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Influence of Environmental Factors on the Site Selection and Layout of Ancient Military Towns (Zhejiang Region)

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Abstract: There are many subjective inferences regarding environment-related studies in modern studies of ancient military defense heritage, and the objective quantitative analysis of citadel site selection and layout has become the key to interpreting the environmental adaptability of citadels under defense strategies. Based on this, it has been proposed in this research that the site selection of ancient military citadels in a specific region (Zhejiang) has environmental adaptability characteristics. Firstly, an elevated hydrological overlay model was established by predicting and graphically verifying the ancient hydrological thresholds through geospatial analysis strategies. Secondly, the hydrological and topographical indicators of the regional environment where the military citadel is located were digitally extracted. Finally, correlation and weight influence calculations were performed for different environmental data. The environmental adaptability characteristics of the site layout of the Ming dynasty-era Zhejiang coastal defense military citadel, based on military defense needs, were obtained. In this way, we promote digital technology for the excavation, conservation and sustainable use of heritage resources.

Keywords: historical GIS; hydrology and topography; Ming dynasty; military citadels

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1. Introduction

The military and cultural heritage of China is essential to world cultural heritage. The Ming dynasty coastal defense relics are indispensable to China's Maritime Silk Road heritage application: a concentrated embodiment of Ming dynasty border construction and military thinking. The ancient Chinese coastal defense network was established during the Ming dynasty and spanned seven regions from the north to the south [1]. After continuous development and improvement during successive Ming dynasties, the sea defense system gradually became a widespread layout pattern, transitioning from coastal to inland areas. It consists of four layers that form an overall military deployment of zoned defense, layered defense and multi-regional collaboration. The first tier is responsible for information collection and transmission, and it includes beacon towers, wayfinding towers and islands. The second tier is the core defense fortress, which is responsible for intercepting foreign enemies at favorable environmental intersections. The third and fourth tiers are institutions for monitoring patrols and transmitting information, which include inspection citadels, passageways and post citadels [2], culminating in a network system of defense consisting of a coastal linear system and the convergence of inland river networks [3] (Figure 1).

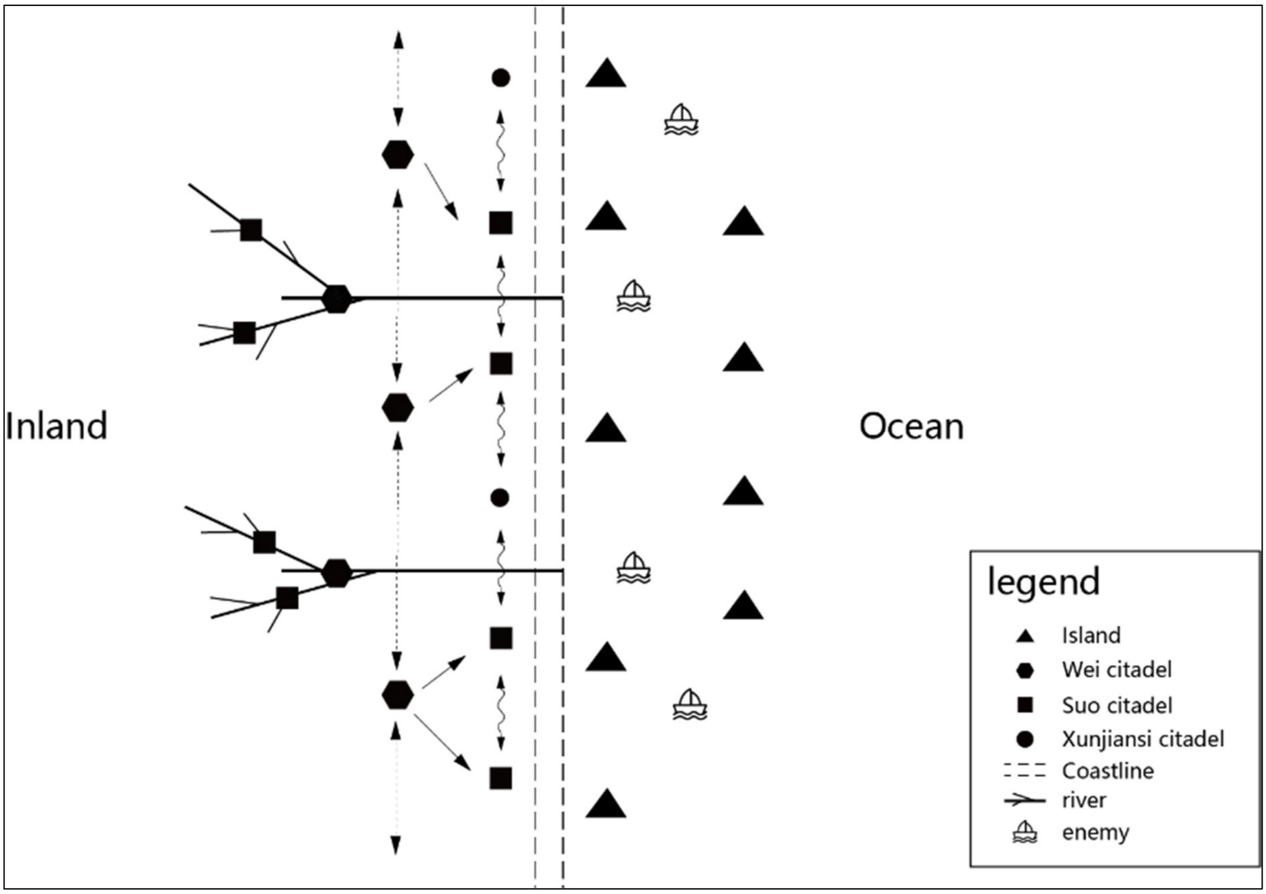

Figure 1. Graphical illustration of the sea defense citadel layout.

