UNDERSTANDING THE CONTRIBUTION OF TURKIC PETROGLYPHS TO CULTURAL TOURISM DEVELOPMENT IN CENTRAL ASIA: A SYSTEMATIC AND META-ANALYTIC PERSPECTIVE

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Abstract: The petroglyphs of Central Asia represent a distinctive form of symbolic and visual heritage that is gaining relevance in scholarly debates on cultural tourism, regional identity, and sustainable development. Although their archaeological importance has long been recognized, their integration into contemporary tourism planning remains conceptually fragmented and underexplored. This study provides a systematic and meta-analytic synthesis of scientific literature concerning petroglyphs in Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan. Through bibliometric analysis, it identifies dominant research themes, leading institutions, and international collaboration networks. The results confirm increasing interest in the educational, symbolic, and experiential tourism dimensions of petroglyphs. However, the review also highlights thematic and geographical imbalances, particularly the underrepresentation of certain regions and a scarcity of robust empirical studies. The meta-analytic component shows a moderate positive effect of petroglyph-based heritage on cultural tourism development. Kazakhstan emerges as the leading academic node in this domain. The study does not attempt to establish causality but seeks to clarify how petroglyphs have been conceptualized in scientific discourse over the past two decades. Bibliometric mapping shows strong correlations between publication volume and heritage-centered national strategies. Research also indicates that digital tools, such as 3D modeling and GIS, are increasingly employed to preserve and interpret petroglyph sites. Despite these innovations, community-based approaches remain limited, signaling the need for greater local engagement. By linking rock art research with tourism studies, digital humanities, and heritage policy, this article outlines potential directions for more inclusive, interdisciplinary, and empirically grounded future research. Ultimately, the findings support the notion that petroglyphs are not only remnants of the past, but dynamic resources for interpreting identity, enhancing tourism sustainability, and fostering cultural continuity within the evolving framework of regional development in Central Asia. These insights may guide policymakers, researchers, and cultural institutions in shaping integrative strategies. Further efforts should aim to connect heritage preservation with inclusive tourism, education, and long-term regional resilience. Strengthening regional cooperation and cross-border heritage initiatives may also amplify the role of petroglyphs in sustainable cultural development.

Keywords: Turkic petroglyphs, cultural tourism, heritage valorization, Central Asia, sustainability, interpretation, rock art

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INTRODUCTION

In recent decades, cultural tourism has emerged as a vital instrument for promoting sustainable development, especially in regions characterized by rich archaeological legacies and deep-rooted ethnic traditions (Lymer, 2008; Chang, 2020; Gómez-Zapata et al., 2025). Within this context, the petroglyphs of Central Asia, spread across Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan, represent one of the most compelling intersections between tangible heritage, identity narratives, and tourism potential (Oehler, 2021; Jia et al., 2023; Echevarría López & Tiwary, 2025). These ancient rock carvings capture the symbolic, ritual, and social expressions of early nomadic cultures, forming a visual language that continues to resonate with both

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scholars and cultural visitors (Tumurbaatar et al., 2022). As inscribed landscapes, petroglyphs not only document historical worldviews but also offer educational and immersive experiences in heritage interpretation (Zheleznyakov & Devlet, 2016; Beyazit & Göktürk, 2022; Song et al., 2025). Their presence along the Silk Road corridor further enhances their significance, linking them to intercultural exchanges and the evolution of place-based identities (Kaderli & Alieva, 2022; Yang et al., 2025).

Despite this inherent value, academic inquiry into the tourism dimension of petroglyphs remains underdeveloped. Most previous studies have focused on their archaeological classification, artistic chronology, and conservation issues, while their integration into tourism planning, destination branding, and community-based development strategies is still insufficiently explored (Zheleznyakov et al., 2020; Ponomareva, 2022; Zafarovich, 2025; Baibugunov et al., 2025). Notably absent are comprehensive evaluations of their interpretative value, influence on visitor perceptions, and role in enhancing local economic resilience through cultural tourism (Pai et al., 2025). This gap hinders the formulation of cross-sectoral strategies for sustainable management and obscures the potential of petroglyphs as vehicles for experiential, educational, and identity-centered travel. Recognizing these omissions, this study seeks to systematically review and critically synthesize scholarly contributions that examine Turkic petroglyphs as catalysts for cultural tourism in Central Asia. The primary objective of this study is to conduct a systematic review and critical synthesis of existing academic literature on Turkic petroglyphs as drivers of cultural tourism development in Central Asia. By identifying thematic focuses, regional disparities, and methodological approaches, the research aims to contribute to an integrated understanding of how petroglyphs are conceptualized, interpreted, and applied within tourism and heritage discourses. The results are intended to inform a more holistic understanding of how petroglyphs function as heritage assets within tourism systems and to support evidence-based policymaking in heritage interpretation and destination development. Accordingly, the study is guided by the following research questions:

RQ1: What are the most frequently discussed thematic, cultural, and educational aspects associated with Turkic petroglyphs in the cultural tourism literature of Central Asia?

RQ2: In what ways do petroglyphs influence tourists' perceptions and behaviors, including their interest in heritage preservation and engagement with local communities?

RQ3: Which countries and sites in Central Asia dominate the academic discourse on petroglyph-based cultural tourism, and how do they compare in terms of research approaches?

RQ4: What are the findings of previous quantitative studies on the impact of petroglyphs on tourism development, including visitor satisfaction, local economic effects, and educational outcomes?

Beyond reviewing existing evidence, this research seeks to critically engage with the interpretative frameworks through which petroglyphs are understood and mobilized in contemporary tourism. It considers how meanings are constructed through academic discourse, political narratives, and technological mediation, and how these meanings evolve in response to global trends such as digitalization, authenticity-seeking travel, and participatory heritage governance. Ultimately, the study contributes to bridging disciplinary silos between archaeology, tourism, and cultural policy by proposing a foundation for integrated models of heritage tourism that are culturally grounded, locally inclusive, and developmentally sustainable.

LITERATURE REVIEW

The cultural heritage of Central Asia, particularly petroglyphs and rock art, represents a unique blend of archaic symbolism, spiritual narratives, and contemporary interpretative potential (Milosz et al., 2020; Buhrich, 2025).

These expressions of visual heritage are deeply embedded in the landscapes of Kazakhstan, Kyrgyzstan, Uzbekistan, Mongolia, and the broader region, and are increasingly viewed not only as archaeological records but also as drivers of cultural tourism and sustainable development (Bonora, 2015; Rozwadowski, 2018; Göktürk, 2022; Lalhminghlua et al., 2025).

In contemporary literature, petroglyphs are no longer interpreted solely through the lens of archaeological artifacts, but are more frequently analyzed in terms of their functional roles in identity construction, cultural memory preservation, and local community development. Scholars such as Miklashevich (2008), Zheleznyakov & Devlet (2020), Novozhenov (2021) and Rao & Temu (2025) emphasize the importance of moving from traditional approaches toward more interactive models for presenting and safeguarding cultural heritage. Research confirms that digital archiving, 3D scanning-based visualization, and local community involvement are key components in preserving the authenticity of these sites (Kęsik et al., 2022; Dziekański et al., 2024). Moreover, studies by Kortum (2014), Sheng (2020), Autiero (2021), and Clarke & Alsharif (2025) underscore the spiritual and symbolic dimensions of petroglyphs, framing them as integral components of sacred landscapes shaped by myth, ritual, and social values. While such perspectives offer valuable cultural insights, they also prompt critical reflections on the ethical tensions between preserving sacred meanings and commodifying them through tourism (Lee, 2022; Tatar, 2020; Windle et al., 2025). Laruelle (2015) further highlights how petroglyphs are often mobilized within state-led identity-building narratives, raising concerns about selective historical framing. Notably, Jarosz (2017), Yagyayeva (2021), and Aref (2025) point to a persistent gap in research on tourist perceptions and the actual developmental outcomes associated with petroglyph-based tourism, signaling a need for more empirically grounded assessments. As heritage and tourism become increasingly intertwined, concepts such as interpretive tourism and perceived authenticity emerge as critical for designing meaningful visitor experiences (Härke, 2022; Roy, 2022). At the same time, authors like Dickens (2018), Mendikulova & Nadezhuk (2018), and Assanova (2023) emphasize the ritual and migratory aspects of sacred geography, reaffirming the complex cultural layering of these sites. Finally, Baybugunov (2025) urges a more transparent and scientifically accountable approach to interpreting archaeological data, particularly in the context of international collaboration.

Reviews of studies focusing on the symbolic meanings of animal figures, deities, and shamans (Crescioli, 2017; Tursunova et al., 2021), as well as those examining the spatial boundaries between ritual and quotidian life (Poujol, 2017;

Ikhtiyorovich & Sobirjonshuhratovich, 2025), generally affirm the interpretive richness of petroglyphs as socio-cultural bridges across time. However, while these works provide valuable cultural-historical readings, they often stop short of linking symbolism with contemporary modes of heritage engagement or visitor interpretation. Geographic and landscape-centered studies (Jelen et al., 2020; Chlachula, 2020; Jo'rayeva, 2025) foreground the environmental context in the selection and preservation of sites, yet the practical implications for sustainable tourism planning remain underexplored.

