate change. The data of other researchers who will benefit from their studies on sustainable winter tourism and climate change are given in Figure 3.



**Figure.3.** Most Cited Authors

**4.3. Keywords Trend Topic Analysis (Keywords Trend Topic Analysis) keywords and Co-occurrence Network Analysis (Co-occurrence Network Analysis) keywords used in publications**

Synonym analysis is based on the assumption that the keywords used to index articles in scientific databases reflect the scientific argument of the article. This analysis is an important tool for understanding the rhetoric of scientific articles. It is predicted that arguments that are well received by indexers will lead to the publication of more articles indexed with similar keyword sequences. Thus, the pair of keywords used to index each article is considered to represent a close relationship between the topics it cites (Law & Whittaker, 1992). Climate change, which has become a very important issue for winter tourism over the years, has always been among the issues that need to be analyzed and thought about by researchers. The studies conducted by scientists on sustainable winter tourism and climate change aim to understand the impacts of climate change on winter tourism and to develop strategies to cope with these impacts. When we look at the studies, the keywords climate change, tourism, impact and sustainability are among the most used keywords. Tourism, climate change and sustainability have always appeared together in publications. Figure 4 below shows the most frequently used keywords in the related studies and the keyword network graph according to their usage together. The blue network map indicates the "Climate Change" topics in the studies, while the red network map indicates the "Tourism" topics in the studies. The thick lines between the blue and red areas indicate which keywords are commonly used in the studies. The thickness of the web line between the words indicates the frequency of use. Figure 4 shows that the keywords "Climate Change" and "Tourism" are the keywords most frequently used together in the studies.



**Figure.4.** Trend Topic Keywords and Association Network

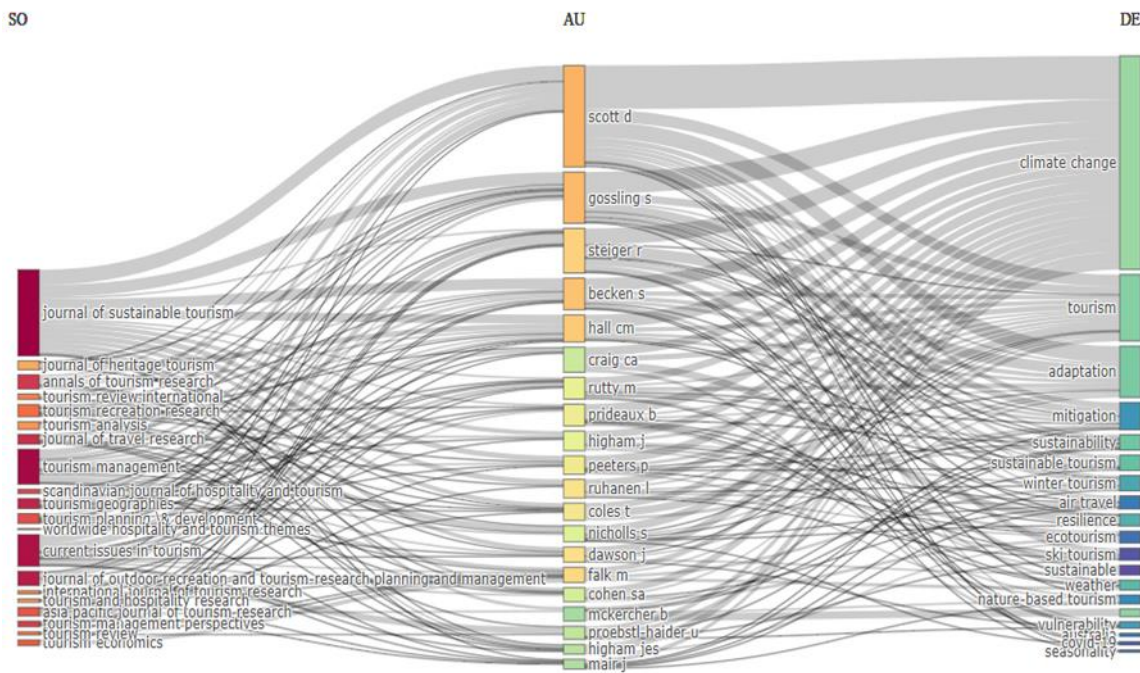
**4.4. Journal-author-keyword analysis of publications (Three-Field Plot Analysis)**

Researchers use different approaches when conducting literature reviews. One of these, the "popularity-based approach", involves bibliometric analysis techniques. This method provides information about research areas by examining authors' keywords and titles of published articles. In

particular, bibliometric analysis can provide additional data such as authors, institutions, popular words, keywords and their frequency of use, providing information not available in other reviews (Choi et al., 2011).