As the highest-ranking and largest military structures in the Ming dynasty sea defense system, the citadels were primarily located in crucial coastal areas, with thousands of garrison troops inside and a mix of civilians and soldiers. At the same time, castles were lower in rank than Wei Citadel and independently occupied important environmental intersections. Wei citadel and Suo citadel constituted the main body of the land defense line of the Ming dynasty sea defense system. They became the core components of the Chinese sea defense system in the Ming dynasty [4]. Therefore, in the face of foreign enemies who used ships as their means of transportation, occupying favorable environmental elements became the key to constructing an effective blockade at the Wei citadel and the Suo citadel.

In the existing historical studies, ancient environmental factors have been considered necessary to the siting of military forts [5–9]. In environmental studies, landscape archaeology and cultural heritage studies of ancient human settlements have also been increasing [10–13]. With the help of a multidisciplinary perspective, the association between environmental factors within the site area and the site layout has become a hot topic of current discussion [14–17]. Among these studies, geographic information system (GIS)-based spatial analysis has been widely used to study large-scale cultural heritage sites [18–20]. Its application in landscape analysis has been able to quantify the spatial layout of sites in a new graphical way on a macroscopic scale [21,22].

In sociological studies, the spatial layout of citadels has pointed more to spatial demographic patterns. In the study of human dynamics, specific patterns of human behavior have been essential for the large-scale models of social organization [23]. At the macroscopic scale, the scientific method of the moment should be used to find and analyze the intrinsic laws that govern the entire collection of individuals. There is a clear correlation between the forces affecting human settlement patterns and changes in settlement patterns, which should be sought from spatial distribution results to produce their independent macro effects, as with the GIS and spatial grid-based approach in [24,25]. Numerous factors determine human behavior patterns, but resource availability is critical for human settlement and such environmental selection favors spatial defense locations because they are essential in defense strategies.

However, in the case of ancient military fortifications, the analysis has been more from the perspective of a single environmental factor. When discussing the relevance of sites in terms of ecological factors, the influence of environmental factors in different areas has been mainly explored from a topographical perspective and has lacked support from objective quantitative data. The analysis of hydrological elements and the comprehensive quantitative evaluation of all ecological features has been limited. In the existing studies on the spatial layout of ancient coastal fortifications, researchers have tended to extract specific topographical and hydrological elements and then interpret the correlations directly, without correlation or weighted analysis. As a result, the conclusions obtained from in-depth studies based on environmental aspects lack a certain degree of objectivity and scientific validity.

In settlement archaeological studies, Willey explored the relationship between settlement sites and the environment in the Weiru Valley [15]. Scholars, such as Dorel Micle, have used GISs (geographic information systems) and remote sensing techniques to analyze the topographic morphology of the site selection of settlements in Romania [16]. Bo Liu added an analysis of location and hydrology to the study of site settlements in the Chan River Basin in Xi'an and analyzed the correlation between site features and the environment through diagrams [17]. However, most relevant studies have been based on qualitative analyses to directly determine the correlation between the two and to assess the relationship trends between the sites and environmental factors through changes in data, and subjective decisions have influenced ambiguous conclusions. The current environmental factor analysis regarding ancient sites lacks relatively accurate old hydrological simulations. Hydrological generation using ArcGIS alone cannot guarantee the authenticity of the hydrological restoration of the study area [26]. Therefore, researchers in archaeological studies have avoided environmental analysis related to hydrology.

The purpose of this study was mainly to investigate the military systems within a specific historical region. With the help of geospatial strategies for predicting historical hydrology and building regional geographic models, we combined the acquisition of site spatial coordinate data with geographic models for environmental data mining and statistical analysis to find environmentally adaptive solutions for the spatial siting of ancient military forts.

We selected the Zhejiang defense area from the Ming dynasty, China, as the study area. Through the recovery of the hydrological environment of Zhejiang during the Ming dynasty combined with a digital elevation model (DEM) to extract and analyze the relevant environmental factors of the Wei and Suo citadels, we were able to determine more clearly the influential factors on the site selection of the coastal defense citadels in Zhejiang during the Ming dynasty and to compare and analyze the inland and coastal defense citadels with different environmental factor weights.

2. Materials and Methods

2.1. Study Area

Zhejiang became an important area for China's coastal defense during the Ming dynasty because of its precarious location and unique hydrological and topographical environment. Zhejiang is located in the southeastern region of China, bordered by the East China Sea on its eastern side, with rivers and lakes accounting for 5.05% of the total area of Zhejiang's territory. The mainland coastline is about 2200 km long, accounting for about 12% of the total national mainland coastline [27]. Figure 2 shows the regional relationship map of the whole of China. According to historical records, in the early years of the Ming dynasty, Hongwu in Zhejiang became an essential place for interaction with Japan and from then on, it was occupied by Japanese invaders [28]. According to *A Brief*

History of Japanese Invasion in the Ming Dynasty, the defense zone of Zhejiang was attacked by Japanese invaders the most frequently and the number of military settlements was the highest among all defense zones. The density distribution of the Wei and Suo citadels was also the highest, with a surface density of 4.3 units per 10,000 km^2 [29].

Figure 2. The location of the study area. The map of China was provided by the Ministry of Natural Resources of China (approval number: GS(2019)1673).

As a critical area of the Ming dynasty sea defense system, Zhejiang had to ensure the overall defense of the entire coastal line, focusing on the river mouths and combining the unique topographical features to form a coastal to inland defense system [3]. Thus, the geographical environment of the fortified area became a prerequisite for site selection for the defense system. The geographical environment of the Zhejiang region consists of two significant elements: topography and hydrology. In addition, ancient coastal defense citadels were often located according to different geographical features, which also became key in the establishment of the sea defense system.

