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ORIGINAL ARTICLE

Research on the Spatial Layout of Military Defense System in Zhuanglangwei Defense Zone of Gansu Town in the Ming Dynasty

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ABSTRACT

The Zhuanglang Defense Area is the geographical area of the Zhuanglang Road Defense Area under the jurisdiction of Gansu Town of the Ming Great Wall. It forms a circular defense against external invasion with the northwest Liangzhou Defense, the southwest Xining Defense Area, and the east Lanzhou Defense. Due to the strategic position and geographical advantage of the defense area, it forms a unique spatial structure and layout characteristics of the Great Wall defense system. By using GIS methods such as elevation analysis, neighbour analysis, density analysis, surface cost analysis, and shortest path analysis, this study explores the spatial characteristics of military settlements in the Zhuanglangwei defense area, revealing their spatial structure, geographical location, and influencing factors, providing a theoretical basis for the protection of historical relics in the Zhuanglangwei area.

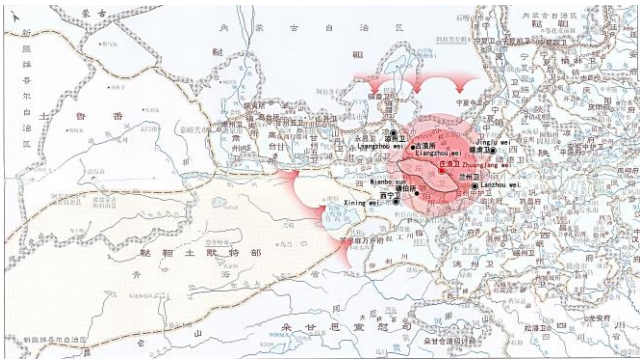
INRODUCTION

1. Military geographical location of Zhuanglangwei defense zone

The geographical location of zhuanglangwei is recorded in history as follows: "……Zhuanglangwei is located east of the Yellow River and serves as the gateway to Lanzhou to the west. It is situated at an important location in Gansu Town and is very convenient to reach Ningxia Town and Jinglu Guard..." Liang Fen et al. (1987). Whether it is to Lanzhou, Liangzhou or Xining, the distance to Zhuanglangwei is moderate and can effectively control the close-range areas of Hezhou. "Zhuanglang Huiji" mentioned: "Zhuanglangwei is located at the head of the fortress in the Hexi region. It was Yunwu County during the Han Dynasty and Guangwu County during the Former Liang Dynasty...". During the Ming Dynasty, the Mongol and Turpan forces were always the two major border troubles in Gansu Town (see Figure 1). As the eastern gateway of Gansu, the Zhuanglang region was heavily plundered multiple times during the Tian Shun period (1457-1464) and later during the Chenghua and Hongzhi periods, resulting in fierce battles between the two sides Ma Zhengyun et al. (2013).

In the early Ming Dynasty, during the initial zoning defense of Gansu Town, in the fifth year of Hongwu (1372), the Gansu Guard Commander's Office and the Zhuanglang Guard Commander's Office were first established with the aim of resettling the former Yuan surrendered generals. In the seventh year of Hongwu (1374), Zhuanglangwei was built. During the Jianwen period, Wei was renamed Qianhu Suo, and in the first year of Yongle, it was renamed Wei. In the same year, the Xi'an Xingdu Commander's Office was established in Hezhou, and in the eighth year of the Hongwu reign, it was renamed the Shaanxi Xingdu Commander's Office. After several young troubles, the Xingdu Bureau was reinstated in Zhuanglang (now Yongdeng) in the twelfth year of Hongwu (1379).

Figure 1: Zhuanglangwei Circular Defense Diagram



(The bottom map is sourced from the<Atlas of Chinese Cultural Relics (Gansu Branch)>Historical Map of Gansu Province during the Ming Dynasty)

With the relocation of the administrative center of Shaanxi Xingdu from Hezhou to Zhuanglang, it proved that the Ming court was determined to strengthen the management of the Hexi and Xining regions, and to

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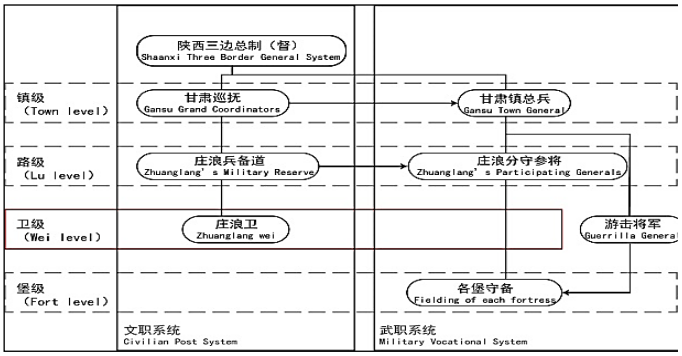
isolate the possibility of Tibetan and Tibetan alliances. It not only strengthened the military presence of the Ming army, but also effectively controlled the Hexi region. Although Ganzhou was later relocated to become the administrative center of Shaanxi Xingdu Si, the initial establishment of the administrative center in Zhuanglang during the Hongwu period was also a symbol of the initial construction of a military town in Gansu Town Liu Jianjun et al. (2013), Liu Biqiao et al. (2012) (see Figure 2).

