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Historical Insights into Sustainable Development: Analyzing the Spatiotemporal Dynamics of Ancient Trade and Settlements

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Abstract: Ancient trade routes significantly influenced political structures, cultural exchanges, economic development, and landscape transformations across diverse regions. The Ancient Tea Horse Road, a prominent historical commercial pathway in China, is crucial for ecosystem and cultural heritage conservations. This study uses content and comparative analysis, Geographic Information System (GIS) technology, and spatial analysis to examine the spatiotemporal relationships between 13,026 settlement points identified via Google Earth and 445 recorded settlement names within the Dali Bai Autonomous Prefecture, Yunnan Province. The findings indicate that the Ancient Tea Horse Road evolved from a simple linear form to a complex radial network, reflecting its growth from local to broad regional connectivity. Settlements related to administrative, postal, and commercial functions emerged in its vicinity, underscoring the route's impact on social structures and economic activities. The development of settlements, mainly within a 10 km radius of the route, was closely linked to its expansion, alteration, and decline, offering insights into contemporary settlement distribution patterns. This research not only enhances the understanding of the Ancient Tea Horse Road and its surrounding settlements but also supports the protection of ancient trade routes and their cultural heritage. It contributes to sustainable development by integrating ecological preservation with the safeguarding of ancient trade routes and their cultural legacies.

Keywords: ancient trade routes; settlements; spatiotemporal analysis; Tea Horse Road; route evolution

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1. Introduction

Throughout the annals of history, ancient trade routes have served not merely as conduits for commercial exchange but also as stages for cultural and political interactions [1,2]. These routes, like threads woven into a fabric, have intricately connected different civilizations, together crafting a rich tapestry of history. As pointed out by Whitfield, these ancient pathways represent both a bridge for human interaction with the natural environment and a bond for multicultural exchanges, not only facilitating the flow of populations and cultural interactions but also acting as fertile grounds for the nurturing of cultural heritage, forming cultural corridors that amalgamate both tangible and intangible values [3,4]. These ancient routes have promoted human migration, activities, and interactions, weaving together tangible and intangible cultural heritages and fostering economically and socially significant cultural heritage corridors [5,6]. Examples such as the Silk Road connecting the east and west, the Spice Route of the Arabian Peninsula, and the Trans-Saharan trade routes in Africa are closely intertwined with social, economic, and cultural transformations [7,8].

The interaction between ancient trade routes and their surrounding cultural and natural environments constitutes a complex human and geographical collective

relationship [9,10]. For instance, Trombold has highlighted that the construction and improvement of roads not only propelled economic development but also facilitated population agglomeration [11]. This specific social phenomenon of ancient trade routes also stimulated changes in settlement landscape patterns and architectural forms, contributing to development and exchange among ethnic groups in the southwest region of China, leaving behind valuable tangible and intangible cultural heritages [12]. In ancient times, the Tea Horse Road, a segment of the Silk Road, played a critical role not only in transportation but also politically, fulfilling the ancient Chinese courts' demand for war horses and being closely related to the policies of the time [13,14]. However, with the advent of modern military and transportation methods, the traditional practice of exchanging tea for horses gradually faded, leading to the abandonment of the Tea Horse Road.

Recent geographical and historical research has marked the emergence of settlement geography, focusing on an in-depth study of the formation, development, morphological characteristics, spatial distribution, and relationships between settlements and their geographical environments [15]. Settlements, serving as basic units for various human production, living, and social activities, are significant markers of human civilization [16]. The selection, morphology, and spatial layout of settlements not only reflect comprehensive considerations of natural and social environmental factors but also the dynamic interplay of human–environment relationships in specific geographical contexts [17]. Although scholars have confirmed the close relationship between settlement geography, spatial distribution, morphology, landscape patterns, and ancient trade routes at a micro-level [18], a more macroscopic examination of settlements and their interactions with surrounding environments and other geographical elements remains insufficiently explored.

Ancient trade routes, as significant geographical elements connecting different regions and promoting exchange between human civilizations, have profound impacts on the formation and evolution of cultural resources and landscapes. While existing research has covered the historical evolution of these routes and strategies for the protection and inheritance of cultural heritage [5], systematic studies on the coupling relationship between ancient trade routes and historical settlements—especially their spatiotemporal dynamics and impact on human societal activities—are still lacking. By delving into the relationship between ancient trade routes and historical settlements, we can not only unveil the complex connections between human migration, activities, exchanges, and the environment but also gain a better understanding of the dynamics of human societal development and the mechanisms of cultural exchange. Furthermore, viewing ancient trade routes and historical settlements as a coupled entity is crucial for devising scientific conservation and planning strategies to protect these valuable cultural heritages.

To address the gaps in the literature, this study aims to explore the spatiotemporal dynamics of the Ancient Tea Horse Road and its impact on the development of historical settlements in the Dali Bai Autonomous Prefecture, Yunnan Province. Specifically, our research questions are as follows:

- What were the historical trajectories of the Ancient Tea Horse Road in the Dali region, and how did they evolve over time?
- How did the Ancient Tea Horse Road influence the formation and development of historical settlements in the Dali area?

Therefore, this study systematically organized multi-source historical toponym data from the Dali Bai Autonomous Prefecture in Yunnan Province and, with the aid of Google Earth technology, accurately extracted 13,026 settlement points. Subsequently, utilizing advanced analysis functions of GIS 10.6 software, such as buffer analysis and kernel density estimation, a quantitative study of these settlement points was conducted. A spatiotemporal database comprising 445 settlements with clear historical backgrounds was established, and the dynamic relationships between these settlements were explored through kernel density and buffer analysis. This work not only deepens the understanding of ancient settlements in the Dali area but also provides new perspectives and data support for the study of the relationship between ancient trade routes and settlements. This research

offers fresh insights into the spatial organization and cultural exchanges of ancient human societies and bears significant theoretical and practical value for the protection of cultural heritage, geographical environment planning, and sustainable development studies. Through this interdisciplinary research approach, we aim to contribute new knowledge and insights to the field of historical human–environment relationship studies.

2. Study Area

The research area of focus is the Dali Bai Autonomous Prefecture, strategically positioned in the central-western segment of Yunnan Province. It assumes a critical role as a principal transport nexus within the region, serving as an essential link that facilitates connectivity between Kunming, Baoshan, Lincang, and Jinggu, thereby extending pathways westward towards Tibet and further afield [19]. The inception of this area's terrestrial transport network can be traced to the Nanzhao era (738–902 AD) during the Tang and Song dynasties, marking the gradual establishment and evolution of a comprehensive transportation framework across Yunnan. Throughout the Dali Kingdom's governance, which spanned over five centuries, the ruling authorities undertook the construction of roads, the establishment of urban settlements, and the inauguration of postal stations. This infrastructure initiative was centralized around Dali Prefecture, weaving a network of postal roads that spanned Yunnan, facilitating connections to Tubo (Tibet), ensuring internal links to the Central Plains, and enabling external outreach to Southeast Asia and South Asian nations [20,21]. This configuration engendered a sophisticated system of postal road transportation, as depicted in Figure 1.

