KEY TRENDS AND DYNAMICS IN ECOLOGICAL DIMENSIONS OF SUSTAINABLE TOURISM DEVELOPMENT: A BIBLIOMETRIC STUDY

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Abstract. *The academic literature clearly demonstrates that sustainable tourism development (STD) is no longer a voluntary, simple process that countries should follow. Rather, STD is an absolute necessity to preserve ecology and help communities cope with resource depletion and environmental degradation. For this reason, a Scopus-based bibliometric dataset is used in this study to investigate the intersection of the ecological aspects of sustainable tourism. The present bibliometric study covers the period from 1992 to 2025 (July) and uses VOSviewer software to uncover the underlying patterns of STD publications. Based on a co-occurrence analysis of the keywords, this study shows that sustainable tourism in protected areas is characterized by complex interactions between stakeholders, reflecting underlying power dynamics and governance challenges. The results confirm that economic growth has begun to consider STD in developing countries in a multidisciplinary and intercultural context. Specific methods such as coupling coordination, spatiotemporal analysis and carbon sequestration have become an important scientific field in recent years. In addition, analysis of the most cited papers in the dataset showed that reconceptualizing STD in the context of failed tourism destinations, the transition to a greener economy and the environmental consequences of human actions are quite popular themes used by scholars. The current findings are of great interest to key stakeholders in government, the tourism industry and academia to understand specific dimensions of bibliometric trends in the STD-related literature.*

Keywords: *Bibliometric study, Ecology, Green transition, Sustainable tourism.*

1. Introduction

Tourism is one of the largest and fastest growing economic sectors in the world. Tourism holds immense potential for wealth creation. However, its conventional models are often associated with significant environmental costs. This also has an impact on local cultures and social justice. Consequently, sustainable tourism development (STD) has evolved from a niche concept to an urgent societal need.

STD is defined as follows: *Tourism that fully considers its current and future economic, social and environmental impacts, considering the needs of visitors, the industry, the environment and host communities (UNWTO)*. Sustainable tourism is becoming increasingly important to societies worldwide as it helps to mitigate environmental degradation, ensure long-term economic viability, promote social equity and preserve cultural heritage (Bunghez, 2016).

Ecosystems and natural resources are severely strained by unsustainable tourism practices. Conventional mass tourism contributes to habitat destruction, biodiversity loss, air, water, noise and plastic pollution, as well as excessive energy and water use. The detrimental effects of unsustainable tourism are particularly apparent in delicate environments like islands, mountains and coasts (Gössling et al., 2012).

Another aspect of unsustainable tourism practices is climate change (Scott et al., 2012). Since STD actively works to reduce these environmental footprints, it is essential. This includes implementing resource-efficient techniques (such as waste reduction, water conservation and renewable energy). Typical measures include encouraging eco-friendly modes of transportation, assisting with conservation initiatives and safeguarding biodiversity through prudent visitor management (Buckley, 2012). To sustain essential services (such as clean water, air, food and climate regulation), societies rely on healthy ecosystems. As a result, STD might soon become a necessity for maintaining environmental resilience and the planet's long-term health.

Given the dynamic nature of STD, this study analyzes biometric trends of the concept from an ecological perspective. This means that the rich literature on the relationship between STD and ecology was analyzed using the Scopus database and VOSviewer software. The research questions of the current study are as follows: How has the volume of research on STD in ecological contexts evolved over time (e.g., annual publication trends, key growth phases)? What are the predominant thematic clusters in STD and ecology research (e.g., ecotourism, carbon footprint, biodiversity conservation) and how have these themes changed over time? How do interdisciplinary connections (e.g., between environmental, economic and tourism sciences) manifest themselves in the STD ecology literature? Our research aim is therefore to create a bibliometric map of the current state of knowledge to identify important trends and dynamics. In this way, the current study traces specific knowledge gaps related to recently published work in the field of the STD-ecology nexus.

We can confirm that the current bibliometric study effectively captures the complex relationships between the keywords that describe STD from an ecological perspective. This topic needs to be revisited and evaluated repeatedly to raise awareness among the readerships. Ongoing bibliometric evaluations can not only track evolving trends in ecological discourse within STD but also help identify emerging gaps and interdisciplinary connections. Therefore, we believe that this study provides some benefit in the context of STD.

The next section contains a literature review on STD in different countries. Section three presents the data and methodology of the present study in detail. Section four briefly presents the results, while section five discusses the results in detail. Section six concludes.