Scientists are investigating the effects of climate change on snow cover, seasonal precipitation, temperature and natural habitats in winter tourism regions. These are all critical factors for the sustainability of ski resorts. Researchers are working to identify the risks posed by climate change in winter tourism destinations and to develop appropriate management strategies (Pröbstl et al., 2008)

These strategies include the use of alternative energy sources, water resource management, sustainable transportation systems and environmental impact assessments. It is important that other scientists have easy access to the works produced by scientists over the years. According to the Three-Field Plot Analysis, which includes the authors of the journals that contribute the most to the field in terms of climate change and sustainable winter tourism and the keywords they use; we can see in Figure 5 that the journals that contribute the most to science on this subject are the "Journal of Sustainable Tourism", while the authors who publish the most on the relevant subject are Daniel Scott, Stefan Gosling and that they use the keywords "Climate Change" and "Tourism" the most in their studies.



**Figure.5.** Journal-Author-Keyword Analysis of Publications

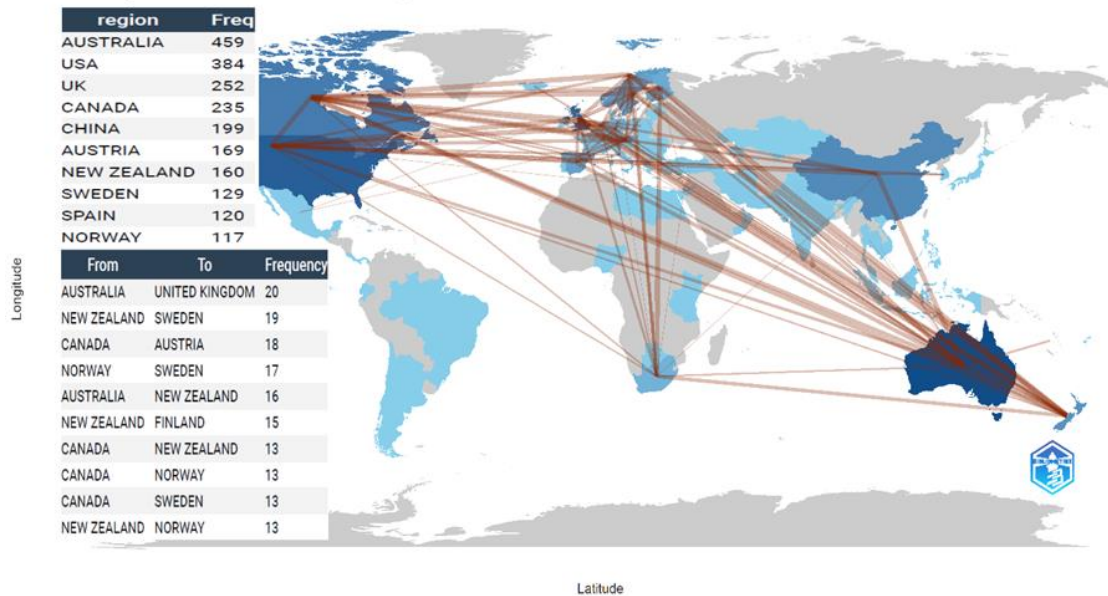
#### 4.5. Distribution of publications by country (Country Collaboration Map)

Australia is at the forefront with 459 publications on "Sustainable Winter Tourism and Climate Change", while the USA ranks second with 384 publications. When the collaborative networks are analyzed, it is seen that countries such as Australia and the United Kingdom, New Zealand and Sweden, Canada and Austria stand out. This shows that scientists attach importance to this issue not only nationally but also globally.

