

Ecotourism in Volcanic Regions: A Systematic Literature Review of Community Impact, Stakeholder Involvement, and Development Implications

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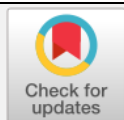
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ABSTRACT

This study conducts a systematic literature review to explore the dynamics of ecotourism in volcanic regions, with a particular focus on its impact on communities and stakeholders. The review was carried out using the PRISMA protocol, focusing on literature published between January 2002 and May 2024 in the Scopus database. An initial pool of 40 articles was filtered through inclusion and exclusion criteria, resulting in 14 eligible studies for synthesis. The findings reveal diverse impacts of ecotourism in volcanic areas, including economic benefits, conservation challenges, sociocultural transformations, and stakeholder governance. Notably, most studies concentrated on the tourism sector, with limited coverage of other relevant industries. The review also identifies methodological and theoretical gaps, with few studies employing explicit theoretical frameworks. This study contributes to the academic discourse by mapping existing knowledge, identifying thematic clusters, and offering practical recommendations for policy and future research aimed at enhancing the sustainability and inclusivity of ecotourism in volcanic landscapes.

Keywords: Community Development; Ecotourism; PRISMA; Stakeholder Engagement; Systematic Review; Volcanic Tourism

1. Introduction

Ecotourism is a form of nature-based tourism that takes place in environmentally sensitive areas and prioritizes minimal ecological impact. It serves as a strategic approach to realizing sustainable development goals in the tourism sector by integrating environmental education, cultural respect, and economic benefits for local communities (Li & Xu, 2022; Zhao et al., 2025). The primary objective of ecotourism is to ensure the sustainable management of ecological resources while fostering awareness and appreciation of natural and cultural heritage (Dai & Ma, 2021).

Volcanic regions represent unique ecotourism destinations due to their dynamic geological formations, biodiversity richness, and cultural significance. Mount Merapi, located in Indonesia, has been the subject of numerous ecotourism studies. For instance, Nomikou et al. examined the Nisyros Geopark in Greece and highlighted its dual function as a site for scientific research and public engagement through direct exposure to volcanic phenomena (Nomikou et al., 2023). Similarly, Langridge and Michaud demonstrated how stakeholder perceptions, particularly concerning safety, governance, and environmental responsibility, play a vital role in shaping sustainable tourism management in active volcanic areas (Langridge & Michaud, 2023). In another context, Sabuhoro et al. emphasized the contribution of ecotourism to community development near Volcanoes National Park (Sabuhoro et al., 2021), while Rebuya (2020) explored how conservation-based tourism strategies in the Bulusan Volcano Natural Park generate both environmental and socio-economic benefits (Rebuya, 2020).

In addition to environmental and social dimensions, some studies have documented the utilization of volcanic landscapes for local resource development. The study by Santika and Susandarini on the Nglanggeran Ancient Volcano revealed the diverse potential of Moraceae species for food, medicine, construction materials, and ornamental use, thus highlighting the multifunctionality of biodiversity in volcanic ecosystems (Santika & Susandarini, 2020).

Despite these contributions, the existing body of literature remains fragmented. Few studies systematically assess the cumulative impact of ecotourism in volcanic regions over time, and the integration of visual documentation, such as photographic analysis, is rarely addressed. Furthermore, the extent to which ecotourism contributes to different economic sectors beyond tourism, such as agriculture, cultural industries, or environmental education, has yet to be comprehensively explored.

In response to these gaps, this study aims to review and synthesize the current literature on ecotourism in volcanic areas through a systematic approach. Focusing particularly on Mount Merapi and comparable case studies, the review investigates how ecotourism affects local communities, stakeholders, and broader development goals. It also identifies prevailing research trends, theoretical limitations, and future directions that may enhance the sustainability and inclusiveness of ecotourism practices in volcanic landscapes.

2. Literature Review

2.1. Ecotourism

Ecotourism has emerged as a significant form of alternative tourism that aligns with the principles of sustainable development. Distinguished by its emphasis on ecological preservation, community participation, and environmental education, ecotourism represents a deliberate shift away from mass tourism toward more responsible and locally integrated tourism models (S. Zhang et al., 2018). As a field of academic inquiry, ecotourism has garnered sustained interest from both global and regional scholars, reflecting its growing relevance in addressing the environmental and social challenges associated with tourism development.

In the early phases of ecotourism research, particularly in Europe and North America, scholars focused primarily on defining its conceptual foundations and clarifying its normative objectives. These early studies explored the ethical underpinnings of ecotourism and its differentiation from nature tourism and adventure tourism (Yan, 2020). As the field matured, the research agenda expanded to include stakeholder analysis (Meng et al., 2022; Salman et al., 2023), tourism market dynamics and tourist motivations (Mathis, 2023; Saidmamatov et al., 2020), and spatial patterns of ecotourism development across different ecological zones (Hassen & Weldu, 2023; Wiratno et al., 2022).

Recent studies have also shifted toward evaluating the socio-environmental impacts of ecotourism and the mechanisms through which these impacts are mediated. For example, emerging literature has examined how ecotourism contributes to biodiversity conservation, local governance structures, and income diversification, as well as the unintended consequences such as ecological degradation or community exclusion (Habibulloev et al., 2024; Peng et al., 2024). In tandem, assessment frameworks and conservation tools have been proposed to monitor the sustainability and acceptability of ecotourism operations (Birendra et al., 2018; Meyer et al., 2021).