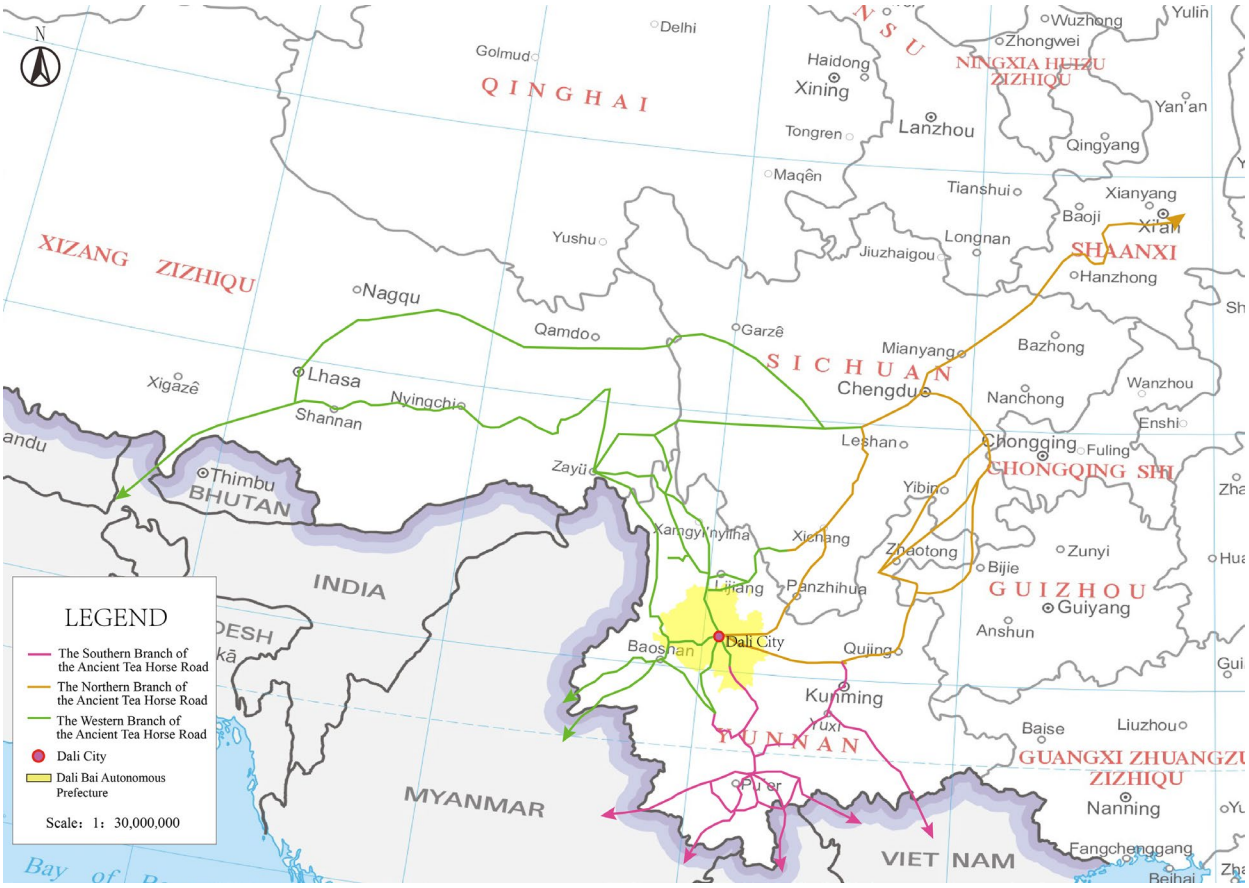

Figure 1. The research area and the routes of the Ancient Tea Horse Road within China.

3. Methods

3.1. Methodology

This study employs a mixed-methods approach, integrating qualitative and quantitative research methodologies to thoroughly explore and interpret complex historical and geographical data. Qualitative analysis aids in understanding and interpreting the intricate historical contexts and human geographical phenomena, while quantitative analysis provides verifiable time–space data support, enhancing the reliability and precision of our conclusions [22]. The application of this mixed methodology enabled a comprehensive analysis of the intertwining of history and reality and has been widely applied in the fields of cultural heritage conservation [23] and human geography [24].

In the qualitative component of our research, we engaged in content analysis and comparative analysis of historical materials, with a focus on delineating the historical development of the Ancient Tea Horse Road and the genesis of settlements surrounding this ancient route. Given the extensive duration and often incomprehensible nature of historical materials, which are typically unstructured, such analysis facilitates the extraction of information from historical documents, aiding in the understanding of developmental changes and historical connections over different time points. Subsequently, we employed quantitative methods in GIS 10.6 software, such as buffer analysis and kernel density estimation, to delve into the spatiotemporal dynamics between the Ancient Tea Horse Road and settlements in Dali Prefecture, as well as conducting a kernel density analysis (KDA) of historical settlements along the road. This aspect of the study not only revealed the relationships and characteristics of geographical elements from spatial and temporal dimensions but also quantified the interaction patterns and influence between the ancient road and its associated settlements through advanced spatial analysis tools in GIS. The quantitative methods include the following.

3.1.1. Establishment of Buffer Zones

Buffer analysis stands as a fundamental GIS operation, involving the creation of zones around geographic features (points, lines, or areas) at specified distances, resulting in polygon layers that envelop the original entities [25]. This operation facilitates the generation of spatial analytical outcomes by illustrating the overlap between the newly created buffer zones and the original geographic layers [26]. It offers a method to quantitatively assess relative proximity among spatial entities. For this project, buffer zones were meticulously constructed around the historical trajectories of the Ancient Tea Horse Road. The objective was to quantitatively evaluate the spatial proximity between these historic routes and the adjacent settlements, utilizing ArcGIS 10.6 software for the analysis.

3.1.2. Kernel Density Estimation (KDE)

Kernel Density Estimation (KDE) is utilized to determine the density of features within the vicinity of each raster cell in the output layer [27]. This analysis was applied to settlement point features, assessing the aggregation pattern of data across the study area by employing point features from the spatiotemporal settlement database of Dali Prefecture, thereby creating a continuous surface of density values. This method is instrumental in quantitatively analyzing historical settlements, representing the spatial distribution and aggregation of historical settlements in various eras through density contours. Higher kernel density values signify a greater concentration of historical settlements.