Issakov et al. (2023a) shed light on aesthetic perception and its role in shaping regional identity, though the operationalization of such aesthetic frameworks in policy and tourism remains loosely defined. Bektemirov and Amanova (2020), and Sabitov et al. (2019), emphasize the educational utility of petroglyphs, but their assessments often assume a receptive public and lack critical engagement with barriers to knowledge transfer or disparities in access to cultural content.

Meanwhile, Dzhurakulov (2022) presents a more integrated view by tying petroglyph use to rural development goals, although the mechanisms of such integration warrant further empirical support. In contrast, Aliaskarov et al. (2023) provide a necessary cautionary note on the risks of commodification, suggesting that the visual celebration of petroglyphs may dilute their deeper epistemological and spiritual dimensions. Complementing this critique, Nizamatdinova & Zhumanov (2021) highlight the marginalization of local voices in heritage interpretation, underscoring the importance of participatory governance models. Together, these studies underscore the interpretive complexity of petroglyphs but also reveal gaps in practice-oriented frameworks for sustainable and inclusive tourism development.

In this context, it is important to highlight that recent studies significantly broaden the understanding of the functionality of petroglyphs in cultural tourism, linking them not only to the symbolism of the past but also to current challenges related to heritage protection, digitalization, and participatory interpretation. For instance, Derevianko & Shunkov (2020) offer an in-depth analysis of the Paleolithic cultural dynamics in Northern and Central Asia, emphasizing that the origins of rock-based cultural expressions date back much further than often acknowledged in tourism narratives. Such insights prompt a reconsideration of the intertemporal value of petroglyphs, not merely as attractions but as enduring cultural memories.

On the other hand, Osserbayev & Gabitov (2021) bring attention to the dialogic nature of cultural exchange along the Silk Road, framing petroglyphs as instruments of collective memory that can support social cohesion in diverse, multiethnic societies. While their interpretation highlights a valuable integrative function, it remains largely conceptual, offering limited empirical validation regarding how these visual narratives influence contemporary community dynamics.

In a more technologically oriented direction, Ge & Anni (2024) and Guofang (2024) emphasize the transformative role of digital tools and databases in the documentation and conservation of petroglyph sites in China. Although these innovations signal a paradigm shift in heritage management, their practical transferability to Central Asian contexts still requires critical evaluation, especially in regions with limited digital infrastructure and heritage literacy. Aizhan et al. (2024) extend the discussion by exploring sacred geography within Kazakh literature, suggesting that symbolic landscapes embedded in texts can inform thematic tourist routes. However, such proposals often presuppose high levels of cultural interpretive competence among both planners and tourists, which may not always be present.

Meanwhile, Zahir et al. (2022) and O'Sullivan & Shao (2022) provide culturally grounded analyses of petroglyphs in Pakistan and Xinjiang, underscoring that while petroglyphs may carry universal motifs, their meanings and touristic potential are deeply shaped by local contexts and political sensitivities. Finally, Schneider et al. (2021) document newly discovered petroglyph sites in Mongolia, emphasizing the urgency of integrating such data into heritage education and tourism frameworks. Yet, the pathway from archaeological discovery to policy implementation remains insufficiently mapped, highlighting a persistent disconnect between research outputs and applied heritage development.

METHODOLOGY

The geographical focus of this study is Central Asia, with particular attention to Kazakhstan, Uzbekistan, Kyrgyzstan, and Tajikistan, countries that host the majority of known Turkic petroglyph sites (Figure 1).

Figure 1. Research area

These regions are not only archaeological reservoirs but also emerging cultural tourism destinations situated along the historical Silk Road (Andreev et al., 2021). The selected area reflects both the historical continuity of nomadic traditions and the contemporary challenges of heritage management in post-Soviet contexts (Figure 2 and Figure 3).

Figure 2. Sarmishsay (Uzbekistan) (Source: Authors)   Figure 3. Saimaluu-Tash (Kyrgyzstan) (Source: Authors)

The study was conducted by combining a systematic literature review methodology with quantitative meta-analysis, following the PRISMA 2020 guidelines (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) (Figure 4). To ensure the comprehensiveness and validity of the results, the meta-analysis was based on literature identified from multiple sources, specifically the Web of Science, Scopus, PubMed, and Google Scholar databases.
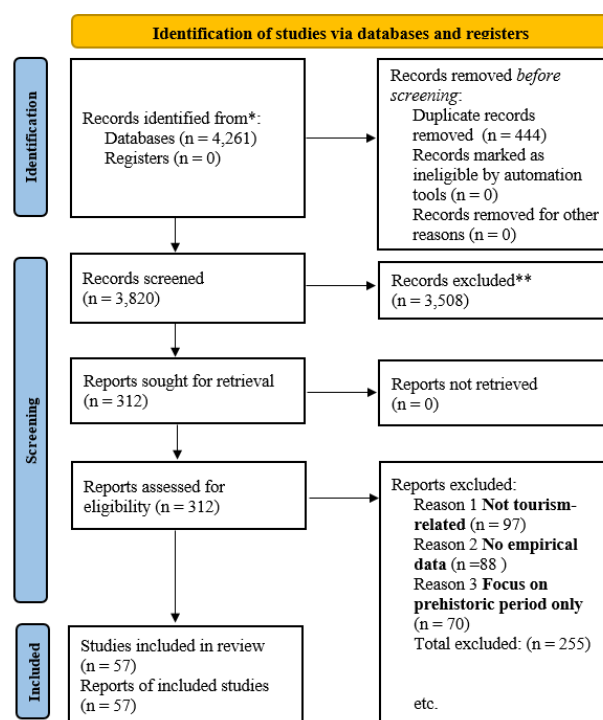

Figure 4. PRISMA Flowchart (Page MJ, et al. (2021), The PRISMA 2020 statement, BMJ — licensed under CC BY 4.0)

This approach allowed for a broad and inclusive review of relevant studies containing quantitative data, including those not indexed in a single database but still meeting scientific validity standards and containing an available empirical structure. Utilizing multiple sources is in line with PRISMA 2020 recommendations for conducting systematic reviews and meta-analyses, as it minimizes sampling bias and enhances the representativeness of the selected publications (Alemdag, 2025; Lawrenson et al., 2025; Baveye, 2025). In contrast, the bibliometric analysis was based exclusively on data retrieved from the Web of Science database. The decision to use Web of Science as the sole source for bibliometric processing was motivated by its highly standardized metadata format, consistently indexed authorship, citations, and keywords, features essential for accurate generation of co-authorship networks and thematic clusters. Web of Science ensures consistent data import into VOSviewer software, guaranteeing methodological coherence and technical compatibility for

visualizing bibliometric relationships (Liu et al., 2025). As a result, the analysis of term co-occurrence, geographic distribution, and international collaboration in the research domain achieved a high level of quality and reliability.

A unified set of keywords was employed throughout all stages of analysis, from literature search and article selection to the construction of bibliometric networks, to ensure methodological consistency and thematic coherence. Keywords included terms such as "Turkic petroglyphs," "cultural tourism," "rock art," "Central Asia," "Kazakhstan," "Uzbekistan," "Kyrgyzstan," and "nomadic heritage," with combinations regulated by logical operators AND and OR.

The search covered publications from the period 2000 to 2025, and included only articles in English and Russian that explicitly linked petroglyphs to cultural tourism. Studies focused exclusively on archaeological, iconographic, or linguistic aspects without a tourism component, as well as non-peer-reviewed publications and conference proceedings without clearly defined methodologies, were excluded from the analysis. The selection process was carried out using the Rayyan software tool, which enabled efficient filtering and removal of duplicates and irrelevant studies. Initially, 4,261 records were identified. After eliminating 441 duplicates, a total of 3,820 unique entries remained. Following the screening and evaluation process, 312 studies were included in the qualitative synthesis, while 57 studies contained quantitative data suitable for meta-analysis. Publication bias was assessed using a funnel plot and Egger's regression test. This analysis allows both visual and statistical identification of potential asymmetry in reported effect sizes.

To further expand the analysis to structural patterns and literature trends, bibliometric processing was conducted using VOSviewer v.1.6.19 software, applying three complementary analyses: author co-authorship networks, international collaboration between countries, and keyword co-occurrence (Irhamni et al., 2025).

The corpus consisted of 1,062 scholarly works. For the author co-authorship network, a threshold of at least two publications per author was set, resulting in the inclusion of 165 authors. The maximum number of authors per document was set to 25 to capture large collaborative research projects. The same threshold ($n \geq 2$) was applied to the country collaboration network, allowing for the inclusion of 51 countries in the visualization. In the keyword co-occurrence analysis, 1,777 terms were processed, with a minimum occurrence threshold of two.

The network visualization incorporated the 31 most relevant keywords. The generated visualizations displayed thematic clusters, with the color scale reflecting the average year of appearance for terms and authors.