Research collaborations are vital for effective productivity, increased impact and deep innovation in science. Stronger partnerships underpin a science strategy that enables individuals and institutions to conduct world-class scientific research (Hu et al., 2020). Over the last decade, international

cooperation to tackle climate change has become more diverse, reflecting different scales of governance and greater integration of climate change issues into other policy areas. Cooperation under the United Nations Framework Convention on Climate Change progressed from the Kyoto Protocol to the Paris Agreement from 1997 to 2015, and other government and private sector international cooperation forums have also emerged. As cooperation in international climate change mitigation efforts increases, the relevant scientific literature is also expanding (Chan et al., 2018). The countries that have done the most work on the topic and the data from the association analysis are given in Figure 6.

### Country Collaboration Map



**Figure.6.** Most Published Journals and Number of Citations

Journal of Sustainable Tourism is a leading tourism journal that advances critical understanding of the relationships between tourism and sustainable development. It publishes theoretical, conceptual and empirical research that explores one or more of the economic, social, cultural, political, organizational or environmental aspects (Tourism, 2024).

Tourism Management is a leading scientific journal focusing on the management of tourism, travel and tourism, including planning and policy. The journal publishes reviews of international, national and regional tourism as well as specific management issues with an interdisciplinary approach (Tourism Management;2024).

Tourism Geographies examines the fields of tourism and tourism-related recreation and leisure studies from a geographical perspective. It is a journal that examines and publishes multidisciplinary approaches from related fields such as geography, anthropology and other social sciences, landscape architecture, urban and regional planning, and environmental science and management (Geographies, 2024).

### CONCLUSION

Numerous studies have examined the consequences of climate change for winter sports and tourism, which constitute critical economic sectors in mountainous and Scandinavian regions. A comprehensive investigation conducted by French and Austrian researchers and published in Nature Climate Change in 2023 analyzed 2,234 ski resorts across 28 European countries. The findings indicate that, in the absence of artificial snow production, 53% of these resorts are projected to face

very high risks to snow reliability under a 2°C global warming scenario, a proportion that increases dramatically to 98% under a 4°C scenario. The study further underscored broader environmental implications, particularly the urgency of limiting global temperature rise through substantial reductions in greenhouse gas emissions.

In Switzerland—host to both the International Ski and Snowboard Federation and the World Meteorological Organization—comprehensive climate projections reinforce these concerns. Since 1850, Alpine glaciers have experienced an estimated 60% reduction in volume. Data from MeteoSwiss reveal that, since 1970, the number of snowfall days below 800 meters has decreased by approximately half, largely due to a higher proportion of winter precipitation occurring as rain rather than snow. Whereas the zero-degree isotherm was situated around 600 meters above sea level five decades ago, it is currently observed at approximately 850 meters, reflecting increasingly warmer winter conditions. According to the Swiss Climate Change Scenarios CH2018, in the absence of effective mitigation efforts, the zero-degree level is expected to rise by an additional 400–650 meters by 2060, reaching elevations between 1,300 and 1,500 meters (World Meteorological Organization, 2024).

Recognizing the severity of the climate crisis, numerous ski destinations have initiated both systemic and localized sustainability measures aimed at reducing their environmental footprint. These developments highlight the necessity of aligning short-term emission reduction policies with long-term strategies that foster technological innovation and structural transformation. Addressing climate change in winter tourism therefore requires not only further scientific inquiry but also a critical reassessment of financial incentives, energy governance frameworks, international agreements, and principles of global equity. Technological innovations must move beyond experimental settings and achieve large-scale implementation if meaningful and durable transformation is to be realized. (Clark et al., 2016).