The analysis employed the Rosenblatt–Parzen kernel estimator [28] with the following formula:

$$fn(x) = \frac{1}{nh}\sum_{i=1}^{n} k\left(\frac{x - Xi}{h}\right)$$

Here, $k\left(\frac{x-Xi}{h}\right)$ represents the kernel function; $h > 0$ denotes the bandwidth; n is the number of point features representing settlements within the area of interest; and $(x - Xi)$ calculates the distance between the point of estimation and the location of an event. Computations were conducted on the ArcGIS 10.6 platform, ensuring a robust and scientifically rigorous analysis of the spatial dynamics at play.

3.2. Data Source

In the course of this investigation, the compiled dataset included the geographical coordinates (latitude and longitude) of settlements, Digital Elevation Models (DEMs), remote sensing images, and an array of local historical documents and gazetteers. The methodology encompassed several pivotal steps.

Initially, this study utilized high-resolution satellite imagery from Google Earth to accurately identify and catalog 13,026 settlement points within the Dali Bai Autonomous Prefecture. These encompassed settlements across Dali City, counties such as Xiangyun, Midu, Binchuan, Yongping, Yunlong, Eryuan, Heqing, Jianchuan, and the ethnically autonomous counties of Yangbi, Weishan, and Nanjian.

Subsequent phases involved the systematic compilation and analysis of historical documents, atlases, and local gazetteers to unearth the historical toponymy of Dali Prefecture settlements. The research particularly benefitted from the detailed historical accounts from works like the *Historical Atlas of China*, analyses of the Qing Dynasty's postal system in the Yunnan–Guizhou area, and comprehensive histories of the Southwest. The historical timeline was segmented into four distinct periods: pre-Yuan (up to 1271 AD), Yuan (1271–1368 AD), Ming (1368–1644 AD), and Qing (1616–1912 AD).

Following this, the study organized data regarding the nomenclature, formation, and etymology of settlements based on the comprehensive place name registries compiled at the end of the 1980s and in the early 1990s in Yunnan provincial surveys. This included detailed gazetteers for various jurisdictions within the prefecture. Notably, due to the scarcity of historical records pertaining to settlements in these gazetteers, researchers aligned ancient and modern place names and the dates of their establishment derived from historical records (gazetteers, atlases), thereby verifying the evolution of settlement names. Using historical documentary analysis, we determined the founding years of these settlements and conducted a meticulous comparison with the 13,026 contemporary settlement points, identifying 445 with documented origins dating back to the Qing Dynasty or before, thus establishing a historical settlement database for the Dali Bai Autonomous Prefecture.

The manual detailed comparison necessitated by the incomplete integration of historical data into the database was both complex and time-intensive, requiring a high degree of precision and thorough manual verification. Despite these challenges, the endeavor was invaluable, enhancing the integration of Geographic Information Systems (GISs) with historical geographical methodologies. Through comprehensive data collection and analysis, this study offers profound geographical and historical insights into the evolution of settlements in the Dali region, highlighting the sophistication and depth of the research methodology in applying technical and scholarly approaches.

4. Findings

4.1. The Historical Development Process of the Ancient Tea Horse Road

The trade centered around tea between the Yunnan and Tibetan areas has a long-standing history, closely tied to the centralized authority's need for warhorses. The Ancient Tea Horse Road in Dali Prefecture evolved over a millennium into a complex, radiating network. Historical documents indicate that this route underwent multiple phases of morphological changes from before the Yuan Dynasty to the Qing Dynasty (Figure 2).

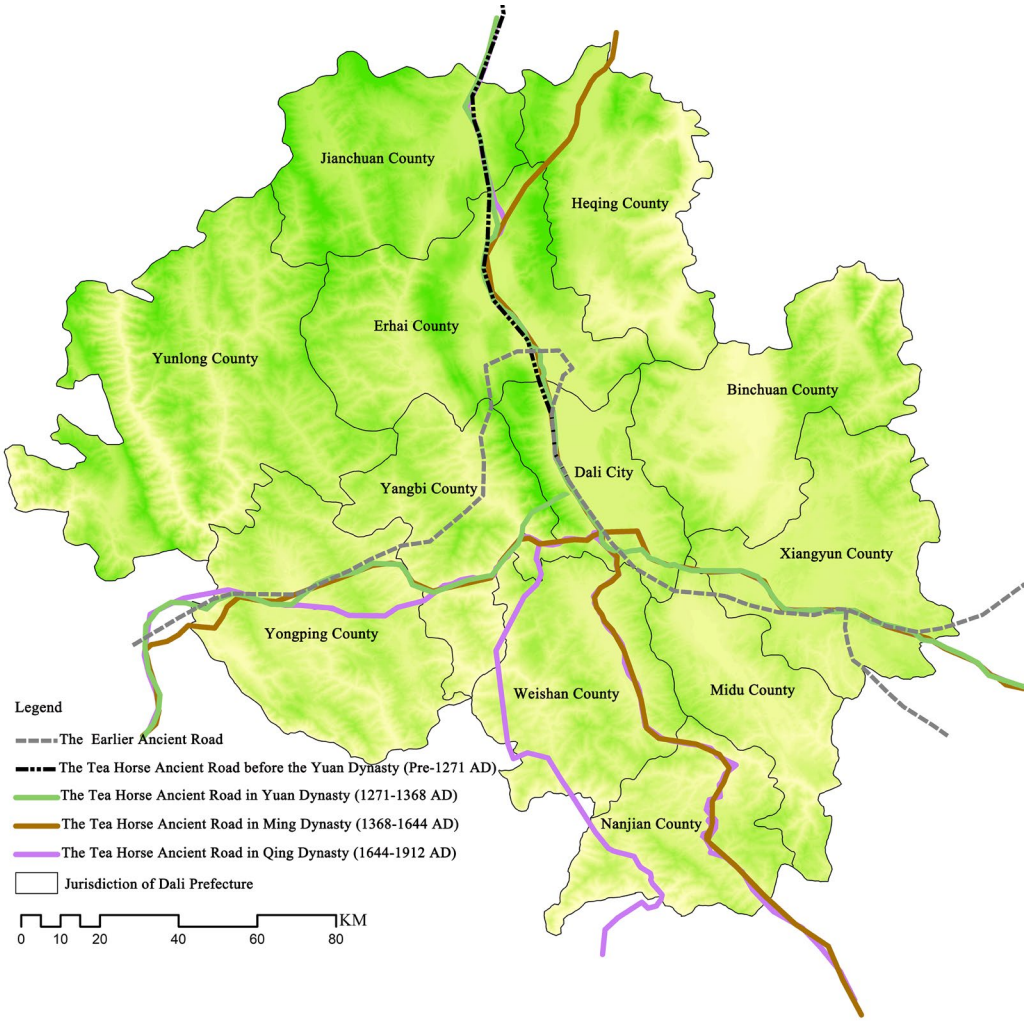

Figure 2. The historical evolution of the Ancient Tea Horse Road.

