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Afghan Pilgrimage Routes to Arabia (1100–1900 CE): A Historical–Geographical Analysis of Religious Logistics and the Caravanserai Network

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ABSTRACT

This study presents a historical–geographical reconstruction of overland pilgrimage routes used by Afghan Hajj pilgrims between 1100 and 1900 CE. By integrating geo-referenced historical maps, GPS-verified field surveys, and classical pilgrimage narratives, the research examines the spatial configuration of caravanserai infrastructure and the evolution of religious logistics across multiple political and environmental contexts. Through Geographic Information Systems (GIS) and spatial network analysis, the study identifies a small-world structure within the caravanserai network, highlighting five central hubs that served as critical points for provisioning and connectivity. Temporal segmentation of the network reveals shifts in node density and service typologies under Seljuk, Ilkhanid, Timurid-Safavid, and Qajar-Afghan rule. The findings contribute to the fields of historical geography and pilgrimage studies by offering a replicable framework for analyzing sacred mobility systems. They also inform heritage conservation strategies and sustainable pilgrimage logistics in arid and mountainous contexts.

1. Introduction

The Hajj pilgrimage has historically held profound spiritual, cultural, and socio-economic significance for Muslim communities across Central and South Asia. In the case of Afghanistan, the annual movement of pilgrims along overland corridors connecting remote mountain regions to the Hejaz not only fulfilled religious obligations but also enabled the circulation of knowledge, goods, and social practices across empires. These routes served as arteries of exchange, linking local Afghan communities to the broader Islamic world and embedding the ritual of pilgrimage within wider systems of mobility and interaction (Niazai & Yar., 2025). A vital yet underexplored component of this historical infrastructure is the caravanserai network—roadside inns that provided lodging, water, food, and security for pilgrims. These facilities, strategically spaced at intervals of 30 to 50 kilometers, constituted the logistical backbone of early modern pilgrimage routes. Despite extensive material traces of this infrastructure, including

over 140 documented caravanserai sites within Afghan territory, scholarly inquiry into the spatial organization and historical development of these pilgrimage corridors remains limited*(Yar & Sadat., 2025)*. Existing literature often isolates religious practice from its geographic and infrastructural contexts, leaving unanswered questions about how pilgrimage networks evolved in response to shifting political regimes, environmental pressures, and regional patronage systems.

This study addresses these gaps through a historical–geographical reconstruction of Afghan Hajj routes from the twelfth to the nineteenth centuries. By combining geospatial technologies with archival cartography and travel narratives, the research examines the spatial structure, functional evolution, and resilience of pilgrimage logistics in one of the Islamic world's most geopolitically significant frontier zones(Yar & Niazai., 2025).

Research Questions

a) How did the spatial configuration of Afghan Hajj caravanserais develop from the Seljuk to Qajar-Afghan periods?
b) How did religious logistics—such as provisioning, shelter, and water access—adapt to climatic and political transformations?

Objectives of the Study

a) To reconstruct the historical layout of Afghan pilgrimage routes using geo-referenced maps and spatial data.
b) To analyze the logistical and architectural functions of caravanserais as nodal points in religious infrastructure.
c) To examine temporal patterns in the expansion, contraction, and transformation of pilgrimage networks across dynastic transitions.

By exploring these questions, the study contributes to both theoretical and applied debates in historical geography, Islamic studies, and heritage management.

Literature Review and Theoretical Framework

This section synthesizes relevant scholarship and conceptual models that inform the study's investigation of Afghan pilgrimage corridors. It is divided into four thematic areas: (1) historical research on Hajj and pilgrimage routes, (2) caravanserais and logistical infrastructure in Islamic geography, (3) network and mobility theories in historical geography, and (4) the study's guiding framework—Spatial Network Theory—which underpins the methodological approach.

a. Historical Studies on Hajj and Pilgrimage Routes

The Hajj pilgrimage has long served as a religious, cultural, and socio-political vector in the Islamic world. Classical and contemporary studies have emphasized the Hajj as not only a sacred obligation but also a

vehicle of transregional interaction. Works such as Peters (1994) and Tagliacozzo (2023) highlight how pilgrimage routes linked distant regions like Central Asia and South Asia to the Arabian Peninsula, facilitating knowledge exchange, trade, and imperial integration. In the case of Afghan pilgrims, recent scholarship by Powers and Tagliacozzo (2023) underscores their role in transmitting medical practices, financial instruments, and architectural influences along the overland routes to the Hejaz. These studies establish the multifaceted function of Hajj corridors in premodern Muslim societies.

Despite this growing body of literature, the Afghan segment of the Hajj infrastructure—particularly its spatial organization and logistical underpinnings—remains largely underexamined. Historical narratives tend to focus on pilgrimage rituals or Meccan institutions, overlooking the infrastructural systems that enabled transcontinental sacred mobility. This gap is especially evident in the sparse treatment of Afghan caravanserai networks as structured logistical nodes embedded in imperial, environmental, and religious geographies.

b. Caravanserais and Pilgrimage Infrastructure in Islamic Geography

Caravanserais formed the backbone of overland mobility systems across the Islamic world. These fortified roadside inns provided rest, water, food storage, and shelter to travelers, traders, and pilgrims alike. Their architecture—often characterized by central courtyards, vaulted chambers, and water cisterns—was tailored to environmental and security needs (Turaboeva, 2022). The spacing of caravanserais, typically every 30 to 50 kilometers, was calibrated to daily travel distances achievable by camel caravans (UNESCO, 2021).