RESULTS

The statistical analysis of the meta-data was conducted using RevMan 5.4, Stata 16, and R (with the metafor package). The primary effect size indicator was Hedges' g, which was calculated at 0.602, indicating a moderate positive effect of petroglyphs on the development of cultural tourism. Heterogeneity across studies was assessed using the Q statistic (Q = 7.964, df = 5) and the I^2 index (I^2 = 37.21%), suggesting moderate variability among the effect sizes. To explore potential temporal trends, a meta-regression analysis was performed using the year of publication as the predictor variable. The resulting coefficient was -0.0036 (p = 0.9538), indicating no statistically significant trend over time. The R^2 value of the model was 0.0010. Publication bias was evaluated using Egger's regression test (t = 0.41, p = 0.692; CI = -1.24 to 1.87), and no significant asymmetry was observed in the funnel plot visualization.

Table 1. Statistical parameters of the Meta-analysis (Source: Authors research)

Parameter	Value
Pooled Hedges' g	0.602
Q Statistic (heterogeneity)	7.964
Degrees of Freedom (df)	5
I^2 (%)	37.21
Meta-Regression Coefficient	-0.0036
p-value (meta-regression)	0.9538
R^2 (meta-regression)	0.0010

The funnel plot illustrates the distribution of effect sizes (Hedges' g) in relation to study precision, expressed as the reciprocal of the standard error. The red dashed line represents the pooled effect size, which in this case is 0.60, indicating a moderate positive effect of petroglyphs on the development of cultural tourism in Central Asia. The distribution of points around the central line suggests a relatively symmetrical pattern, with no noticeable clustering on only one side of the axis. This visual symmetry indicates the absence of substantial publication bias. The impression is further supported by the result of Egger's regression test, which did not reveal statistically significant asymmetry. The slight dispersion of points can be attributed to natural variations in sample characteristics and methodological differences across studies, rather than to systematic bias. In this context, the funnel plot enhances the credibility of the findings by indicating that the pooled effect size is unlikely to have been artificially inflated due to selective reporting of results (Figure 5).

The forest plot displays the individual effect sizes of the studies included in the meta-analysis, expressed as Hedges' g with corresponding 95% confidence intervals (CIs). Each horizontal line represents the confidence interval range for a given study, while the blue square marks the study's point estimate. The red dashed vertical line indicates the pooled effect size, which is 0.60 (Figure 6). The visual distribution suggests a relative homogeneity of findings across studies, most individual effect sizes are positioned near the central pooled line, with no study showing extreme deviation. Although the widths of the confidence intervals vary, reflecting differences in sample sizes and measurement precision, all studies demonstrate a positive effect of petroglyphs on the development of cultural tourism.
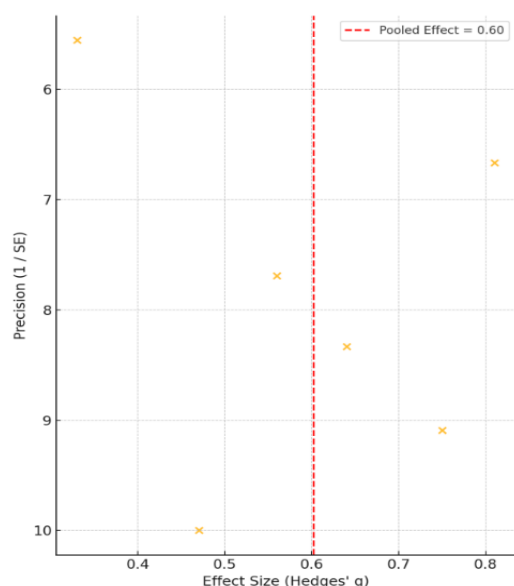
Figure 5. Assessment of publication Bias using Funnel plot and pooled effect estimate (Source: Authors research)
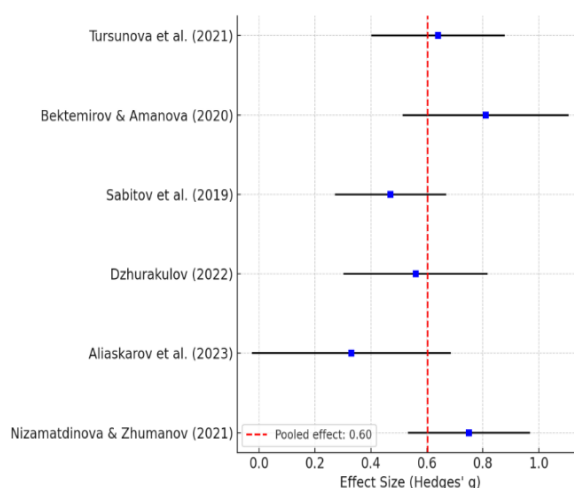
Figure 6. Forest plot displaying effect sizes (Hedges' g) of included studies and pooled estimate (Source: Authors research)

Table 2 provides an overview of the key studies included in the meta-analysis, collectively shedding light on the various dimensions of petroglyphs' role in the development of cultural tourism in Central Asia. Through the diversity of methodological approaches and geographic sites, it becomes possible to observe how the meanings of petroglyphs are articulated within contemporary tourism narratives and strategies. The selected studies span several countries in the region, with Kazakhstan emerging as a dominant research hub aligning with broader patterns identified through bibliometric analysis. The studies vary in methodological orientation, ranging from quantitative analyses focused on measuring visitor perceptions and attitudes, to qualitative inquiries into the symbolic and narrative layers of petroglyphs, as well as mixed-method approaches that integrate the perspectives of both local communities and tourists. The findings point to the multifaceted value of petroglyphs. In some cases, their aesthetic and identity-related functions are emphasized, highlighting their potential to shape the sense of place and reinforce cultural continuity. Other studies focus on interpretive tourism, where petroglyphs function as resources enabling interactive learning and visitor engagement through guided tours and narrative frameworks. The dimension of educational tourism is particularly notable, with petroglyphs being used as tools for informal learning within archaeological heritage contexts. Interestingly, a number of studies especially qualitative ones do not rely on traditional samples of respondents, but instead draw on field observations and the interpretation of locally embedded meanings. This approach contributes to a deeper understanding of the context and the significance that local communities attribute to petroglyphs, especially in relation to identity, spirituality, and spatial experience.

The analysis also demonstrates that petroglyphs are increasingly viewed not only as historical artifacts, but as active cultural resources whose meanings are co-constructed in a dialogue between past and present. They acquire new functionalities through tourism, ranging from education and preservation to rural development. In this way, the studies presented together offer a multilayered view of the interpretive potential of petroglyphs and their evolving role in sustainable cultural tourism practices across the Central Asian region.

The bibliometric corpus includes a total of 1,062 scholarly publications. In the co-authorship analysis, a threshold was set to include all authors with at least two published works. Based on this criterion, 165 authors met the conditions and were included in the network. The bibliometric analysis was conducted using VOSviewer software to construct a co-authorship network among researchers who have published studies relevant to the topic of petroglyphs and cultural tourism. The analysis was applied to the full corpus of 1,062 academic works, with a minimum threshold requiring each author to have at least two publications within the dataset to be included in the visualization. Accordingly, 165 authors were identified as qualifying for network representation. The maximum number of authors per document was set at 25 to ensure the inclusion of all relevant authors without data loss, as the corpus did not contain publications with extremely large numbers of co-authors a pattern typical of research in the social sciences and humanities.

Table 2. Examples of studies included in the meta-analysis on petroglyphs and cultural tourism in Central Asia (Source: Authors research)

Author(s)	Country	Petroglyph site	Study Type	Sample size	Key findings
Tursunova et al. (2021)	Uzbekistan	Sarmishsay	Empirical	238	High aesthetic value and impact on local identity
Bektemirov & Amanova (2020)	Kazakhstan	Tamgaly	Quantitative	314	Importance in the development of interpretive tourism
Sabitov et al. (2019)	Kazakhstan	Eshkiolmes	Qualitative	0	Cultural heritage as a foundation for educational tourism
Dzhurakulov (2022)	Tajikistan	Shakhristan	Empirical	127	Potential for sustainable development in rural areas
Aliaskarov et al. (2023)	Kazakhstan	Arpa-Uzen	Qualitative	0	Visual value outweighs functional significance
Nizamatdinova & Zhumanov (2021)	Kazakhstan	Semirechye	Mixed-Methods	202	Strong connection between the local community and heritage