2.2. Data Collection and Visualization

The data on the coastal defense citadels of Zhejiang used in this study were taken from Chou Hai Tu Pian [30] and local history books on Zhejiang during the Ming dynasty. The coastal defense citadels used for the analysis were divided into two categories according to their levels: the Wei and Suo citadels. At the macro level, they were divided into coastal defense citadels and inland defense citadels according to their spatial location, with coastal defense citadels belonging to the front positions of the sea defense system and inland defense citadels being primarily located in the vital river network as a critical source of supplementary defense.

The geographical coordinates of the coastal defense citadels used in this study were determined by the cross-validation of historical books and field research to ensure their accuracy. In this study, the DEM (horizontal accuracy of 30 m and vertical accuracy of 20 m) published by the Computer Network Center of the Global Academy of Sciences [31] and the Zhejiang coastal defense citadels coordinate data (Appendix A) were combined to form a geographic data map of the coordinates of the Zhejiang coastal defense citadels during the Ming dynasty [32] (Figure 3).

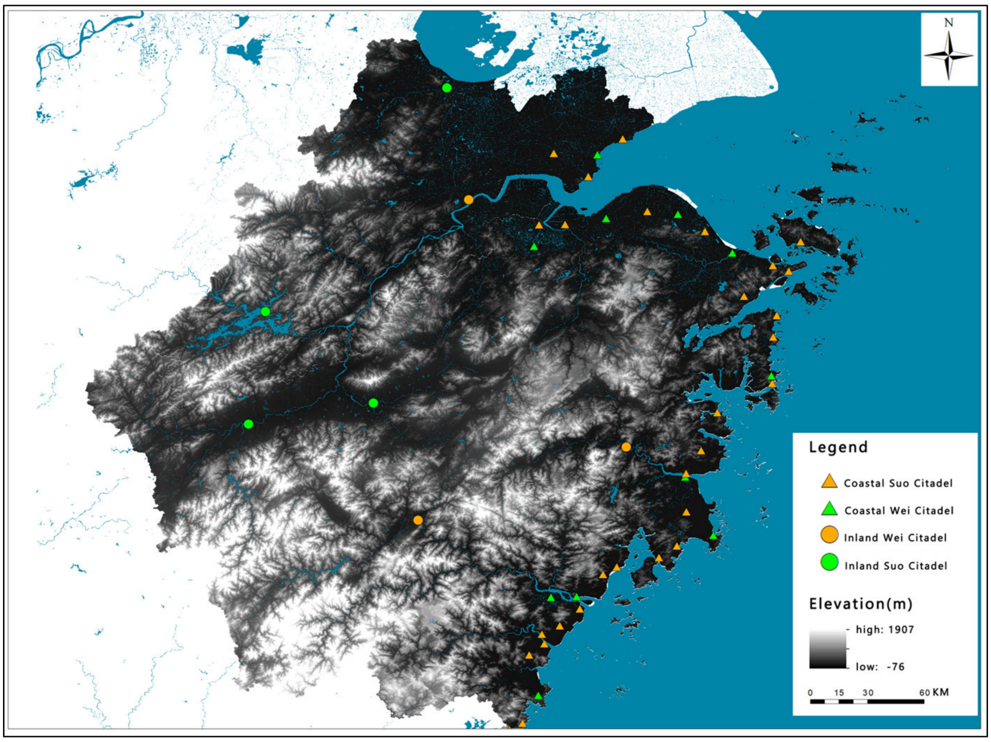

Figure 3. The coordinate registration of the coastal defense citadels in Zhejiang province during the Ming dynasty. The base map was from ASTER GDEM (30 m elevation data).

2.3. Methods

In this study, we first recovered ancient hydrographical information by the modern coordinate geo-correction of a map of Zhejiang during the Ming dynasty using ArcMap10.5 software on the ArcGIS platform. We then quantitatively analyzed the density of the river networks on the map to establish a hydrological model of Zhejiang in Ming dynasty [33]. It was an archaeological predictive model study based on a graphical similarity analysis and it was used to provide a research basis for past human activities [34]. We combined the hydrological model of the Ming dynasty-era Zhejiang with the geographical alignment of the Zhejiang DEM to form a digital elevation and hydrological base model and used it as a basis for spatial environmental studies.

Next, using information related to historical and military defense research, the types of influential factors used to determine the topographical and hydrological environment were identified. Then, the data mining of digital elevation and hydrological models using the coordinate points of the Wei citadel was performed to form a database for the environmental analysis.

Finally, the statistical analysis and environmental analysis were combined with the correlating topographical and hydrological factors of the Wei and Suo citadels. The correlation prerequisites were determined from the perspective of data-based quantitative analysis. The calculation of the respective independence weights was made in the correlation state of each influencing factor. The weight values of each environmental factor in a specific regional environment were obtained to determine the degree of influence of that environmental factor on the location of ancient coastal defense citadels in different regions, which showed the logical framework of the evaluation model of the ecological factors (Figure 4).