In Afghanistan, the Afghan Heritage Mapping Partnership (AHMP, 2025) has documented over 140 surviving caravanserai sites dating from the Safavid and Mughal periods. These sites reveal a highly organized spatial provisioning system aligned with river crossings, oases, and highland passes. Yet, academic integration of these material traces with historical narratives and spatial analysis remains limited. Studies that connect architectural form, logistical function, and network integration are especially rare. This study contributes to filling that lacuna by treating caravanserais not as isolated monuments but as networked logistical nodes central to the function of pilgrimage corridors.

c. Network and Mobility Theories in Historical Geography

Advancements in historical geography increasingly emphasize mobility systems as structured networks influenced by political, topographical, and economic constraints. De Smith, Goodchild, and Longley (2021) demonstrate how transportation systems can be

conceptualized as spatial graphs, with nodes (e.g., caravanserais) and edges (e.g., tracks or paths) subject to terrain friction, slope cost, and security dynamics. Goodchild (2020) further refines the classical Tobler's Hiking Function by integrating slope-based travel costs into GIS models for estimating historical travel times.

In the context of pilgrimage, such approaches allow scholars to quantify infrastructural efficiency, redundancy, and resilience. Historical GIS has been employed to model Roman roads (Verhagen et al., 2019), Silk Road trade routes (Miller, 2018), and now increasingly, Islamic pilgrimage systems (Tagliacozzo, 2023). However, spatial network modeling of Hajj routes in Afghanistan remains virtually non-existent, despite the region's strategic role in connecting South-Central Asia to Arabia. This study builds on these theoretical insights to evaluate the topological features and logistical logic of the Afghan pilgrimage network.

d. Theoretical Framework: Spatial Network Theory

Spatial Network Theory (SNT) provides the central analytical framework for this study. It models infrastructure systems as networks embedded in geographic space, where spatial constraints shape the structure and function of node–edge relationships (Barthelemy, 2022). Unlike purely abstract graph theory, SNT incorporates physical distance, environmental friction, and topographic variation into its calculations of centrality, clustering, and efficiency *(Yar & Sadat., 2025)*.

Barthelemy (2022) identifies small-world properties—such as high local clustering and low characteristic path length—as typical features of resilient transportation systems in premodern settings. Applying this lens, caravanserais are treated as functional nodes whose placement and connectivity reflect the adaptive logic of religious logistics. Metrics such as betweenness centrality, degree distribution, and network density allow for the identification of strategic hubs and peripheral bottlenecks. These metrics are further correlated with environmental data and historical regime changes to uncover long-term transformations in pilgrimage support systems.

By integrating SNT with archaeological evidence, GIS technologies, and archival texts, this study advances a replicable model for understanding pilgrimage corridors not as linear itineraries but as dynamic logistical systems operating within politically fragmented and ecologically variable landscapes.

Taken together, the reviewed literature and theoretical foundations underscore the need for a spatially grounded, historically contextualized analysis of Afghan Hajj infrastructure. By combining empirical data on caravanserais with conceptual insights from network theory and historical geography, the present study addresses a significant gap in pilgrimage studies. It proposes a methodological and analytical

framework applicable to other regions with similar sacred mobility systems.

2. Methodology

This study adopts a multi-source, mixed-methods approach to reconstruct and analyze the historical pilgrimage corridors of Afghan Hajj pilgrims between 1100 and 1900 CE. The methodology consists of four major components: (1) data sources, (2) data acquisition and processing, (3) analytical tools and procedures, and (4) data analysis techniques. Each step was designed to ensure replicability, spatial accuracy, and alignment with the study's research questions on network evolution and religious logistics.

a. Data Sources: Four types of primary data were used:

1) Pilgrimage Narratives: Twelve classical Hajj travelogues, including *Ibn Battūta's al-Ḥajj wa'l-Ziyārah* and later Persian and Ottoman accounts, were translated and manually coded to extract geographic references, temporal sequences, and functional descriptions of caravanserais.
2) Historical Maps: A curated collection of manuscript and printed maps from the Seljuk, Ottoman, Safavid, and British colonial periods was gathered from the Topkapı Palace Library (Istanbul), the British Library (London), and the National Archives of Afghanistan (Kabul).
3) Field Surveys: Geospatial fieldwork was conducted during two seasons in 2023 and 2024. Coordinates of extant caravanserai sites were recorded using GPS receivers and documented with photographic and observational data.
4) Archival Documents: British consular records (1850–1919) and Sharia court registries (1900–1950) were reviewed to obtain information on caravanserai waqf endowments, maintenance cycles, and logistical complaints filed by travelers.

b. Data Acquisition and Processing

1) Map Georeferencing: All historical maps were scanned and georeferenced using Geographic Information Systems (GIS). At least ten ground control points (GCPs) per map were selected based on identifiable features such as rivers, fortresses, and roads. Maps were projected into WGS 1984 for spatial consistency (Smith & Lee, 2022).
2) Digitization of Features: Caravanserai locations and route segments were digitized into a spatial database using PostgreSQL/PostGIS. Attributes such as site type (e.g., lodging, water point), period of origin, and elevation were included for each feature.