Throughout the Tang to Dali Kingdom periods (618–1253 AD), the primary trajectory of the Ancient Tea Horse Road facilitated a north–south linkage between Dali and Lijiang, initially establishing a rudimentary linear pathway. Concurrently, integral components of the Southwestern Silk Road, which was inclusive of the Bonan, Wuchi, and Qingxi Roads, were instituted. These east–west directional routes equally contributed to the tea transport function.

During the Yuan Dynasty (1271–1368 AD), Dali Prefecture witnessed an augmentation of its transportation infrastructure, with the establishment of new postal relay stations predicated upon existing ones. This era marked the integration of the Ancient Tea Horse Road with the Southwestern Silk Road, culminating in a triradial-shaped network configuration.

By the Ming Dynasty (1368–1644 AD), intensified efforts to cultivate Yunnan through immigration and agrarian colonization strategies significantly bolstered the Ancient Tea Horse Road. Notably, the extension of routes towards Pu'er manifested in a cross-shaped configuration, comprising north–south axes.

In the Qing Dynasty (1644–1912 AD), escalating dependency on "Pu'er Tea" rendered the erstwhile pathways connecting Pu'er with Dali City inadequate. Thus, the Ancient Tea Horse Road was expanded southwards, evolving from a cross-shaped to a central radial-shaped structure, prominently integrating southbound extensions towards Lincang and Pu'er, without the establishment of new relay stations along these trajectories.

This sequential evolution of routes not only mirrors the historical progression of commerce between the inland regions and Tibetan areas but also illuminates the systematic expansion and complexification of the Ancient Tea Horse Road within Dali Prefecture as a pivotal transportation conduit. This narrative underscores the intricate interplay between geographical settings and the economic imperatives of distinct historical epochs, manifesting the scholarly exploration of trade dynamics and infrastructure development within historical geographical contexts.

4.2. Settlements Associated with the Management, Production, and Service Functions of Ancient Roads

The genesis and transformation of historical settlements are intricately linked to the geographical environment, socio-economic evolution, and impact of transportation networks [29]. However, delving into the developmental history of settlements spanning from centuries to millennia confronts the challenge of scarce information on their initial location selections and growth. Settlement names or place names can reveal insights into the natural and socio-cultural conditions prevailing at the time of their establishment, offering valuable evidence for examining changes in the geographical landscape, transportation infrastructures, and socio-economic dynamics through historical epochs [30].

Along historical postal routes, there were not only official relay stations but also transportation service facilities such as "铺" (representing shops), "哨" (representing outposts), and "岗" (representing watchtowers), which could evolve into settlements over time. For example, the name "桃园铺 (Taoyuan Shop)" traces back to a commercial establishment along the ancient Bonan Road, named after its renowned production of green peaches; "马场 (Horse Farm)" was identified for its rich pastures in the Ming Dynasty, serving as a vital grazing land for horses; "杉松哨 (Shansong Outpost)" and "桥头哨 (Qiaotou Outpost)" owe their names to their respective roles as surveillance points on ancient routes, which gradually transformed into established settlements.

Through a detailed examination of the place names in Dali Prefecture's gazetteers and historical material, settlements associated with the transportation network can be classified into four distinct categories: administrative management functions, postal service functions (including document transmission and guard defense), commercial service functions, and equine service functions. Leveraging modern satellite imagery from Google Earth, a total of 127 pertinent settlements were identified within the Dali Prefecture. Subsequent spatial overlay analysis correlated these settlement points with ancient thoroughfares across different historical periods, culminating in the production of a comprehensive map that delineates the distribution of ancient roads alongside their associated production, service, and management settlements (Figure 3). The results corroborate Sternberg's research, not only enriching the understanding of the historical interplay between settlements and transportation networks from both geographical and historical perspectives but also laying a solid foundation for exploring the dynamic interactions between human activities and the geographical environment.

The figure delineates the intricate nexus between the development of administrative functionalities in settlements across Dali Prefecture and the Ancient Tea Horse Road. With the exception of Yunlong and Binchuan counties, this mercantile artery extended through all county-level administrative divisions within the prefecture. Consequently, the Ancient Tea Horse Road was pivotal not only for facilitating the commerce of tea–horse exchange but also for the dissemination of administrative governance and military intelligence. Historical documentation elucidates that the spatial organization of administrative centers was strategically optimized to enhance proximity to trade corridors, ensuring the expedited relay of military intelligence and official communiqués to proximate governing locales within a single day.

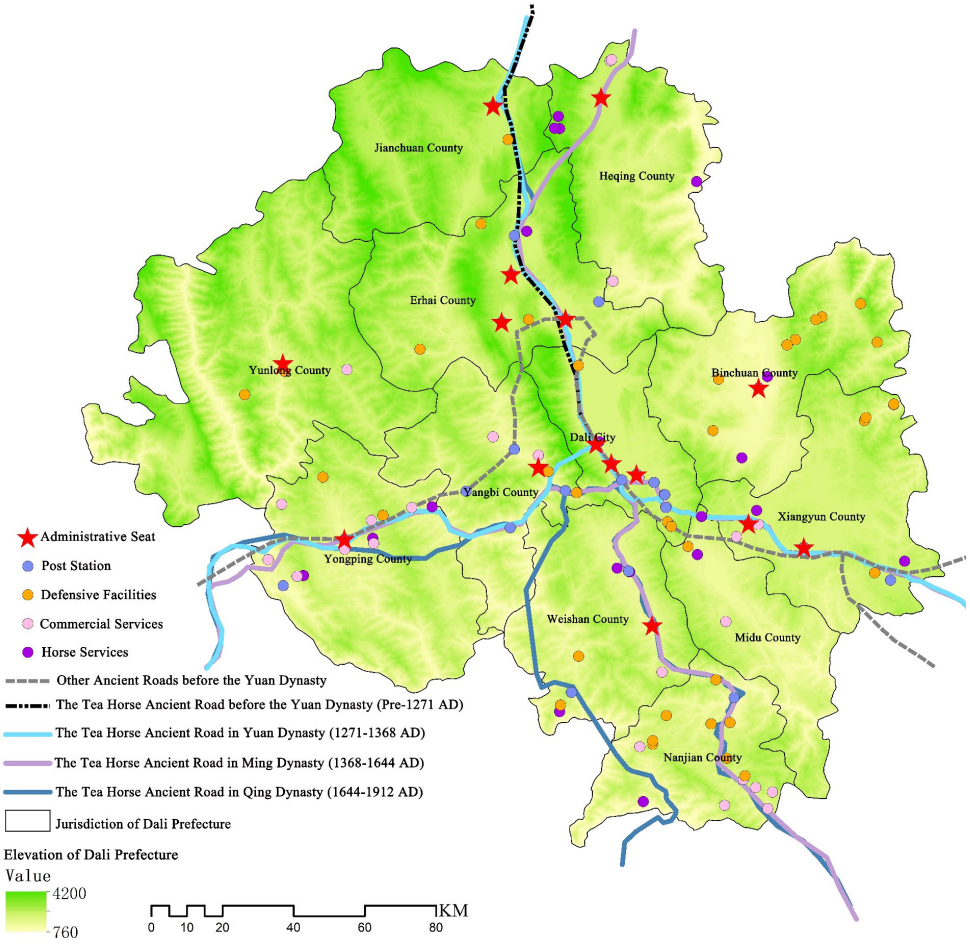

Figure 3. Tea Horse ancient road and distribution map of settlements related to the ancient road in Dali Prefecture.