In the Central Asian context, particularly in countries with rich but vulnerable ecotourism resources such as China, Mongolia, and Kazakhstan, the academic discourse has taken a slightly different trajectory. Here, researchers have integrated theoretical development with practical case studies that emphasize the unique ecological, political, and socio-cultural contexts of the region. Key areas of research have included foundational theories of ecotourism (Yang & Ma, 2017), methodological innovations for assessing tourism suitability and ecological carrying capacity (Shang, 2008), and broader analyses of ecotourism's role in promoting sustainable development (Huang et al., 2024; Zhao et al., 2025). In addition, scholars have paid particular attention to ecotourism valuation techniques (Wang et al., 2022) and strategies for enhancing ecological resilience and protection (E. Zhang et al., 2021).

Taken together, the global literature on ecotourism reveals a maturing research field that is increasingly interdisciplinary, empirically grounded, and policy-relevant. However, a comparative gap remains in understanding how ecotourism unfolds in high-risk geophysical contexts, such as volcanic landscapes, where the intersections of environmental vulnerability, cultural heritage, and tourism governance require more nuanced investigation.

2.2. Ecotourism

Mountain tourism is a distinctive segment of the travel industry that relies heavily on ecological carrying capacity and place-based value systems. It plays a pivotal role not only in promoting environmental stewardship but also in improving the socio-economic conditions of mountain communities by fostering employment opportunities and increasing participation in local, regional, and national policy agendas (Weng et al., 2019). As a form of tourism embedded in sensitive and often remote ecological zones, mountain tourism requires a nuanced approach that integrates sustainability principles across ecological, financial, and social dimensions (Mutana & Mukwada, 2018).

A central challenge in mountain tourism development lies in regulating the scale and type of tourism activities so that they do not exceed environmental thresholds or undermine the socio-cultural fabric of local populations. Sustainable mountain tourism must therefore strike a balance between utilization and preservation. This entails preserving the ecological assets upon which tourism depends, improving the quality of life for local residents, and enhancing the overall satisfaction of visitors. Such a balance cannot be achieved without clearly defined regulatory

mechanisms, robust local institutions, and administrative capacities that align with both contemporary governance models and traditional knowledge systems (Cheung et al., 2021).

The sustainability of mountain tourism is contingent on inclusive planning processes and equitable benefit-sharing mechanisms. Without adequate local control, community involvement, and strong grassroots leadership, mountain tourism risks becoming extractive and unsustainable, benefiting a narrow segment of wealthy external investors at the expense of the broader population (Majeed et al., 2025). In many cases, the absence of locally embedded governance structures results in short-term tourism ventures that fail to deliver long-term benefits, and often contribute to resource depletion, cultural commodification, and increased social inequality.

Consequently, there is a growing consensus that mountain tourism should be guided by a multi-stakeholder governance model, one that prioritizes environmental conservation while simultaneously empowering local communities. This involves not only participatory decision-making but also capacity-building efforts that enable residents to assume meaningful roles in tourism planning, operations, and benefit distribution. When appropriately managed, mountain tourism has the potential to act as a catalyst for sustainable development, environmental education, and cultural revitalization in some of the world's most ecologically and socially fragile regions.

3. Research Methodology

This study employs a Systematic Literature Review (SLR) approach to synthesize the current body of knowledge on ecotourism in volcanic areas. The methodology follows the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency, replicability, and rigor in the literature identification, selection, and synthesis process.

3.1. Inclusion and Exclusion Criteria

To ensure the relevance and quality of the reviewed literature, a set of inclusion and exclusion criteria was established prior to the screening process. The inclusion criteria were as follows: (1) the article must be published in a peer-reviewed journal; (2) the focus of the article must be directly related to ecotourism in volcanic contexts; and (3) the publication must be written in English. Additionally, only articles published between January 2002 and May 2024 were considered eligible for inclusion.

Conversely, studies that did not meet all three of these criteria, such as conference proceedings, non-peer-reviewed sources, or articles outside the specified time frame or thematic scope, were excluded from the final review. This step was essential to ensure the consistency and scholarly relevance of the literature base.

3.2. Data Sources and Search Strategy

The literature search was conducted using the Scopus database, chosen for its comprehensive indexing of peer-reviewed publications in the social and environmental sciences. The search strategy involved the use of Boolean operators and keyword combinations: (Ecotourism) AND (Volcano). This search was executed in May 2024, covering articles published between January 2002 and May 2024.

The initial search yielded a total of 40 articles. Following this, four duplicate records were removed. The remaining 36 articles were subjected to title and abstract screening, which resulted in the exclusion of 22 articles that did not meet the thematic or methodological focus of this

review. After a full-text eligibility assessment, 14 articles were retained for final analysis, all of which fulfilled the predefined inclusion criteria.

The selection process is visualized in **Figure 1**, following the PRISMA flow diagram format. This process ensured that only the most relevant, high-quality, and thematically aligned studies were synthesized in the subsequent analysis.