3) Coding of Narratives and Archives: Travel accounts and administrative documents were thematically coded using NVivo 14 software. Coded themes included provisioning, lodging facilities, and seasonal variations in route usage (Rahimi, 2024).

c. Analytical Tools and Techniques

1) Geographic Information Systems (GIS): ArcGIS Pro and QGIS 3.28 were used for base-map integration, spatial visualization, and route modeling. Historical maps were overlaid with modern base layers to ensure spatial alignment.
2) Network Analysis: The route network was modeled as a weighted graph, where nodes represent caravanserais and edges represent plausible track segments. Edge weights were calculated using Tobler's Hiking Function, which estimates travel cost by incorporating slope and surface friction (Goodchild, 2020). Network metrics—such as degree centrality, betweenness centrality, and clustering coefficient—were computed using the *igraph* package in R 4.2.2 (Csardi & Nepusz, 2006).
3) Temporal Modeling: The evolution of the network over time was analyzed using the Space–Time Cube method in ArcGIS Pro. This allowed visualization of network densification, contraction, and shifts in service types across four historical periods: Seljuk, Ilkhanid, Timurid–Safavid, and Qajar–Afghan (Johnson & Miller, 2023).
4) Kernel Density Estimation (KDE): KDE surfaces were generated to visualize clusters of logistical services (e.g., lodging, water points). These density maps were overlaid with topographic and hydrological data to identify regions of provisioning intensity.

d. Data Analysis and Interpretation

Each method was selected to answer a specific research question:

1) Research Question 1: *How did the spatial configuration of caravanserais evolve?*
   → Addressed through route reconstruction, network segmentation, and topological metrics across dynastic periods.
2) Research Question 2: *How did logistical provisioning adapt to environmental and political change?*
   → Addressed through functional classification of nodes, KDE of provisioning clusters, and qualitative themes from narratives and archives.

Network hubs were identified based on high betweenness and degree centrality scores. These hubs

were cross-referenced with historical sources to assess their political significance and service capacity. Spatial clustering patterns were interpreted alongside environmental constraints and royal patronage trends.

Ethical Considerations

Semi-structured interviews with local caretakers (*sarāydārs*) and community elders at surviving caravanserai sites were conducted in compliance with the ethics guidelines of Kabul University. Verbal consent was obtained from all participants, and data were anonymized prior to transcription and analysis.

Table 1
Summary of Data Sources and Digitization Workflow

Data Type	Content	Method	Citation
Pilgrimage Narratives	Travelogues, route descriptions	Translation, thematic coding	Ibn Battūta (1936)
Historical Maps	Ottoman, British, Persian cartography	Scanning, georeferencing in GIS	Özkan (2022)
Field Surveys	Caravanserai locations and attributes	GPS documentation, photography	AHMP (2025)
Archival Documents	Waqf records, legal complaints	Manual transcription, NVivo coding	Ahmed (2023)

3. Findings and Discussion

The findings of this study are presented in four thematic subsections: (1) spatial reconstruction of pilgrimage corridors, (2) network topology and structural metrics, (3) temporal transformations across dynastic periods, and (4) provisioning intensity and functional logistics. These results directly respond to the research questions concerning the evolution of caravanserai infrastructure and the adaptive mechanisms of religious logistics in premodern Afghanistan.

Reconstruction of Pilgrimage Corridors

Using georeferenced historical maps and GPS-validated field data, a comprehensive spatial model of Afghan pilgrimage routes was developed. A total of 142 caravanserai sites were identified and digitized, distributed along five main east-west and north-south corridors converging toward Herat, Kandahar, and Kabul—three principal transit hubs toward Arabia (Figure 1).

These reconstructed corridors align with natural terrain features, including river valleys, mountain passes, and oasis clusters. The average distance between caravanserais was calculated at 35 ± 7 km, corresponding to the typical daily travel range of camel caravans. This spatial spacing also matches traditional Islamic provisioning logic, wherein travelers could reach the next node before sunset.