2. Literature review

2.1. Overall conceptualization

Sustainable tourism is defined as "meeting the needs of present tourists and the host community while protecting and enhancing opportunities for the future." It ensures that resources are managed to satisfy economic, social and aesthetic requirements while preserving cultural integrity, crucial ecological processes, biological diversity and life support systems (Yang et al., 2023). Sustainable development term started to gain importance and be discussed thanks to World Commission on Environment and Development (WCED) published in 1987 and called Brundtland Report shortly. According to WCED sustainable development is described as *"a development that meets the needs of the present without compromising the ability of future generations to meet their*

own need" (Bayramli, 2024). Sustainable tourism has emerged as a significant priority for governments, businesses and visitors worldwide. The concept of sustainable tourism acknowledges that travel and tourism can have both positive and negative effects on the environment, society and economy, and it tries to encourage socially, ecologically and economically responsible tourism (Li et al., 2023).

The first step seeking sustainability in tourism business is the identification of problems (Angelevska-Najdeska & Rakicevik, 2012). One of the most painful problems in tourism are: non-traditional kinds of tourism, sorting of waste and seasoning. Having identified problems—it is necessary to prepare a plan of the key measures and a strategy. Having commenced the implementation of the actions and having gained positive activity outcomes, the next stage for the strengthening of the sustainable tourism are extra actions, which would assure the stability of the achieved result. Analyzing scientific literature, the following key aspects of STD can be defined: *creation of new workplaces including employment opportunities in tourism destinations, preservation of natural environment, climate change mitigation, pollution and waste reduction, promotion of green and sustainable consumption practices* (Streimikiene et al., 2020).

Tourism is one of the world's largest economic sectors and generates 10.4 % of global GDP in 2018. It contributed to around 4% of the world's GDP in 2019. On the negative side, around 5% of carbon dioxide emissions emanates from travel-related activities in the same year (Agarwal et al., 2024). Tourists often do not realize that their arrival at a given place may have a negative impact on the local economy or residents. But they seem to forget that the inhabitants in such destinations live normal lives and work, despite the holiday season and increased number of tourists (Zaei & Zaei, 2013). They often work hard so that the tourists can forget about their problems and relax. The inhabitants often have to tolerate tourists who do not respect their rights. It also happens that tourists do not respect the place they visit. They go in where they are not allowed, they drop litter, destroy monuments or take "something" as a souvenir. Therefore, the promotion of sustainable tourism and the rights of local communities is also important and should be respected by tourists (Ingaldi & Dziuba, 2022).

Although tourism market is dependent on the health and natural environment, however simultaneously it often affects them negatively. Therefore, environmental issues of tourism development require special attention and were addressed by several important studies (Streimikiene et al., 2020). The development of sustainable tourism faces many barriers to its implementation, which can include economic, social, political and environmental barriers. One frequent barrier is the lack of commitment on the part of the main players in the tourism industry, such as hotels and tour operators (Aqaba, 2017). It is argued that many of these companies consider sustainability as an additional factor that contributes to increasing profits and therefore do not prioritize the implementation of sustainable practices.

Lack of stakeholder involvement is also a major barrier to implementing sustainable tourism (Lalicic & Weber-Sabil, 2022). Stakeholder engagement should be more proactive, involving local groups and communities more to ensure that local needs and concerns are addressed and incorporated into the planning process.

Another significant barrier is the lack of awareness and education about sustainable tourism. Many tourism stakeholders, such as tourists, businesses and policy makers, may not be fully aware of the concept and benefits of sustainable tourism or may not have the necessary skills and information to adopt sustainable practices (Nawijn & Peeters, 2012). Many tour operators and

tourists are not aware of the negative impacts that tourism can have on the environment and local communities, which can lead to unsustainable practices that hinder the development of sustainable tourism. Thus, education should be provided to both tourists and tourism companies and operators to raise awareness of sustainable practices and encourage the implementation of these practices.

Finally, lack of funding is another common barrier to implementing sustainable tourism. Implementing sustainable tourism may require additional financial, human and technical resources, which may not be available or accessible for some tourism actors, especially small and medium enterprises and local communities (Dias et al., 2024).

2.2. Selected country perspectives

Uzbekistan is one of the leading countries in terms of ecotourism potential and rich unrepeatable ecological destinations. One of the main factors that distinguishes the attractiveness of the tourist area is the exotic nature of Uzbekistan, rich landscape, diversity of flora and fauna because of four different seasons. The diversity of seasons creates a complex ecological system. Also, observation of different temperature dynamics for twelve months increases the choice of optimal temperature for tourists (Sayfullayeva, 2022).