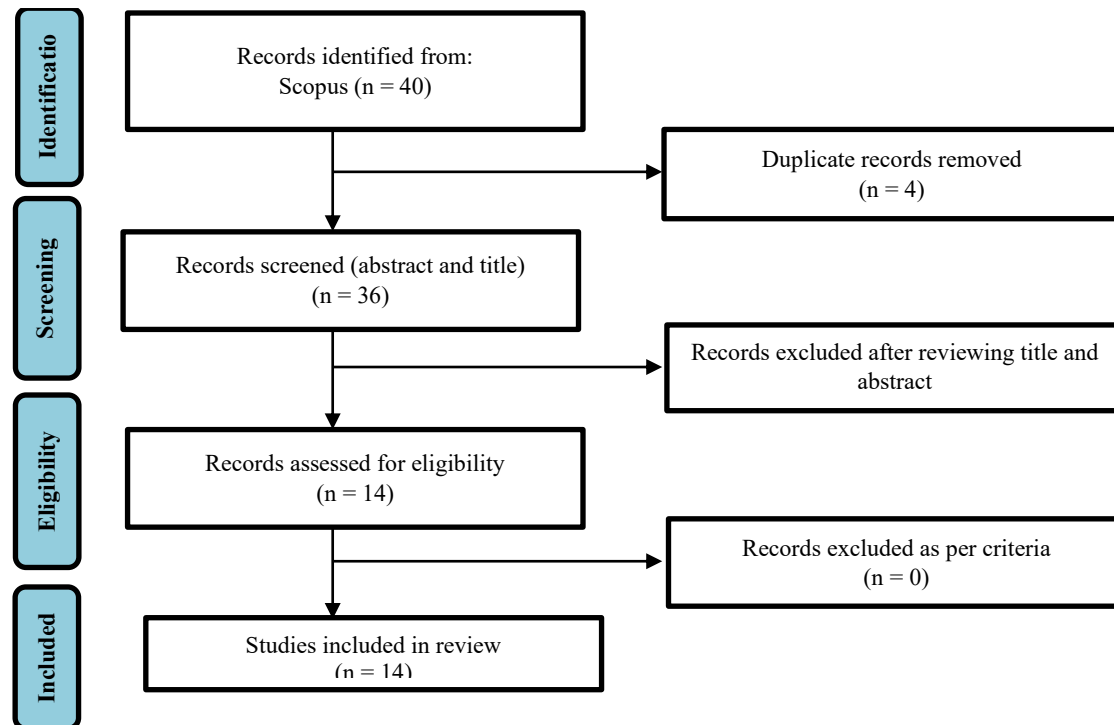


Figure 1. Article Selection Process

4. Results and Discussion

Based on the systematic screening and synthesis process, a total of 14 articles were identified as meeting the inclusion criteria and aligned with the objectives of this study. These articles were analyzed and categorized by year of publication, country of focus, industry or sector, research design, theoretical framework, and main findings. The distribution of studies reflects a broad geographical and thematic diversity, although with notable concentrations in the tourism sector and limited theoretical grounding in several cases.

The summary of the selected literature is presented in **Table 1**.

Table 1. Summary of Systematic Literature Review

No	Author(s)	Country	Sector	Method/Design	Theory	Key Findings
1	(Nomikou et al., 2023)	Greece	Geology	Descriptive	–	Nisyros Geopark provides scientists and visitors opportunities to explore volcanic features directly.
2	(Langridge & Michaud, 2023)	Iceland	Tourism	Qualitative	–	Stakeholder perceptions significantly influence volcanic tourism development strategies.
3	(Sabuhoro et al., 2021)	Rwanda	Tourism	Quantitative	–	Mountain gorilla tourism does not

No	Author(s)	Country	Sector	Method/Design	Theory	Key Findings
						sufficiently benefit local communities.
4	(Rebuya, 2020)	Philippines	Tourism	Mixed Methods	–	Bulusan Volcano Park combines conservation efforts with socio-economic development initiatives.
5	(Santika & Susandarini, 2020)	Indonesia	Biodiversity	Descriptive	–	Moraceae species around Nglanggeran Volcano have multipurpose use (food, medicine, construction, etc.).
6	(Ariani et al., 2019)	Indonesia	Tourism	Qualitative	–	Ecotourism contributes to women's roles in rural village economies.
7	(Hermawan et al., 2019)	Indonesia	Tourism	Quantitative	Control Attribution Theory	Safety and amenities influence tourist satisfaction but not loyalty.
8	(Munanura et al., 2016)	Rwanda	Governance	Qualitative	–	Revenue-sharing programs in Volcanoes National Park show limited conservation impact.
9	(Koizumi & Chakraborty, 2016)	Japan	Tourism	Descriptive	–	Geocotourism fosters environmental awareness and supports conservation education.
10	(Zangmo Tefogoum et al., 2014)	Cameroon	Tourism	Not specified	–	Geomorphological features of Mount Manengouba are key tourist attractions.
11	(Wang et al., 2022)	China	Culture	Not specified	–	Volcanic geotourism contributes to strengthening local economies.
12	(de los Angeles Somarriba-Chang & Gunnarsdotter, 2012)	Nicaragua	Tourism	Mixed Methods	–	Local community participation is central to successful ecotourism development.
13	(Erfurt-Cooper, 2011)	Europe	Tourism	Not specified	–	Effective risk management is essential in geothermal and volcanic tourism settings.
14	(Hearne & Salinas, 2002)	Costa Rica	Tourism	Experimental	Utility Theory	Tourists value improved infrastructure and information in ecotourism settings.

4.1. Distribution of Literature by Country

Figure 2 presents the geographical distribution of the selected studies. The findings indicate that Indonesia is the most represented country, with **three** studies focused on volcanic ecotourism within its territory. This reflects Indonesia's active volcanic landscape and growing emphasis on community-based and conservation-driven tourism models. Other countries are represented by a single study each, including Rwanda (Africa), China, Costa Rica, Europe, the Philippines, Iceland, Japan, Cameroon, Nicaragua, and Greece. The limited geographical concentration suggests that while ecotourism in volcanic areas is a globally relevant theme, empirical research remains scattered and often site-specific.