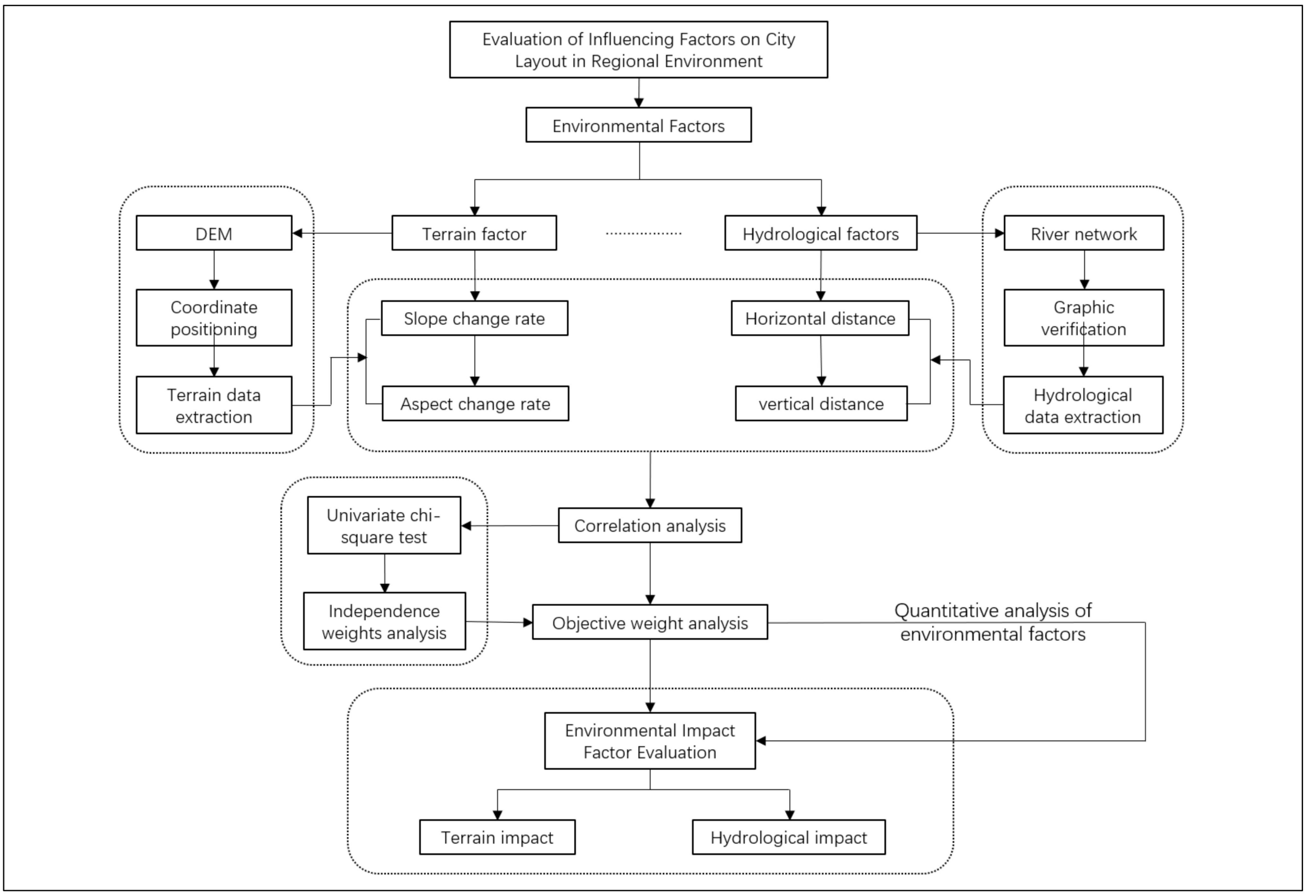

Figure 4. The logical framework.

2.3.1. Construction of the Zhejiang Elevation and Hydrological Model

Restoration of Hydrographic Graphics in Ming Dynasty

The key to the extraction of the influential environmental factors was the recovery of details regarding the Ming dynasty environment. For topographical environmental analysis, the current mainstream practice is to superimpose the site point data onto the digital elevation model and then extract the topographical feature values [35]. In the case of hydrological recovery, it is necessary to model and test the accuracy of the recovery model before the further extraction of hydrological feature data [36]. The Ming dynasty-era Zhejiang hydrology recovery flow chart (Figure 5) presents the full process simulation of the ancient hydrology. The key to the simulation was predicting the historical hydrological state of Zhejiang and the accurate alignment of the historical map.

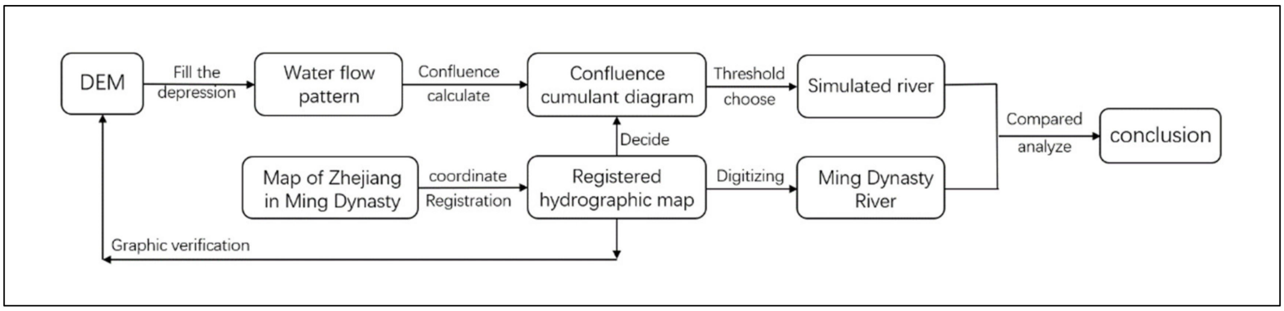

Figure 5. The flow chart of the hydrological digital recovery.