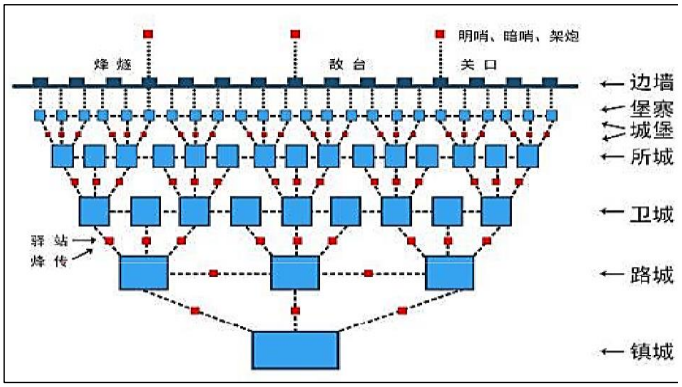
Figure 2: Hierarchical Structure of Border Town



Sorting out the Military Defense System of Zhuanglangwei

The academic research on the military defense system of the Ming Great Wall has gradually formed a system, dividing the military system of the Ming Great Wall into six levels, namely the end facilities such as Lucheng—Weicheng—Suocheng—Baocheng— Beacon towers. (See Figure 3).

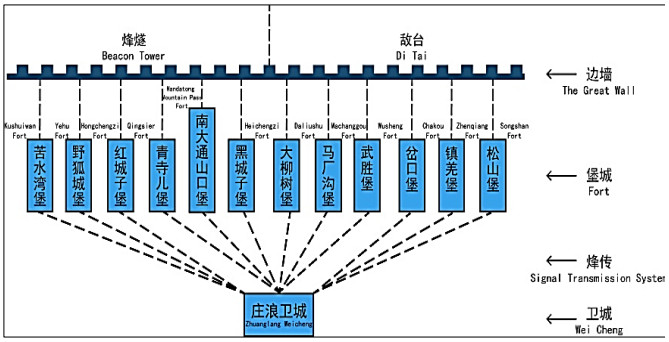
Figure 3: The military defense system hierarchy of the Great Wall



(Source: Lingyu Xu "Comprehensive Protection Strategy for the Military Defense System of the Ming Great Wall" Xu Lingyu et al. (2018))

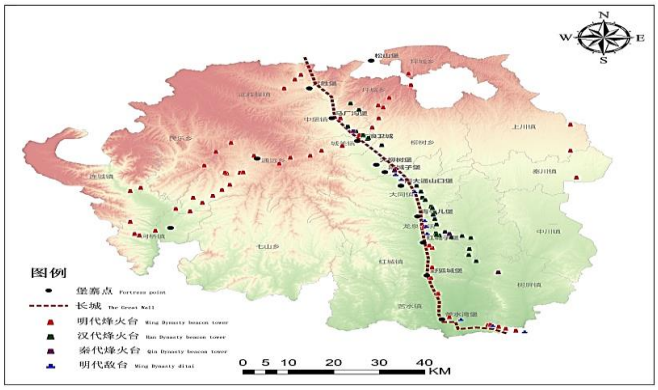
However, for military defense systems with different regions, not all of these six levels are included. Therefore, the military defense system of the Zhuanglang Garrison only includes the Acropolis, Fortress, as well as terminal facilities such as beacon towers and enemy towers (see Figure 4). According to the " Zhuanglangwei stretches 3000 kilometers from the Zhongwei border in Ningxia to the east, 80 kilometers from the Xining border to the west, 115 kilometers from the Lanzhou border to the south, 70

Figure 4: The military defense system hierarchy of Zhuanglangwei (self-drawn)



kilometers from the Gulangsuo border to the north,125 kilometers from the Ba Sha border to the northeast, 70 kilometers from the Heichuan border to the southeast, 150 kilometers from the Bazhou border to the southwest, 130 kilometers from the Xueshan border to the northwest, and 465 kilometers from the Gansu town." Most areas today are located in the Yongdeng area. "Village Six... Camp Seven... Forts Twenty-Eight... Passes Thirty-Two... Piers Eighty-Five... Trenches One" (see Figure 5) Zhang Yu et al. (1968). The fortresses and passes do not match the actual jurisdiction of the garrison, for example, Shajing'er Fort should be under the jurisdiction of Lanzhou garrison.