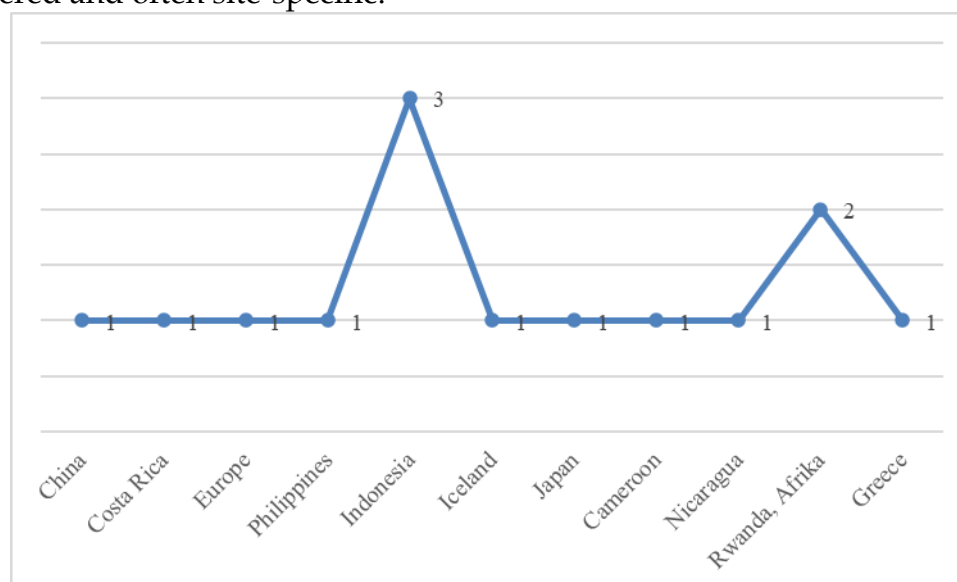


Figure 2. Distribution of Articles by Country

4.2. Distribution of Literature by Year

As illustrated in **Figure 3**, the distribution of studies over time reveals no clear upward or downward trend, but rather intermittent scholarly attention. The years 2023, 2020, 2019, 2016, and 2014 each produced two publications, indicating occasional surges of interest likely tied to specific events, policy changes, or volcanic eruptions. The earliest study in this review was published in 2002, while the most recent one was published in 2023. This sporadic pattern of publication underscores the need for a more sustained and programmatic research agenda on volcanic ecotourism.

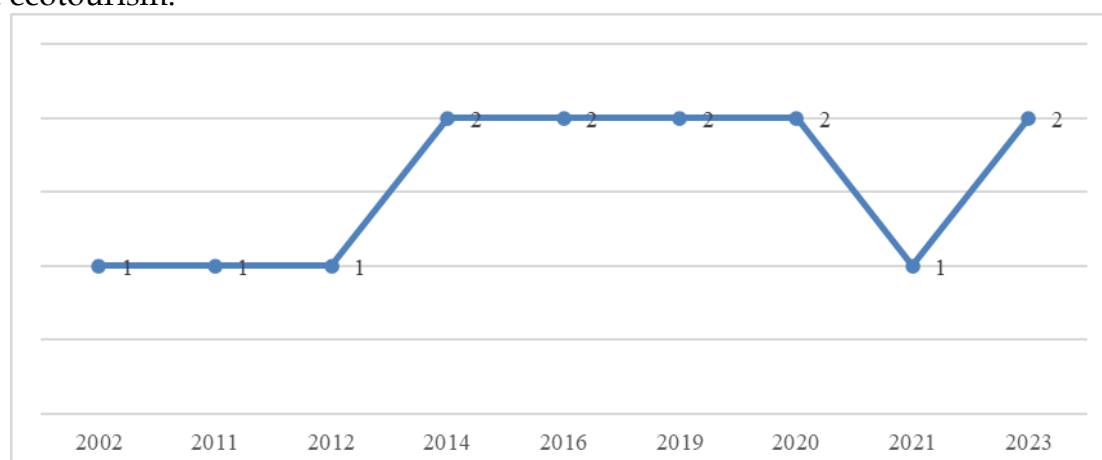


Figure 3. Distribution of Articles by Year

4.3. Distribution of Literature by Sector

The reviewed literature spans five primary sectors (see **Figure 4**). A substantial majority of the studies ($n = 10$) are situated within the tourism sector, reflecting a dominant focus on visitor experience, stakeholder engagement, and local development. The remaining studies are distributed across four other sectors: culture ($n = 1$), geology ($n = 1$), biodiversity/rubber-based livelihoods ($n = 1$), and public administration ($n = 1$). This concentration indicates a thematic bias toward tourism-related dimensions of ecotourism, while ecological, cultural, and institutional domains remain underexplored in the context of volcanic landscapes.

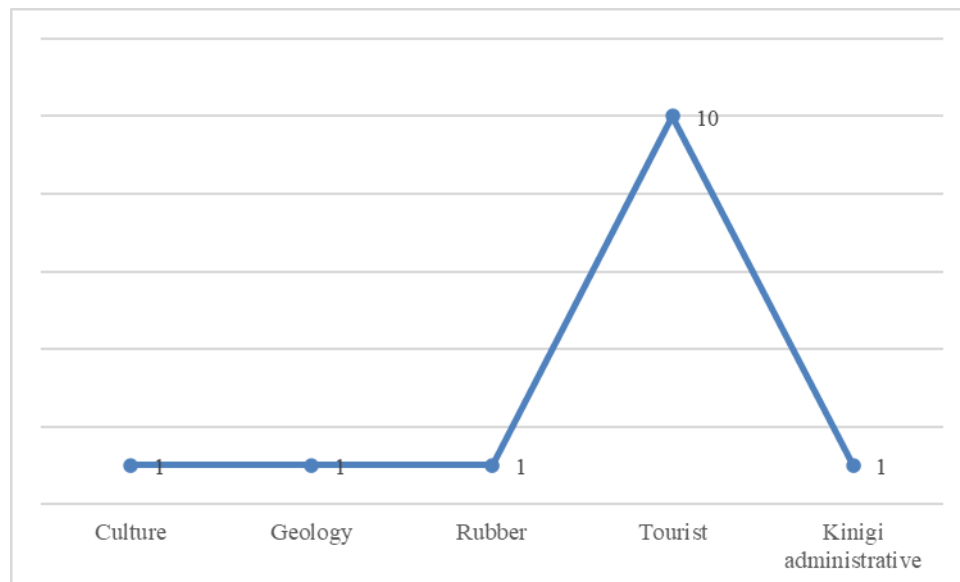


Figure 4. Distribution of Articles by Sector

4.4. Methods Used

The methodological approaches employed across the 14 studies are presented in **Figure 5**. The review shows a diversity of research designs, though qualitative and descriptive methods are the most commonly applied (each $n = 3$). Other methods include quantitative approaches ($n = 2$), mixed methods ($n = 2$), and experimental designs ($n = 1$). Notably, three studies did not explicitly report their methodological orientation. The prevalence of qualitative and descriptive designs highlights an emphasis on exploratory and interpretive insights, yet also points to a need for more rigorous, comparative, and hypothesis-driven research, particularly to assess long-term impacts and policy outcomes.