Zhejiang is part of China's Yangtze River Delta region and water systems have been a constant part of Zhejiang's development. With the socio-economic development of the Ming dynasty, the reliance of towns on shipping increased [37], which contributed to the gradual establishment of Zhejiang's water systems during the Ming dynasty. Zhejiang's topographical and geomorphological conditions have not changed significantly since the Ming dynasty; the inland water systems intersected due to the topographical height difference and the rivers flowed toward the lower terrain. Hence, the differences in the inland water systems in Zhejiang today are minor compared to those in the Ming dynasty. In this study, by using the georeferencing tool of ArcMap10.5 combined with polynomial transformation and irregular triangulated network (TIN) interpolation algorithms, [38] Zhejiang maps from the Ming dynasty [39] from the Chinese historical atlas were geo-aligned, with the coordinate point data of the coastal defense citadels of different orientations as the anchor points (Figure 6).

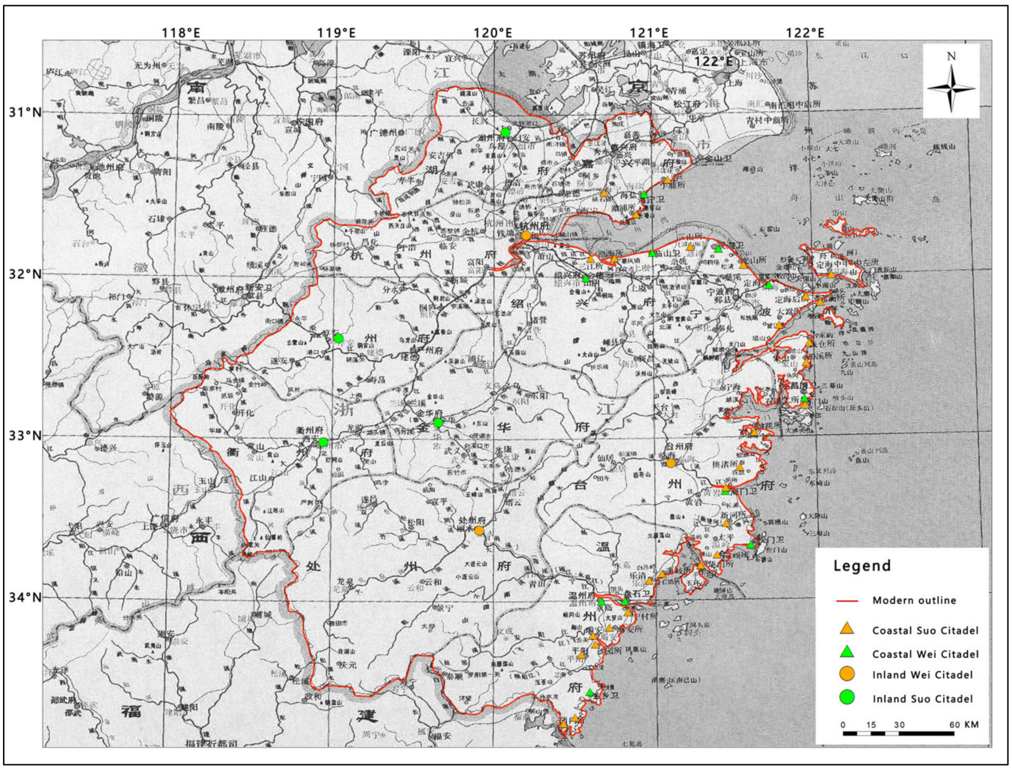

Figure 6. Ming dynasty map alignment and validation in Zhejiang province. The base map was from *China Historical Atlas*.

The graphical recovery of the Ming dynasty hydrological river network based on the geographical alignment (Figure 7) was used as a reference and validation prerequisite for the subsequent hydrological model. As map alignment could only express the distribution status and hydrological relationship of the Wei and Suo citadels in the Ming dynasty in a graphical state without geographical significance [36], we used the geographically corrected Ming dynasty map as the only reference for the hydrological distribution of the Ming dynasty. The river network was generated using the "Dinf" algorithm in combination with the hydrological analysis of ArcMap10.5 [40].

Construction and Verification of Hydrological Digital Model in Ming Dynasty

The primary basis for generating the river network in Zhejiang was flow accumulation. The flow accumulation is the relative volume of water collected at each level. When the flow accumulation reaches a specific value, a streamflow is formed [41]. The choice of threshold value in the calculation of flow accumulation is the key to influencing the morphology of the generated river network, and the results of related studies have shown that there is a power exponential function between the size of the threshold value in the calculation of flow accumulation and the total length of the river network [42]. In this study, different threshold values were used to generate the river network (the higher the threshold value, the lower the density of the river network and the smaller the internal watershed area). Subsequently, the existence of a correlation between the threshold value and the total length of the river network was analyzed using linear, logarithmic and polynomial functions. For trend analysis, the correlation was best fitted with the multiplicative power function y = 2E + 06x − 0.485, with an R^2 value of 0.9999 (Figure 8).