Figure 5: Hierarchy diagram of Zhuanglangwei defense system (self-drawn)



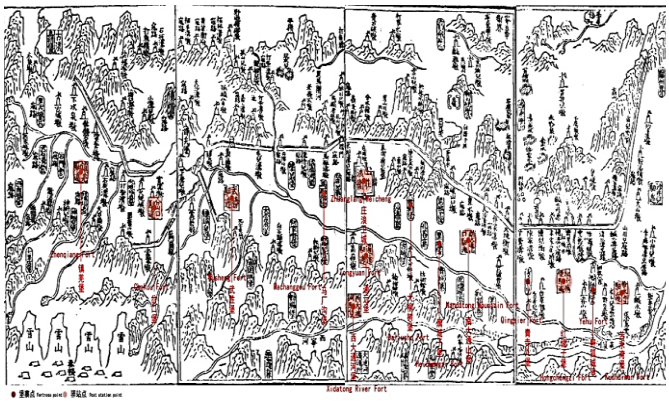
Zhuanglangwei Great Wall Body

The Great Wall built by the Ming Dynasty in Gansu was divided into two side walls: the south wall and the north wall. The southern wall is the starting point of the southern connection between Guyuan Town and Gansu Town. At the same time, it is divided into two routes, one of which is the main line: starting near Yanchangbao Street in Anning District, heading west along the Yellow River, entering Yongdeng territory, heading northwest along the west bank of Zhuanglang River, entering Gulang, and finally reaching Wuwei City. This route is not only the western route of the Ming Great Wall in Gansu, but also known as the North Bank Great Wall. Liu Jianjun et al. (2013), Li Chenbo et al. (2021), Zhang Caiyun et al. (2019), Ai Chong et al. (1990) adopted the traditional method of "blocking according to danger", adapting measures to local conditions and using materials locally.

Zhuanglangwei Relay System

Gansu Town has a narrow strip distribution from southeast to northwest in its defense area, so the main transportation lines are mostly distributed around the inside and outside of the Great Wall. Due to limited terrain, there are fewer branch roads. It can be roughly divided into five sections: Lanzhouwei-Liangzhou section; Extend a branch post road from Liangzhou to the northeast direction; Liangzhou - Zhencheng; The post road from Zhencheng to Jiayuguan in Suzhou and from Zhuanglangwei to Xiningwei. Among them, the road from Lanzhou to Jiayuguan is the lifeline of transportation in Gansu, which is related to the survival of Gansu town. Secondly, complex terrain is also a reason for the shortage of roads, so Lanzhou to Jiayuguan is an important road that runs through the Hexi Corridor. There are a total of thirteen post stations and delivery stations in the Lanzhou Liangzhou section. Shajing'er Post, Kushuiwan Post, Hongchengzi Post, Nandatong Shankou Post, Zhuanglangwei Zaicheng Post, Wusheng Post, Chakou Post, Zhenqiang Post, Heisonglin Post, Gulangzaicheng Post, Jingbian Post, and Liangzhou Wei Zaicheng Post. Among them, the stations belonging to Zhuanglangwei include Kushuiwan Station, Hongchengzi Station, Nandatong Shankou Station, Zhuanglangwei Zaicheng Station, Wusheng Station, Chakou Station, and Zhenqiang Station. In addition, there are nine post stations, including Tongyuan Post and Datonghe Post. Due to the fact that most of the post stations are built inside the fortress, this type of post station is also known as the urban post station (see Figure 6).

Figure 6: Distribution of Zhuanglangwei Fortress and Post Stations



(The bottom map originates from "Border Political Examination: Zhuanglang Map Volume 4")

In addition to post stations, post delivery systems also include delivery stations and express delivery shops. Delivery to all Red Chengzi Delivery Stations, Datonghe Delivery Stations, Zhuanglang Delivery Stations, Tongyuan Delivery Stations, Wusheng Delivery Stations, and Zhenqiang Delivery Stations. Urgent delivery shop has found two shops, Dianzi and Ziping, after reviewing the materials Peng Wei et al. (2020).

The site selection of post stations and delivery stations in the northwest region is also based on the post stations on the ancient Silk Road, combined with the location of the Great Wall defense line and military fortress settlements, setting up an important passage that can accommodate the army, store food, and conduct trade and mail. Therefore, post stations and delivery stations were mostly combined with military bases and the Great Wall Line, horizontally distributed in various areas of the Ming Dynasty border. The distribution of express delivery shops is mainly centered around the total shops in various states and counties, radiating in all directions and penetrating into the interior, connecting the nine border roads and the interior roads. Therefore, express delivery shops are mostly set up in states, counties, and villages according to the principle of "ten miles, one store", forming a vertical distribution network that radiates across the country, connecting the nine-border postal system with the mainland postal system, and laying the foundation for the subsequent development of postal transportation.