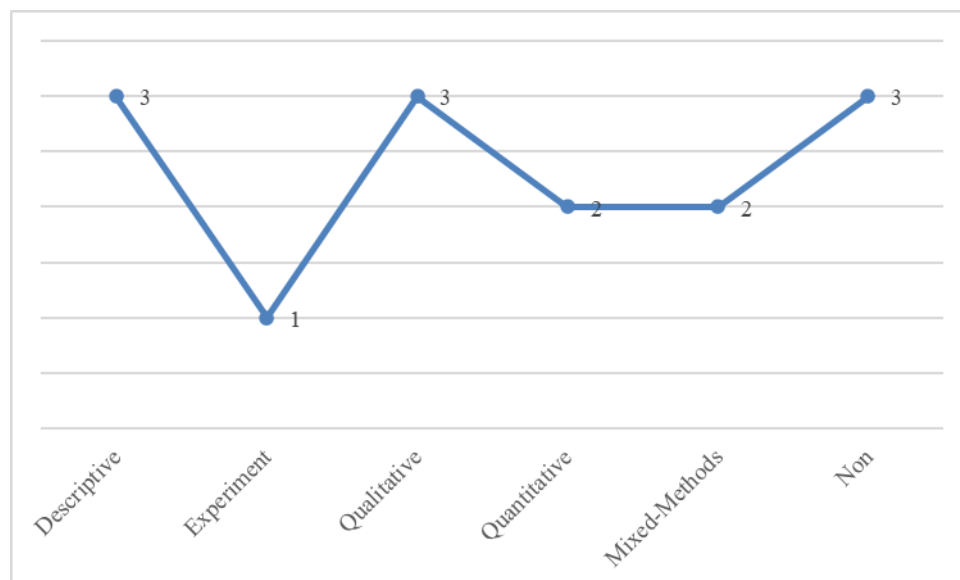


Figure 5. Distribution of Articles by Method

4.5. Theoretical Frameworks Used

As shown in **Figure 6**, the integration of theoretical frameworks in ecotourism research in volcanic areas is notably limited. Among the 14 studies reviewed, only two employed formal theoretical models: Control Attribution Theory (Hermawan et al., 2019) and Utility Theory (Hearne & Salinas, 2002). The absence of theoretical grounding in the majority of studies suggests a predominantly empirical orientation, with limited efforts to connect findings to broader conceptual frameworks. This represents a significant gap, as the application of theory can enhance explanatory power, facilitate cross-case comparisons, and guide policy-oriented analysis in ecotourism scholarship.

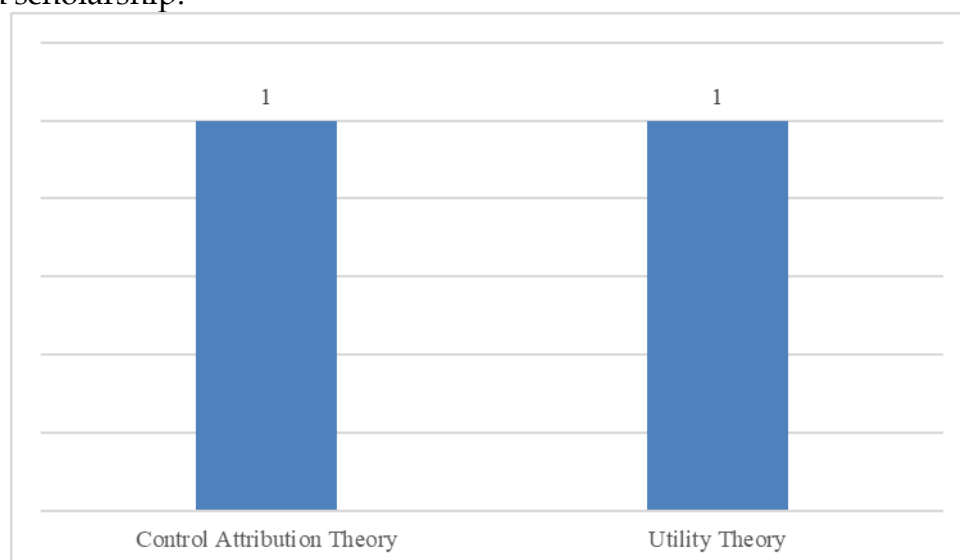


Figure 6. Distribution of Articles by Theoretical Framework

4.6. Theory Used

Nisyros Geopark is an open-air geological, biological and cultural laboratory, which not only provides an opportunity for scientists from various fields of expertise, but also for visitors to experience first-hand an active volcano, discover the various volcanic products that shaped its geological history, identify five eruption cycles, and even walk inside one of the largest

hydrothermal vents on the planet and listen to the roar of the living planet Earth. Nomikou et al. in their research managed to present the official website of the Geopark, its first virtual guide (mobile application), a new informative brochure, a number of installed informative panels and signs, and a guidebook, as the first efforts made to achieve the goal of achieving UNESCO global geopark status (Nomikou et al., 2023). The importance of preserving this fascinating heritage while successfully promoting and disseminating the science behind it, has undoubtedly dictated the need to create a series of products that, through a combination of modern and traditional means, will bring Nisyros, from now on, closer to everyone.