Although national tourism policies increasingly acknowledge both the vulnerability of destinations to climate change and the sector's contribution to environmental degradation, they also outline a range of strategic pathways to achieve low-emission and climate targets. These policy frameworks generally emphasize the integration of climate adaptation and mitigation measures within tourism planning and operations. Key priorities include reducing dependence on fossil fuels, enhancing energy efficiency across tourism facilities and services, and accelerating the adoption of renewable energy sources. In addition, many national strategies advocate for the development and implementation of sustainable governance models, regulatory instruments, and management practices designed to ensure long-term environmental responsibility within the tourism sector. Collectively, these approaches reflect a growing recognition that tourism policy must move beyond acknowledgment of climate risks and actively embed sustainability principles into institutional, operational, and investment decisions. (Tourism, 2023). Studies on Sustainable Winter Tourism and Climate Change should be handled on a global scale rather than a national scale (Maráková et al., 2025). Research addressing Sustainable Winter Tourism and Climate Change should be evaluated through an integrative perspective, enabling the formulation of coherent and evidence-based policy frameworks. Synthesizing existing findings rather than treating studies in isolation enhances conceptual clarity and strengthens policy relevance. In this regard, periodic bibliometric analyses and systematic review studies play a critical role in ensuring that accumulated scientific knowledge remains accessible, traceable, and strategically organized for diverse stakeholders.

Scholars, national research agendas, and academic journals that prioritize Sustainable Winter Tourism and Climate Change significantly shape the intellectual and policy landscape of the field. Their contributions extend beyond theoretical advancement by generating actionable recommendations aimed at safeguarding the long-term viability of winter tourism destinations. Such policy guidance primarily seeks to enhance the sector's resilience to climate-related risks while embedding sustainability principles into governance and operational structures. Commonly proposed measures include improving the energy efficiency of winter tourism infrastructure, reducing reliance

on fossil fuels, expanding the integration of renewable energy sources, conserving natural assets, and supporting ecosystem restoration initiatives. The systematic implementation of these strategies would not only mitigate environmental pressures but also facilitate a structural transition toward a more sustainable and climate-resilient winter tourism model. Ultimately, this transformation is essential for preserving ecological integrity and ensuring intergenerational environmental responsibility. (Balaskas et al., 2025). Climate change is a problem that needs to be addressed not through the efforts of a single country, but with a global perspective and cooperation. Policies and agreements need to be established and implemented at the international level to protect the sustainability of winter tourism destinations and minimize the impacts of climate change. Cooperation between countries allows for the identification of common strategies for reducing greenhouse gas emissions, promoting the use of renewable energy, protecting natural resources and restoring ecosystems (Agrawala, 2007) . International collaboration constitutes a fundamental pillar in addressing the challenges posed by climate change to winter tourism. Effective cooperation facilitates the exchange of knowledge and best practices, enables technology transfer, and mobilizes financial resources necessary for both mitigation and adaptation efforts. Multilateral engagement also strengthens institutional capacity and promotes policy harmonization across regions that share similar environmental vulnerabilities. Through international climate frameworks such as the Paris Agreement, numerous countries have committed to pursuing a shared vision centered on limiting global temperature rise and implementing coordinated action plans. While such commitments represent significant progress, the current scale and pace of climate impacts indicate that deeper cooperation and more structured coordination mechanisms remain necessary. Strengthening transnational partnerships would enhance the design and enforcement of comprehensive, science-based policies tailored to the specific needs of winter tourism destinations. In this context, sustained intergovernmental collaboration emerges as a decisive factor in advancing sustainable winter tourism and reinforcing global climate governance. Without collective action, isolated national efforts are unlikely to generate the systemic transformation required to secure the long-term viability of the winter tourism sector in a warming world.

### **Ethical Statement**

I hereby solemnly declare that the research titled "Conceptualization Of Publications On 'Sustainable Winter Tourism And Climate Change': A Bibliometric Analysis Using R Programming", authored by me, has been conducted in full accordance with established ethical standards and principles.

### **Financial support**

Financial support is not available.