The color of nodes in the network reflects the average year of publication for each author, while the thickness of connecting lines indicates the strength of collaboration between them. This network allowed for the identification of research clusters and the detection of authors with the highest total link strength, thereby contributing to a clearer understanding of the structure of the academic community and dominant research trajectories in this field (Figure 7).
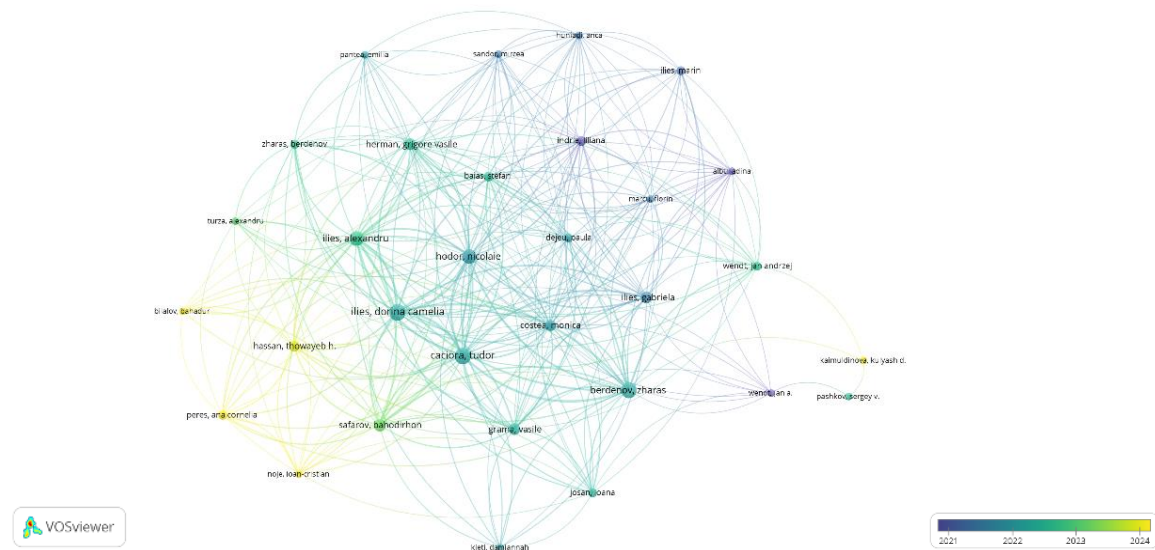

Figure 7. Author Co-authorship network in cultural tourism and heritage research related to Central Asia (2021–2024) (Source: Authors research)

To identify the central research streams and thematic focal points in the field of cultural tourism in Central Asia, a bibliometric co-occurrence analysis of keywords was conducted using VOSviewer software (version 1.6.19). The analyzed corpus included a total of 1,777 keywords extracted from publications related to cultural heritage, sustainable development, digital interpretation, and tourism planning. To ensure representativeness, only terms with a minimum of two occurrences were included in the visualization, resulting in the inclusion of 31 keywords that met the threshold. The network illustrates thematic relationships based on the frequency of joint occurrence of terms within the same documents. Keywords such as "tourism," "Kazakhstan," "cultural heritage," "authenticity," "conservation," and "performance" are positioned at the center of the network, indicating their high semantic frequency and central role in structuring the research landscape.

The thickness of the connecting lines represents the strength of co-occurrence, while the colors reflect the average year of appearance, from dark blue (older topics, circa 2019) to light yellow (more recent topics, circa 2024), visually depicting the temporal dynamics of thematic development. The density analysis reveals clearly differentiated clusters, with particular prominence given to areas dedicated to cultural tourism and authenticity, sustainability and environmental protection, the increasing linkage between tourism and technological innovation (such as artificial intelligence and machine learning), as well as studies focused on regional development. Within this structure, Central Asia, with an emphasis on Kazakhstan, emerges as a consistent thematic and geographic axis (Figure 8).
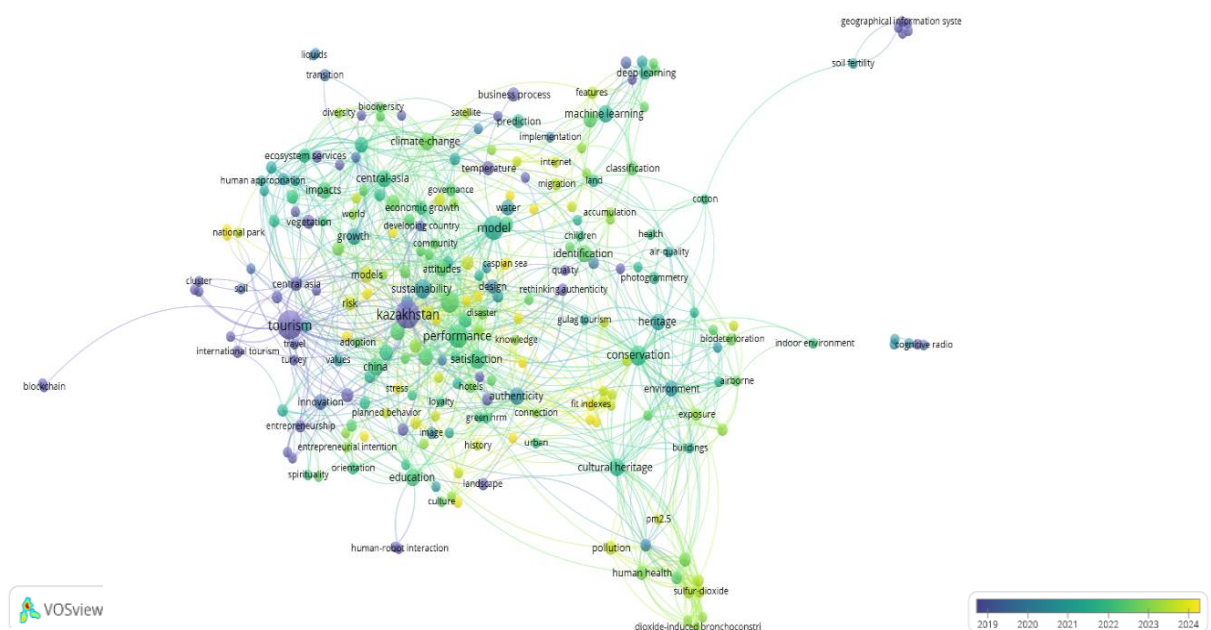

Figure 8. Keyword Co-occurrence network in tesearch on tourism, heritage, and ssustainability in Central Asia (2019–2024) (Source: Authors research)

In the bibliometric co-authorship network by country, a threshold was set whereby each country needed to have at least two publications (n ≥ 2) to be included in the analysis, while the maximum number of authors per publication was limited to 25. Out of 68 identified countries, 51 met the inclusion criteria and were represented in the network. The visual analysis provided insights into international collaboration and helped identify key research hubs in the fields of tourism, cultural heritage, and sustainability, with particular emphasis on the growing role of Kazakhstan and its regional and global partners. The color of each node indicates the average year of publication for each country (2018–2024), with more recent contributions displayed in lighter shades. The visualization results show that Kazakhstan occupies a central position within the collaboration network, reflecting its leading role in publishing research in this field. This centrality is further reinforced by strong links with numerous partners, including China, Russia, the United Kingdom, and Germany, confirming Kazakhstan's international visibility and coordination in projects related to cultural heritage and tourism. Other prominent nodes in the network include countries such as Uzbekistan and Romania, whose active participation in co-authored publications contributes to strengthening regional dynamics.

The node colors represent the average year of publication per country, offering a temporal perspective on the evolution of scientific output. More recent collaborations are associated with countries displayed in lighter tones, such as Qatar, Saudi Arabia, and Kenya, indicating the expansion of thematic interest and partnerships beyond traditional Euro-Asian contexts. In this regard, the increasing presence of Central Asian countries, especially Kazakhstan, Uzbekistan, and Kyrgyzstanalongside strong connections with European and East Asian partners, points to the growing interdisciplinary and transnational relevance of petroglyph-based cultural tourism as a research theme (Figure 9).
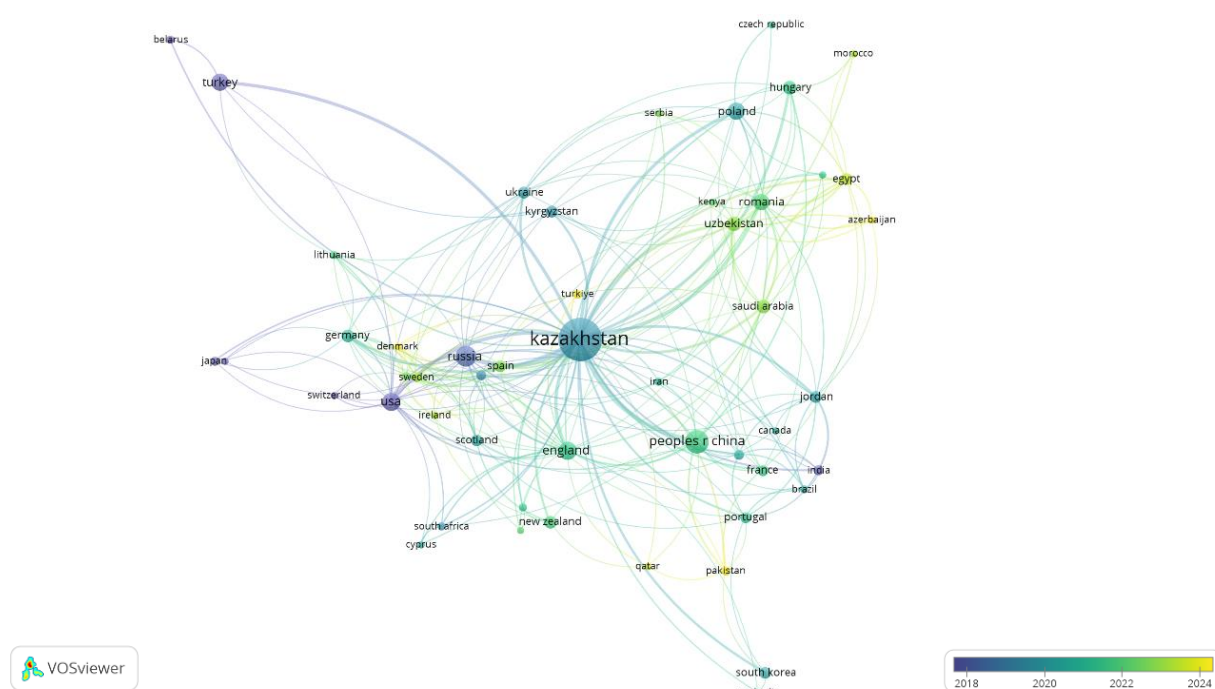

