Applied Research on GIS-Based Map Visualization of Li Bai's Travel Routes

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Abstract. This study employs GIS to present a systematic visual map of Li Bai's travel itineraries. More than 120 travel sites were extracted from The Complete Tang Poems, related literature, and historical maps. A spatial database was built using ArcGIS, and Li Bai's travels were divided into four life periods. Three main routes were identified: leaving Shu for Chang'an, wandering in the Yangtze River Basin, and the exile-and-return journey in his later years. A kernel density heat map was generated, and empirical findings show that about 65% of the destinations are distributed in the Yangtze River Basin, forming a high-density area around Jinling (Nanjing). The research further follows a four-stage technical path: literature collation, data extraction, spatial analysis, and visual presentation. By integrating literary geography theory with GIS technology, this study provides a new spatial perspective for Li Bai scholarship and validates the feasibility of GIS visualization in digital humanities research.

Keywords: GIS, Li Bai, Travel Routes, Map Visualization, Digital Humanities

1. Introduction

In recent years, Geographic Information System (GIS) technology has been widely applied in historical and humanities research, offering innovative methodologies and analytical frameworks for tracing the movements of ancient literati. It visualizes spatial activity trajectories through forms such as timelines and heat maps. As the preeminent romantic poet of the Tang Dynasty, Li Bai left his footprints across the northern and southern regions of China. Traditional studies on Li Bai have primarily relied on documentary verification and textual analysis. Consequently, there is a distinct absence of systematic spatial mapping regarding his spatiotemporal trajectories, and the relationship between his geographical settings and poetic content has not been sufficiently examined.

Therefore, based on GIS visualization technology, this paper extracts geographic information from "The Complete Tang Poems" and related literature through four steps: literature review, data extraction, spatial analysis, and visual presentation. It systematically reconstructs his spatiotemporal trajectories and analyzes spatial distribution characteristics, with the objective of providing a new spatial analysis perspective for Li Bai research and promoting the integration of GIS technology with literary geography.

2. Literature review

2.1. Application of GIS technology in humanities research

As GIS has been widely applied in the humanities. Yaguo et al. proposed methods such as capital distance and migration index to analyze historical figures [1, 2]. Guan Meibao et al. demonstrated GIS's role in visualizing human activity patterns [3, 4]. In cultural heritage protection, Ivlieva and Manukhov mapped an 18th-century Russian scholar's expedition routes [5]. Huang Libin et al. argued that GIS can serve as both an information management platform and a research-oriented information processing platform [6]. These studies provide methodological references for this paper.

2.2. Current status of Li Bai research

Traditional Li Bai studies rely mainly on textual research and literary analysis, lacking systematic spatial mapping of his itineraries. Wan Dejing and Wang Pengfei verified Li Bai's return journey from southern Shanxi to the Central Plains, noting the impact of geography on his poetry [7]. Xuan Guofu et al. studied Li Bai's travel traces in southern Anhui and analyzed the poems and historical sites he left there [8]. Zhang Jianli et al. made significant strides by integrating Li Bai studies with GIS: they processed 967 poems, extracted spatial information, built an ArcGIS-based poetry spatial database, and applied spatial statistical methods to analyze the distribution of his poems—providing crucial technical and data support for this paper [9]. However, their research focused on database construction and statistical description, failing to dynamically visualize the progression of his lifelong travels.

2.3. Literary geography and digital humanities methodology

The theoretical framework of this study is built upon the integration of literary geography and digital humanities. Zeng Daxing systematically constructed a theoretical system of Chinese literary geography with empirical research as its core, integrating the "human-land relationship" theory with geography to study the geographical distribution and migration of literati, which provides a theoretical basis and methodological guidance for this study [10]. Dai Juncheng pointed out that literary geography spans multiple disciplines and is highly interdisciplinary, noting that geospatial analysis methods endow literary research with a new perspective [11].

Digital humanities is a new field that merges information technology with humanities research, bringing methodological innovations to traditional literary studies. Yang Qingfeng explored the methodological essence of digital humanities through a fourfold inquiry into intellectual history, emotion theory, ontology, and subjectivity. He argued that digital humanities is not only a research method but also holds holistic methodological significance, providing theoretical justification for the use of digital technology in this paper [12]. Liu Shengying et al. proposed a research paradigm framework for digital humanities consisting of technology, process, and behavior. They divided the digital humanities platform into hierarchical structures including the literature layer, data layer, interface layer, tool layer, and presentation layer, providing an important reference for the technical implementation path of this study [13].

2.4. Research gaps

Existing studies have applied GIS technology and verified Li Bai's travel traces, but GIS visualization research specifically on Li Bai's travel routes remains limited. A comprehensive study

combining literary geography, digital humanities, and GIS is still lacking. Therefore, this paper uses GIS map visualization to systematically present Li Bai's travel routes and explore the relationship between his poetry and geographical space.