Zhuanglangwei Signal Transmission System

The signal transmission system has always been an indispensable part of the military defense system. When divided, it forms a unique faction, and when combined, it weaves into an invisible network, integrating various parts together to form a complete military defense system. More than fifty beacon towers in the Yongdeng area constitute the main body of the signal transmission system. As an indispensable vertical axis in the military defense system of the Great Wall, it appears from a distance on an unknown mountain. The beacon towers along the Great Wall in Yongdeng area are often built on mountaintops and are densely constructed, closely related to the local special terrain.

The beacon towers of Zhuanglangwei are mostly located along the Great Wall and in the northern part of Zhuanglangwei, totaling dozens of locations. In addition to the Ming Dynasty, there are also a large number of beacon tower sites from the Yuan, Song, Qin, and Han dynasties, indicating the military importance of the Zhuanglangwei region. Due to different geographical locations, it can be divided into four types: within the Great Wall defense line; Beyond the Great Wall defense line; Piers and abutments along the edge; Internal piers and abutments.

In addition, the piers and abutments in the Zhuanglangwei area are divided into two types: Bingdun and Tiandun. Bingdun is not only the most common type of beacon, but also used for border defense to convey military information. Bingdun is often built on the top of mountain ridges, with the highest point on the mountaintop, providing a broad view and facilitating the transmission of information. The other type of Tiandun, although also intended to convey messages, has a different audience.

Bing Dwen serves as a reminder to the military, while Tian Dwen serves as a reminder to ordinary people. Although the terrain of Zhuanglangwei is complex and easy to defend, it still cannot cover all areas, and there are ultimately many areas that are safe to defend. The setting of Tiandun can enable the people to protect themselves to the greatest extent possible. When encountering foreign invasions, beacon fires are lit in various Tiandun to transmit messages. The people can carry livestock to hide inside Tiandun, achieving the effect of clearing the wilderness Li Chenbo et al. (2021).

Zhuanglangwei Military Settlement

Zhuanglangwei has a total of fifteen castles, all of which are military fortresses located along the Great Wall (see Table 1) Liu Jianjun et al. (2013), Zhang Yu et al. (1968). Due to the unknown specific construction dates of Tongyuan Fort and Xida Tonghe Fort, they are temporarily not included in the statistics.

In addition to hierarchical divisions, there are also many defensive fortifications called "guan" in the military settlements of the Great Wall. In ancient Chinese, "guan" refers to the guard positions set up in dangerous areas or national borders.

In the Great Wall system, these "passes" are usually distributed in settlements with steep terrain or transportation routes, while smaller ones are called "mouths", "Chong", and "Ai", corresponding to lower-level military settlements of the Great Wall. (See Table 2)

Table 1: Statistical Table of Zhuanglangwei Fortress Data (Self drawn)

Name	Establishment time	Number of Soldiers and Horses	Type of Official	Settlement Pattern
Kushuiwan Fort	In the 13th year of the Hongwu reign of the Ming Dynasty（1380）	300 government troops and 2 horses	One stationed defense officer	Fort
Yehu Fort	During the Hongwu period of the Ming Dynasty	200 government troops and 2 horses	One stationed defense officer	Fort
Hongchengzi Fort	In the second year of Hongwu in the Ming Dynasty（1369）	400 government troops and 4 horses	One stationed fielding	Fort
Qingsier Fort	During the Hongwu period of the Ming Dynasty	200 government troops and 1 horse	One stationed defense officer	Fort
Nandatong Mountain Pass Fort	During the Hongwu period of the Ming Dynasty	200 government troops and 2 horses	One stationed defense officer	Fort
Heichengzi Fort	During the Hongwu period of the Ming Dynasty			Fort
Daliushu Fort	During the Hongwu period of the Ming Dynasty			Fort
Zhuanglang Weicheng	In the tenth year of the Hongwu reign of the Ming Dynasty（1377）	3069 government troops and 1257 horses	One resident magistrate	Weicheng
			One member of Canjiang	
Machanggou Fort	During the Hongwu period of the Ming Dynasty			Fort
Wusheng Fort	During the Hongwu period of the Ming Dynasty	400 government troops and 88 horses	One stationed defense officer	Fort
Chakou Fort	During the Hongwu period of the Ming Dynasty	328 government troops and 15 horses	One member of the stationed commander in chief	Fort

Zhenqiang Fort	In the 26th year of the Wanli reign of the Ming Dynasty（1598）	765 government troops and 128 horses	One stationed fielding	Fort
Songshan Fort	In the 27th year of the Wanli reign of the Ming Dynasty（1599）			Fort

Table 2: Statistical Table of Zhuanglangwei Pass Data (Self drawn) Zhang Yu et al. (1968)

