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WebGIS-Based Geospatial Information Visualization of Ancient Villages Along the Long March Trail

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Abstract
This research employs GIS spatial analysis and historical archival methods to examine the distribution patterns and cultural significance of ancient villages along China’s Long March route (1934–1936). By developing a three-tier geospatial screening model, 150 core villages were systematically identified from a national inventory of 8,171 traditional settlements, establishing a multidimensional database integrating terrain features, ethnic compositions, and revolutionary event records. Spatial analysis reveals these villages’ critical role as unique spatial carriers of revolutionary history, demonstrating: terrain-adaptive distributions that facilitated military operations, multi-ethnic interactions preserving oral histories of soldier-civilian solidarity, and transhistorical overlaps with ancient military corridors. The study further proposes WebGIS-based digital narrative platforms to transform red heritage into interactive cultural resources. This integrated approach bridges historical geography and cultural heritage studies, providing empirical foundations for leveraging Long March legacy in rural revitalization through systematic preservation and innovative dissemination strategies.

1. Introduction

The Long March, undertaken by the Chinese Workers’ and Peasants’ Red Army from October 1934 to October 1936, was a strategic retreat led by the Communist Party of China to break through the encirclement of the Nationalist forces and preserve revolutionary strength. This monumental journey, from the southern revolutionary bases to the Shaanxi-Gansu revolutionary base, not only secured the Party’s northern expedition against Japanese aggression but also laid the foundation for its pivotal role in the Anti-Japanese War, ultimately forging the enduring spirit of the Long March. The military, political, and spiritual significance of the Long March has been extensively studied both domestically and internationally.

Reflecting on China’s revolutionary history, the success of the "encircling the cities from the countryside" strategy underscores the critical role of rural areas as the bedrock of revolution(Wang ZY,2023). These regions provided essential material support, manpower, and base-building resources for the revolutionary victory. As a key phase of this strategy, the Long March route was deeply embedded in the rural hinterland of China. Ancient villages—early settlements rich in historical, cultural, and natural heritage—serve as fundamental units oagrarian civilization and cultural carriers(Ministry of Housing and Urban-Rural Development of the People's Republic of China [MHURD], 2012)(Qi S and Shi L,2019). Along the Long March trail, these villages were not only vital nodes for rest, supply, and recruitment but also key spaces for interaction between revolutionary forces and local communities. Their spatial distribution reflects distinct natural and socio-historical patterns, creating a unique and valuable spatial-historical-social interplay when intersecting with the Long March.

Studying these ancient villages along the Long March trail holds multifaceted significance: historically, it reveals the mutual support between villages and the Long March, as well as the spread of revolutionary ideas; regionally, it aids in leveraging red culture and historical resources for rural revitalization; culturally, it explores how revolutionary spirit integrates with local traditions, and how digital technologies like WebGIS can transform these resources into interactive narratives, breaking the limitations of traditional displays and enhancing rural cultural vitality and social cohesion.

This study employs Geographic Information System (GIS) technology to analyze and visualize the spatial distribution of ancient villages along the Long March trail. By constructing a spatial database that integrates village locations, environmental parameters, cultural attributes, and Red Army activity trajectories, the research aims to:

First, uncover the spatial relationship between the Long March route and the natural-geographical environment; Second, visualize the coupling between major revolutionary events and specific natural-human environments; Third, explore systematic integration and innovative dissemination of red cultural resources in ancient villages, particularly through WebGIS-based interactive platforms that transform red heritage into dynamic digital narratives, serving rural cultural revitalization and social cohesion.

2. Literature Review

2.1 Research on the Long March Route

The study of the Long March route has evolved over decades, forming a research trajectory that begins with the interpretation of spiritual values and gradually expands into cultural heritage preservation and technological applications. Early research primarily focused on the historical shaping and cultural value of the Long March spirit, such as elucidating its threefold connotations—revolutionary struggle, route strategy, and resistance against nature (Shi ZQ, 2012). These studies laid the ideological foundation for Long March route research but often treated the route’s length and hardships merely as evidence of its spiritual significance, failing to examine the route itself as an independent research subject.