3. Research methodology

3.1. Research design

The methodology comprises four phases: literature review, data extraction, spatial analysis, and visualization. It is structured into three task modules: data layer, processing layer, and presentation layer [14]. These modules successively fulfill the tasks of literature collection, geographic information extraction, spatial database creation and statistical analysis, as well as map and interactive display. The three layers are synergistically integrated to accomplish the systematic transformation from text to space.

3.2. Data sources and processing (data layer)

The data sources of this study mainly consist of Li Bai's poems compiled in The Complete Tang Poems, geographical textual records about Li Bai in historical documents, ancient historical maps, and modern geographic databases [6, 7]. Toponymic information (creation sites, depicted places, travel locations) is extracted from the poems [9]. Toponymic resolution employs methods such as explicit positioning, directional inferential positioning, approximate alternative positioning, and spatiotemporal inferential positioning to resolve the issues of ancient and modern place name changes. This ultimately forms a highly credible dataset of Li Bai's travel locations.

3.3. Application of GIS technology (processing layer)

ArcGIS is used to build a spatial database integrating geographic coordinates, attribute data (location names, poem titles, creation time), and relational associations [8, 15]. Based on Li Bai's life stages, his travel routes are divided into four periods: Shu, Grand Travel, Hanlin Academy, and Late Life. Based on the stages of Li Bai's life, his travel routes are divided into the Shu Period, the Grand Travel Period, the Hanlin Academy Period, and the Late Life Period, employing a timeline to display the dynamic process of his travels.

3.4. Data statistics and visualization (presentation layer)

GIS spatial analysis quantifies travel sites, regional ranges, and core activity areas. Spatial trajectory algorithms calculate distance to the capital and migration index per period [1]. Kernel density analysis generates a heat map of primary activity areas. A kernel density analysis method is used to generate a travel density heat map, which clearly illustrates his primary areas of activity. The visualization takes the forms of static maps, dynamic route maps, and heat maps, using points to represent locations, lines to represent routes, and colors to distinguish periods. This builds an interactive spatiotemporal information interface that enables flexible switching and overlay analysis of map layers [4].

4. Visualization of Li Bai's travel routes

4.1. Overview of Li Bai's life travels

Based on the aforementioned spatial database, approximately 120 primary travel locations throughout Li Bai's life were selected and annotated from "The Complete Tang Poems" and other materials. Referring to An Qi's "Chronological Annotations of the Complete Works of Li Bai" and the research methods of Zhang Jianli et al., his life trajectory is divided into four stages based on major life events and spatial migration nodes: the Shu Period (701-724), the Grand Travel Period (725–742), the Hanlin Academy Period (742-744), and the Late Life Period (745-762) [9]. By conducting GIS spatial range calculation on these 120 spatial points, this study identifies the spatial span of his travels: east to Kuaiji, west to the Shu region, south to the Dongting Lake area, and north to the Taiyuan region. His activity scope generally covers the main economic and cultural regions of the Tang Dynasty.

4.2. GIS presentation of main travel routes

With the aid of ArcGIS software, this study maps and illustrates three representative travel routes of Li Bai. Figure 1a displays Li Bai's travel route from Shu to Chang'an. Starting from Mianzhou (present-day Mianyang, Sichuan), the main route down the Yangtze River is marked with a solid red line, sequentially passing through Yuzhou and Kuizhou, and traveling along the Yangtze River to Jingzhou, Wuchang, and Jinling, before reaching Yangzhou. The geographical locations of poetic works such as "Early Departure from Baidi City" and "Viewing Heaven's Gate Mountains" are annotated along the way. A timeline is adopted to show his traveling process from Shu to Jiangnan, constructing a tripartite correspondence among route, time and poetic creation. Figure 1b illustrates his repeated itineraries in the Yangtze River Basin during the Grand Travel period (725-742). Multiple routes overlay in Jinling, Mount Lu, and Yangzhou Kernel density analysis reflects Li Bai's sustained attention to and in-depth travels within the core cultural and economic belt of the Yangtze River Basin.

The routes of his exile and return journey in his later years (Figure 1c) reflect a markedly constrained and involuntary character, centrally covering key geographical nodes such as Yelang, the point of his pardon, Jiangling, and Xunyang. This study uses different line types to differentiate them: dashed lines represent the exile route, while solid lines represent the eastward return route. The visualization results intuitively restore the core geographical space implied in the verse "Returning to Jiangling, a thousand miles away, in a single day" from Early Departure from Baidi City, and clearly reveal the spatial trajectory discrepancies between Li Bai's exile and his eastward return in later life.

Figure 1. (a) Route from Shu to Chang'an; (b) Yangtze River travel routes; (c). Late life journey

4.3. Analysis of spatial distribution characteristics

Based on the previously constructed GIS spatial database, the distribution characteristics of all his travel locations are analyzed from a global perspective. Spatial statistical analysis reveals that the regional distribution of Li Bai's travel locations shows significant differences: the Yangtze River Basin accounts for 65%, regions north of the Yellow River account for about 20%, and the remaining minor distributions fall within 15%. In terms of provincial administrative divisions, Jiangsu, Anhui and Hubei record the widest distribution of his travel sites, further confirming that the Yangtze River Basin served as his main activity scope (illustrated in Table 1).