Uzbekistan stands at a critical juncture in its tourism development, with the potential to harness its growing popularity as a cultural and eco-tourism destination while safeguarding its rich heritage and natural resources. The country has made notable strides toward sustainable tourism. However, significant challenges persist, including water scarcity, waste management issues and limited awareness of sustainable practices. To achieve a fully sustainable tourism model, Uzbekistan must prioritize strict environmental regulations, increased investment in eco-friendly infrastructure and community involvement in tourism. Educational campaigns targeting both tourists and local businesses will further encourage responsible behavior, helping to mitigate environmental impact. Through a balanced approach that addresses both the environmental and economic aspects of tourism, Uzbekistan can position itself as a leader in sustainable tourism in Central Asia.

In Azerbaijan, over the past 25 years, significant work has been done in the field of tourism development, the legislative base of tourism has been strengthened, promotion activities have been expanded and state programs on the development of this sphere have been prepared (Aliyev & Suleymanov, 2023; Akhundova, 2022). Sustainable tourism development in Azerbaijan is characteristic of developing countries. Thanks to these measures, significant increases have been registered in the number of foreign tourists, as well as hotels and travel agencies. Several reforms have been performed in relation to the development of tourism, a certain infrastructure has been created, tourism legislation has been improved, and a network of hotels that can accommodate 4–5 million tourists a year in a country with a population of 10 million has been established. The necessity of sustainable tourism development has been highlighted in tourism travel programs and the Strategic Road Map, and sustainable development of tourism has been included in the priority targets (Rahmanov et al., 2020). At the same time, it is encouraged to optimize the impact of tourism on the environment, to develop ecotourism, pasture tourism and agro-tourism.

Croatia obtains most of its tourist visits in the Adriatic tourist region over a short period of summer, which puts great pressure on the environment. Nevertheless, other parts of Croatia have tourist resources that are visited by numerous tourists as well (Brosy, Zaninovic, & Matzarakis, 2014). Global trends in the tourism market show that national parks are attracting more tourists.

This is reflected by increasing numbers of visitors in such areas, and consequently, as increased revenue from selling tickets consistent with such tourist traffic in Croatian national parks. Increase in tourist trends in the world has caused many positive changes (e.g., income from tourism, employment). However, many negative effects of tourism have become visible (e.g., waste, water pollution, crowds, noise) where tourism makes intensive use of space.

The biggest challenges in implementation of indicators of sustainable tourism lie in the fact that each tourist destination is different regarding its specific features and because it needs to find its own model of long-term sustainable development. Cooperation between stakeholders is crucial for tourism development on principles of sustainability. Tourism could provide economic growth for the local population, however, if it is not properly planned and regulated, it could have negative environmental and social impacts. In this process, sustainable financing could have crucial importance. Sustainable financing could be defined as "any form of financial service integrating environmental, social and governance (ESG) criteria into the business or investment decisions for the lasting benefit of both clients and society at large" (Bucar et al., 2021).

In Thailand, the tourism authorities have consistently pushed for promotional programs to encourage tourism growth through mass tourism. The massive increase in tourist arrivals has led to the environmental degradation of many tourist attractions in Thailand, for example, Maya beach, Samaesarn Island, Virgin Island, etc. Although the tourism sector in Thailand is linked to lower carbon dioxide emissions, the profit-seeking mass tourism has resulted in the deterioration and closure of several tourist destinations in Thailand. The local community hardly perceives the benefits of sustainable development schemes because they do not associate such policies with improvements in their social wellbeing. Consequentially, tourist operators would opt to develop the local economy and not include environmental measures unless there is a monetary incentive. As a result, it is crucial to refocus the tourism development policies from mass tourism to an approach based on sustainable development (Chulaphan & Barahona, 2021).

In Slovenian case, within tourism, the hospitality industry is a crucial contributor; it is imperative to comprehend how various factors, including prices, monetary and fiscal components and external variables such as carbon dioxide emissions, influence wages within this sector. The European Union's (EU) Green Deal is of the utmost importance to the present commission and intends to transform the continent into the first climate-neutral region in the world. Slovenia, a member of the EU since 2004, is dedicated to achieving net-zero greenhouse gas emissions by 2050, following the commission's guidelines. Furthermore, the southern region of the EU is a sought-after vacation spot with a considerable influence on national economies (Gricar et al., 2023).