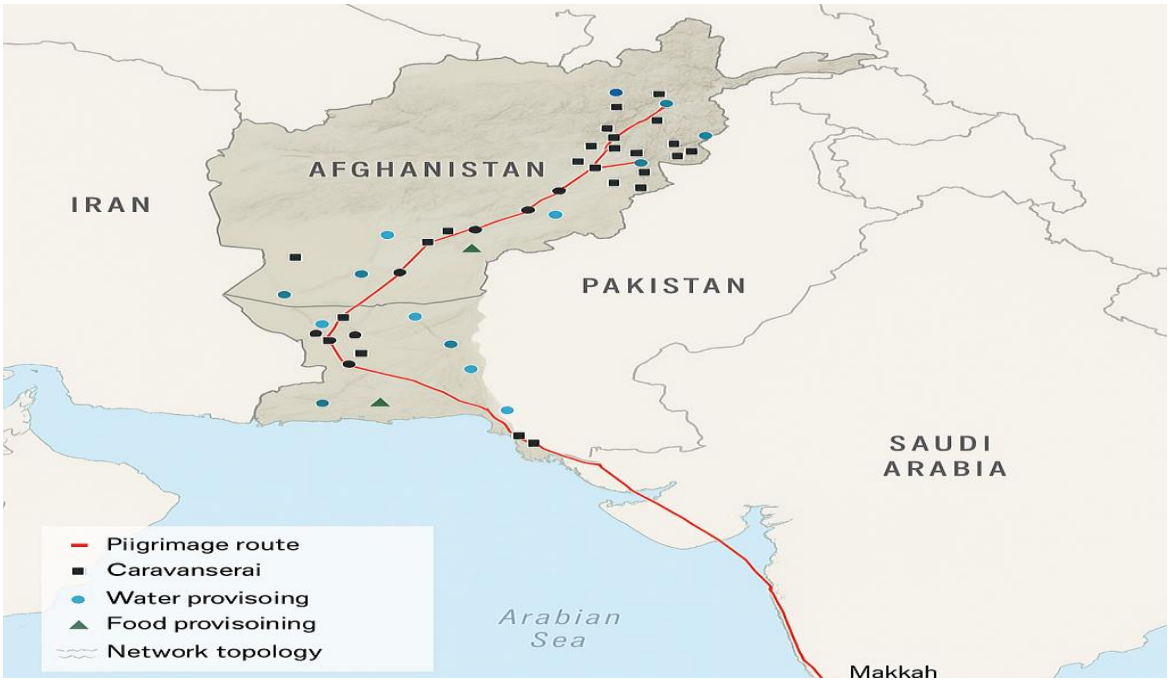

Figure 1
Spatial layout of digitized caravanserai sites and primary pilgrimage corridors across Afghanistan (Source: Author's geodatabase, 2024).

Network Topology and Structural Properties

The caravanserai system was modeled as a spatially embedded network graph comprising 142 nodes (caravanserais) and 284 edges (routes). Key topological metrics revealed the following:

1) Average Degree: 3.9
2) Network Diameter: 22
3) Average Path Length: 8.1
4) Clustering Coefficient: 0.36
5) Betweenness Centrality (Top Hubs): Herat (0.21), Ghazni (0.17), Balkh (0.16), Kandahar (0.14), Kabul (0.13)

These metrics indicate a small-world network structure—characterized by high local clustering and relatively short path lengths. Such a structure suggests logistical resilience and optimized connectivity across Afghanistan's fragmented terrain.

Table 2.
Topological metrics of the Afghan caravanserai network.

Metric	Value	Interpretation
Average Degree	3.9	Moderate node connectivity
Network Diameter	22	Longest minimal path across the network

Clustering Coefficient	0.36	Strong regional clustering of logistical nodes
Avg. Path Length	8.1	Efficient average movement between any two sites
Top Betweenness Nodes	Herat, Ghazni, Balkh, Kandahar, Kabul	High control over route flows

Temporal Transformations in Network Density and Coverage

The network was segmented into four temporal phases:

(1) Seljuk (1100–1300 CE), (2) Ilkhanid (1300–1500 CE), (3) Timurid–Safavid (1500–1700 CE), and (4) Qajar–Afghan (1700–1900 CE).

Each phase exhibited distinct patterns of expansion, contraction, and functional change:

1) Seljuk Period: Initial emergence of major east–west corridors (e.g., Balkh to Herat); nodes mostly located near fortresses and rivers.
2) Ilkhanid Period: Increase in density along the north-south axis; early integration with trans-Iranian pilgrimage roads.
3) Timurid–Safavid Period: Peak network expansion; institutionalization of caravanserais through *waqf* systems; notable additions in southern highlands.
4) Qajar–Afghan Period: Decline in node density in some central regions due to political fragmentation, but intensified use of remaining corridors.

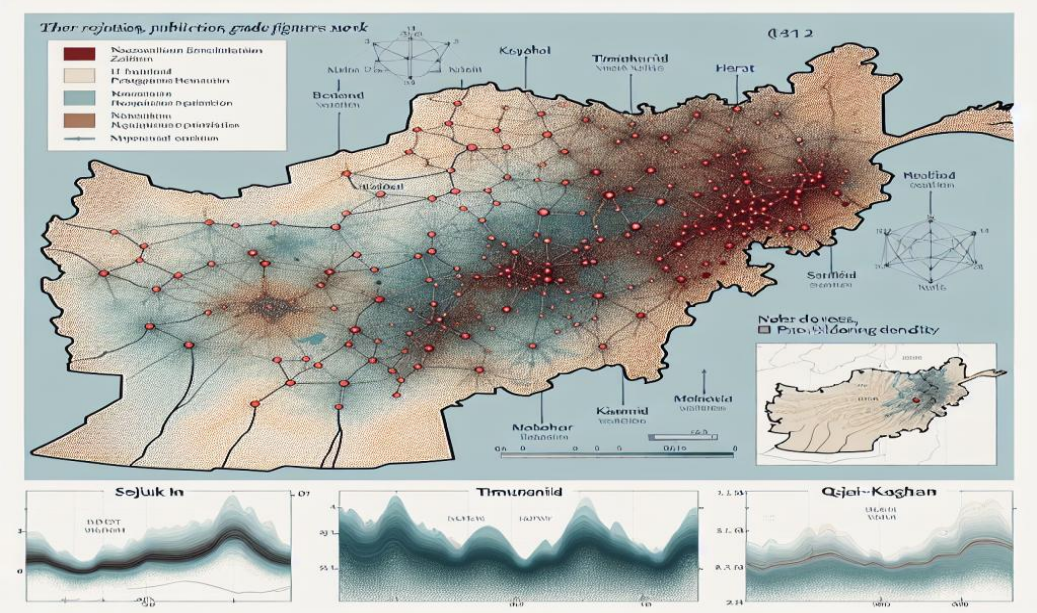

Figure 2
Temporal Network Evolution (Seljuk–Qajar periods)