Name	Distance(meters)	Current location
Huoshigou Pass	55000	Huoshigou Village, Tianzhu Tibetan Autonomous County, Gansu Province
Shimen Pass	40000	Shimenggou Village, Yongdeng County, Gansu Province
Longba Pass	30000	
Jiugucheng Pass	35000	Gucheng Village, Yongdeng County, Gansu Province
Manling Pass	60000	Manlinggou in Yongdeng County, Gansu Province
Ahibangou Pass	65000	Shibangou in Yongdeng County, Gansu Province
Shihuigou Pass	12500	Shihuigou Village, Tianzhu Tibetan Autonomous County, Gansu Province
Pugou Pass	7500	Pujiagou Kouzi, Yongdeng County, Gansu Province
Machanggou Pass	5000	Machanggoukou, Yongdeng County, Gansu Province
Shuicaogou Pass	3000	Shuicaogou Village, Yongdeng County, Gansu Province
Chenjiagou Pass	10000	Chenjiagou, Yongdeng County, Gansu Province
Poshan Pass	15000	
Sunjiagou Pass	20000	Sunjiagou in Yongdeng County, Gansu Province
Qingshuigou Pass	40000	Qingshuigou in Yongdeng County, Gansu Province
Xianshuigou Pass	70000	Xianshuigou, Xigu District, Lanzhou, Gansu Province
Limayugou Pass	95000	
Huangcaochong Pass	50000	Huangcao Village, Tianzhu Tibetan Autonomous County, Gansu Province
Dujiashagou Pass	25000	Dujiazhuang Village, Gulang County, Gansu Province
Bailingou Pass	35000	Zhulin Gully, Yongdeng County, Gansu Province
Xishagou Pass	25000	Xigou, Yongdeng County, Gansu Province
Qiaoshanggou Pass	15000	Qiaoshangou, Yongdeng County, Gansu Province
Dachaigou Pass	14000	Dachaigou Village, Tianzhu Tibetan Autonomous County, Gansu Province
Shifoshan Pass	12500	
Huangxuergou Pass	2500	
Shuangdiangou Pass	3500	Shuangchagou in Yongdeng County, Gansu Province

Zhichonggou Pass	1500	Zhichonggou in Yongdeng County, Gansu Province
Datongshan Pass	17500	
Datongshagou Pass	15000	Shagoukou, Yongdeng County, Gansu Province
Hongchenggou Pass	35000	Caogou, Yongdeng County, Gansu Province
Chuanyagou Pass	50000	
Sahnchuan Pass	85000	

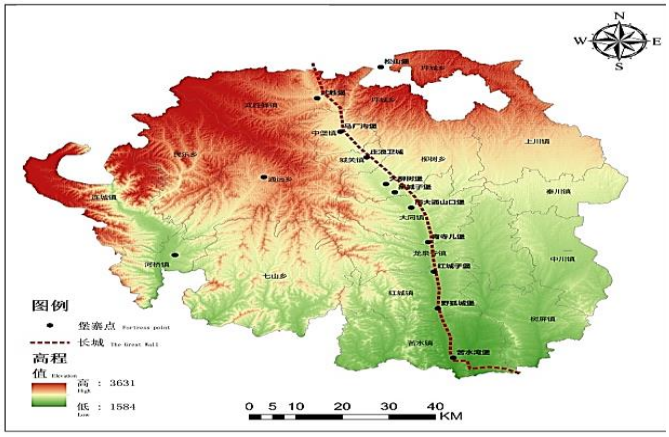
RESULTS

The geographical location characteristics of military settlements

Site selection characteristics under the influence of terrain and landforms

The Zhuanglangwei Great Wall is built along the eastern side of the Zhuanglangwei River basin, with an average elevation of around 2100 meters (see Figure 7), and there is no construction along the eastern foothills (see Table 3).

Figure 7: Elevation Analysis of Zhuanglangwei (Self drawn)



The reason for this situation is that the cost of constructing the Great Wall needs to be considered first. To reduce the maintenance cost after the completion of the Great Wall, materials can be sourced locally near the river valley. Secondly, due to the continuous foothills on the east side, with an average slope between 14 and 26 degrees, it is not convenient for the enemy to launch large-scale attacks, so there is no need to deliberately build at high altitudes. In addition, due to the large amount of rainstorm in summer in Gansu, the vertical erosion of rainwater is likely to cause large and small gullies on the wall of the Great Wall, which will be washed away over time. Therefore, the construction of the Great Wall in the Zhuanglang Defense Zone is located in the valley area by the Zhuanglang River, in accordance with the principle of "adapting to local conditions" layout.