With the rise of cultural heritage preservation concepts, the holistic value and regional transformation pathways of the Long March route have gained attention. The areas along the route are predominantly "old revolutionary, ethnic, border, mountainous,

and impoverished" regions, characterized by harsh natural conditions, lagging economic development, and widespread poverty. In 2011, China actively promoted the application of the Long March route as a World Heritage Site. This initiative aims to leverage Long March cultural resources to plan and develop a cultural-economic corridor, alleviate regional poverty, and support rural revitalization. Following policy trends, scholars proposed systematic recommendations for "Long March route heritage nomination," conducting in-depth case studies to analyze the preservation challenges and urgency of heritage nomination for local red culture resources. They also suggested "planning and constructing a cultural-economic corridor along the Long March route to holistically preserve its heritage" (Wang Qiang et al., 2013)(Wang Qiang et al., 2014). Research on the Long March route gradually shifted from preserving historical memory to exploring cultural capital. However, Long March cultural resources remain fragmented and dispersed. For instance, studies on Long March relics suffer from insufficient historical documentation and theoretical support, making it difficult to establish an integrated framework and leading to unsystematic resource utilization practices (Pei RJ and Hu AH, 2023).

Recent technological advancements have spurred the rise of quantitative research on the Long March route. Examples include the development of a WebGIS-based geographic information system to visualize the spatiotemporal trajectory of the route (Qi MH et al., 2022) and the use of GIS to design ideological education case studies, enhancing the precision of route cognition through terrain analysis and spatial measurement (Xiong LY et al., 2021). While such studies improve the rigor of spatial representation, they predominantly focus on the impact of natural geography on military movements, neglecting the symbiotic relationship between the route and cultural landscapes.

To protect the Long March route as cultural heritage, it is necessary to address its complexity—"long distance, broad scope, and diverse involved communities" (Zhong LF and Zheng S, 2018). Current practices, however, overly emphasize landmark nodes while paying insufficient attention to grassroots cultural units such as ancient villages and ethnic settlements, which serve as "natural-cultural composite carriers," hindering the dynamic transmission of spiritual connotations.

In summary, current research on the Long March route follows an evolutionary logic of "spiritual interpretation—heritage preservation—technological application," yet these three dimensions lack effective integration: the exploration of spiritual values has not fully engaged with rural contexts, heritage preservation studies lack cross-scale resource consolidation, and technological applications prioritize natural spatial analysis over humanistic ecological dimensions. There is an urgent need for in-depth exploration of key spatial units, such as ancient villages, to bridge the current divide between natural and humanistic approaches in Long March route research.

2.2 GIS Research on Ancient Villages

Research on the geographic spatial distribution of ancient villages has become an important interdisciplinary field, with significant progress in understanding spatial patterns and influencing mechanisms at both macro and micro scales. At the macro level, nationwide studies reveal that ancient villages exhibit distinct spatial clustering, forming four high-density zones (Kang JY et al., 2016). At the micro level, research often focuses on case studies within specific cultural or topographic regions, such as the spatial evolution of ancient villages in Huizhou, driven by both patriarchal social structures and natural environments (Li JL et al., 2018).

Research on the geographic distribution of ancient villages has dynamically deepened over time. Early studies emphasized static pattern analysis of natural geographic factors, highlighting the foundational role of terrain elevation and river systems (Tong YQ, 2014). Mid-term studies incorporated socioeconomic factors to reveal the mechanisms linking these factors to the "marginalization" of ancient villages (Dou YD et al., 2015). Recent research has shifted toward technology-enabled preservation innovations, such as GIS-based platforms integrating spatial geographic information with intangible cultural heritage archives (Ren Y and Liu SJ., 2020), or using complex network analysis to construct village cluster preservation frameworks, emphasizing cross-village cultural node connectivity and network resilience (Wang H et al., 2025).