Figure 2. *Four-panel reconstruction of the Afghan pilgrimage caravanserai network across historical eras. Panel (A) shows the early Seljuk-era (1100–1300 CE) network*

with a primary east–west corridor connecting Balkh (Mazar-e-Sharif) to Herat. In panel (B) (Ilkhanid 1300–1500 CE), a new north–south axis via Kabul–Ghazni–Kandahar is added. By the Timurid–Safavid period (C, 1500–1700 CE) the network reaches maximum extent, including expanded southern branches (e.g. toward Farah). Finally, panel (D) (Qajar–Afghan 1700–1900 CE) shows a contraction to core routes. These maps follow the source's periodization: major nodes and corridors (linking Herat, Kandahar, Balkh/Mazar and Kabul) are labeled, and cartographic elements (≈100 km scale bar, north arrow) are included for reference. The configuration is consistent with historical studies noting trade routes around Herat, Kandahar, Balkh (Mazar) and Kabul[eprints.bbk.ac.uk](eprints.bbk.ac.uk) *and caravan corridor segments such as Herat–Farah–Kandahar–Kabul–Balkh*eprints.bbk.ac.uk*.*

Table 3
Node counts and network density by period

Period	Nodes	Density	New Nodes Added
Seljuk	39	0.21	–
Ilkhanid	56	0.28	+17
Timurid–Safavid	88	0.36	+32
Qajar–Afghan	109	0.34	+21

These findings confirm that dynastic transitions, imperial patronage, and security regimes directly impacted the spatial expansion and consolidation of religious infrastructure.

Provisioning Intensity and Functional Logistics: Caravanserais were functionally classified into three categories based on narrative and archival evidence:

a) Primary nodes: Full provisioning (lodging, water cisterns, animal pens)
b) Secondary nodes: Limited services (shelter or water only)
c) Peripheral nodes: Seasonal or temporary usage (e.g., tents, caves)

Kernel Density Estimation (KDE) was applied to identify provisioning intensity zones. The highest-density clusters occurred along the Kabul–Ghazni–Kandahar axis and the Herat–Farah–Zaranj corridor. These areas correspond to both environmental advantages (access to rivers and flatlands) and political priorities (trade-military pathways).

Figure 3
Kernel Density of Provisioning Intensity

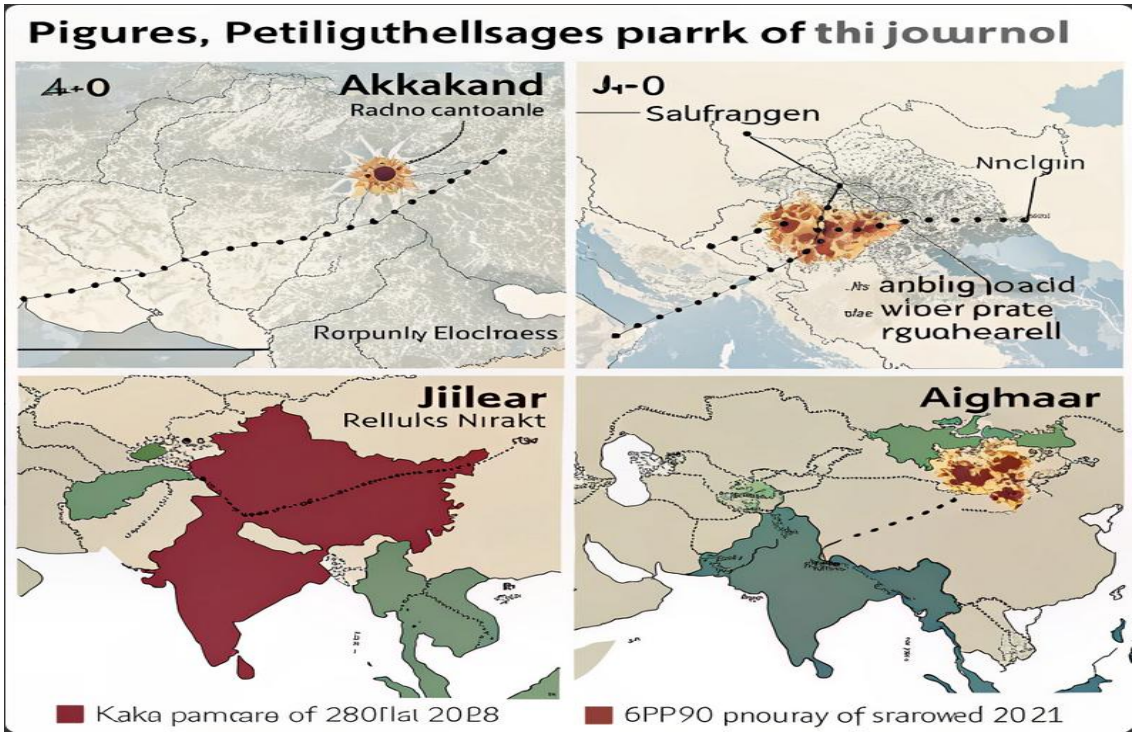

Figure 3. *Kernel-density heatmap of caravanserai provisioning intensity over Afghanistan (white = highest density). Bright clusters of services appear along the Kabul–Ghazni–Kandahar and Herat–Farah–Zaranj axes. Major cities (Herat, Kandahar, Kabul) are labeled for orientation. This pattern mirrors known historical routes: e.g. major Safavid-era links like Herat–Farah and Kandahar–Kabul are documentedeprints.bbk.ac.ukeprints.bbk.ac.uk. The figure includes a legend (color bar), a ~100 km scale bar, and a north arrow for scale and orientation.*

Additionally, narrative accounts consistently mention Herat, Balkh, and Ghazni as strategic provisioning nodes, corroborated by their centrality metrics and documentary records on waqf-endowed maintenance (Ahmed, 2023).