Meanwhile, due to the unique geographical location of Zhuanglangwei, a special type of fortress has evolved - "Zaichengyi". For example, Hongchengzi Station, Kushuiwan Station, Yehu Station, Wusheng Station, etc. Especially in military fortresses built in mountainous areas, the location of Wushengyi Fortress should be as close as possible to the gap between the two mountains. These mountain passes are usually the main routes for enemy attacks. When building military fortresses in mountainous areas, it is generally advisable to choose valleys with open and flat terrain, which is both convenient for construction and garrison. The Wusheng Yibao under the jurisdiction of Zhuanglang Road in Gansu Town is located in the valley area of Zhuanglangwei (see Figure 8). The East West is a towering mountain range composed of Magpie Ridge, Jiguan Mountain, etc. The Zhuanglang River flows through the valley from north to south, forming a natural passage and an important gateway to Lanzhou. In the early Ming Dynasty, Feng Sheng achieved a great victory here, so he built Wusheng Fortress and set up a post station inside the fortress, dispatching a large number of troops to garrison. Wushengyi fort is built at the widest point of the Zhuanglang River Valley, with a distance of 1000-1500 meters from east to west. The north-south passage is very narrow, with the narrowest point only over 200 meters. Wusheng Yibao utilizes such a natural barrier to build mountain walls and dangerous cliffs on both sides of the mountain, guarding this important road and becoming an important stronghold and transportation hub for guarding Zhuanglangwei.

Figure 8: Section of Zhuanglangwei Wushengbao (viewed from south to north) (Self drawn)

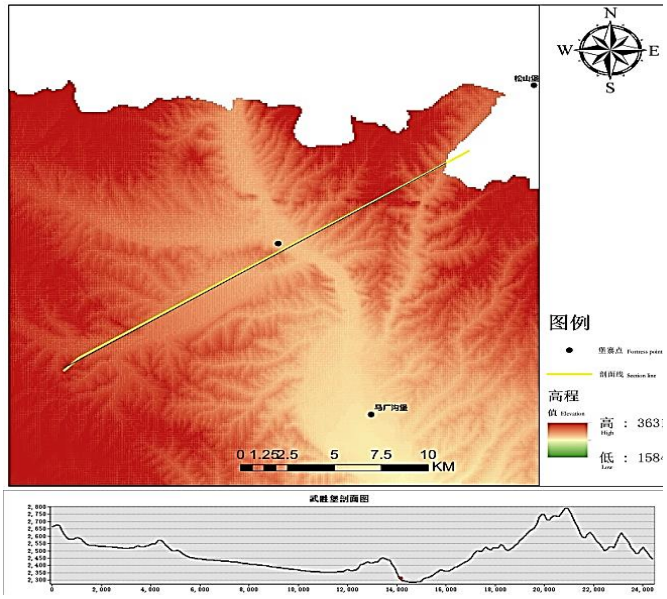


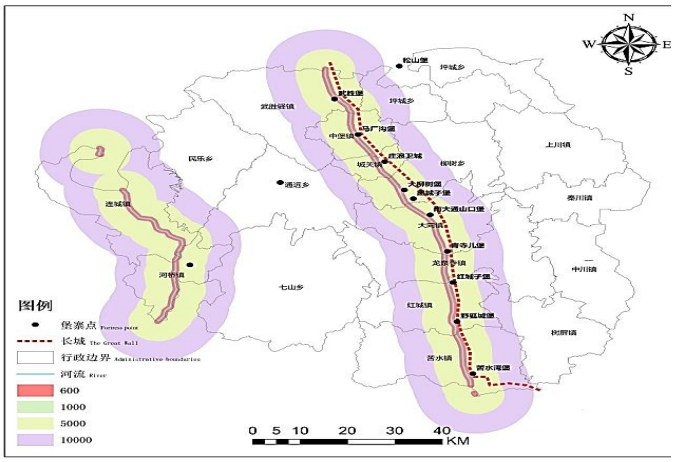
Table 3: Statistical Table for Elevation and Nearest Distance Data of Zhuanglangwei (Self drawn) Liu Jianjun et al. (2013)

Name	Settlement Pattern	Elevation (meters)	Adjacent fortresses	Closest Distance (meters)
Kushuiwan Fort	Fort	1639	Yehu Fort	13842
Yehu Fort	Fort	1730	Hongchengzi Fort	10196
Hongchengzi Fort	Fort	1824	Qingsier Fort	8149
Qingsier Fort	Fort	1864	Nandatong Mountain Pass Fort	8149
Nandatong Mountain Pass Fort	Fort	1960	Heichengzi Fort	5107
Heichengzi Fort	Fort	2010	Daliushu Fort	2735
Daliushu Fort	Fort	2040	Zhuanglang Weicheng	2735
Zhuanglang Weicheng	Weicheng	2125	Machanggou Fort	8079
Machanggou Fort	Fort	2204	Wusheng Fort	8392
Wusheng Fort	Fort	2292	Chakou Fort	10061
Chakou Fort	Fort	2501	Zhenqiang Fort	17761
Zhenqiang Fort	Fort	2754	Songshan Fort	13379
Songshan Fort	Fort	2527	Heigucheng Fort	14009

Site selection characteristics under the influence of river systems

Gansu Province is connected to the Yellow River system, Shiyang River system, Heihe River system, Beida River system, and the Great Wall from east to west. The first three are not only the main channels for cavalry to invade southward, but also natural channels. At the same time, only three military fortresses were set up within 5000 meters of the Zhuanglang River in the Zhuanglang Defense Zone, and two military fortresses were set up beyond 10000 meters of the Zhuanglang River, while the rest were within 1000 meters of the Zhuanglang River (see Figure 9).