The countries mentioned above are exemplary for the improvement of STD and general tourism potential in a developing country. However, it is important to look at the global trends in scientific publications to get a holistic overview, which is the main objective of this study. It is repeatedly pointed out that scientific publications in the field of STDs are dynamic and rapidly changing. For this reason, a systematic evaluation of the literature is of great importance.

3. Data and methodology

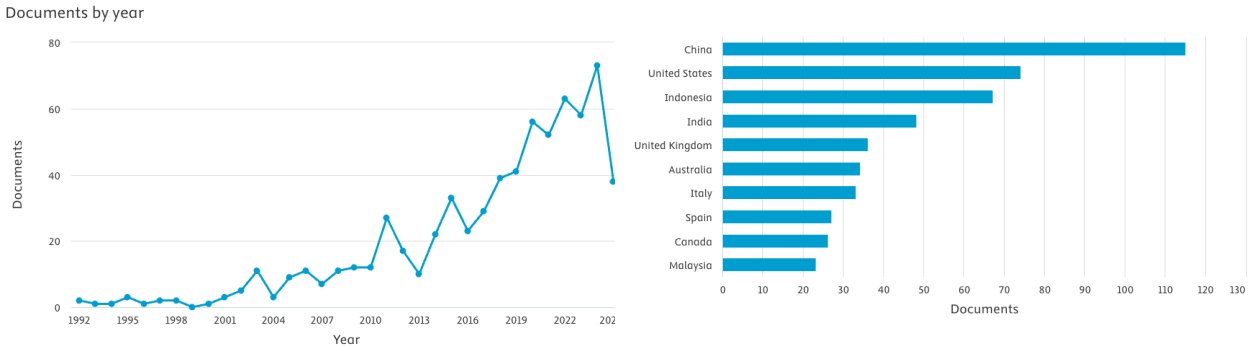
Bibliometric studies are the quantitative analysis of publication and citation patterns. They go beyond a purely numerical analysis in library science and provide information about the internal patterns of scientific sources (Bastow, Dunleavy & Tinkler, 2014). In the dynamic and influential field of economics, they provide a powerful, objective lens through which scholars, students, policy

makers and interested academics of all disciplines can look. This is why bibliometrics is an invaluable tool for navigating the vast economics literature and understanding disciplinary trends. The growing trend towards the publication of bibliometric studies shows that the critical evaluation of research contributions is becoming increasingly important for the generation. For this reason, the bibliometric analysis method is used in this paper to analyze the economic dimensions of STD.

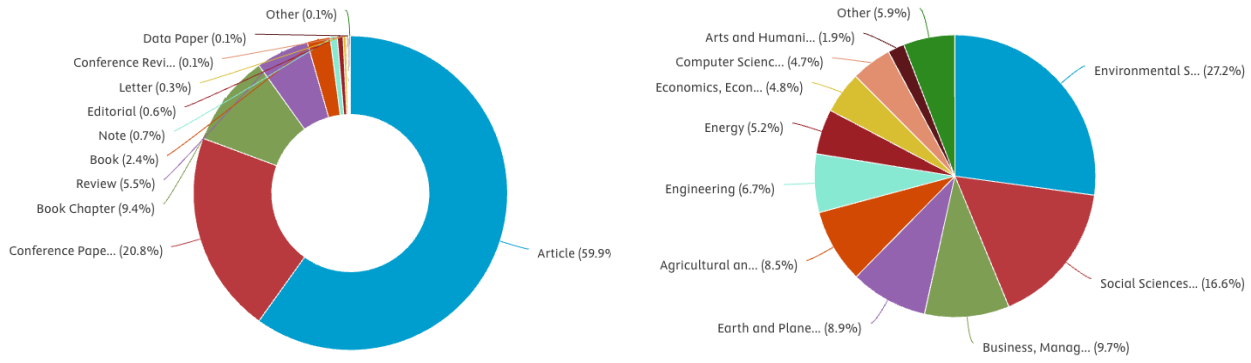
The data for this article were collected using the following combination of keywords in the Scopus database (Elsevier LTD): "sustainability" or "sustainable tourism" and "tourism" and "ecology" for the date range of 1992 and 2025 (July). The search combination was applied to titles, abstracts and keywords of the publications. Overall, 678 documents were found. Most of the studies were in English (641). Some of them were in Chinese (19), Spanish (4) and French (4) with English abstract and keywords. While journal articles accounted for 459 studies, 113 studies were conference proceedings, 67 studies were book chapters, book series covered 36 studies and trade journal were three. The top five largest subject areas were environmental science (385), social sciences (235). business management accounting (138), earth and planetary sciences (126) and agricultural and biological sciences (120). Similarly, most of the authors came from China (115), United States (74), Indonesia (67), India (48) and United Kingdom (36). Complete information about the dataset can be found in Figure 1.