### **REFERENCES:**

- Agrawala, S. (2007). Climate change in the European Alps: Adapting winter tourism and natural hazards management. Organisation for Economic Cooperation and Development (OECD).
- Andrés, A. (2009). Measuring academic research: How to undertake a bibliometric study. Elsevier.
- Aria, M., & Cuccurullo, C. (2017). Bibliometrix: An R-tool for comprehensive science mapping analysis. *Journal of Informetrics*, 11(4), 959–975. <https://doi.org/10.1016/j.joi.2017.08.007>
- Balaskas, S., Yfantidou, I., & Komis, K. (2025). From awareness to action: Modeling sustainable behavior among winter tourists in the context of climate change. *Psychology International*, 7(3), 72.
- Beyazit, M. F., & Koc, E. (2010). An analysis of snow options for ski resort establishments. *Tourism Management*, 31(5), 676–683. <https://doi.org/10.1016/j.tourman.2009.07.002>

- Burakowski, E. A., Wake, C. P., Braswell, B., & Brown, D. P. (2008). Trends in wintertime climate in the northeastern United States: 1965–2005. *Journal of Geophysical Research: Atmospheres*, 113(D20). <https://doi.org/10.1029/2008JD009870>
- Chan, G., Stavins, R., & Ji, Z. (2018). International climate change policy. *Annual Review of Resource Economics*, 10, 335–360. <https://doi.org/10.1146/annurev-resource-100517-023321>
- Choi, J., Yi, S., & Lee, K. C. (2011). Analysis of keyword networks in MIS research and implications for predicting knowledge evolution. *Information & Management*, 48(8), 371–381. <https://doi.org/10.1016/j.im.2011.09.004>
- Clark, P. U., Shakun, J. D., Marcott, S. A., Mix, A. C., Eby, M., Kulp, S., Levermann, A., Milne, G. A., Pfister, P. L., & Santer, B. D. (2016). Consequences of twenty-first-century policy for multi-millennial climate and sea-level change. *Nature Climate Change*, 6(4), 360–369. <https://doi.org/10.1038/nclimate2923>
- Dalgaard, P. (2008). *Introductory statistics with R*. Springer. <https://doi.org/10.1007/978-0-387-79054-1>
- Donthu, N., Kumar, S., Mukherjee, D., Pandey, N., & Lim, W. M. (2021). How to conduct a bibliometric analysis: An overview and guidelines. *Journal of Business Research*, 133, 285–296. <https://doi.org/10.1016/j.jbusres.2021.04.070>
- Elsasser, H., & Bürki, R. (2002). Climate change as a threat to tourism in the Alps. *Climate Research*, 20(3), 253–257. <https://doi.org/10.3354/cr020253>
- Fang, Y., Yin, J., & Wu, B. (2018). Climate change and tourism: A scientometric analysis using CiteSpace. *Journal of Sustainable Tourism*, 26(1), 108–126. <https://doi.org/10.1080/09669582.2017.1329310>
- FIS. (3 OCTOBER 2024). *FIS and WMO partnership highlights the harmful effects of climate change on winter sports and tourism*. [https://www.fis-ski.com/inside-fis/news/2024-25/fis-and-wmo-partnership-highlights-the-harmful-effects-of-climate-change-on-winter-sports-and-tourism?utm\\_source=chatgpt.com](https://www.fis-ski.com/inside-fis/news/2024-25/fis-and-wmo-partnership-highlights-the-harmful-effects-of-climate-change-on-winter-sports-and-tourism?utm_source=chatgpt.com)
- Gössling, S., & Scott, D. (2025). Climate change and tourism geographies. *Tourism Geographies*, 27(3-4), 642-652.
- Hopkins, D. (2014). The sustainability of climate change adaptation strategies in New Zealand's ski industry: A range of stakeholder perceptions. *Journal of Sustainable Tourism*, 22(1), 107–126. <https://doi.org/10.1080/09669582.2013.804830>
- Hu, Z., Tian, W., Guo, J., & Wang, X. (2020). Mapping research collaborations in different countries and regions: 1980–2019. *Scientometrics*, 124, 729–745. <https://doi.org/10.1007/s11192-020-03498-6>
- Hughes, G. (1995). The cultural construction of sustainable tourism. *Tourism Management*, 16(1), 49–59.
- Journal of Sustainable Tourism. (2024). *Journal of Sustainable Tourism*. Retrieved from <https://www.tandfonline.com/journals/rsus20>