Figure 9: Analysis of Zhuanglangwei River Buffer Zone (Self drawn)



The main reason for this establishment is due to terrain limitations, located in the valley area. But if the Great Wall crosses over water, it is necessary to consider building water gates to resist the enemy.

DISCUSSION

Space characteristics of defense system

Space structure characteristics of defense system

(1) Multi level nodes, linear radiation

The defense system of the Great Wall in the Zhuanglang Defense Area is arranged from the side walls layer by layer towards the interior of the defense area, corresponding to a multi-level progressive defense structure (see Figure 10). The spatial defense structure of the Zhuanglang Garrison presents three levels, with the first being the central Zhuanglang Garrison; Next are the remaining twelve fortresses arranged along the side walls; The final level includes the passes along the side walls and military settlements and passes within the defense zone.

(2) Beacon stations connected in series, surface defense

The Zhuanglang Defense Zone is located in the transportation lifeline of Gansu Town and is a key transportation artery from the mainland to the Hexi Corridor. At the same time, the layout of piers and abutments in the Zhuanglangwei area does not always conform to the characteristics of "five li and one pier", with intervals of less than five li and intervals of about ten li. This is a flexible construction based on the size of the border hazards facing Yongdeng County in four directions: east, south, west, and north. The Zhuanglangwei beacon is divided into three routes, all starting from the Zhuanglangwei city:

1. The Xilu Fengsui Bridge extends southwest through the Datong River to Xiningwei, and is built on the left and right

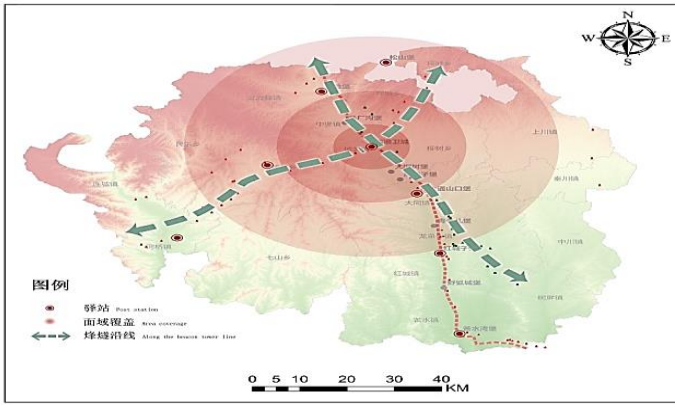
sides of the original Tongyuanshagou Ancient Road. The beacon tower built on the top of the high mountain is used for alarm and transmission, while the one built on both sides of the ancient road belongs to the postal system, which is a guide and distance recording facility.

2. The northern route of Fengsui passes through Xiamen Gou in Qingshui Township, and extends to Songshan District in Tianzhu Tibetan Autonomous County. The geographical location of Songshan during the Ming Dynasty was very important and it was a battleground for soldiers.

3. The Zhonglu Fengsui runs through the north and south sides of the Great Wall in the central part of Zhuanglangwei, from the Xianshui River to Wushengyi. The number of Zhonglu beacon towers along the route is the highest, and there are also a large number of piers and abutments in the Han Dynasty, which are placed side by side in the pier system. This is also one of the reasons why the Ming Dynasty Zhuanglangwei beacon towers were set differently from other places.

The beacon and relay systems connect the various systems of the Zhuanglang Defense Area with each other, and combine them with the spatial structure of the military defense system radiated by multi-level nodes to form a complete surface defense structure (see Figure 11). The defense systems at each level are capable of handling their respective regions while also infiltrating each other, achieving a perfect defense effect.

Figure 11: Distribution of Zhuanglangwei Station and Beacon Flights (Self drawn)



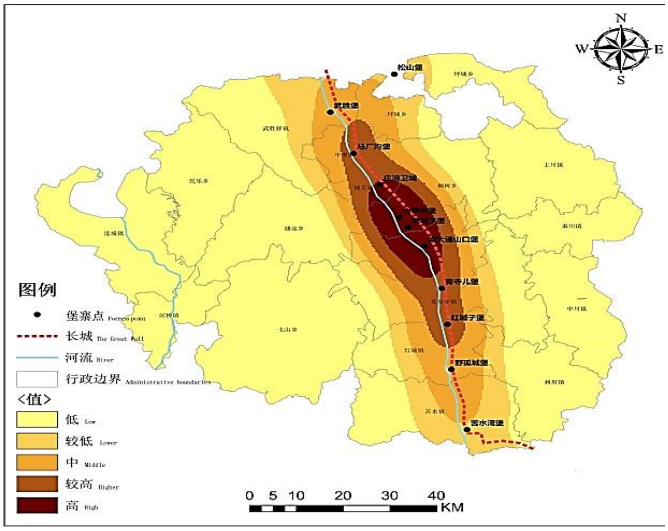
Spatial distribution characteristics of defense system