Figure 1. Full descriptive information about the dataset of the current study.

a. Documents per year. *b. Documents by country or territory.*



c. Documents by type. *d. Documents by subject area.*



Source: Authors' own construction.

We used VOSviewer software (version 1.6.20) and VOSviewer manual by Van Eck and Waltman (2020) to conduct high quality and reliable bibliometric analysis. The normalization process in the analysis relied on association strength measurements, where connection widths were maximized to emphasize the strongest relationships. Standard software configurations were preserved for all other options to ensure consistency with established bibliometric research

practices. All our analyzes are reproducible and based on publicly available data in the Scopus database. We do not report conflicts of interest or ethical implications.

4. Results

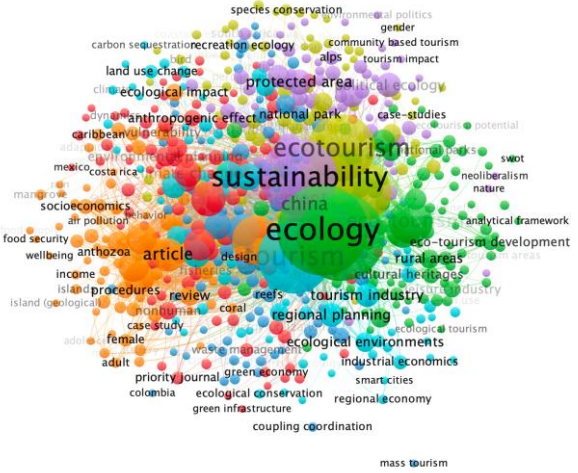
Figure 1 shows the analysis of the co-occurrence of all keywords in the dataset. Minimum number of the cooccurrence of the keywords was set to three and out of 4,751 keywords, 628 fulfilled these criteria. There are seven clusters, of which the largest contains 108 elements and the smallest 77 elements. In panel *a* of Figure 1, keywords such as ecology, sustainability, ecotourism, sustainable tourism, environmental protection, biodiversity, conservation of natural resources and environmental management form the largest nodes, indicating a high overall linkage strength, measured by total link strength (TLS).

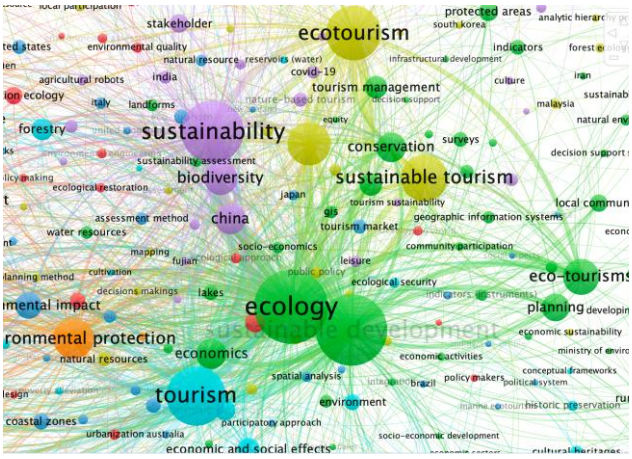
The frequent co-occurrence of keywords such as ecology, tourism, economics, sustainability and China suggests a strong interdisciplinary focus on sustainable development, particularly in the context of ecotourism and environmental conservation (see Figure 1, panel *b*). This pattern indicates growing academic interest in how tourism can be aligned with ecological goals, especially in rapidly developing regions like China. The presence of terms like planning and tourism management implies an emphasis on strategic policy approaches to balance economic growth with biodiversity protection. Overall, the pattern reflects a research trend that integrates environmental science, economic planning and tourism studies to promote sustainable regional development.

The clustering of keywords such as ecosystem, human, conservation of natural resources and climate change points to a strong environmental-human systems focus, emphasizing the interaction between ecological sustainability and human activity (see Figure 1, panel *c*). The inclusion of tourism, socioeconomics and environmental planning suggests that research in this area often examines how tourism and development impact ecosystems, and how integrated planning can mitigate these effects. This pattern reflects a multidisciplinary approach, where environmental management is studied not in isolation but as a part of broader socioeconomic systems, particularly under the pressures of climate change. The emphasis appears to be on finding balanced strategies that support both ecological integrity and human development goals.