However, current research on the geographic distribution of ancient villages has limitations: First, it often focuses on static spatial patterns or generalized cultural characteristics, rarely adopting a dynamic approach centered on major historical events. Second, humanistic historical studies of ancient villages prioritize clan culture or feng shui site selection, overlooking the relationship between modern revolutionary history and village spatial evolution. Third, there is insufficient exploration and integration of red resources, as the "red legacy" embedded in ancient villages has not been incorporated into cultural landscape value assessment systems or effectively utilized.

Studying the geographic distribution of ancient villages along the Long March route can fill the gap in "event-oriented" village research, revealing the interaction between revolutionary historical processes and settlement spatial patterns while challenging traditional "spatial determinism" perspectives. Moreover, it can provide scientific foundations for the systematic preservation of revolutionary relics and reference for delineating cultural heritage protection zones. In terms of cultural transmission, it can expand the value recognition of ancient villages along the Long March route, uncover integrated cultural value development, and promote the coordinated revival of material spaces and spiritual cultures in rural revitalization.

3. Data Modelling and Geospatial Filtering Methodology

3.1 Data Foundation and Screening Model

This study utilizes the *List of Chinese Traditional Villages* (2012–2019, six batches) published by the Ministry of Housing and Urban-Rural Development as the spatial data foundation, encompassing 8,171 ancient villages. Historical records from *the Historical Archives of the Chinese Workers’ and Peasants’ Red Army’s Long March* were incorporated to construct a three-tiered geospatial screening model.

Firstly, using vector data of the Long March route and county-level administrative boundaries, 261 core counties traversed by the Red Army (including the First, Second, and Fourth Front Armies, as well as the 25th Army) were identified. Secondly, from these counties, 1,527 potentially associated ancient villages were extracted. Finally, through cross-referencing local chronicles and archival materials, a high-precision geodatabase of approximately 150 core villages was established. Attributes include spatial coordinates, ethnic distribution, troop passage records, and elevation ranges.

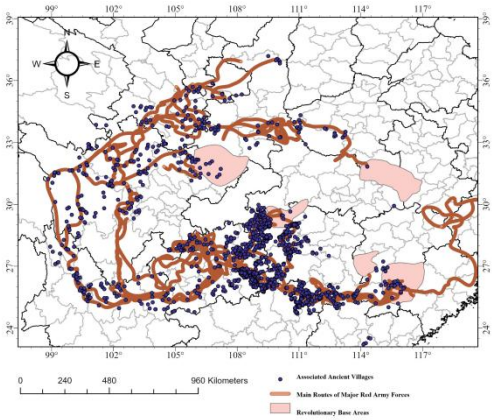

Figure 1. Distribution Map of Potential Associated Ancient Villages.

3.2 Geospatial Technical Workflow

The study employed ArcGIS for three key analytical modules:

3.2.1 Spatiotemporal Visualization Module: Dynamically reconstructs the Red Army’s marching routes. Integrates an interactive timeline (1934–1936) for querying village distributions.

3.2.2 Spatial Correlation Analysis Module: Examines clustering patterns of the 1,527 villages along the marching paths. Analyzes elevation-based distribution differences among core villages.

3.2.3 Layered Map Overlay Module: Combines historical elements (e.g., regimental-level battles, key events) with terrain layers (e.g., grasslands, mountain crossings). Overlays historical maps with coordinate data to contextualize major Long March events.

4. Construction of Spatiotemporal Analysis Framework

4.1 Multi-Source Data Integration Framework

The study integrates four core datasets:

4.1.1 Spatial Coordinates of Ancient Villages: from *List of Chinese Traditional Villages.*

4.1.2 Long March Route Vector Data: from historical atlases in the Historical Archives.

4.1.3 Historical Event Records: major battles, strategic decisions from provincial archives like *The Long March in Sichuan*.