The results of the kernel density analysis (Figure 2) show that the hotspot areas of Li Bai's travels are centered on Jinling (present-day Nanjing), radiating outwards towards Yangzhou, Mount Lu, and Dongting Lake. The dark-colored areas (with the highest density) are concentrated in the Nanjing-Zhenjiang-Yangzhou region in the lower reaches of the Yangtze River. This indicates that this region witnessed Li Bai's longest stays and most frequent itinerations in his lifetime, which forms a clear spatial correlation with the rich Jiangnan imagery in his poetic works.

Table 1. Statistics of Li Bai's travel locations

Regional Classification	Number of Locations	Percentage	Major Provinces
Yangtze River Basin	78 locations	65%	Jiangsu, Anhui, Hubei, Sichuan
Yellow River Basin	24 locations	20%	Shaanxi, Henan, Shanxi
Other Regions	18 locations	15%	Zhejiang, Guangdong, etc.
Total	120 locations	100%	-

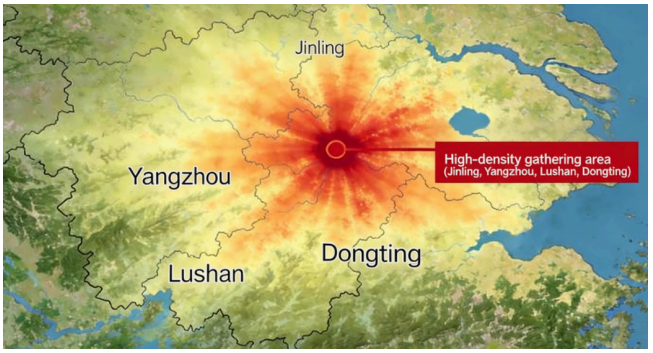

Figure 2. Heatmap of travel density

5. Discussion

5.1. The correlation between poetry creation and geographical space

Using GIS spatial overlay analysis, this study overlays Li Bai's poems of different themes (landscape, farewell, historical reflection) with geographical features. Landscape poems concentrate around famous mountains such as Mount Lu and Mount Huang; farewell poems cluster along major routes like Jinling and Yangzhou; historical reflection poems focus on ancient capitals including Chang'an and Jinling. Thus, Li Bai's poetry is intrinsically linked to geographical space: mountains inspire romantic sentiment, capitals embody political ambition, and Jiangnan harbors seclusion ideals.

5.2. Research significance and expanded applications

The visualization results provide a quantified spatial distribution basis for interpreting the Jiangnan imagery in Li Bai's poetry, proving the feasibility and effectiveness of GIS visualization in literary geography research. By breaking through the limitations of traditional literary paradigms, GIS technology, through timelines, heat maps, and spatial overlays, captures Li Bai's travel patterns and intrinsic rules that are difficult to uncover otherwise. Spatial density and trajectory analysis reveal that Li Bai's roaming was not aimless but a goal-oriented reciprocating movement within regions of high cultural and economic significance. While traditional studies often divide the stages of his poetic style evolution based on chronology or major life events, the spatiotemporal trajectories in this study provide a continuous geographical background for that evolution. By closely correlating spatial trajectories with changes in poetic style, this study offers a geospatial cognitive method for analyzing the evolution of Li Bai's spiritual world.

Furthermore, based on the visualization of Li Bai's travel routes, this study constructs a reproducible GIS technical workflow. This workflow can be directly applied to trajectory verification and spatial analysis of other ancient poets, and can support visual comparisons of spatial activity differences among different groups of poets. Thus, it provides a referential practical paradigm for ancient literary geography research from the perspective of digital humanities.

6. Conclusion

This paper adopts GIS visualization methods to extract more than 120 travel locations from "The Complete Tang Poems" and related literature, identifying three main routes: from Shu to Chang'an, wandering in the Yangtze River Basin, and the exile and return journey in his later years. The research indicates that his travel areas were centered on the Yangtze River Basin (65%), forming high-density agglomeration areas in places like Jinling, Mount Lu, and Dongting. Furthermore, there is a significant correlation between the geographical environment and his poetry creation style. The main contributions include: providing a new perspective of spatial analysis, constructing a reproducible technical workflow, and validating the feasibility of integrating GIS with literary geography.

However, this study has three main limitations. First, verification of some place names remains controversial; this can be improved through multi-source literature cross-validation. Second, spatial positioning errors due to ancient-modern place name discrepancies can be reduced by integrating CHGIS. Third, GIS prioritizes geospatial analysis and cannot capture the affective nuances of poems; future work may incorporate NLP and VR.

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