Furthermore, the amalgamation of thoroughfares, postal relays, and fortifications formed an essential infrastructure for state governance, postal communications, and military logistics, reflecting the profound interconnectivity among these facets. Divergent from contemporary transport modalities, the Ancient Tea Horse Road predominantly relied on ponies for the conveyance of goods, rendering facilities catering to equine needs along this corridor indispensable. Predominantly positioned in geographically advantageous locations that were abundant in resources and conducive to grazing, these stations not only embody the ancient populace's intricate understanding and stewardship of the geographical landscape but also align closely with historical accounts in regional gazetteers. This reflects a symbiotic relationship between anthropogenic activities and geographical environments in the utilization of land resources.

4.3. Spatiotemporal Dynamics between the Ancient Tea Horse Road and Settlements in Dali Prefecture

This research meticulously collated and verified temporal data of settlement names to investigate the spatial interrelations between the Ancient Tea Horse Road and its adjacent settlements during periods when the road remained a vital conduit and had not fallen into disuse. To this end, the establishment of settlements is delineated across four historical epochs: pre-Yuan Dynasty, Yuan Dynasty, Ming Dynasty, and Qing Dynasty. Utilizing buffer zone analytical methodologies, this study delineates the settlement distribution patterns within proximity of the Ancient Tea Horse Road in Dali Prefecture through these distinct periods (Figure 4). The findings indicate that significant settlement development

during the Yuan, Ming, and Qing epochs predominantly occurred within 10 km of the Ancient Tea Horse Road, with a notable concentration within a 5 km buffer.

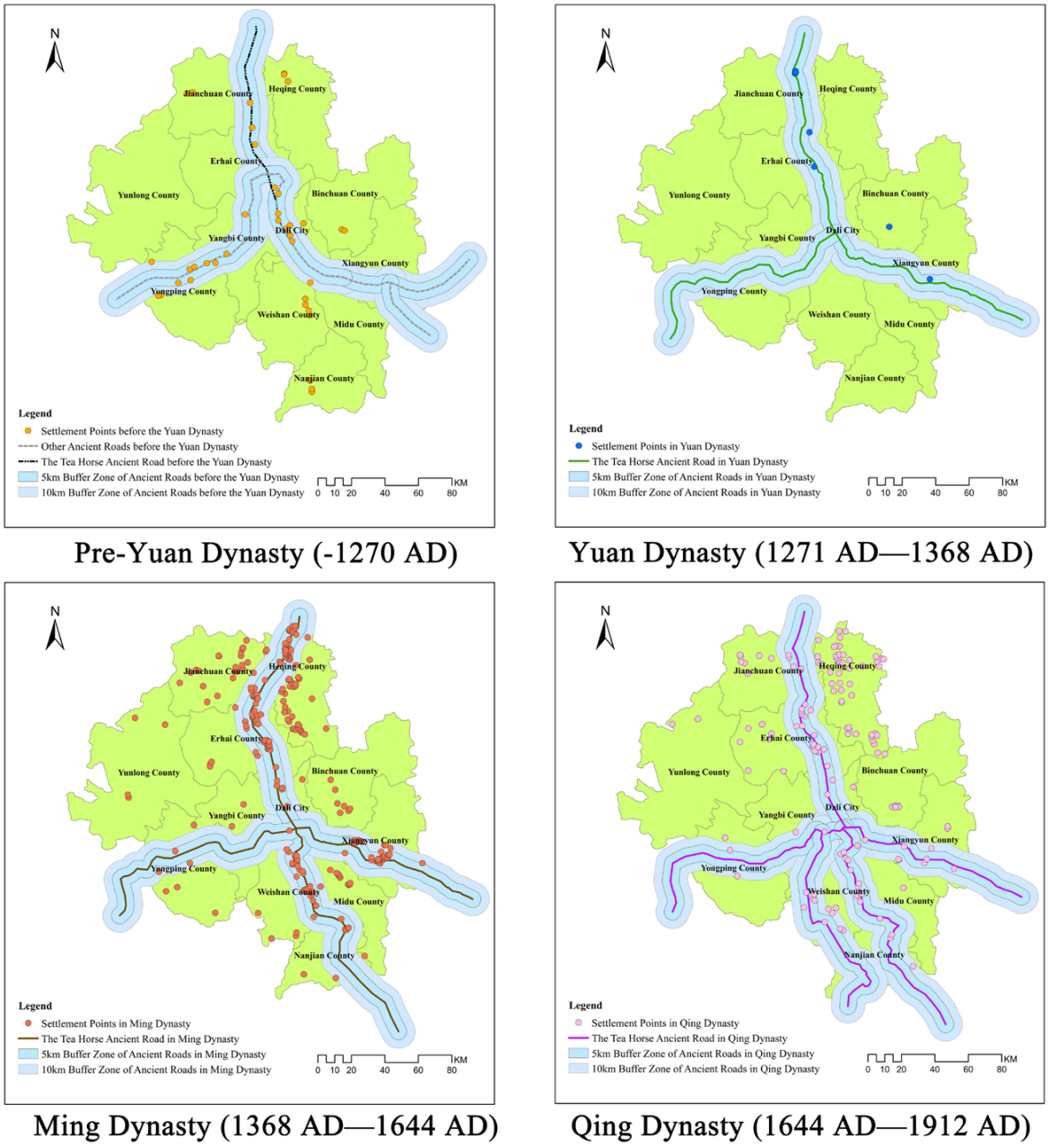

Figure 4. Buffer areas of Tea Horse Ancient Road and maps of the evolution of settlements of each period in Dali Prefecture.

Settlements established prior to and during the Yuan Dynasty were almost exclusively located within a 5 km radius of the roadways, underscoring a profound spatial linkage with the settlements serving as administrative hubs in Dali Prefecture. Yuan Dynasty settlements were chiefly clustered around the Xiaguan area and Yongping County, signifying that the inception of administrative centers markedly stimulated the growth of adjacent rural communities.