4.1.4 Local Chronicles: from *Gazetteer of Aba Prefecture; The Red Army’s Long March in Aba* for cross-verification.

4.2 Spatiotemporal Analytical Workflow

A four-tiered approach was adopted:

4.2.1 Spatial Anchoring: County association → buffer analysis → archival validation to pinpoint core villages.

4.2.2 Pattern Analysis: Terrain-based evaluation of village distribution constraints (e.g., outputting comparative elevation profiles for different army routes).

4.2.3 Feature Extraction: Data annotation of village attributes (ethnicity, dynastic origins, battle associations) using local historical records.

4.2.4 Application Output: Generating digital narratives (e.g., interactive route-village correlation maps, strategic stronghold clusters) via WebGIS.

5. Spatial Distribution Patterns and Influencing Mechanisms

5.1 Natural Distribution: Terrain Constraints and Adaptations

The spatial distribution of ancient villages reflects the interplay between the Long March route and natural geography, as well as military-civilian interdependence.

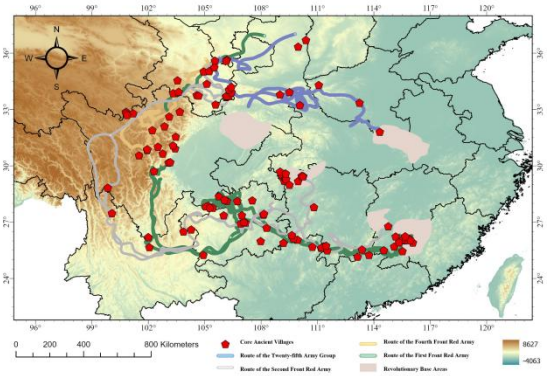

Figure 2. Topographic Map of the Main Route of the Red Army Through Core Ancient Villages.

5.1.1 Early Long March Phase: Prior to the Xiangjiang Campaign, 42.3% of the associated ancient villages were concentrated in the Jiangnan Hills and Nanling Mountains. This region features hilly terrain and karst peak-cluster depressions at elevations of 200-500 meters. Villages predominantly clustered in mountain basins and river valleys. The dense river networks and steep Wuling Mountains formed major geographical barriers. These terrain features slowed troop movement, leading to encirclement situations.

In low-elevation fragmented terrain like the Xiangjiang River basin, forces heavily relied on waterway passages and concealed basins. Most villages in this area were located at valley passes, serving as critical waypoints. For instance, Jieshou Town in Xing'an County, Guangxi - a commercial hub since the Han Dynasty - became the crucial ferry point where the Central Red Army (including the First and Second Front Armies) established their crossing headquarters in November 1934. During the campaign, enemy bombing repeatedly destroyed the pontoon bridges. Local villagers proactively dismantled doors and building materials to assist bridge repairs, playing a pivotal role in ensuring the successful river crossing.

5.1.2 Middle Long March Phase: Entering the Yunnan-Guizhou Plateau and Hengduan Mountains, 43.4% of associated villages were mainly distributed across karst (flatlands) and deep-cut valleys. Extreme elevation variations characterized this region. Critical events like the Grassland Crossing and Four Crossings of the Chishui occurred here. The harsh environment posed severe survival challenges.Troops frequently utilized wind-sheltered valley villages for temporary rest. Local communities provided essential supplies. This zone recorded the highest number of direct Red Army-village interactions. Extensive oral histories document friendly exchanges between soldiers and ethnic minorities. In July 1935, the Fourth Front Army reached Heishui County in Sichuan's Aba Tibetan-Qiang Autonomous Prefecture. Here they convened the Luhua Conference, where grain procurement for the upcoming grassland crossing was a key agenda item. Effective ethnic policies secured Tibetan support - local gazetteers record approximately 7.1 million jin (3,550 metric tons) of grain collected, ensuring logistical capacity for the arduous trek ahead.