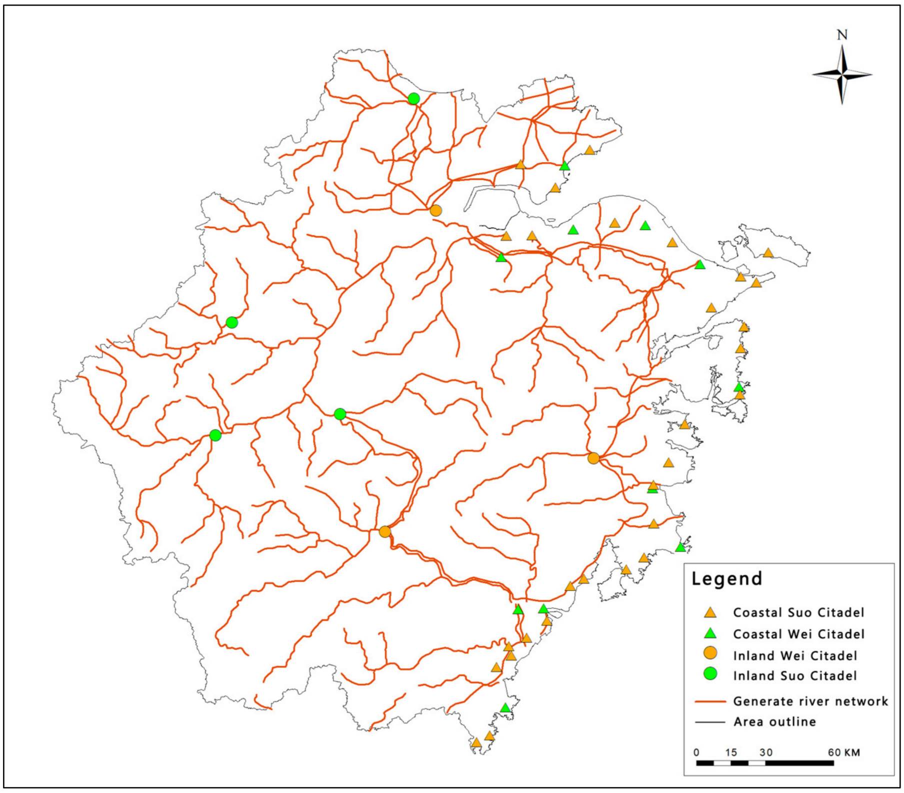

Figure 7. The graphical estimation of the hydrological river network in Zhejiang province during the Ming dynasty.

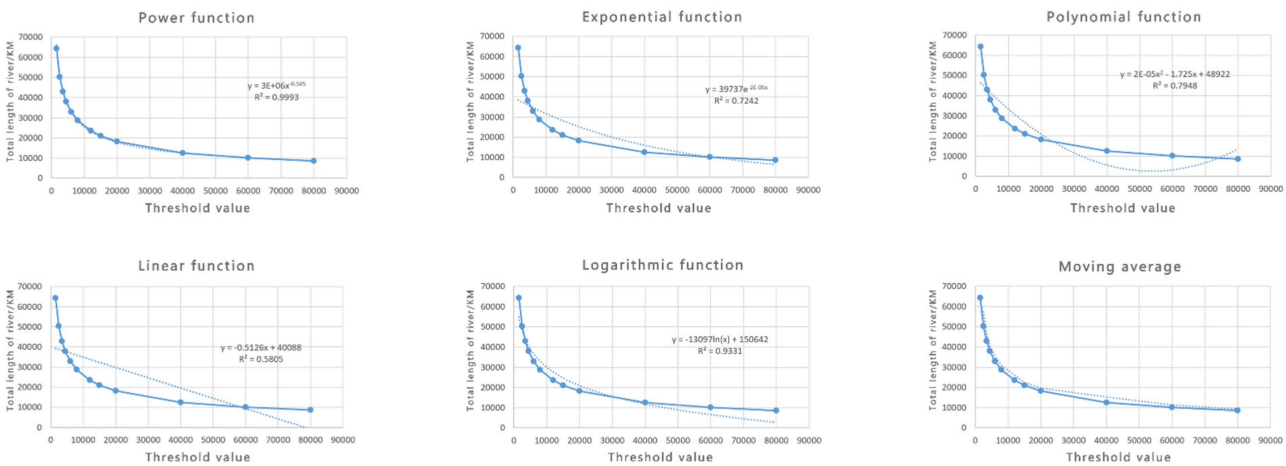

Figure 8. The correlation analysis between the threshold of flow accumulation and the total length of the river.

The lengths and densities of the river network under different flow accumulation thresholds in the river network generation were compared to the lengths and densities of the river graphics of the restored river network in the Ming dynasty, based on the correlation between the flow accumulation threshold and the length of the river network (Table 1). The total length of the river network was similar to that of the restored river network in the Ming dynasty when the flow accumulation threshold was set to 80,000 and the density of the river network was 0.08. Therefore, we selected this threshold as the threshold value for the river network generation and the river network restoration.

Table 1. The total length of the generated rivers under different flow accumulation thresholds.

Indicator	Threshold Setting										Restoring River
	1500	2500	3500	6000	8000	15,000	20,000	40,000	60,000	80,000	
Total length, km	64,333	50,372	42,914	32,979	28,765	21,094	18,189	12,521	10,063	8639	8549
River density, km/km^2	0.63	0.49	0.42	0.32	0.28	0.21	0.18	0.12	0.10	0.080	0.08

The river network map generated under the flow accumulation threshold of 80,000 was classified (Figure 9a) and compared to the restored river network map of the Ming dynasty (Figure 9b). The obtained overlap rate between the two was more than 90%. Except for the artificial water system in the Jiaxing area, which could not be recovered accurately, the hydrological environment generated by the river network was the same as that of the Ming dynasty. Therefore, we were able to use the river network map generated under this threshold as the basis for extracting data on the Ming dynasty citadels.