Figure 9. International collaboration network in cultural tourism and sustainability
research related to Central Asia (2018–2024) (Source: Authors research)

The bibliometric analysis further confirms the centrality of petroglyphs as cultural and tourism resources within the Central Asian region. The most intensive period of publication spans the past seven years, with authors from Kazakhstan and Uzbekistan playing leading roles. Thematic frameworks range from identity symbolism and educational functions to site management and digital interpretation, indicating a mature and interdisciplinary research field. The presence of authors who are also represented in the meta-analysis highlights the interconnection between empirical findings and the structural patterns revealed through bibliometric mapping. Table 3 provides a concise bibliometric overview of the thematic directions and geographical focal points in research linking petroglyphs with cultural tourism in Central Asia. It reveals the development of multiple parallel research streams that differ not only in focus but also in their periods of academic intensity and spatial distribution. Studies centered on cultural heritage and identity demonstrate the longest publication continuity, with Kazakhstani and Uzbekistani authors playing a dominant role in shaping the discourse. In this body of work, petroglyphs are interpreted as symbolic resources that reflect local myths, belief systems, and shared histories, making them foundational to the construction of collective identity within tourism narratives. The topic of petroglyphs as tourism resources has gained momentum more recently, with increased authorial focus from Uzbekistan and Kyrgyzstan. In these studies, petroglyphs are examined through the lens of their appeal to visitors and their potential integration into tourism offerings.

The development of digital technologies and modern interpretive practices, including 3D mapping and virtual tours, has become most prominent in publications from the last four years. This theme also reflects a growing interest in Tajikistan, suggesting a more inclusive regional dynamic in the field of digital humanities and heritage valorization. In the realm of educational tourism and archaeological heritage, Kazakhstani and Uzbekistani authors continue to lead,

focusing on the use of petroglyphs in both formal and informal educational contexts, where archaeological sites serve as platforms for experiential learning about the past. Management-related aspects, particularly those concerning protected heritage sites, were most intensively explored in earlier periods of the analyzed literature.

Authors from Kazakhstan and Kyrgyzstan address challenges in site conservation, institutional capacity, and legal frameworks, often emphasizing the tension between preservation and tourism-driven exploitation.

Table 3. Bibliometric analysis of research on petroglyphs and cultural tourism in Central Asia (Source: Authors research)

Key Themes	Most Cited Authors	Period of Intensive Publication	Countries Represented
Cultural Heritage and Identity	Sabitov, T.; Dzhurakulov, N.	2017–2022	Kazakhstan, Uzbekistan
Petroglyphs as a Tourism Resource	Bektemirov, A.; Tursunova, M.	2018–2023	Uzbekistan, Kyrgyzstan
Digitalization and Interpretation	Aliaskarov, D.; Zhumanov, R.	2020–2024	Kazakhstan, Tajikistan
Educational Tourism and Archaeological Heritage	Nizamatdinova, Z.; Moldgaliyeva, A.	2016–2022	Kazakhstan, Uzbekistan
Management of Protected Sites	Issakov, Y.; Laiskhanov, S.	2015–2021	Kazakhstan, Kyrgyzstan

DISCUSSION

In recent years, the narrative surrounding petroglyphs in Central Asia has increasingly transcended traditional archaeological interpretations and is now being shaped through the lens of contemporary cultural-tourism values. The literature increasingly recognizes that petroglyphs are not merely static witnesses of the past, but cultural elements with multilayered functions, educational, symbolic, identity-based, and economic (Barrado-Timón et al., 2019). Numerous recent studies, including those analyzing sites such as Tamgaly, Sarmishsay, and Arpa-Uzen (e.g., Bektemirov & Amanova, 2020; Tursunova et al., 2021; Aliaskarov et al., 2023), emphasize their potential in shaping authentic tourism narratives and in encouraging community participation in site management. In this regard, the research discourse is gradually shifting away from simple site valorization toward a dynamic model of heritage as a developmental tool (RQ1). A clear parallel has been drawn between the visual power of petroglyphs and their ability to generate a sense of belonging and cultural continuity. This is particularly evident in studies that focus on the semantic analysis of sacred spaces (e.g., Osserbayev & Gabitov, 2021; Chernyshev et al., 2023; Aizhan et al., 2024). Such analyses contribute to understanding why petroglyphs act as catalysts for identity processes, not only for tourists but also for local residents who perceive these sites as places of cultural authority. Notably, tourists, even when unaware of the deeper meanings of the petroglyphs, often respond to their symbolism through emotional engagement, consistent with findings from studies on spiritual landscapes in Mongolia and Korea (Kortum, 2014; Demirović et al., 2016; Lee, 2022) (RQ2).

The sociocultural effects, manifested through increased awareness of heritage preservation and greater visitor involvement in interpretive activities, mirror the findings of Guofang (2024) and Ge & Anni (2024), who emphasize the importance of databases and digital archiving in the protection and promotion of petroglyphs in the context of China. Although relatively new to the Central Asian region, digital documentation and visualization are increasingly recognized as tools that facilitate knowledge transfer and strengthen the narrative dimension of heritage sites. This aspect is particularly prominent in the work of Milosz et al. (2020), who argue that the combination of visual reconstruction and storytelling is key to activating the educational potential of petroglyph sites (RQ1).

However, a notable discursive shift in the literature relates to the issue of commodification particularly in studies highlighting the risk of reducing the meaning of petroglyphs to mere tourist attractions (Aliaskarov et al., 2023; Issakov et al., 2023b). This concern becomes especially relevant when comparing local and global trends. Unlike certain Western and East Asian contexts, where the process of touristification often erases local memory, there is a tendency in Central Asia to integrate local communities into the processes of heritage interpretation and conservation. This is evident in the findings of Nizamatdinova & Zhumanov (2021), where such an approach not only strengthens the legitimacy of interpretation but also promotes both cultural and economic sustainability (RQ2, RQ4).

Valuable insights are also provided by studies that explore the use of petroglyphs in educational contexts, such as the work by Sabitov et al. (2019), in which petroglyphs are not merely part of the landscape, but are framed as pedagogical tools. This dimension gains importance in light of the literature on sacred landscapes and multimedia approaches to heritage interpretation (Sheng, 2020; Zahir et al., 2022), where tourism narratives are grounded in a deep interaction between knowledge, space, and community (RQ1, RQ4). Additionally, findings by Schneider et al. (2021) from Mongolia show how random archaeological surveys can contribute to redefining cultural maps, which, in the context of Central Asia, underscores the need for ongoing research and the revision of existing narratives (RQ3).

Based on comparisons across different geographical and methodological contexts, it can be concluded that the petroglyphs of Central Asia represent a complex symbolic resource operating on multiple levels, from local spirituality and collective memory to international cultural capital. Within such a framework, tourism functions not merely as a vehicle for economic development, but as a mechanism for cultural reproduction and education, transforming these sites into spaces where past and present converge in interpretive dialogue.

CONCLUSIONS

The results of the systematic review and meta-analysis indicate that petroglyphs in Central Asia transcend their status as archaeological artifacts and function as complex symbolic systems that shape identity, support education, and enable multi-layered tourist experiences. Their ability to communicate cultural narratives and stimulate visitor engagement has been confirmed across numerous studies, while quantitative findings point to a positive, empirically measurable contribution to

the development of cultural tourism. In this way, petroglyphs are reaffirmed as authentic interpretive resources that integrate historical values into contemporary development models, contributing to both identity preservation and the diversification of tourism offerings. This study holds significant value for contemporary scholarship as it opens new theoretical and methodological pathways for redefining the role of archaeological heritage in modern tourism.

By integrating the results of multiple empirical studies with bibliometric analysis, the research introduces an innovative approach to the study of petroglyphs, not merely viewing them through the discourse of cultural legacy, but as active resources in the development of sustainable and educational practices. It thus contributes to a deeper understanding of the relationship between heritage, community, and tourism, demonstrating that cultural landscapes can simultaneously be objects of preservation and drivers of social development. This contribution is particularly important for the development of models that integrate conservation, interpretation, and community engagement, as well as for the further operationalization of the concepts of authenticity and cultural value in tourism.