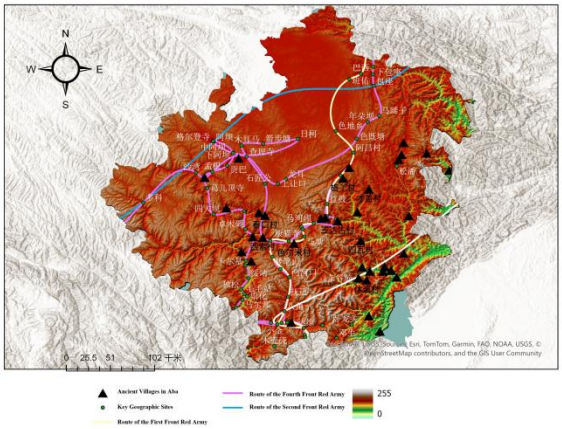

Figure 3. The Red Army Route in Aba Prefecture, Sichuan Province and Surrounding Traditional Villages.

5.1.3 Late Long March Phase: After crossing the Qinling Mountains, 14.3% of associated villages were principally located on the Loess Plateau and Liupan Mountain foothills. The characteristic loess landforms of yuan (tablelands), liang (ridges) and mao (knolls) formed core settlement zones. Severe aridity significantly challenged troop movements.Village distributions clearly reflected strategic nodal functions. Around Huining County - the reunion site for main forces - 18 villages radiated outward, demonstrating its geographical centrality. This settlement pattern also provided natural defensive positions for subsequent campaigns like the Shanchengpu Battle.

Identification of Core Ancient Villages and Their Natural Distribution Significance: Through systematic review of local gazetteers, archival documents, and field surveys, this study rigorously filtered the preliminary database of associated villages, ultimately identifying approximately 150 core ancient villages with definitive historical connections to the Long March. The selection criteria were as follows: villages must have reliable documentary evidence confirming that Red Army troops passed through during the Long March and engaged in substantive interactions with local villagers, such as material supply, medical aid for wounded soldiers, or guidance support. Alternatively, villages must have been utilized for military activities at specific natural or cultural sites, such as ferry crossings, mountain passes, ancestral halls, or caves.

The spatial distribution and elevation variations of these core villages serve as empirical evidence of how the natural geographic environment both constrained and supported the Long March route in distinct phases. The Central Red Army (including the First and Second Front Armies) traversed the longest and most topographically diverse route, transitioning from low hills to the Yunnan-Guizhou Plateau in a step-like progression. Similarly, the later route of the Fourth Front Army through the high-altitude, oxygen-deprived northwestern Sichuan plateau to join forces in southern Gansu is clearly reflected in the geographic data of these core villages.

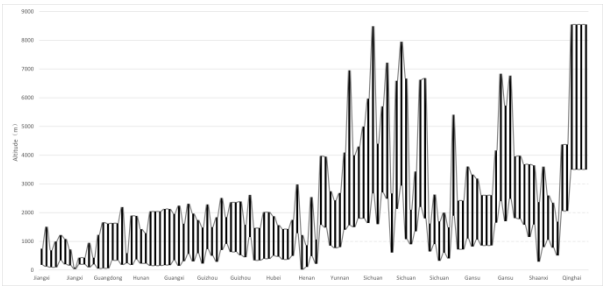

Figure 4. Distribution of Altitude Differences in Core Villages.

5.2 Humanistic Distribution Characteristics: The Historical Legacy of Military-Civilian Interaction

The spatial distribution of ancient villages along the Long March route is not only shaped by natural conditions but also deeply rooted in specific cultural and historical contexts. These villages serve as carriers of military-civilian interaction, historical military geography, and cultural memory.

5.2.1 Multi-Ethnic Military-Civilian Interaction: The distribution of ethnic minority settlements along the Long March route bears witness to the integration of Red Army forces with local communities during their strategic retreat. The route encompasses traditional villages of over 20 ethnic groups, which became critical nodes of civilian support for the Red Army. For example, Banqian Village in Banma County, Sichuan, a traditional Tibetan settlement, provided guides and grain supplies to the Red Army. The surviving sentry posts and Red Army slogans in the village stand as important material testaments to the Long March in southern Qinghai.