With the advent of the Ming Dynasty, the genesis of civilian settlements was intricately tied to strategic shifts in the trajectory of the Ancient Tea Horse Road. The Ming period witnessed a redirection of the route, bypassing the Jianchuan-to-Lijiang extension in favor of a new path from Heqing County to Lijiang, precipitating an upsurge in civilian settlements around Heqing County. The region's fertile lands and ample water supply, coupled with the flourishing tea–horse exchange, promoted increased population aggregation and settlement formation. Concurrently, the southern expanses of Dali Prefecture saw the introduction of a novel route from Pu'er to Dali City, which was paralleled by a rise in civilian settlements in such sites as the Weishan and Nanjian counties.

During the Qing Dynasty, the integration of additional routes towards Pu'er in Dali Prefecture catalyzed the emergence of new settlements within a 10 km vicinity of these routes. The burgeoning popularity and production of Pu'er tea underscored Dali Prefecture's enhanced role as a transport nexus. The escalation in Pu'er tea transport to Dali Prefecture contributed to the proliferation of civilian settlements along the Ancient Tea Horse Road, exemplifying the route's persistent socio-economic vigor and its reciprocal interactions with the surrounding geographical milieu.

4.4. Kernel Density Analysis (KDA) of Historical Settlement Agglomerations along the Ancient Tea Horse Road in Dali Prefecture

Utilizing kernel density analysis, this research generated detailed density maps for the Ancient Tea Horse Road and its associated settlements throughout various historical periods (referenced in Figure 5). This method provides an intricate portrayal of the spatial distribution and density of settlements, highlighting how settlement clusters have evolved over time. The findings indicated that the peaks of settlement density in each historical phase were either directly on or near the routes of the Ancient Tea Horse Road. This spatial alignment underscores the critical role the road played in the establishment and development of settlements along its path.

The analysis further revealed a dynamic shift in the centers of settlement concentration, which corresponded to changes in the route of the Ancient Tea Horse Road. This shift is not merely a matter of physical relocation but reflects deeper socio-economic and strategic adaptations. Specifically, the migration of settlement epicenters alongside modifications to the Ancient Tea Horse Road's course demonstrates the adaptability of ancient communities to changing trade dynamics and routes. This adaptability was crucial for accessing the strategic and economic advantages offered by the horse trade, which was significantly influenced by governmental policies and the geopolitical landscape of the time.

The kernel density maps vividly capture the transformation of settlement patterns, from denser clusters in regions where the Ancient Tea Horse Road was most prominent to new centers of agglomeration emerging in response to the road's rerouting. This transition highlights the enduring impact of the Ancient Tea Horse Road on regional development, indicating that the road served not only as a critical conduit for trade but also as a catalyst for urban and rural settlement evolution.

The results of this kernel density analysis provide a comprehensive understanding of the interplay between ancient trade routes and settlement development. The shifts in settlement concentration areas underscore the Ancient Tea Horse Road's significance as a lifeline for economic activity and strategic movement in ancient China. Furthermore, the analysis offers insights into how policies and trade dynamics influenced settlement patterns, suggesting that the road and its surrounding settlements were integral components of a larger socio-economic system that shaped the historical landscape of the region.

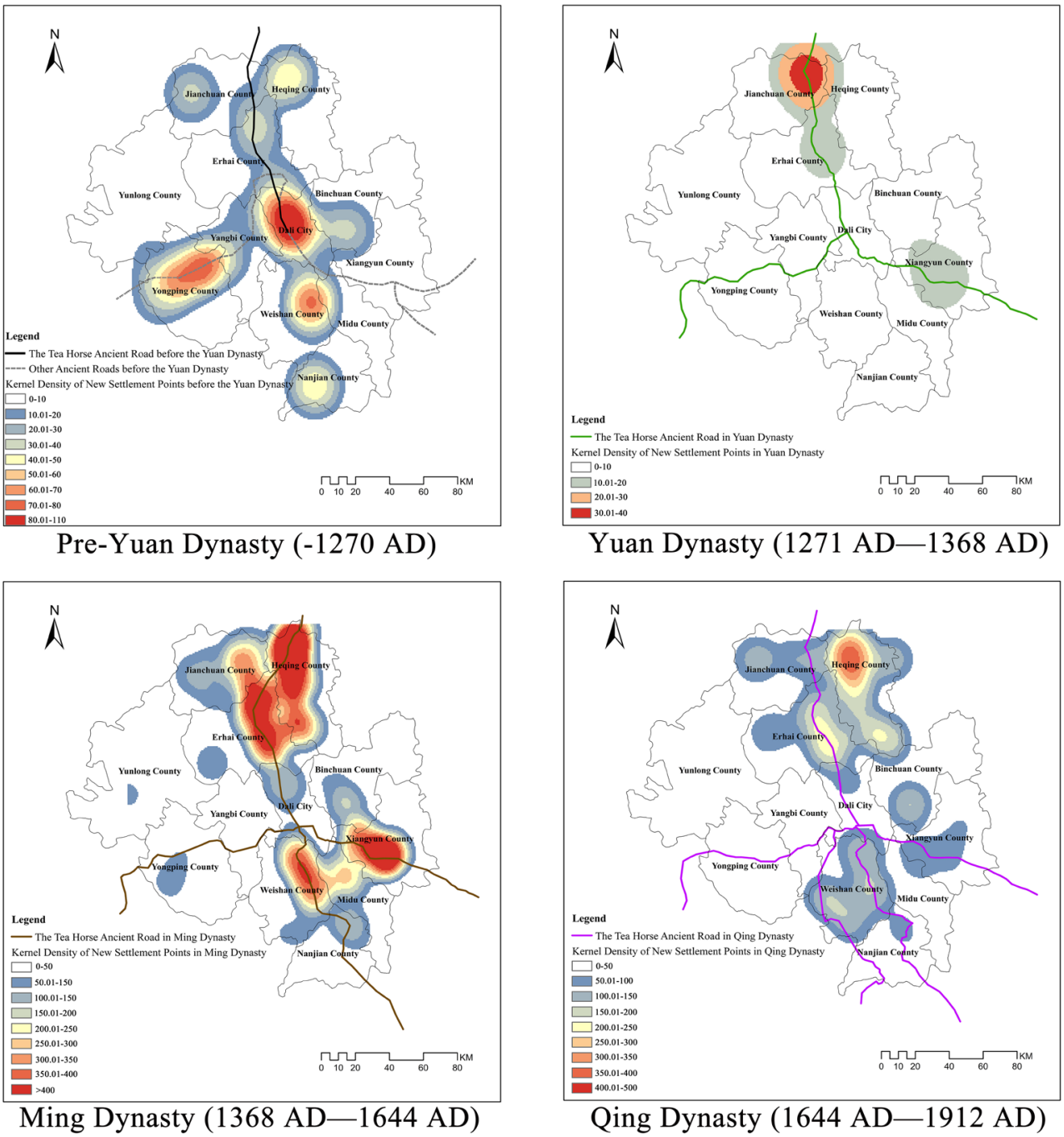

Figure 5. Core density maps of settlements and the Ancient Tea Horse Road in each period in the Dali Prefecture.