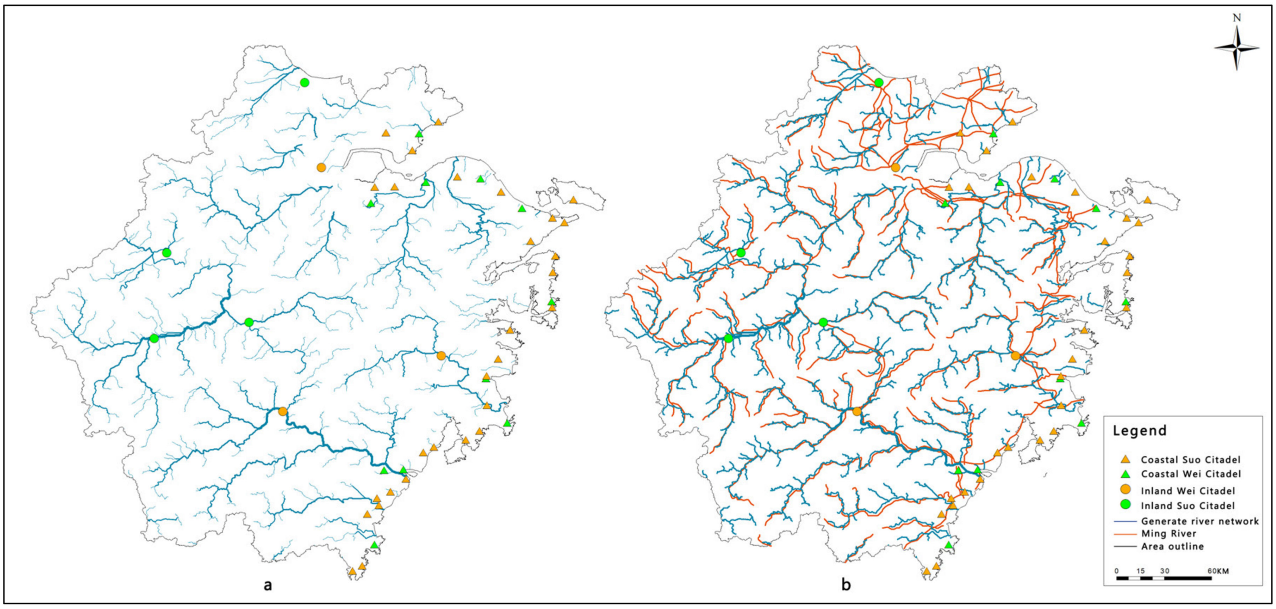

Figure 9. The hydrological simulation and Ming dynasty hydrology comparison in Zhejiang province. (**a**) ArcGIS hydrological simulation; (**b**) superimposed contrast river.

Construction Elevation and Hydrological Data Overlay Model

In analyzing the influence of natural landforms on the layout of large-scale traditional settlements, DEM data were used to analyze the topographical characteristics and were then coupled with the settlement location distributions, one by one [43]. We superimposed the Zhejiang elevation data onto the hydrological data model generated above in the ArcGIS platform and, finally, obtained the Zhejiang elevation and digital hydrological models. Then, the coordinates of Zhejiang's Wei and Suo citadels were combined with the height and digital hydrological model, which was used as the primary platform for the subsequent environmental factor extraction analysis (Figure 10).

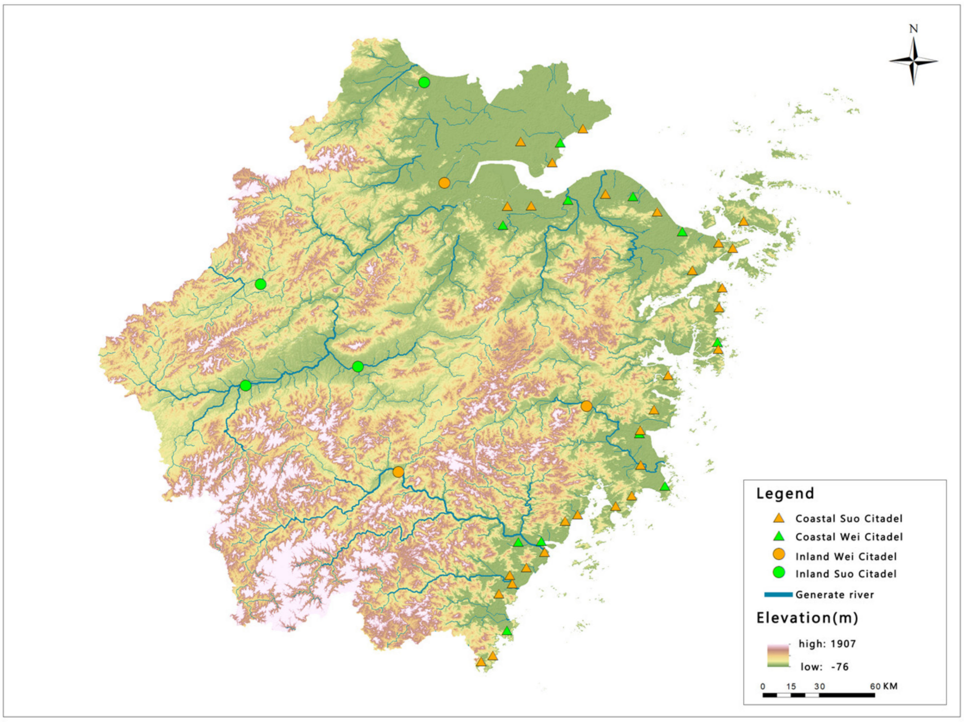

Figure 10. The integrated elevation and hydrological model of Zhejiang province during the Ming dynasty.

2.3.2. Determination and Extraction of Urban Environmental Impact Factors

Environmental Impact Factor Determination

Chinese geography scholars have proposed a correlation between the topographical and hydrological factors of the site selection of the ancient settlements and the environmental factors [44]. During the Ming dynasty, the Wei and Suo citadels were significantly correlated with the environment, based on military needs. Choosing a favorable environment, from a military perspective, was key for the site selection of a coastal defense citadel.