The stories of the Long March have become an inseparable part of the historical narrative in these villages, particularly in the mid-phase crossing of the Yunnan-Guizhou Plateau and Hengduan Mountains. Extensive oral histories document widespread friendly interactions between Red Army soldiers and local ethnic minorities, further enriching this legacy.

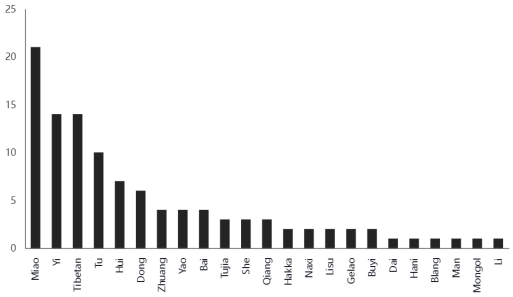

Figure 5. Statistical Chart of Minority-Inhabited Villages in Core Villages.

5.2.2 Spatial Overlap of Historic Military Strongholds: By analyzing statistical data on major battles at division level and above during the Long March, this study identified 62 counties where key battles occurred, encompassing 304 traditional villages within their territories. Cross-analysis of historical battle data in these strategically important counties revealed significant spatial overlap between critical Red Army combat zones and ancient military strongholds, highlighting the enduring strategic value of specific geographic units across extended military history. For instance, the "Yinping Ancient Path" used for surprise attacks during the Three Kingdoms period in Wen County, Gansu, nearly coincides with the Fourth Front Army's 1935 tactical route through Motian Ridge - both utilizing the steep gorges of the Qinba Mountains for covert maneuvers. Similarly, Jingning County, site of both the Song Dynasty's "Jingning Fortress Battle" and the Long March's "Jieshipu Rendezvous," demonstrates how the loess ridge terrain of the Liupan Mountains' eastern foothills provided natural defensive advantages for both ancient fortress systems and Red Army assembly positions. This trans-dynastic military geographic overlap suggests that Long March route selection incorporated not only immediate tactical considerations but also latent references to historical military geography.

Province	County	Number of Traditional Villages in the County	Name of Historical Battle	Dynasty of Historical Battle
Henan	Xichuan	1	Battle of Danyang	Warring States Period
Shanxi	Xiangfen	1	Battle of Hexi between Wei and Qin	
Shaanxi	Shangzhou	2	Battle of Danyang between Qin and Chu	
Hunan	Yuanling	22	Ma Yuan's Expedition against the Wuxi Barbarians	Han Dynasty
Gansu	Wen	7	Stealth Crossing at Yinping	Three Kingdoms
Jiangxi	Gan	5	Sun Wu's Pacification of Shanyue	
Sichuan	Jiange	1	Battle of Jiange Path	
Sichuan	Zhaohua	13	Battle of Jiameng Pass	
Sichuan	Jiangyou	1	Battle of Jiangyou Pass	
Gansu	Lintan	6	Battle of Taozhou	Tang Dynasty
Gansu	Jingchuan	2	Battle of Jingzhou	
Shanxi	Shilou	3	Battle of Shilou	
Shanxi	Lishi	3	Battle of Lishi	
Shaanxi	Lantian	1	Battle of Lantian Pass during the An Lushan Rebellion	
Sichuan	Mao	3	Battle of Weizhou	
Sichuan	Songpan	7	Battle of Songzhou	
Sichuan	Hanyuan	4	Battle of Qingxi Pass	
Sichuan	Yingjing	2	Nanzhao's Invasion of Shu	
Yunnan	Xiangyun	8	Battle of Taihe City during the Tianbao War	
Gansu	Huating	1	Battle of Huating Fort	Song Dynasty
Gansu	Jingning	2	Battle of Jingning Fort	
Ningxia	Longde	7	Battle of Haoshui River	
Ningxia	Haiyuan	1	Battle of Xi'anzhou	
Ningxia	Xiji	1	Battle of Shicheng and Dexing Village Mutiny	Ming Dynasties
Guangxi	Guanyang	32	Battle of Guanyang against Qing	Ming Dynasty
Guangxi	Quanzhou	16	Battle of Quanzhou	
Guizhou	Dafang	2	Battle of Shuixi	
Guizhou	Shiqian	22	Shiqian Miao Uprising	
Hunan	Cili	1	Tan Lu Uprising	
Shanxi	Xiaoyi	9	Liu Liu and Liu Qi Uprising	
Sichuan	Qingchuan	6	Battle of Qingchuan during Li Zicheng Uprising	
Sichuan	Mingshan	1	Zhang Xianzhong's Attack on Mingshan	
Guizhou	Yuping	2	Yuping Dong Uprising	Qing Dynasty
Hunan	Jingzhou	1	Qian-Jia Miao Uprising	
Sichuan	Beichuan	2	Jinchuan Campaigns	