In panel *d* of Figure 1, the co-occurrence of keywords like economic and social effects, regional planning and cultural heritage indicates a research focus on how tourism influences both local economies and communities. The inclusion of planning and ecological environments suggests an integrated approach. Sustainable development and the preservation of the environment are conceptualized alongside cultural and economic priorities. Studies in this area likely explore how strategic regional planning can harness the tourism industry to support cultural heritage. At the same time, minimizing negative impacts on ecological systems are kept in the center of attention.

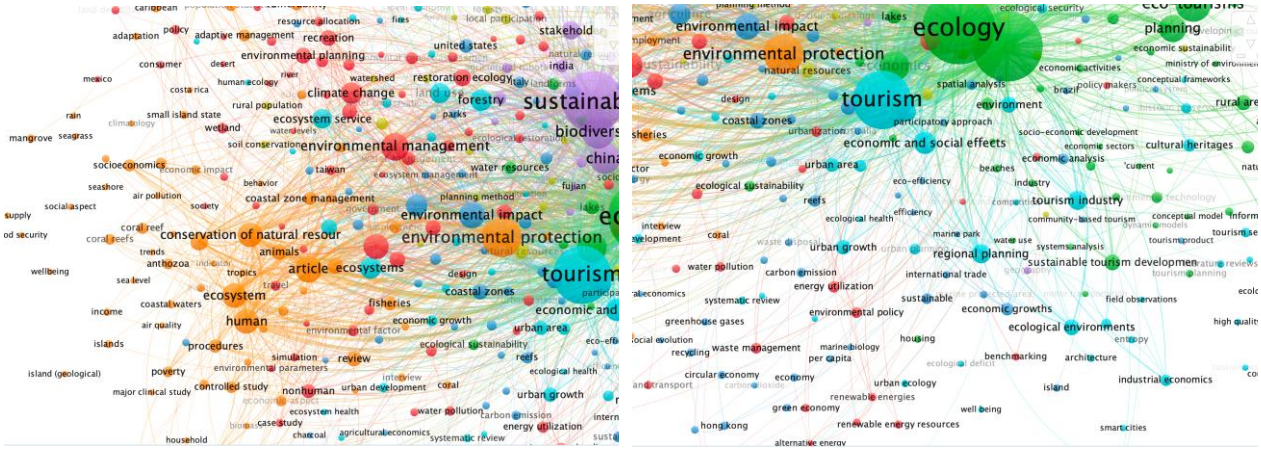
Figure 1. Selected clusters of the co-occurrence analysis of all keywords in the dataset.
a. Overall co-occurrence analysis. *b. Snapshot of the selected cluster No 1.*



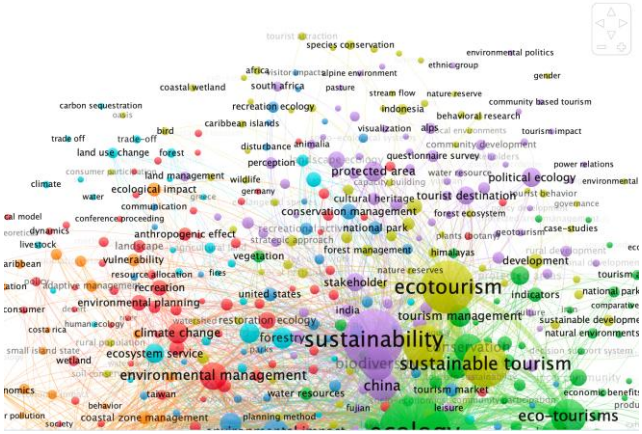


c. Snapshot of the selected cluster No 2.

d. Snapshot of the selected cluster No 3.



e. Snapshot of the selected cluster No 4.