Research conducted by Langridge & Michaud also highlights issues that stakeholders consider important around the concepts of authority, access, responsibility, safety and funding in the ongoing management of the site (Langridge & Michaud, 2023). This research also shows the validity of previous warnings that as tourist numbers increase, compliance with public safety measures is likely to decline (Bird & Gísladóttir, 2020). This research suggests that in order to transform Fagradalsfjall into a sustainable and responsibly managed tourist attraction, there needs to be measures and infrastructure that take greater responsibility for the safety of tourists within Iceland's "right to roam" framework, rather than leaving them to make their own safety decisions; restrictions on visitors on site to reduce environmental impacts; greater enforcement of policies by those in charge; a federal government system and structure around taxes and fees paid to access natural attractions in line with other countries managing volcanic tourist destinations; and ongoing collaboration and communication between stakeholders involved in or affected by development. The common goal heard from stakeholders working on this issue is to prioritize preserving the natural environment in the Fagradalsfjall volcanic area so that future residents and visitors can enjoy it safely.

Langridge & Michaud conducted a study on the development of Fagradalsfjall into a tourist destination due to the volcanic eruption that occurred there in the spring and summer of 2021, showing that the inclusion of emergency response and civil defense in the initial management of the site was crucial as most visitors flocked to the site immediately after the eruption began (Langridge & Michaud, 2023). All stakeholders had relatively positive perceptions of the initial management of Fagradalsfjall under ICE-SAR. This is in line with previous research in southern Iceland during previous volcanic eruptions that showed respect and trust for local public safety officials (Bird & Gísladóttir, 2020).

Sabuhoro et al. indicate two conditions that must be met to ensure the success of ecotourism development and ensure that it contributes to conservation and community development (Sabuhoro et al., 2021). First, economic incentives that provide direct benefits to local communities must be clearly identified. Second, these incentives must be commensurate with the scale of current threats to biodiversity conservation. Given the importance of mountain gorilla tourism in generating much-needed revenue, conservation strategies around it must be able to demonstrate evidence of successful conservation (W. Adams et al., 2001; Leader-Williams & Dublin, 2002). Without this evidence, the idea that conservation incentives can save wildlife and lead to community development will be a failed strategy (W. M. Adams & Infield, 2003).

Rebuya in his research indicated that Bulusan Volcano National Park as a tourist destination has good ecotourism attributes that are manifested from visitor experiences along with entertainment, education, escape, and aesthetics (Rebuya, 2020). It can be observed that escape is the most desired experience for visitors in the park that involves a higher level of involvement and active participation in the natural environment and destination. The feeling of isolation from urban society is what makes Bulusan Volcano National Park more important to visitors.

According to Wolf et al., the environment changes people to go outside to find solitude and escape from the pressures of urban society (Wolf et al., 2019).

Positive visitor experience findings can be enhanced by good resource protection strategies towards sustainable ecotourism and conservation of protected areas implemented in Bulusan Vulcano National Park. This is an effective social and environmental conservation strategy and is more emphasized in Bulusan Vulcano National Park. Likewise, physical or behavioral conservation strategies are also recognized as effective mechanisms in managing visitor use (Rebuya, 2020). Although entertainment is well experienced, products still need to be improved to provide more authentic cultural experiences (tangible and intangible). This can be enhanced through the revival of authentic cultural performances, the development and production of local handicraft products/souvenirs, and support for local cuisine. According to Lasarte understanding visitors' desires and travel experiences is at the heart of a successful tourism destination (Lasarte, 2020).

Santika & Susandarini provided evidence in their research that the diversity of Moraceae species in the Nglanggeran Ancient Volcano is relatively low when compared to other studies, both from the same area and other areas in Indonesia (Santika & Susandarini, 2020). Six species were found in this study, namely *Artocapus altilis*, *Artocarpus heterophyllus*, *Ficus benjamina*, *Ficus septica*, *Maclura cochinchinensis*, and *Streblus taxoides*. The potential use of Moraceae is as food, medicine, construction, soil protection plants, and ornamental plants.

Ariani reported in her research results that the division of labor in ecotourism management in Sembalun Lawang village showed that men still dominate women (Ariani et al., 2019). Women get a share that is not far from domestic work such as serving guests when there are tourists staying, from cooking to preparing beds, not infrequently women also have free time to open laundry and ironing services for tourists while in Sembalun Lawang village. Women also play a role in making handicrafts in the form of weaving and women also produce souvenirs from Sembalun Lawang agricultural products. Meanwhile, men get a share of the work that has more opportunities to deal directly with tourists such as being a tour guide, keeping entrance tickets to being a porter and guide during climbing, being a driver and so on. There are no specific written regulations that require women to have a role that is very closely related to work in the domestic sector, such as the work done by women in everyday life.

Hermawan in his research stated that loyalty has become the focus of attention of marketing experts (Hermawan et al., 2019). Loyalty is also the center of attention in the eyes of tourist destination managers. Loyal tourists who return to visit a particular destination and spend money there continuously will increase the income of the tourist destination. Meanwhile, positive recommendations will increase the positive image of the destination, so that its popularity in the tourism market will increase. In short, tourist loyalty ensures the sustainability of the tourism business. This study proves that satisfaction is a significant variable that intervenes in the factors that influence tourist loyalty in the Nglanggeran Ancient Volcano ecotourism. Thus, the key is to develop tourist loyalty by increasing independent variables or certain factors.