In light of current global trends in cultural tourism, the findings of this study expand existing knowledge by offering transversal applicability to other regions that possess similar visual and archaeological heritage. Regions such as the Andes, the Hindu Kush, or North Africa, which also feature petroglyph sites, may adopt the approach presented in this paper to develop interpretation strategies that promote both economic sustainability and participatory conservation.

This methodological and conceptual transferability makes the study relevant not only in academic discourse but also in the practice of cultural managers, educators, and local planners.

The chosen methodology further reinforces the reliability of the findings, its systematic approach, grounded in the PRISMA framework, ensured transparency and replicability, while the meta-analytic indicators provided empirical validation for previously qualitatively inferred claims. The results are presented clearly, statistically sound, and interpretively accessible to both professional and general audiences, making them understandable and useful even to non-experts. This gives the study a dual function, contributing to the academic community while also offering guidance for policymaking and governance in the field of heritage tourism. This work may be particularly useful to researchers in tourism studies, cultural geography, archaeology, and ethnology, as well as to educators and students engaged with topics such as cultural authenticity, sustainable tourism, and local development. It is also recommended for practitioners involved in the planning and promotion of cultural routes and for institutions developing heritage policies in rural and peripheral areas.

Limitations and directions of future research

One of the key challenges in interpreting the results of this study lies in the uneven geographical representation of countries within the analyzed body of literature. The majority of publications focus on Kazakhstan and Uzbekistan, while Kyrgyzstan and Tajikistan are significantly underrepresented. This disproportion may reflect differences in research infrastructure, institutional support, or source availability, but it also introduces the risk of geographic bias in the study's conclusions. Additionally, although the meta-analysis allowed for a quantitative synthesis of findings, the limited number of studies with statistically processable data restricts the potential for drawing stronger generalizations. While statistical tests did not confirm publication bias, it remains a latent methodological concern, given the academic tendency to more frequently publish studies with positive outcomes. Further limitations relate to the thematic scope of the available literature. Despite the multidimensional meanings associated with petroglyphs, most studies remain within the bounds of cultural interpretation, with far fewer exploring topics such as economic viability, measurable community impact, or the effects of digital transformation. The absence of longitudinal data also limits the ability to trace the evolution of the meaning of petroglyphs within the context of an increasingly dynamic tourism market and shifting cultural policies.

In light of these limitations, the future development of this research area requires a strategic shift toward models that move beyond classical descriptive and interpretive approaches. The complexity of petroglyphs' function in contemporary tourism demands multidimensional analyses capable of integrating spatial, symbolic, educational, and economic aspects of heritage into a unified analytical framework. Future studies should not be limited to identifying the existing functions of petroglyphs but should also investigate how their meanings transform over time, especially under the influence of tourism practices, digital innovation, and cultural policy. A particularly promising direction lies in the application of geospatial methods such as GIS mapping, geo-narrative modeling, and landscape analysis which would allow petroglyphs to be understood not merely as isolated cultural entities, but as dynamic components within broader cultural-ecological landscapes. Such approaches can reveal spatial patterns that contribute to better understanding how petroglyph sites function in relation to population centers, transportation infrastructure, and tourism flows, ultimately enhancing their integration into spatial planning and destination development. Significant innovation could also be achieved through the integration of augmented reality (AR) and virtual reality (VR) technologies, which may redefine how modern tourists experience petroglyphs. Future research could evaluate the effects of such digital interventions on perceptions of authenticity, emotional responses, and visitors' willingness to engage in heritage preservation. In this regard, user-experience-oriented research strategies using experimental designs represent the logical next step for the field.

Another avenue that requires attention is the cross-cultural comparative analysis of petroglyph sites across different regions of the world. Comparative studies involving sites in the Sahara, the Andes, or Australian Aboriginal territories may contribute to the development of universal principles for heritage interpretation in tourism. Such an approach would allow researchers to better understand global challenges related to balancing preservation and commercialization of sacred spaces, and how different cultural and institutional settings influence heritage management strategies. At the same time, it is essential to strengthen the role of local communities not only as beneficiaries of heritage, but also as interpreters and co-creators of meaning. The use of participatory methods, ethnographic interviews, and collaborative

workshops can support the development of more inclusive interpretive practices that affirm collective knowledge and local narratives. This would help ensure both cultural continuity and the legitimacy of tourism-based interpretations, which is particularly important in regions where petroglyphs carry spiritual and mythological significance.

Future research should also address institutional aspects examining the role of local and national policies, legal frameworks, and international standards in the protection and utilization of petroglyphs. Evaluating the effectiveness of current management models and identifying best practices for integrating archaeological heritage into cultural tourism can be crucial for building sustainable systems of heritage protection that are both culturally sensitive and economically viable. Finally, it is necessary to strengthen research capacity in underrepresented Central Asian countries through the establishment of regional centers of excellence and international research networks. Such initiatives would enable more balanced knowledge production and equitable participation in global academic discourse, while also increasing the visibility of sites and empowering the cultural sovereignty of the communities that steward them.

The significance of this research field extends beyond academia it holds the potential to contribute to the development of cultural economies, the reinforcement of shared identity, the advancement of education, and the creation of socially responsible tourism. In this sense, the study of petroglyphs in tourism should not be viewed as a narrowly specialized topic, but as an open field of interdisciplinary inquiry with the capacity to shape both cultural policy and social practice.

REFERENCES

Aizhan, Y., Alua, T., Satemirova, D., Sarbassov, B., & Irina, C. (2024). The image of the sacred places in literature genesis: A case study Kazakhstan. *Journal of Ecohumanism,* 3(8), 11673–11682. https://doi.org/10.62754/joe.v3i8.5767

Aliaskarov, D.T., Kaimuldinova, K..D., Laiskhanov, Sh.U., Salimzhanov, N.O. (2023). Historical-geographical aspects of sustainable development of small towns (on the example of small towns in Zhambyl region). *Journal of Geography and Environmental Management,* 69(2), 14-22. https://doi.org/10.26577/JGEM.2023.v69.i2.02

Alemdag, E. (2025). The effect of chatbots on learning: a meta-analysis of empirical research. *Journal of Research on Technology in Education,* 57(2), 459-481. https://doi.org/10.1080/15391523.2023.2255698

Andreev, A. A., Raschke, E., Biskaborn, B. K., Vyse, S. A., Courtin, J., Böhmer, T., Stoof-Leichsenring, K., Kruse, S., Pestryakova, L. A., & Herzschuh, U. (2021). Late Pleistocene to Holocene vegetation and climate changes in northwestern Chukotka (Far East Russia) deduced from lakes Ilirney and Rauchuagytgyn pollen records. *Boreas*, 50(3), 838–859. https://doi.org/10.1111/bor.12521

Aref, M. (2025). Morphology of cultural and social archetypes of women with Iranian identity in Persian literature. *Classical Persian Literature, 16*(1). https://doi.org/10.30465/cpl.2025.10051

Assanova, D. (2023). Female toponymy of Kazakhstan. In *Heritage and identity in the Turkic world: Contemporary scholarship in memory of Ilse Laude-Cirtautas (1926–2019) 167–184.* Boston: Academic Studies Press. https://doi.org/10.1515/9783110720228-011

Autiero, S. (2021). Between Gandhāra and Xinjiang: Notes on the Upper Indus petroglyphs, Buddhism and globalization. *Journal of Asian Civilizations,* 44(1), 1–18. http://dx.doi.org/10.54691/bcpssh.v14i.189

Baibugunov, B., Baş, A., Sapatayev, S., Zholdassuly, T., & Kuralova, Z. (2025). Restoration of the Karakhan Mausoleum: architectural and ideological transformations in the history of the monument. *Kazakhstan Archeology*, (1 27), 293–313. https://doi.org/10.52967/akz2025.1.27.293.313

Barrado-Timón, D. A., & Hidalgo-Giralt, C. (2019). The historic city, its transmission and perception via augmented reality and virtual reality and the use of the past as a resource for the present: A new era for urban cultural heritage and tourism?. *Sustainability,* 11(10), Article 10. https://doi.org/10.3390/su11102835

Baveye, P. C. (2025). Beyond PRISMA 2020 and AMSTAR 2: Further Actions Are Needed to Deal With Problematic Meta-Analyses. *Learned Publishing,* 38(2), e1666. https://doi.org/10.1002/leap.1666

Beyazit, M., & Göktürk, B. D. (2022). Yandaklıdere petroglifleri. *Journal of Ankara Studies / Ankara Araştırmaları Dergisi,* 10(1), 45–56. https://dx.doi.org/10.5505/jas.2022.10327

Bektemirov, A., & Amanova, L. (2020). Digital transformation in the agricultural sector of Kazakhstan. *Central Asian Economic Review,* 2(1), 23–35. https://caer.kz/index.php/journal/article/view/2020-2-1