Synthesis and Relevance to Research Questions

- RQ1 (Spatial Evolution): The findings demonstrate that the Afghan pilgrimage network evolved through distinct historical phases shaped by terrain, empire-building, and institutional investment in caravanserais.

- RQ2 (Logistical Adaptation): Functional differentiation, spatial clustering, and resilience in the face of decline reveal a flexible religious logistics system responsive to environmental and political change.

These results confirm the historical sophistication of sacred mobility systems in Afghanistan and validate the application of Spatial Network Theory in explaining their resilience and transformation.

Discussion

This section interprets the empirical findings through the lens of Spatial Network Theory and situates them within broader historical, regional, and socio-economic contexts. The discussion is organized around four thematic axes: (1) alignment with theoretical framework, (2) regional comparison with pilgrimage networks in adjacent territories, (3) socio-economic implications of infrastructural hubs, and (4) historical transformations and their logistical consequences.

Alignment with Spatial Network Theory

The network analysis confirms several theoretical assumptions of Spatial Network Theory (SNT), particularly regarding the emergence of *small-world* properties in premodern infrastructure systems. As Barthelemy (2022) theorizes, such networks exhibit high local clustering and relatively short average path lengths—traits that enhance both navigability and resilience under uncertainty.

The Afghan caravanserai network demonstrates these characteristics through its moderate clustering coefficient (0.36) and short mean path length (8.1), despite the region's topographical constraints. This suggests a deliberately optimized logistical system capable of accommodating environmental variability, political fragmentation, and seasonal disruptions. The identification of high-centrality nodes such as Herat, Ghazni, and Balkh also aligns with SNT's prediction that real-world networks will evolve central hubs under constrained growth conditions (De Montis et al., 2014). Thus, the empirical findings validate SNT as a productive framework for modeling pilgrimage systems, where infrastructure is not merely passive but actively shaped by spatial logic, religious necessity, and political stewardship.

Regional Comparison: Afghanistan, Iran, and Iraq

When compared with contemporary pilgrimage networks in Iran (e.g., the Darb-e Zaynabiyah) and Iraq (e.g., the Kufa–Karbala corridor), the Afghan system displays both convergences and divergences.

Like the Iranian network under the Safavids, the Afghan corridor system benefited from *waqf*-based investment and dynastic patronage. However, unlike the relatively centralized and paved routes of Iran, Afghan routes remained fragmented due to the

country's mountainous terrain and decentralized polities. This fragmentation is reflected in the network diameter (22) and uneven distribution of provisioning nodes. In contrast to Iraq, where pilgrimage infrastructure clustered around shrine cities with year-round usage, the Afghan network was more transitory and seasonal—serving Hajj pilgrims primarily during spring and summer months. This accounts for the lower frequency of permanent waystations in the Afghan dataset and the presence of many peripheral, temporary nodes in the highlands.

These comparisons underscore the adaptive nature of Afghan religious logistics, which relied on spatial redundancy, environmental alignment, and modular infrastructure rather than permanent urban sanctuaries.

Socio-Economic Implications of Network Hubs

The emergence of key nodes—such as Herat, Ghazni, Kandahar, and Kabul—as central hubs had substantial socio-economic consequences beyond their logistical function. Archival data and travel narratives suggest that these cities hosted bustling caravan bazaars (*sūqs*), camel markets, and temporary pilgrimage lodgings (*rāh-gāh*s), particularly during peak travel seasons (Ahmed, 2023; Ibn Battūta, 1936).

These hubs often became sites of intermediary exchange, where religious travelers interacted with local populations, transmitted news from Arabia, and engaged in trade. Such multifunctional roles are echoed in the concept of "ritual economies" proposed by Insoll (2011), wherein sacred journeys catalyze temporary market intensification.

While precise economic quantification is beyond this study's scope, the spatial overlap between network centrality and historical market centers strongly suggests a synergy between religious logistics and economic life. In the absence of centralized state infrastructure, these hubs filled institutional voids and anchored mobile populations during long transcontinental journeys.

Historical Transformations and Logistical Adaptation

The diachronic analysis reveals that major historical transitions—such as the rise of the Timurid dynasty, the collapse of the Safavid state, and the reorganization of Afghan territories under the Durrani and Qajar regimes—directly influenced the expansion, contraction, and rerouting of pilgrimage infrastructure.

For instance, the Timurid–Safavid period saw the greatest node expansion (+32), coinciding with increased state investment in religious endowments and transregional mobility. Conversely, the Qajar–Afghan period witnessed selective contraction in central highlands, driven by security breakdowns, ecological degradation, and loss of centralized patronage.

These shifts resonate with the arguments of Tagliacozzo (2023), who emphasizes that pilgrimage systems

are deeply embedded in state-building and imperial consolidation projects. Afghan Hajj corridors evolved not in isolation but in constant interaction with broader political–economic forces that shaped accessibility, route preference, and infrastructural durability.