The most proven dominant factor influencing satisfaction and loyalty in this study was tourist attraction, which showed a positive correlation. This positive correlation implies that increasing tourist attraction will also increase tourist satisfaction, which in turn will shape tourist loyalty. There are other determinants that are also studied, namely safety and facilities. However, these other determinants only influence satisfaction and have not been proven to be significantly able to grow tourist loyalty, either directly or through satisfaction media. This phenomenon occurs because it is said that the segment of tourists visiting the Ancient Volcano is a society with an adventurous character and is large in number. Adventure tourists are tourists who seek

satisfaction from challenging experiences and tend to dare to take risks. The minimal influence of amenities on loyalty is possible because tourists visiting the Nglanggeran Ancient Volcano see amenities only as supporting facilities for tourism in general. Thus, these tourists do not consider amenities as a factor for loyalty to a destination.

Facilities have proven to be insignificant in influencing tourist satisfaction. In fact, there is no correlation at all with tourist loyalty at Nglanggeran Ancient Volcano. Thus, limiting the construction of facilities at Nglanggeran Ancient Volcano is a wise action in order to support the preservation of Nglanggeran nature which contains protected ecosystems and biodiversity. Evaluation of important zones is carried out to determine which zones may be built facilities and which zones are included in the core conservation area. Tourists need to be informed about the division of zones and understand them.

Munanura et al. revealed in their study that the conservation impact of tourism revenue sharing is very minimal (Munanura et al., 2016). Sustainable livelihood analysis shows that tourism revenue sharing is unable to address the core livelihood constraints of the poorest residents around Volcanoes National Park well enough to justify changes in livelihood behavior that threaten wildlife. The study findings indicate that such livelihood constraints among the poorest residents around Volcanoes National Park have created persistent food insecurity, impoverishment, and illegal logging of forest resources to meet livelihood needs. These findings support previous research in Volcanoes National Park, which stated that the lack of basic livelihood needs has been a major driver of forest dependence (Munanura et al., 2014). Similar views have emerged from other developing countries, highlighting the importance of recalibrating tourism revenue sharing to address food insecurity and improve livelihood capabilities among the poorest people living around natural areas (Adhikari et al., 2007; Brandon & Wells, 1992; Masozera & Alavalapati, 2004; Nyaupane & Poudel, 2011). Poverty is a key driver of livelihood behaviors that threaten Rwanda's Nyungwe National Park (Masozera & Alavalapati, 2004).

Research conducted by Koizumi & Chakraborty provides an analysis of geocotourism and its potential for environmental conservation (Koizumi & Chakraborty, 2016). Geocotourism is a new form of sustainable tourism, geocotourism can also be seen as a hybrid form of geotourism. Geocotourism combines aspects of standard geotourism that primarily occurs in geoparks with a focus on geological land formation processes, and ecotourism that typically occurs in natural areas and has a primary focus on the long-term sustainability of the natural landscape. Geocotourism is a new development and its economic impact is likely to be small. However, geocotourism has a very high potential for realizing natural environmental conservation and its primary importance lies in its educational value.

Furthermore, two case studies in the Hakusan peak area and the Bandaisan caldera site in Japan explain how geological events change the nature of the landscape and how ecological processes such as vegetation growth respond to these changes and the analysis of feedback allows us to conclude that the tours were generally rated very well by the participants. These geocotourisms also illustrate how it is possible to take vegetation cover as a key to explore geological events that may have influenced the current ecological conditions of the landscape. The cases show how careful and critical observation of ecological properties can help to understand geological processes. Although the need to integrate the geological and ecological sciences is consistently felt by scholars, so far only a limited integration has been possible in practice. The cases therefore provide important lessons on how geocotourism can be carried out, and how it can deepen our understanding of the interrelationships between geological and ecological phenomena and processes that together make our earth a dynamic planet to live on.

Tefogoum et al. explained in their research results that Mount Manengouba is one of the most beautiful volcanic complexes along the Cameroon Volcanic Line (Zangmo Tefogoum et al., 2014). This mountain has several important vegetation and natural resources that support various economic activities. For this purpose, there are several active populations (Mbo, Bakossi, Bamileke, Bamenda, and Bororo), and people from neighboring areas still migrate and settle there. The "green open space" conflict has caused tribal conflicts that have caused settlements and livestock on the peak and agriculture on the slopes of the volcano.

Furthermore, the geomorphological features of Mount Manengouba that have geoheritage significance, or geomorphosites that include two nested sub-circular calderas, three permanent lakes, basins, broken domes and cones, and natural grassy lawns. The uniqueness of these geomorphological features and thermo mineral springs nationally and partly internationally makes Mount Manengouba important nationally and internationally. The main threats to the natural assets of Mount Manengouba are mining in the broken cone of the volcano, and overgrazing. The main obstacles to tourism are poor roads and lack of shelter and facilities at tourist sites. The geomorphosites of Mount Manengouba's summit (caldera, lakes, cones, and domes) are the main tourist attractions.

Wang et al. stated that Arxan-Chaihe Volcano Area (ACVA) protects spectacular landforms and structures produced by geologically young volcanism with high geological and geomorphological values (Wang et al., 2022). The area provides a complete collection of volcanic products and landforms and is easily accessible for scientists and the general public to view. Since ACVA was approved as a geopark, the protection of park resources has been improved to a certain extent. For example, the Arxan National Geopark Authority has been established, training and education for managers have been developed, several geosites have been fenced, and tourism infrastructure has been built. Meanwhile, volcano geotourism has made significant contributions to the local economy. The main problems identified are inefficient conservation management, uncoordinated development, and insubstantial interpretation system. The area is not far from Wudalianchi and Jingbohu Global Geoparks in Heilongjiang Province, in the volcanic tourism district of Northeast China. Consequently, ACVA should use these advantages to enhance its profile. If proper solutions can solve these problems, ACVA will become a major volcano tourism destination. In the long term, the two geoparks should jointly apply for global geopark designation, to promote local tourism development. Geotourism is a type of cultural industry, and the promotion of volcanic geological heritage is promising for the future.