- Law, J., & Whittaker, J. (1992). Mapping acidification research: A test of the co-word method. *Scientometrics*, 23(3), 417–461. <https://doi.org/10.1007/BF02016662>
- Maráková, V., Lament, M., Krištofík, P., & Bukowski, S. (2025). Climate change as a socio-economic challenge for the tourism sector: an econometric analysis of countries with the highest economic losses. *Technological and Economic Development of Economy*, 31(5), 1644-1664.
- Niewiadomski, P., & Brouder, P. (2024). From 'sustainable tourism' to 'sustainability transitions in tourism'? In (Vol. 26, pp. 141-150): Taylor & Francis.
- One Planet Network. (2024). Tourism & climate change - Policy snapshot. Retrieved from <https://www.oneplanetnetwork.org/programmes/sustainable-tourism/glasgow-declaration/policy-snapshot>
- Pang, S. F., McKercher, B., & Prideaux, B. (2013). Climate change and tourism: An overview. *Asia Pacific Journal of Tourism Research*, 18(1–2), 4–20. <https://doi.org/10.1080/10941665.2012.688509>
- Polderman, A., Haller, A., Viesi, D., Tabin, X., Sala, S., Giorgi, A., Darmayan, L., Rager, J., Vidovič, J., & Daragon, Q. (2020). How can ski resorts get smart? Transdisciplinary approaches to sustainable winter tourism in the European Alps. *Sustainability*, 12(14), 5593. <https://doi.org/10.3390/su12145593>
- Pröbstl, U., Prutsch, A., Formayer, H., Landauer, M., Grabler, K., Kulnig, A., Jesch, M., Dallhammer, E., & Krajasits, C. (2008). Climate change in winter sport destinations—transdisciplinary research for implementing sustainable tourism. *WIT Transactions on Ecology and the Environment*, 115, 289–298. <https://doi.org/10.2495/ST080281>
- Scott, D. (2011). Why sustainable tourism must address climate change. *Journal of Sustainable Tourism*, 19(1), 17–34. <https://doi.org/10.1080/09669582.2010.539694>
- Scott, D. (2021). Sustainable tourism and the grand challenge of climate change. *Sustainability*, 13(4), 1966. <https://doi.org/10.3390/su13041966>
- Scott, D., Gössling, S., & Hall, C. M. (2012). International tourism and climate change. *Wiley interdisciplinary reviews: Climate change*, 3(3), 213-232. <https://doi.org/10.1002/wcc.165>
- (SCNAT), S.A.o.S. (2018). *CH2018 –Climate Scenarios for Switzerland*. [https://scnat.ch/en/uuid/i/9f501878-b55b-5c6e-a203-a000d8266a4c-CH2018-%E2%80%93Climate Scenarios for Switzerland](https://scnat.ch/en/uuid/i/9f501878-b55b-5c6e-a203-a000d8266a4c-CH2018-%E2%80%93Climate%20Scenarios%20for%20Switzerland)
- Steiger, R. (2010). The impact of climate change on ski season length and snowmaking requirements in Tyrol, Austria. *Climate Research*, 43(3), 251–262. <https://doi.org/10.3354/cr00941>
- Steiger, R., & Mayer, M. (2008). Snowmaking and climate change. *Mountain Research and Development*, 28(3), 292–298. <https://doi.org/10.1659/mrd.0978>
- Tourism, U. (2023). *Climate Action*. [https://www.untourism.int/sustainable-development/climate-action?utm\\_source=chatgpt.com](https://www.untourism.int/sustainable-development/climate-action?utm_source=chatgpt.com)
- Tourism Geographies. (2024). *Tourism Geographies*. Retrieved from <https://www.tandfonline.com/journals/rtxg20>

Tourism Management. (2024). Tourism Management. Retrieved from <https://www.sciencedirect.com/journal/tourism-management>

World Meteorological Organization (WMO). (2024). FIS and WMO partnership highlights the harmful effects of climate change on winter sports and tourism. <https://wmo.int/news/media-centre/fis-and-wmo-partnership-highlights-harmful-effects-of-climate-change-winter-sports-and-tourism>

Zhijian, B., & Yang, Z. (2025). Impact of Climate Change on Ski Tourism: A Review. *Journal of Resources and Ecology*, 16(3), 898-906.