In a parallel analytical vein, this study also subjected the contemporary dataset of 13,026 settlement points to kernel density examination, culminating in a contemporary kernel density depiction of Dali Prefecture's settlement patterns (Figure 6). This contemporary analysis attests to the persistence of historical settlement clustering patterns within Dali Prefecture, evidencing the enduring influence of ancient administrative nexus. It becomes apparent that the contemporary apexes of settlement clustering within Dali Prefecture are a direct legacy of the settlement expansion, concentration, and evolution fostered by the ancient commercial conduits. This insight underlines the sustained socio-economic vitality and strategic significance of the Ancient Tea Horse Road in shaping settlement dynamics within the region.

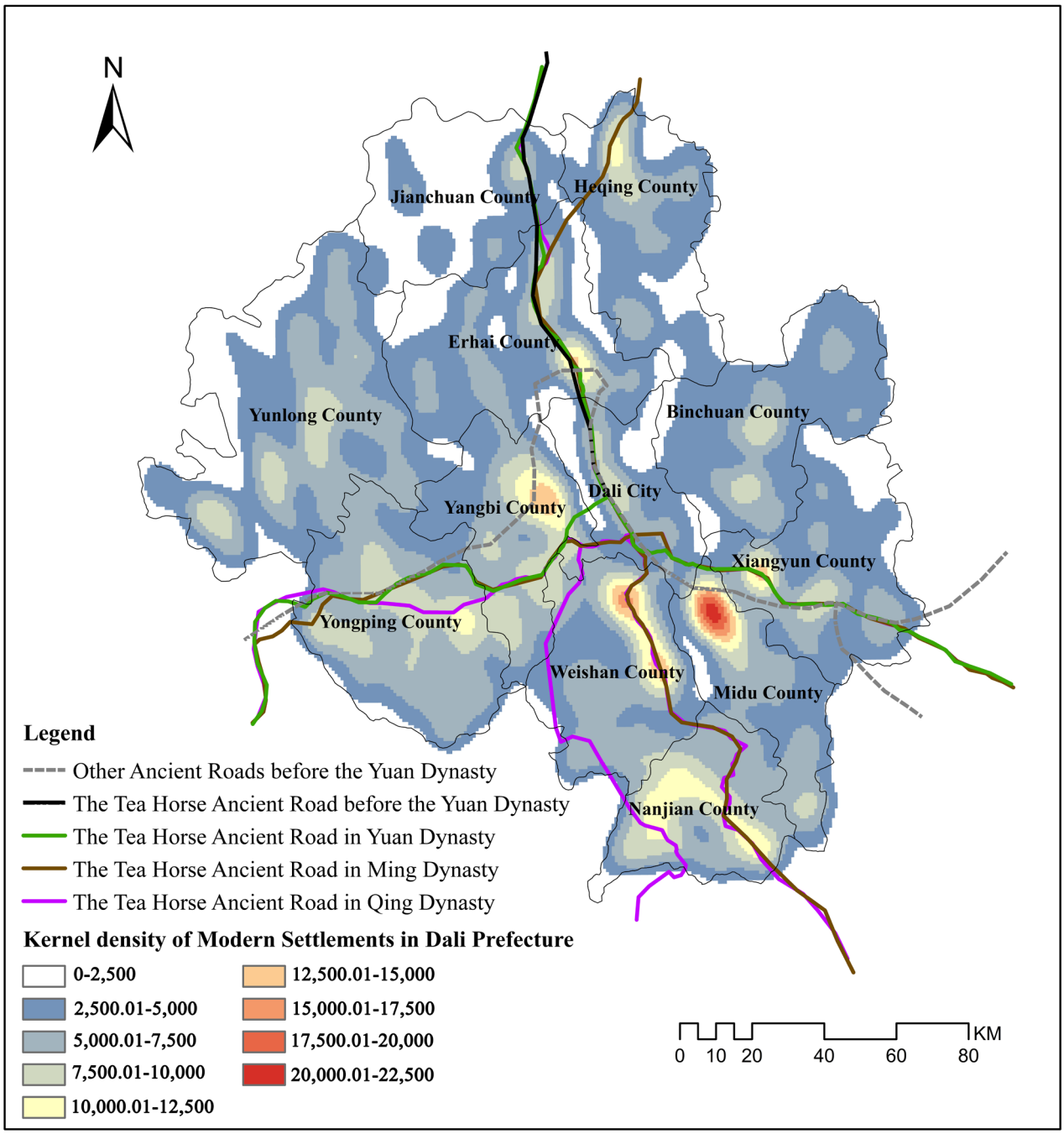

Figure 6. Core density map of modern settlements and Ancient Tea Horse Road in Dali Prefecture.

5. Conclusions and Discussion

5.1. Discussion and Implications

The strategy for the modern conservation and utilization of ancient trade routes and their surrounding settlement heritage should integrate both tangible and intangible cultural resources, creating a diversified heritage corridor [31]. Based on our results, we classified the resources into five types (as shown in Table 1): natural resources associated with the formation of the road and settlements, transportation and hydraulic resources, military management resources, commercial system resources, religious belief resources, and other resources. Specifically, tangible cultural resources include, but are not limited to, the ancient pathways themselves; hydraulic facilities along the route, such as postal stations and bridges; military installations like camps and agricultural colonies; and religious sites, such as temples, stupas, and tombs. These resources not only bear rich historical informa-

tion but also directly reflect the lifestyles, economic conditions, and technological levels of ancient societies. They further demonstrate that ancient trade routes relied on the geographical environment and natural resources of sur-rounding settlements, as Yang et al. have indicated. Water bodies like Erhai Lake and the Yangbi River not only provided water sources but were also vital avenues for trade and communication [12]. Transportation and hydraulic facilities, such as postal stations and bridges, enhanced the connectivity and efficiency of the road network, fostering interaction and resource sharing between settlements. Military installations like camps and agricultural colonies ensured the safety of the routes, secured the stability of the settlements along them, and reflected their critical role in defense systems. The prosperity of commercial activities, showcased through workshops and markets along the route, promoted technological and cultural exchange and economic diversification. Religious sites like temples and stupas not only represented religious beliefs but also served as centers for cultural exchange and spiritual life.

Table 1. Natural resource overview of ancient road and settlement protection system.