The impact of ecotourism in the study of Somarriba-Chang & Gunnarsdotter has positive and negative impacts (de los Angeles Somarriba-Chang & Gunnarsdotter, 2012). The positive aspects include increasing national income and some communities, recognition of the importance of conservation awareness and minimizing the exploitation of natural resources. Negative aspects were shown in individual and group interviews with farmers in the Mombacho Volcano Nature Reserve, who were exposed to considerable tourism. They expressed concerns about environmental degradation, poachers, drugs and juvenile delinquency. Both positive and negative aspects were found in other studies. Stronza & Gordillo who studied three Amazonian ecotourism projects and found that ecotourism brought incentives for conservation, positive economic changes, higher self-esteem and greater community organization (Stronza & Gordillo, 2008). On the other hand, communities witnessed new restrictions on time, decreased reciprocity and social conflicts. Hernandez et al. argue that in many cases, ecotourism development has resulted in more negative consequences than benefits for local people and ecosystems, such as the exclusion of local communities from the management and administration of these projects, excessive numbers of tourists, and damage to the local ecological and cultural environment

(Hernandez Cruz et al., 2005). In our research, we found similar obstacles for local communities, particularly in the Mombacho Volcano Nature Reserve.

Erfurt-Cooper explains in his research findings that the volcano tourism sector makes a significant contribution to the local economy, resulting in increased marketing and promotion of 'volcano holidays' (Erfurt-Cooper, 2011). Although volcano and geothermal tourism has the potential to cause unexpected disasters in currently active volcanoes, visitor numbers continue to increase, partly due to easy access and affordable airfares, as well as better infrastructure in many destinations. The demand for tourism in unique environments such as active volcanoes and geothermal areas is based on the increasing interest in natural areas combined with the adventurous experience of gaining knowledge about unique landforms.

Research conducted by Hearne & Salinas demonstrated that choice experiments are a viable mechanism for analyzing user preferences for protected area management in developing countries (Hearne & Salinas, 2002). This research was facilitated by the fact that there was an urgent need for information to help park managers appropriately develop the Barva Volcano site. This reduced the hypothetical nature of choice experiments and the correspondence bias. Furthermore, the implementation of this study was aided by the fact that a nearby surrogate site, Poa Volcano, was a convenient location for conducting the survey, and that visitors to Poa could be considered informed consumers of the facility in question.

Furthermore, national and foreign visitors' preferences were similar in direction and largely similar in magnitude. Visitors preferred better information and aerial trams and observation towers. Both modern and semi-rural infrastructure were preferred over rural infrastructure. In general, survey respondents indicated a preference for site development, with efforts to provide more information, better views, and more modern infrastructure. This preference for site development is in contrast to the fact that 72% of foreign visitors expressed concern that congestion detracts from their visit, but it is consistent with the indifference expressed by Costa Rican visitors to the impacts of congestion. It may be difficult for Park managers to develop use restrictions that address the concerns of foreign tourists, who want to enjoy nature in relative seclusion, and Costa Rican visitors who want a natural setting for family recreation and picnics. However, it should be noted that Costa Rican families tend to visit during the weekend, whereas foreign visitors can schedule their visits during the week and experience less congestion. If necessary, Park managers could restrict access to certain trails during the week, to allow for isolated nature appreciation, and to allow unrestricted access during the weekend when crowds require more space.

5. Conclusion

This systematic literature review has provided a comprehensive synthesis of academic studies on ecotourism in volcanic areas, highlighting both the progress made and the gaps that persist in the field. The findings indicate that while ecotourism research has been conducted across various domains, including culture, geology, biodiversity-based livelihoods (e.g., rubber production), and public administration, the vast majority of studies remain focused on the tourism sector. This thematic concentration underscores the need to broaden the analytical lens and incorporate perspectives from underrepresented sectors, particularly those related to environmental governance, community resilience, and socio-ecological adaptation.

The methodological tendencies observed across the reviewed studies reveal a strong reliance on qualitative and descriptive designs, with only limited integration of theory-driven or hypothesis-based approaches. Notably, only two of the fourteen studies employed explicit theoretical frameworks, suggesting an underutilization of conceptual tools that could enhance

analytical depth and comparability. This absence of theoretical engagement represents a missed opportunity to connect localized ecotourism outcomes to broader debates in sustainability science, development studies, and environmental sociology.

Several limitations of this review must be acknowledged. The dataset was restricted to articles indexed in the Scopus database, which, while robust, may exclude relevant contributions from other platforms such as Web of Science or regional academic journals. Moreover, the review did not incorporate grey literature or unpublished studies, which may offer valuable insights, particularly in community-based and practitioner-led ecotourism initiatives. The focus on a limited set of variables also constrained the analytical scope, limiting the capacity to capture complex interrelations across ecological, economic, and social dimensions.

Importantly, most of the studies examined ecotourism in mountainous volcanic settings, with minimal attention given to comparable dynamics in riverine or coastal volcanic environments. Given the increasing significance of climate-adaptive tourism models, future research should adopt a more comparative and spatially diverse orientation. Investigating ecotourism across various ecosystems, such as coastal zones, crater lakes, and fluvial volcanic basins, would offer critical insights into how geophysical context shapes community engagement, risk perception, and sustainability outcomes.

In conclusion, this review contributes to the existing literature by mapping current knowledge, identifying blind spots, and suggesting a research agenda that prioritizes theoretical integration, sectoral diversification, and ecological contextualization. Strengthening these dimensions will be essential for building a more holistic and inclusive understanding of ecotourism in volcanic landscapes, one that is not only academically rigorous but also relevant to policymakers, practitioners, and communities navigating the complexities of sustainable tourism in geologically active regions.

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The authors have declared no potential conflicts of interest regarding this article's research, authorship, and/or publication.

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