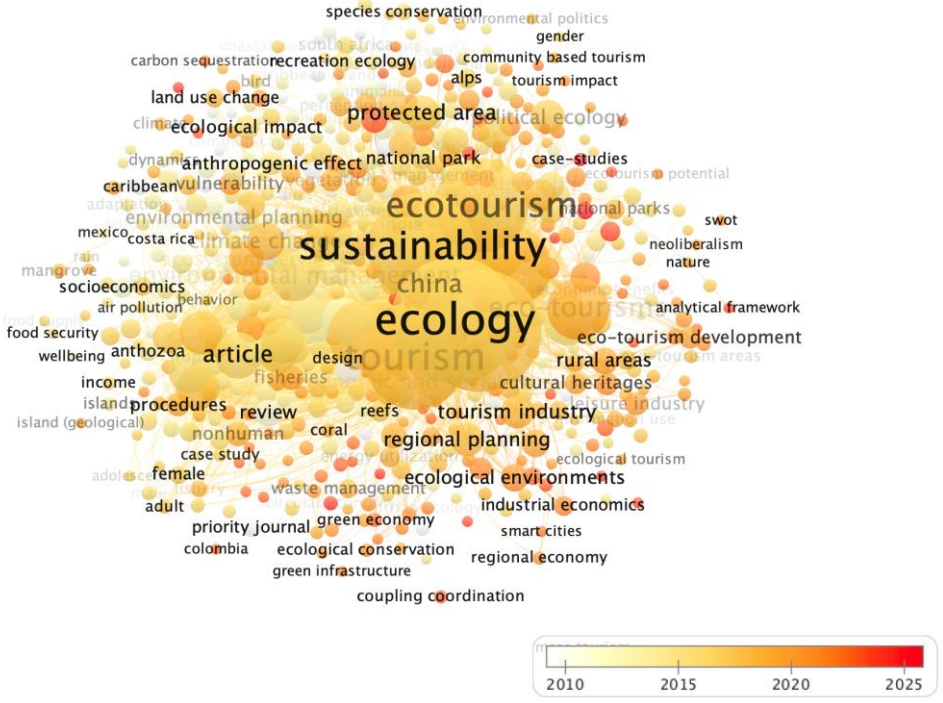


Source: Authors' own construction.

Lastly, the main keywords in panel *e* of Figure 1—protected area, political ecology, stakeholder, tourist destination and ecotourism development—point to a body of research that grapples with the real-world tensions between conservation and tourism. It is not just about preserving nature; it is also about who gets to decide how that happens. Political ecology brings in a critical perspective, showing how different actors—governments, local communities and businesses—shape the future of protected areas. What emerges is a complex picture of ecotourism as both an opportunity and a point of contestation, where environmental goals meet economic interests and local realities.

In addition, in our analysis, we attempted to evaluate which keywords have been used recently compared to some other keywords that are more established in the scientific literature (see Figure 2). We found that the application of case studies and the analysis of specific countries and regions such as Colombia, Indonesia, Brazil and the Himalayas are relatively new, which happened in 2024 and 2025. This also applies to regional economies where specific methodologies such as the coupling of coordination, spatiotemporal analysis and carbon sequestration have been applied. Green economy, circular economy, smart cities, AI-based sustainable tourism management and ecological environments have also been published in the last two or three years. Broder keywords have dominated the literature since 2010.

Figure 2. The overlay visualization of the keywords, 2010–2025.



Source: Authors' own construction.

Table 1 shows the ten most frequently cited articles in our dataset dealing with STD, based on Scopus. Seraphin, Sheeran and Pilato (2018) published on overtourism in Venice, and Hall (2019) published on tourism and the 2030 Agenda. These studies address highly visible global issues such as overtourism, sustainability, climate change and economic and environmental balance. The work of Pan et al. (2018) attempts to build a bridge between the concept of the green economy and STD. These are therefore important themes in tourism, environmental science and political discourse that are attracting broad academic and political interest.

Farrell and Twining-Ward (2004) have also attempted to reconceptualize or rethink tourism development—this demonstrates intellectual leadership and leads to further citations of scholars attempting to build on or critique these frameworks. Dickinson & Lumsdon (2010) introduce new ideas such as "slow travel," contributing to new areas of tourism research. Steven et al. (2011) use ecological approaches to examine human impacts and involve researchers from environmental management and conservation biology.

Table 1. The Scopus-based most frequently cited top ten papers in the dataset of the current study.