Bonora, G. L. (2015). Le ricerche archeologiche nella repubblica del Kazakhstan negli anni dell'indipendenza (1991–2015). *Asiatica Ambrosiana: Saggi e ricerche di cultura, religioni e società dell'Asia,* 7, 193–217. Available online: https://www.torrossa.com/en/resources/an/4137553

Buhrich, A. (2025). Dendroglyphs, pictographs and social identity in the Wet Tropics rainforest of Northeastern Australia. *Archaeology in Oceania*, 60(1), e2200237. https://doi.org/10.1002/arco.5353

Chang, C. (2020). Archaeological Sites, Cultural Heritage, and Sustainable Development in the Republic of Kazakhstan. *IntechOpen.* https://doi.org/10.5772/intechopen.86916

Chernyshev, K. A., Alov, I. N., Li, Y., & Gajić, T. (2023). How real is migration's contribution to the population change in major urban agglomerations?. *Journal of the Geographical Institute" Jovan Cvijic", SASA,* 73(3), 371-378. https://doi.org/10.2298/IJGI2303371C

Chlachula, J. (2020). Geoheritage of East Kazakhstan. *Geoheritage,* 12(4), 91. https://doi.org/10.1007/s12371-020-00490-y

Clarke, C., & Alsharif, S. M. (2025). The lost large mammals of Arabia. *Journal of Biogeography,* 52(6), e15086. https://doi.org/10.1111/jbi.15086

Crescioli, L. (2017). Necropoli o santuari? La dimensione funeraria, rituale e sociale dei kurgan sciti: nuovi dati dalla necropoli di Kaspan (regione del Semirech'è, Kazakhstan). *Atti dell'Istituto Italiano di Preistoria e Protostoria,* 47, 321–335. Available online: https://iris.unive.it/handle/10579/10263

Demirović, D., Petrović, M. D., Monteiro, L. C. N., & Stjepanović, S. (2016). An examination of competitiveness of rural destinations from the supply side perspective. *Journal of the Geographical Institute" Jovan Cvijic", SASA,* 66(3), 387-400. https://doi.org/10.2298/IJGI1603387D

Derevianko, A. P., & Shunkov, M. V. (2020). Northern and central Asia: Culture during the Lower Paleolithic era. *In C. Smith (Ed.), Encyclopedia of Global Archaeology 7992–8006.* Cham: Springer International Publishing. http://dx.doi.org/10.1007/978-1-4419-0465-2_1897

Dickens, M. (2018). Syriac Christianity in Central Asia. *In D. King (Ed.), The Syriac world 583–624.* Routledge. http://dx.doi.org/10.4324/9781315708195-32

Dzhurakulov, S. (2022). Urbanization trends in Uzbekistan: Challenges and opportunities. *Urban Studies in Central Asia,* 5(1), 67–80. https://usca.uz/index.php/uscaj/article/view/2022-5-1

Dziekański, P., Popławski, Ł., & Popławska, J. (2024). Interaction Between Pro-Environmental Spending and Environmental Conditions and Development. *Journal of the Geographical Institute "Jovan Cvijić" SASA,* 74(3), 329-345. https://doi.org/10.2298/IJGI2403329D

Echevarría López, G. T., & Tiwary, S. K. (2025). Geoglyphs: A phenomenological approach. *Rock Art Research*, 42(1), 3–17. https://doi.org/10.56801/rar.v42i1.534

Ge, C., & Anni, J. (2024). Otugsar petroglyph site complex, northwest China. *Rock Art Research: The Journal of the Australian Rock Art Research Association (AURA),* 41(2), 226–229. Available online: https://search.informit.org/doi/10.3316/informit.T2024092500000150185524110

Göktürk, B. D. (2022). Ankara Güdül Adalıkuzu petrogliflerinde kam/şaman tasvirleri. *Electronic Turkish Studies,* 17(6), 1673–1689. http://dx.doi.org/10.7827/TurkishStudies.64196

Gómez-Zapata, J. D., Herrero-Prieto, L. C., & Arboleda-Cardona, J. A. (2025). A choice experiment economic valuation of cultural heritage tourism ecosystems. *Journal of Sustainable Tourism,* 33(3), 591–612. https://doi.org/10.1080/09669582.2024.2382840

Guofang, C. (2024). Database construction and protection of Inner Mongolian rock paintings. *Pacific International Journal,* 7(5). http://dx.doi.org/10.55014/pij.v7i5.698

Härke, H. (2022). A dozen years of Central Asia: An archaeologist's blog. *Kulturní Studia,* 18(1), 57–80. http://dx.doi.org/10.7160/KS.2022.180103

Ikhtiyorovich, I. N., & Sobirjonshuhratovich, A. (2025). Urban planning and its development in Central Asia during the Early Iron Age. *Journal of Social Sciences and Humanities Research Fundamentals, 5*(05), 144–147. https://doi.org/10.2307/j.ctvrnfq57

Irhamni, I., Kurnianingtyas, E., Muhtadin, M., Bahagia, B., & Yusop, A. F. (2025). Bibliometric Analysis of Renewable Energy Research Trends Using VOSviewer: Network Mapping and Topic Evolution. *International Journal of Engineering and Technology,* 1(1), 75-82. Available online: https://e-journal.scholar-publishing.org/index.php/ijet/article/view/30

Issakov, Y., Aktymbayeva, A., Assipova, Z., Nuruly, Y., Sapiyeva, A., Shaken, A., Pavlichenko, L., Kaliyeva, A., Plokhikh, R., & Dávid, L. D. (2023a). Study of the impact of UNESCO heritage sites on sustainable tourism development: a case study of the mausoleum of Khoja Ahmed Yasawi, Turkestan. *GeoJournal of Tourism and Geosites,* 51(4spl), 1717–1727. https://doi.org/10.30892/gtg.514spl12-1167

Issakov, Y., Aktymbayeva, B., Artemyev, A., Kubessova, G., Abdreyeva, S., Surina, A., Tuyebekova, Z., El Archi, Y., Benbba, B., & Dávid, L. D. (2023b). Digital transformation reshaping tourism education: Investigating the influence of MOOCs on teaching tourism fundamentals and local lore. *GeoJournal of Tourism and Geosites*, 49(3), 1015-1026. https://doi.org/10.30892/gtg.49317-1101

Jarosz, K. (2017). The attractiveness of Cholpon Ata Resort and the Museum of Petroglyphs as a tourist destination. *Folia Turistica / Akademia Wychowania Fizycznego im. B. Czecha w Krakowie,* 44, 9–29. http://dx.doi.org/10.5604/01.3001.0010.8725

Jelen, I., Angelija, B., & Francesco, C. (2020). Geography of Central Asia. Cham: Springer International Publishing. Available online: https://link.springer.com/book/10.1007/978-3-030-61266-5

Jia, S., Chi, O. H., Martinez, S. D., & Lu, L. (2025). When "old" meets "new": Unlocking the future of innovative technology implementation in heritage tourism. *Journal of Hospitality & Tourism Research,* 49(3), 640-661. https://doi.org/10.1177/10963480231205767

Jo'rayeva, M. Y. (2025). Folklorist Mamatqul Jo'rayev and Uzbek mythology. *European International Journal of Philological Sciences, 5*(05), 91–94. https://doi.org/10.55640/eijps-05-05-14

Kaderli, L., & Alieva, C. (2022). An evaluation on detection study of the petroglyphs in the region of Cholpon-Ata, Kyrgyzstan. *Cedrus,* 10, 69–93. Available online: https://dergipark.org.tr/en/pub/cedrus/issue/70538/1123145

Kęsik, J., Miłosz, M., Montusiewicz, J., & Israilova, N. (2022). Documenting archaeological petroglyph sites with the use of 3D terrestrial laser scanners—a case study of petroglyphs in Kyrgyzstan. *Applied Sciences,* 12(20), 10521. https://doi.org/10.3390/app122010521

Kortum, R. (2014). Sacred imagery and ritual landscape: New discoveries at the Biluut petroglyph complex in the Mongolian Altai. *Time and Mind,* 7(4), 329–384. https://doi.org/10.2752/175169714X14126963397436

Lalhminghlua, S., Singson, V., & Lalrinkima, C. (2025). A report on new petroglyphs from Lianpui Village, Champhai District, Mizoram. *ArchaeoAnthropology*, 16(3), 29–38. https://doi.org/10.47509/AA.2025.v16i.3

Laruelle, M. (2015). In search of Kazakhness: The televisual landscape and screening of nation in Kazakhstan. *Demokratizatsiya: The Journal of Post-Soviet Democratization,* 23(3), 321–340. Available online: https://www.researchgate.net/publication/343893987_In_Search_of_Kazakhness

Lawrenson, J. G., Huntjens, B., Virgili, G., Ng, S., Dhakal, R., Downie, L. E., & Walline, J. J. (2025). Interventions for myopia control in children: a living systematic review and network meta-analysis. *Cochrane Database of Systematic Reviews,* (2). https://doi.org/10.1002/14651858.cd014758.pub2