Attribute	Description	Examples of Place/Settlement Names
Natural Resources Associated with the Formation of Ancient Roads and Settlements	• Locations near water sources; villages situated on or at the foot of mountains; areas on flat terrain; • Regions within mountains characterized by dense bamboo forests or lush vegetation; • Places abundant in thicket vegetation; • Locales often nestled against or atop mountains	Erhai Lake, Yangbi River, Jian Lake, Pine Shrubbery, Cangshan Mountain, Laojun Mountain
Transportation and Hydraulic Resources of Ancient Roads	• Shops providing rest stops along the trade route; • Outposts or watchtowers stationed along the trade route; • Bridges situated near the trade route; residences tasked with managing hydraulic facilities	Tea Shop, Wo Shop, Plum Blossom Shop Shang Village, Dashi Outpost, Changling Post Ma'an Bridge, Beiqing Bridge Yanpai, Shangpai
Military Management Resources of Ancient Roads	• Campsites for soldiers; • Territories allocated for military; civilian colonization; • Areas designated for soldier training	Xiahuo Camp, Zhujiayin Village Caotun, Qitun Village, Lengshui Field
Commercial System Resources of Ancient Roads	• Workshops dedicated to handicrafts or horse trading; • Venues for small markets or market gatherings	Ban Platform, Iron Platform, Da Platform, Xiaohu Street, Xitan Street
Religious Belief Resources of Ancient Roads	• Sites for Buddhist practice; • Locations for deity worship; • Structures designed for Feng Shui regulation or the preservation of relics	Xiao Guanyin Temple, Jingguang Temple, Xian Shen Temple, Shan Shen Temple
Other Resources	Ancient burial sites	Tombstone Mountain

Furthermore, the scope of tangible cultural heritage should be expanded to include the geographical characteristics of settlement locations, the spatial layout and patterns of settlements, the interrelationships between settlements, the texture and style of architecture, and the organization of internal spaces. These elements not only demonstrate ancient people's adaptation to and utilization of the natural environment but also reflect the evolution of social structures, economic models, and cultural traditions [32,33]. For example, settlements along the Ancient Tea Horse Road displayed specific wisdom in site selection based on their production and living needs, such as the use of river valleys and plains or defensive arrangements in mountainous areas. Within the context of the trade and production life of these settlements along the Ancient Tea Horse Road, unique handicraft skills, ethnic clothing, customs, festival activities, music and dance, drama and folk arts, folklore, and ethnic specialties and flavors emerge as intangible cultural heritage, thus constitut-

ing a comprehensive repository of both tangible and intangible cultural heritage resources surrounding the ancient pathways and their settlements.

As Xu et al. assert, adopting a holistic approach to heritage conservation is crucial, acknowledging the interconnectedness of tangible and intangible cultural assets within the historical ecosystem of ancient trade routes [34]. This approach advocates for policies and practices that honor and preserve the rich tapestry of cultural expressions and historical narratives embedded in these landscapes.

Our study, through an in-depth analysis of the evolution of ancient trade routes, elucidates their impact on the development of settlements and, consequently, their influence on regional economic and social development. We underscore the importance of the unified protection and study of both the ancient pathways and their surrounding settlements. This research provides crucial theoretical insights into understanding the dynamics of ancient trade routes, the interplay of geographical elements, and their relationships with historical settlements. On a practical level, our study offers significant implications for the conservation and utilization of the heritage associated with ancient trade routes and their adjacent settlements. We emphasize that comprehensive consideration of both tangible and intangible cultural resources and the establishment of diversified heritage corridors are essential for better preserving and transmitting the historical cultural heritage of ancient trade routes. Additionally, we highlight the pivotal role of trade routes in regional administrative management and strategic planning, providing valuable insights for related policies and practices.

Our conclusions not only offer valuable insights for research on similar trade routes and their surrounding settlements in other regions, such as the Spice Routes in the Arabian Peninsula and the trans-Saharan trade routes in Africa, but also serve as a reference for similar historical and geographical studies. Moreover, our methodology can be applied to other types of cultural heritage research, particularly those with temporal and spatial characteristics, such as cultural exchange routes, ancient hydraulic engineering, urban development evolution, and more.

5.2. Conclusions

To investigate the relationship between ancient trade routes and their surrounding settlements, this paper employed a combination of qualitative analysis and GIS spatial analysis. By examining temporal and spatial data, it explored the interrelationship between the ancient trade route—the Ancient Tea Horse Road—and the evolution of settlements in Dali Prefecture. By reconstructing the development of the ancient pathway and the progression of settlements, the study examined the impact of this geographical element on the genesis and development of historical settlements.

The conclusions of this study are as follows:

(1) The Ancient Tea Horse Road in Dali Prefecture evolved from a simple linear pathway into a complex radial network. From the Tang Dynasty to the Qing Dynasty, this trade route underwent several significant morphological transformations, gradually integrating and strengthening its connection with the Southwestern Silk Road. This showcases a dynamic development process under the mutual influence of trade demands and the geographical environment. It illustrates how the evolution of trade routes reflects broader socio-economic trends and adaptations to physical geographies, underscoring the fluid nature of trade and cultural exchange over time.

(2) The development of historical settlements is closely linked to the transportation network. Roads, postal stations, and defensive facilities together constructed a comprehensive national management and communication network, reflecting the Ancient Tea Horse Road's economic, political, and social functions in ancient China. This integrated network facilitated the spread of goods, ideas, and cultural practices across vast distances, significantly impacting settlement patterns, administrative efficiency, and the social fabric of communities along the route.

(3) The aggregation and migration of settlements in Dali Prefecture are closely related to the changes in the route of the Ancient Tea Horse Road, emphasizing the continuous role of the ancient path in promoting regional settlement development and interaction of human activities. The adaptability of human settlements to shifts in trade routes reveals the intertwined nature of human geography and economic imperatives, demonstrating how infrastructure, in the form of ancient trade routes, served as a catalyst for regional development, population distribution, and cultural exchange.

5.3. Limitations and Future Research

The study of ancient trade routes and their relationships with surrounding settlements faces challenges such as severe damage to the original routes and the absence of historical data. Settlement names, serving as key clues for understanding the historical background and reasons for evolution, offer a method to analyze settlement evolution from geographical and historical perspectives. This research, integrating GIS spatial analysis techniques with qualitative studies of settlement names, aimed to bridge this research gap. However, discussions are limited by the incompleteness of historical records and are based on the limited existing materials.

Future research could focus on comprehensive consideration of the tangible and intangible cultural heritage between the Ancient Tea Horse Road and its adjacent settlements, further revealing the interaction mechanisms between these heritages and the ancient route. Moreover, a deeper exploration of the impact of the routes of the Ancient Tea Horse Road and historical settlement aggregation points on modern transportation networks and urban layouts in Dali Prefecture would not only uncover more characteristics of the ancient path but also provide a scientific basis for the protection, inheritance, and development of ancient trade routes. Such studies not only hold geographical academic value but also offer important references for the management and planning of historical and cultural heritage.

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