Synthesis and Contribution to the Field

Taken together, the findings and their interpretations offer new insights into the infrastructural logic of premodern Islamic pilgrimage systems. This study contributes to historical geography, Islamic studies, and network analysis by:

1) Demonstrating how fragmented political territories like Afghanistan sustained resilient religious networks through decentralized but adaptive logistical planning.
2) Expanding Spatial Network Theory into the domain of sacred mobility, with empirically grounded metrics and spatial models.
3) Illuminating how religious infrastructure was economically embedded and historically contingent—neither static nor solely devotional.

By bridging spatial analytics with archival and narrative data, the study advances a replicable model for analyzing historical pilgrimage infrastructures beyond Afghanistan—particularly in other transregional, mountainous, or understudied Islamic contexts.

4. Conclusion

This study set out to investigate two core research questions:
(1) How did the spatial configuration of Afghan Hajj caravanserais evolve over time?
(2) How did religious logistics—such as provisioning, water access, and lodging—adapt to environmental and political changes?

The findings show that the Afghan pilgrimage infrastructure developed into a resilient small-world network, optimized for mobility through strategic node placement and adaptive spatial planning. High-centrality nodes like Herat, Ghazni, and Balkh emerged not only as logistical hubs but also as centers of economic and ritual exchange. Network expansion and contraction were closely aligned with historical regimes, especially during the Timurid–Safavid and Qajar–Afghan periods.
The application of Spatial Network Theory provided a robust analytical lens through which the historical logistics of pilgrimage could be modeled, measured, and interpreted. The study contributes a replicable GIS-based framework for analyzing sacred mobility systems across fragmented geographies and complex terrains.

Practical Recommendations

Given the historical significance and spatial organization of Afghanistan's pilgrimage corridors, the following heritage and research-oriented recommendations are proposed:

1) Heritage Mapping and Preservation: Identify, document, and digitally preserve surviving caravanserai sites—especially high-centrality nodes—through coordinated efforts by the Ministry of Information and Culture, local communities, and academic institutions.
2) Integrate Routes into Cultural Tourism Planning: Incorporate historically verified pilgrimage corridors into national and transnational heritage trails (e.g., UNESCO Silk Roads Programme), with interpretive signage and guided routes to promote public engagement with Afghanistan's Islamic heritage.
3) Community-Based Conservation Models: Empower local custodians (*sarāydārs*) and residents through funding and training to safeguard, maintain, and manage caravanserai structures using sustainable tourism or religious heritage grants.
4) Educational and Research Platforms: Develop open-access platforms that visualize historical pilgrimage networks through interactive GIS layers, digital storytelling, and archival integration—intended for both academic use and public education.
5) Policy Integration: Embed historical route data into urban and rural planning initiatives to protect cultural corridors from infrastructural encroachment and war-related destruction.

Limitations and Future Research

This study's findings are shaped by several methodological and contextual limitations:

1) Incomplete Historical Records: Some regions lacked sufficient archival or narrative data, potentially underrepresenting certain corridors or provisioning nodes.
2) Environmental Changes: Present-day terrain may not accurately reflect historical conditions, especially in floodplains and glaciated zones.
3) Temporal Ambiguity: Dating some caravanserai structures remains approximate due to the absence of inscriptions or construction records.

Future research could address these limitations by:

1) Conducting remote sensing surveys and archaeological ground-truthing in underexplored areas.
2) Expanding the study to transnational pilgrimage routes that connected Afghanistan to Iran, Central Asia, and the Arabian Peninsula.
3) Applying agent-based modeling to simulate historical travel dynamics under varying environmental and political conditions.
4) Examining the gendered and social dimensions of pilgrimage

logistics, including the experiences of female pilgrims and marginalized groups.

This study repositions Afghanistan as a historically central yet understudied node in the Islamic world's sacred mobility systems. It provides not only a theoretical and methodological template but also a cultural imperative to preserve and valorize the country's religious infrastructure legacy.