Lee, S. (2022). Preservation of endangered Bangudae petroglyphs in Korea. *In D. M. Pearce & B. David (Eds.), Global perspectives for the conservation and management of open-air rock art sites 317–330.* Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9780429355349-21/preser

Liu, Q., Ali, N. L., & Lee, H. Y. (2025). Applying VOSviewer in a bibliometric review on English language teacher education research: an analysis of narratives, networks and numbers. *Cogent Education,* 12(1), 2449728. https://doi.org/10.1080/2331186X.2025.2449728

Lymer, K. (2008). The light fantastick: Rock art, visions and the myth of solarism in Central Asia. *The Journal of the Traditional Cosmology Society,* 47, 32–49. Available online: https://thisisthetcson.wordpress.com/wp-content/uploads/2016/07/cosmos-22

Mendikulova, G., & Nadezhuk, E. (2018). Religious migrations in contemporary Central Asia. *In M. Singh & J. Jafari (Eds.), Religious tourism in Asia: Tradition and change through case studies and narratives 110–117.* Wallingford, UK: CABI. https://www.cabidigitallibrary.org/doi/abs/10.1079/9781786392343.0110

Miklashevich, E. A. (2008). Rock art research in Siberia and Central Asia 2000–2004. *In P. Bahn, N. Franklin, & M. Stecker (Eds.), Rock art studies: News of the world III 138–178.* Oxford: Oxbow Books. http://dx.doi.org/10.2307/j.ctvxrq0fv.14

Milosz, M., Kęsik, J., & Montusiewicz, J. (2020). 3D scanning and visualization of large monuments of Timurid architecture in Central Asia – A methodical approach. *Journal on Computing and Cultural Heritage,* 14(1), 1–31. https://doi.org/10.1145/3391198

Nizamatdinova, A., & Zhumanov, T. (2021). Educational reforms in Kazakhstan: A decade in review. *Central Asian Education Review,* 3(2), 89–102. https://caer.kz/index.php/education/article/view/2021-3-2

Novozhenov, V. A. (2021). Central Asian rock art on the Silk Road. *In International Conference on Silk Road Sustainable Tourism Development and Cultural Heritage 129–137.* Cham: Springer Nature Switzerland. http://dx.doi.org/10.1007/978-3-031-31027-0_11

Oehler, A. (2021). Humans and dogs of mountainous inner Asia: Sensory collaboration and personhood. *Human Ecology,* 49(6), 765–778. https://doi.org/10.1007/s10745-021-00245-w

O'Sullivan, R., & Shao, H. (2022). The Bronze and Iron Age rock art of Altay Prefecture, Xinjiang: A synthesis. *Rock Art Research: The Journal of the Australian Rock Art Research Association (AURA),* 39(1), 83–96. https://search.informit.org/doi/10.3316/ informit.393429520553211

Osserbayev, Y., & Gabitov, T. (2021). Cultural transitions and dialogues in the Great Silk road area: experience in preventing cultural deviations. *Journal of Philosophy, Culture and Political Science,* 75(№1), 61–73. https://doi.org/10.26577/jpcp.2021.v75.i1.07

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., & Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. *BMJ,* 372, n71. https://doi.org/10.1136/bmj.n71

Pai, C. H., Zhang, Y., Wang, Y. L., Li, K., & Shang, Y. (2025). Current challenges and opportunities in cultural heritage preservation through sustainable tourism practices. *Current Issues in Tourism,* 1–19. https://doi.org/10.1080/13683500.2025.2000000

Ponomareva, I. (2022). A history of rock art research in Russia. *In J. McDonald & P. Veth (Eds.), Powerful Pictures: Rock Art Research Histories around the World 160–174.* Oxford: Oxbow Books. https://www.researchgate.net/publication/367149001_The_History_of_Rock_Art_

Poujol, C. (2017). Spatial boundaries, social frontiers: From the visible to the invisible in the geographic, economic, and social space of present-day Central Asia. *Diogenes,* 64(1–2), 126–142. https://doi.org/10.1177/0392192117712794

Rao, S. K., & Temu, E. L. (2025). Prehistoric petroglyphs of heritage from Ukaguru Forest Savanna in central Tanzania: Preliminary survey. *Social Science and Human Research Bulletin,* 2(3), 80–88. https://doi.org/10.1126/science.aao3212

Roy, R. (2022). Kyrgyzstan in history: Accounts of Russian scientists and travellers. *In A. Palat (Ed.), Cultural histories of Central Asia 204–220.* Routledge.

Rozwadowski, A. (2018). Rock art of Northern, Central, and Western Asia. *In D. S. Whitley (Ed.), The Oxford handbook of the archaeology and anthropology of rock art 151–176.* Oxford University Press. http://dx.doi.org/10.1093/oxfordhb/9780190607357.013.3

Sabitov, R. A., Smirnova, G. S., Elizarova, N. U., & Sabitov, S. R. (2019). Intelligent management of supply chains and outsourcing in mechanical engineering under "Industry 4.0" conditions. *In IOP Conference Series: Materials Science and Engineering (Vol. 570, No. 1, p. 012081).* IOP Publishing. https://doi.org/10.1088/1757-899X/570/1/012081

Schneider, J. S., Yadmaa, T., Farquhar, J. M., & Hadel, P. (2021). Entering new territory: The results of a random-sample archaeological inventory at Ikh Nartiin Chuluu Nature Reserve, Dornogovi Aimag, Mongolia. *Archaeological Research in Asia,* 25, 100251. https://doi.org/10.1016/j.ara.2021.100251

Sheng, S. (2020). Huashan Mountain petroglyphs. *In C. Smith (Ed.), Encyclopedia of Global Archaeology 5310–5312.* Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-30018-0_1270

Song, H., Chen, J., & Li, P. (2025). Decoding the cultural heritage tourism landscape and visitor crowding behavior from the multidimensional embodied perspective: Insights from Chinese classical gardens. *Tourism Management,* 110, 105180. https://doi.org/10.1016/j.tourman.2024.105180

Tatar, B. (2020). The Bangudae petroglyph: Whaling and re-modernisation in a South Korean industrial city. *Journal of Intercultural Studies,* 41(3), 299–321. https://doi.org/10.1080/07256868.2020.1741303

Tumurbaatar, T., & Makarewicz, C. A. (2021). Cattle, yaks, traction, and the Bronze Age spread of pastoralism into the Mongolian steppe. *In N. D. Munro & L. Makarewicz (Eds.), Cattle and people: Social dynamics in the Holocene, 303–322.* Springer. https://doi.org/10.5913/archbio04.15

Tursunova, M. O., Khaydarov, N. K., Abdullaeva, M. B., Abdukodirov, E. I., & Nazarova, M. F. (2021). Significance of transient ischemic attacks (TIA) in the development and course of ischemic strokes. *International Journal of Health and Medical Sciences*, 4(2), 215-219. https://media.neliti.com/media/publications/411138-significance-of-transient-ischemic-attac-ba162bc8.pdf

Windle, M., Tuvshinjargal, T., Zhang, C., Li, Y., Brandišauskas, D., Piezonka, H., Ochir, Y., Ariunzul, G., Kertanis, R., & Taylor, W. (2025). Understanding the origin of reindeer riding in Northeast Asia through animal paleopathology and collaborative archaeology. *Arctic, Antarctic, and Alpine Research,* 57(1), 2493391. https://doi.org/10.1080/15230430.2025.2493391

Yagyayeva, E. B. (2021). Tourism in Uzbekistan. *Academicia Globe,* 2(6), 360–366. https://doi.org/10.17605/OSF.IO/3NKFG

Yang, J., Luo, J. M., & Yao, R. (2025). Elevating cultural celebrity endorsements' impact in intangible cultural heritage tourism: Role of generativity. *Humanities and Social Sciences Communications,* 12(1), 1–12. https://doi.org/10.1057/s41599-025-02435-3

Zafarovich, K. D. (2025). Utilizing ethnographic resources to enhance tourism effectiveness in Uzbekistan. *Academia Open,* 10(1), 10–21070. https://doi.org/10.21070/acopen.10.2025.10629

Zahir, M., Khan, I., Gauhar, F. A., & Khalil, M. S. K. (2022). Contextualisation of petroglyphs at Shatial Das, Upper Kohistan, Pakistan. *Rock Art Research,* 39(2), 130–142.Available online: https://www.academia.edu/87114777/Contextualisation_of_Petroglyphs_

Zheleznyakov, B., & Devlet, E. (2017). Rock art studies, management and presentation in Central Asia. *In P. Bahn, N. Franklin, & M. Strecker (Eds.), Rock art studies: News of the world V 115–134.* Oxford: Oxbow Books. https://doi.org/10.2307/j.ctvxrq0fv

Zheleznyakov, B., Sapatayev, S., & Biver, J. (2020). Tamgaly (Kazakhstan), petroglyphs within the landscape. *In C. Smith (Ed.), Encyclopedia of Global Archaeology 10484–10489.* Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-51726-1_2832-1