N	Author name	Title of the paper	Year	Cited
1	Seraphin H.; Sheeran P.; Pilato M.	Over-tourism and the fall of Venice as a destination	2018	503
2	Hall C.M.	Constructing sustainable tourism development: The 2030 agenda and the managerial ecology of sustainable tourism	2019	503
3	Farrell B.H.; Twining-Ward L.	Reconceptualizing tourism	2004	501
4	Pan S.-Y.; Gao M.; Kim H.; Shah K.J.; Pei S.-L.; Chiang P.-C.	Advances and challenges in sustainable tourism toward a green economy	2018	455
5	Dickinson J.; Lumsdon L.	Slow travel and tourism	2010	304
6	Danielopol D.L.; Griebler C.; Gunatilaka A.; Notenboom J.	Present state and future prospects for groundwater ecosystems	2003	288
7	Steven R.; Pickering C.; Guy Castley J.	A review of the impacts of nature based recreation on birds	2011	254
8	Mbaiwa J.E.	The socio-economic and environmental impacts of tourism development on the Okavango Delta, north-western Botswana	2003	251
9	Balmford A.; Gravestock P.; Hockley N.; McClean C.J.; Roberts C.M.	The worldwide costs of marine protected areas	2004	242
10	Moss L.A.G.	The amenity migrants: Seeking and sustaining mountains and their cultures	2006	241

Source: Authors' own construction.

Mbaiwa (2005) on Botswana and Balmford et al. (2004) on marine protected areas are of geographical and political importance. They help to link tourism development to real-world policy, conservation and regional planning—and are frequently cited by researchers and institutions in the fields of development studies, geography and environmental policy.

Moss (2006) with the book "The Amenity Migrants" is frequently cited in works on migration, lifestyle mobility and upland communities. It provides a basic or comprehensive treatment of its subject and is therefore an important source from an STD perspective. A more technical work is by Danielopol et al (2003).

5. Discussion

The results shown in Figure 1 reveal several significant and nuanced trends that are important from a practical perspective. The prevalence of terms such as ecology, sustainability, ecotourism and environmentalism in the largest group reflects a conceptual focus on the chosen theme. This shows that STD research focuses on ecological integrity and the need to reconcile tourism practices with ecological limits. This was one of the reasons why we pointed out at the beginning of this study

that STD should no longer be based on a voluntary decision. Rather, it is a process that forces societies to apply it in a way that balances rapid economic growth with environmental protection. This signals an evolution in the literature from a general sustainability discourse to a more applied and systems-based approach.

The further phases of the keyword analysis show an increasing interdisciplinary orientation of research in the field of sustainable tourism, particularly with regard to themes such as ecology, economy and governance. China is an important context due to its rapid development and environmental challenges. The Chinese presence indicates that competition between societies in terms of sustainable development is increasing in favor of Asian countries. Keywords such as ecosystem and climate change indicate a growing interest in socio-ecological systems, while cultural heritage and spatial planning reflect efforts to reconcile conservation with economic and community priorities. The emergence of political ecology signals a critical engagement with power dynamics. We cannot deny that there are conflicts between stakeholders in ecotourism. However, these should be resolved in line with societal interests. Overall, the literature is shifting towards more integrated and equality-oriented approaches to sustainability.

STD is not a static concept. From the beginning, certain topics were firmly anchored, but in the last two or three years some new areas have been added. This is very understandable as the methodological skills of scientists increase over time. New methods shed light on new aspects of old topics. STD is not an exception. However, the trend is not yet clear. Put differently, it is not possible to precisely identify specific topics that have emerged in recent years, but it is much easier to do so in the context of already established topics such as sustainable development or environmental protection. Also, while certain topics may shift in prominence over time, our dataset indicates that the reconceptualization of STD in relation to various economic and ecological dimensions will remain central, as evidenced by the high citation counts these themes continue to receive.

6. Concluding remarks

In the field of STD, there are both consolidated issues and evolving debates that require systematic and continuous assessment by the scientific community. In the present work, data were collected between 1992 and 2025 using the Scopus database to uncover underlying patterns on ecological aspects of STD. The study shows that the discourse on STD is becoming increasingly interdisciplinary, combining ecological, economic and governance perspectives in both global and regional contexts. Furthermore, the concept of STD is not static, but subject to rapid change. However, there is still a lack of a clear pattern showing which areas have evolved in recent years. By uncovering these patterns of ideas, this bibliometric analysis contributes to a more nuanced understanding of the research landscape.

The present study has several limitations and contains recommendations for future studies. First, the present study only analyzed the co-occurrence of keywords and focused on highly cited articles in the dataset. To uncover the underlying bibliometric relationships, bibliographic linkage and co-citation analyzes should also be conducted. Second, the institutional distribution of publications was not considered in this study, which may provide some insights into the conceptualization of STD. Finally, bibliometric studies do not tell a story but rather show quantitative ideas that also invite qualitative assessments. Future research should further explore stakeholder relationships and governance mechanisms to better align tourism strategies with

ecological and community-based priorities. The use of qualitative methods is strongly recommended to gain deeper context and insight into the research objectives.

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