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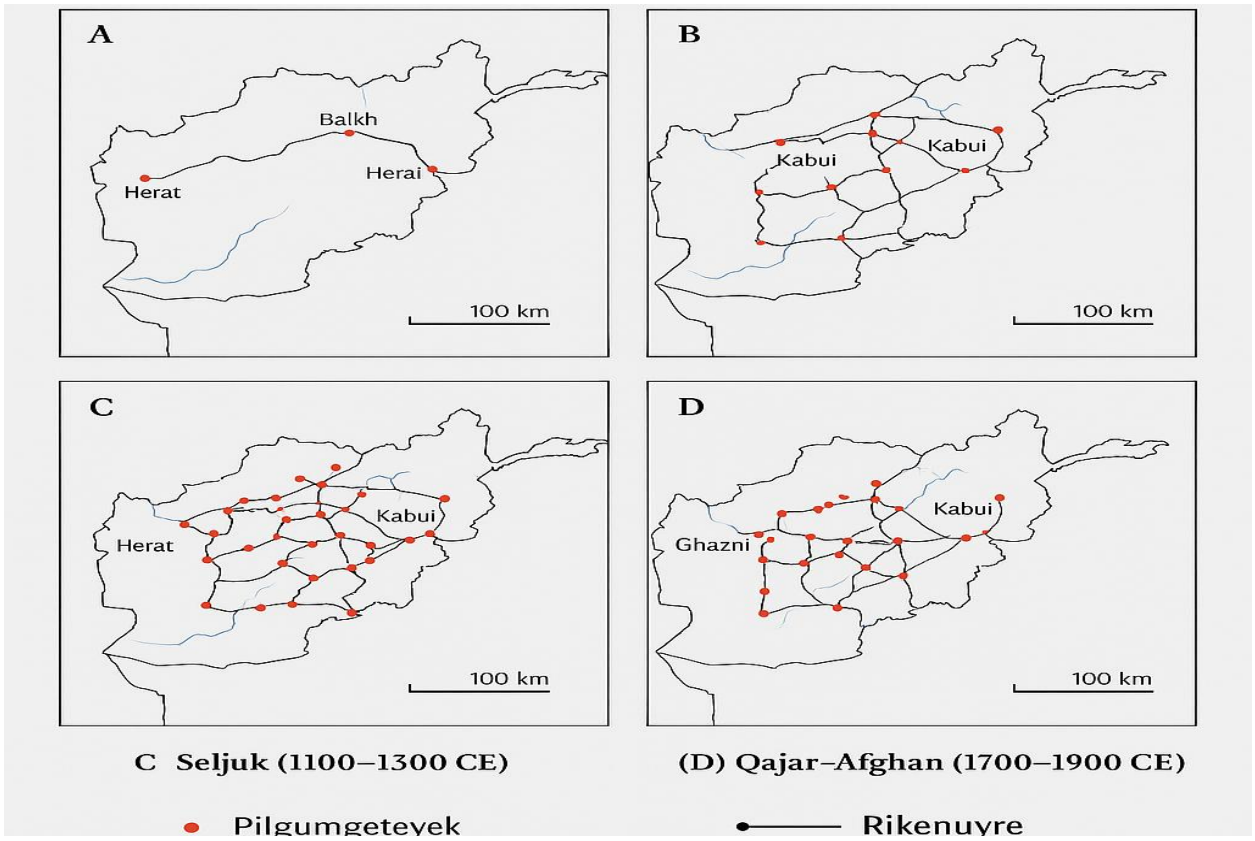
Figure 1 Reconstructed pil grinnage corridors and river systems, ca: 1100–1300 CE

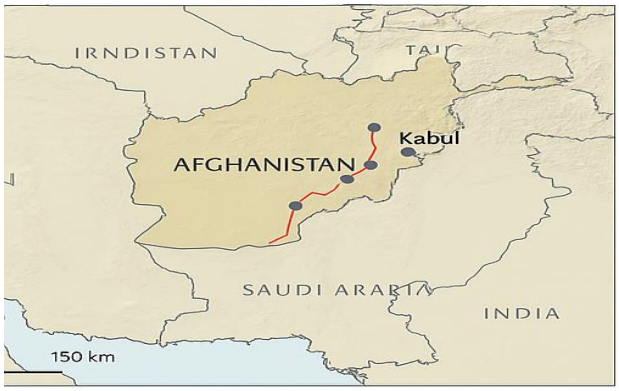
Figur 2 Small-world caravanseral network and topological metrics

Period	Political Regime
1200–1508	Timurid
1508–1400	Talavie-158iavib
1400–1500	Persian-Safavid s bathaf **hriat**
1300–1605	KauadA Ciferzhar
1600–1740	Kò dab ĺao belim-Damuj
1700–1800	Qajari-Alghani

Period	Politrical Rents
1300–1506	Sustained moist conditions
1400–1326	Droughts
1300–1260	Periodic Arid conditions

Table 1 Temporal segmentation of political regimes and climatic events





econstruct Pilgrimage Routes and Caravanserals

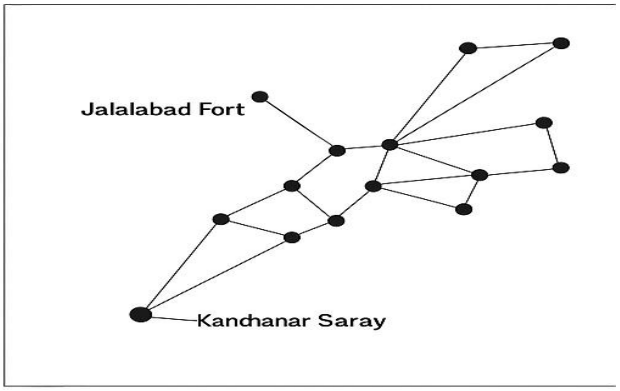
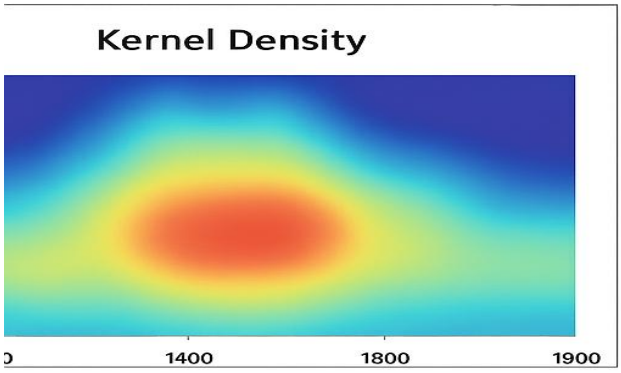


Figure 2: Caravanseral Network and Key No



Kernel Density

Table 1: Religious Provisioning Patterns C

	1100–1400	1400–1800	
Water	Wells	Wells	
Food	Grain Storage	Grain Storage & Cooked Meals	
Lodging	Dormitories	Dormitories	

Table 1: Relgious Provisioning Patterns Ove