Table 1. Historical Battle Statistics of Major Campaigns of Units Above the Regimental Level in the Long March Region.

5.2.3 Deep Value of Red Cultural Relics: Systematic documentation of red cultural relics in traditional villages along the Long March route through open platforms has revealed numerous underutilized historical resources. Beyond protected conference sites and memorial facilities, these villages preserve a precious material testaments network including bullet marks and temporary fortifications in residential buildings, daily artifacts evidencing military-civilian interaction (such as farming tools and medical equipment gifted by the Red Army), and landmark landscapes bearing collective memory. The full value of these physical remains remains underdeveloped, requiring deeper integration with local oral histories and folk legends. Currently, while abundant, these oral accounts remain fragmented and need creative synthesis with villages' inherent architectural techniques, festival customs, and artisanal traditions. Transforming Long March relics into tangible, interactive cultural resources and embedding collective memories into village production and life networks can authentically achieve symbiotic development of red heritage transmission and rural revitalization.

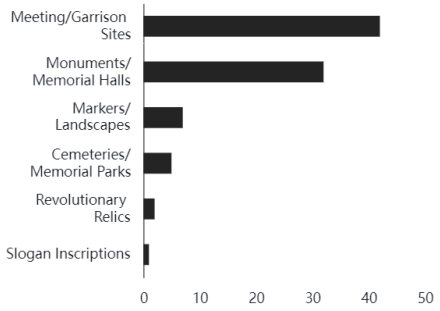

Figure 6. Statistical Chart of Physical Remnants of the Long March in Core Villages.

6. Outcomes and Impacts

The ancient villages along the Long March route constitute unique spatial vessels of revolutionary history, blending the Long March spirit, military geographic wisdom, and profound rural traditions into a cultural landscape interwoven with revolutionary, traditional and natural elements. Their irreplaceable value lies in perpetuating red heritage, revitalizing rural culture, and boosting regional development. These villages exhibit striking natural-geographic and cultural-historical composite characteristics that underscore specific geographic units' enduring strategic military value across time. However, current research and conservation efforts face challenges including insufficient spatial correlation studies, inadequate cultural integration, and resource fragmentation.

Studying these villages' composite spaces carries multifaceted significance: it transcends geographical determinism by constructing a dynamic framework for understanding historical events' interaction with geographic environments and village societies; treats red relics and traditional villages' architectural/folk culture as organic wholes to form living heritage networks. Essentially products of revolutionary history deeply embedded in traditional rural spaces, these villages' preservation must balance natural foundations with cultural accumulation, revolutionary narratives with local contexts, and heritage conservation with innovative development. This provides comprehensive theoretical perspectives integrating spatial carriers, historical memory, and community transmission

for understanding and preserving linear cultural heritage like the Long March.

Study limitations include: the core village database's coverage and precision require enhancement; the universality of spatial analysis-based cultural integration models across different village types needs further case validation; and digital storytelling depth and community participation demand continuous strengthening. Future work will expand data collection, deepen interdisciplinary integration, and optimize technical applications to better achieve long-term goals of coordinated natural-human development in Long March route villages.

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