(1) Density distribution characteristics

From a vertical perspective, the military settlements in the Zhuanglangwei Defense Zone are arranged closely against the side walls, showing a trend of a single linear layout (see Figure 12). At the same time, Zhuanglangwei has a large number of military settlements near the Great Wall, and the distance between the settlements is relatively dense. The degree of dispersion of the vertical defense system is determined by the defense situation, which involves both strategic and tactical aspects and is the core factor determining the density distribution of settlements.

Along the Great Wall, facing enemy attacks directly, there is significant defensive pressure. Therefore, the military settlement of Zhuanglangwei is arranged in a linear pattern along the defensive boundary, striving for no defense gaps and achieving full line defense. The defense pressure of military settlements within the defense zone is low, and the distribution of settlements is sparse. This is not only to protect the post roads, but also to timely coordinate with nearby defense zones.

Figure 12: Analysis of Nuclear Density of Zhuanglangwei (Self drawn)



(2) Traffic connection characteristics

1. Between levels - flexible transportation along the route with radial distribution

In terms of the overall traffic relationship structure, the roads within the Zhuanglangwei defense area are all centered around the city and distributed radially towards the interior of the defense area, further confirming the hierarchical management relationship of the military defense system of the Zhuanglangwei Great Wall in a radial manner; For the internal transportation network of the defense zone, the development level of the transportation network between military settlements adjacent to the side walls is significantly higher, mainly dominated by the Tongyuan Shagou Ancient Road.

2. Between regions - circular defense, flexible traffic organization

The Zhuanglangwei Defense Zone is located east of the outer border and serves as the entrance for enemy troops to enter Gansu Town, making it a top priority. Due to the unique geographical location, the transportation layout of the Zhuanglangwei Defense Zone allows for flexible military settlements located within the defense zone, without the need to fully comply with its boundaries. By strengthening the transportation connections between adjacent defense zones, military settlements intersect with each other, forming a circular defense network to the outside world.

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(3) Accessibility characteristics

Generally speaking, in the military defense system of the Great Wall, the distance between military settlements must be controlled within a reasonable spatial range. If the distance is too close or too far, it is easy for the defense effect of military settlements to not be fully utilized. The mutual cooperation and support of military settlements at all levels can timely solve the shortcomings of long defense lines and dispersed military forces.

By calculating the closest distance between military settlements, it was found that the average distance between settlements was 9430.3 meters, about 18 miles. Cavalry rushed to provide reinforcements, and according to current time calculations, one hour is enough. If infantry go to provide support, it can take half a day to arrive, fully meeting the need for mutual support between troops and horses. The distribution of military settlements within the defense zone is relatively reasonable, and the number of military settlements is decreasing towards the interior of the defense zone, in order to provide timely material and military support.

CONCLUSION

Through spatial analysis of military settlements in Zhuanglangwei Defense Zone, the following conclusions can be drawn:

(1) The spatial structure characteristics of the military defense system in Zhuanglangwei Defense Zone exhibit a linear radiation structure with multi-level nodes, as well as a planar structure with a series of beacon posts and planar defense.

(2) The spatial distribution characteristics of the military defense system in Zhuanglangwei Defense Zone show a single linear density distribution - the density of settlements along the Great Wall is higher than that inside the defense zone. Taking Zhuanglang Weicheng as the core; Next are the other twelve fortresses on the inner side of the side walls; Finally, there are military settlements and passes along the side walls and within the defense zone. The defense zones rely on strategic nodes within the defense zones to connect with each other;

The spatial layout between military settlements is reasonable to meet the accessibility needs of military defense forces. In summary, the particularity of the military defense system of Zhuanglangwei lies in the spatial layout of its military settlements along the main line of the Great Wall. Military settlements of different levels and levels are closer to the Great Wall, and the overall layout is highly compatible with the direction of the Great Wall. Secondly, Zhuanglangwei borders the outside world to the east, constantly plagued by bandits, and has become the entrance for northern bandits to enter Gansu Town. Therefore, as the easternmost guard post in Gansu Town and the gateway to the Hexi Corridor, it holds an extremely important strategic position. Finally, although Zhuanglangwei has lost its original military defense value, the many traces left behind, as well as its defense system and spatial layout, have filled the gap in the research of the military defense system in Gansu Town.

DECLARATIONS

Ethical Approval

The object of this study is the military defense system of the Ming Great Wall, and does not involve research on humans or animals.

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Availability of data and materials

All of the material is owned by the authors and/or no permissions are required.

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