The environmental factors for the location of defensive citadels had to be combined with their core function of serving as a defensive barrier against foreign invasion. The selection of the hydrological characteristics of the sea and rivers, as they were the primary transportation support for foreign invasion, was based on the spatial relationship between the citadel and the hydrology. Horizontal and vertical distances determined its relative location. In contrast, the selection of topographical factors had to consider the spatial relationship of the integrated terrain. However, the single quantity of topographical influence factors, such as elevation, slope and direction, cannot reflect the comprehensive topographical characteristics of the area. In the face of complex terrain, the rate of change of terrain can be used to summarize the shift in elevation, slope and direction of the area. The rate of change of terrain is divided into the horizontal rate of change and the vertical rate of change, which are also called the rate of change of slope direction and the rate of slope change, respectively.

The horizontal distance refers to the horizontal distance between the coastal defense citadels and the nearest river network in the two-dimensional coordinate system, which represents the horizontal proximity between the coastal defense citadels and the hydrological system. The vertical distance refers to the height difference between the height of coordinate points of the coastal defense citadels and the closest point to the water system, which illustrates the vertical proximity between the coastal defense citadels and the hydrological system [45]. In addition to hydrological influence factors, the site selection of the coastal defense citadels was also related to topographical elements. Among the topographical factors, the slope change rate and the aspect change rate were common micro-topographical features of the sites of coastal defense citadels. The aspect change rate extracts the variation degree of the slope aspect based on the topographical aspect, reflecting the curvature degree of the contour line. The slope change rate is the degree of change in the ground slope of the micro-space, reflecting the profile curvature [46].

Coordinate Point Data Extraction

Using the ArcGIS extraction analysis tool, we combined the coordinates of the Zhejiang Wei and Suo citadels with the 30-m precision digital elevation model (DEM) to extract the slope change rate and the aspect change rate of the site of each coastal defense citadel. Then, we combined the coordinates of the coastal defense citadels with the DEM to extract the horizontal and vertical distance data between the coastal defense citadels and the nearest hydrological points (Appendix B).

2.3.3. Calculation of Environmental Relevance and Impact Weights

Calculate the Correlation of Environmental Impact Factors

In order to determine the degree of impact of the various environmental factors on the coastal defense citadels in different areas, it was necessary to first perform a correlation test on each environmental factor to prove its correlation with the spatial location of the coastal defense citadels. For the correlation test, we used a univariate chi-squared test [47]. This method is used in archaeology to test the correlation between the spatial distribution of ruins and settlements and environmental factors. Ancient road restoration studies also commonly use univariate chi-squared tests to determine whether the environmental factors that affect road site selection are correlated [48].

The first columns in Tables 2–5 list the four environmental factors. The single environmental factors extracted from each coordinate point needed to be classified using natural discontinuity point classification before the univariate chi-squared testing to ensure that the grading of the series, in which their environmental factor values were located, was statistically significant [49]. The slope change rates and the aspect change rates of the topographical elements of the Zhejiang Wei and Suo citadels, as well as the horizontal distances and vertical distances of the nearest hydrological elements, were divided into three levels. The second columns present the total number of the Wei and Suo citadels corresponding to the environmental factor data of the different levels. In line with ArcGIS, the third columns in Tables 4 and 5 show the area statistics of the three-level topographical factors. The third columns in Tables 6 and 7 show the distance statistics of the hydrological factors and the fourth columns list the calculated percentages of the different levels based on the grading area/grading distance. In relation to the second and fourth columns, the fifth column shows the calculations of the number of expected coastal defense citadels of the different levels. Based on these data, the following hypothesis test was developed:

Table 2. The univariate chi-squared test for the slope change rate.

Slope Change Rate (m^−1)	**Total Number of Citadels Q_i**	**Graded Area, km^2**	**Proportion of Graded Area, %**	**The Expected Number E_i of the Citadels under the Assumption of H_0**	**The Difference between the Actual Number and the Expected Number χ2**
First level (0–1.8247)	38	31,966.10	42.35%	19.88	16.52
Second level (1.8247–4.2578)	8	24,945.65	33.05%	15.51	3.64
Third level (4.2578–6.6908)	1	18,563.43	24.60%	11.56	9.65
Sum	47	75,475.18	100.00%	47	29.80

Table 3. The univariate chi-squared test for the aspect change rate.

Aspect Change Rate (m^−1)	Total Number of Citadels Q_i	Graded Area, km^2	Proportion of Graded Area, %	The Expected Number E_i of the Citadels under the Assumption of H_0	The Difference between the Actual Number and the Expected Number $\chi 2$
First level (0–23.3245)	12	47,104.00	44.65%	21.0	3.85
Second level (23.3245–46.6491)	18	34,622.69	32.82%	15.4	0.43
Third level (46.6491–78.5670)	17	23,773.30	22.53%	10.6	3.88
Sum	47	105,500.00	100.00%	47	8.16

Table 4. The univariate chi-squared test of the horizontal distance.

Horizontal Distance (m^−1)	Total Number of Citadels Q_i	Graded Distance, km^2	Proportion of Graded Distance, %	The Expected Number E_i of the Citadels under the Assumption of H_0	The Difference between the Actual Number and the Expected Number $\chi 2$
First level (47.9276–1351.2704)	22	11,680.99	12.12%	5.7	46.67
Second level (1351.2704–3355.4586)	14	33,600.80	34.86%	16.4	0.35
Third level (3355.4586–6856.2597)	11	51,111.15	53.02%	24.9	7.78
Sum	47	96,392.94	100.00%	47	54.80

Table 5. The univariate chi-squared test of the vertical distance.

Vertical Distance (m)	Total Number of Citadels Q_i	Graded Distance, km^2	Proportion of Graded Distance, %	The Expected Number E_i of the Citadels under the Assumption of H_0	The Difference between the Actual Number and the Expected Number $\chi 2$
First level (0–9)	33	150.00	35.71%	16.8	15.66
Second level (9–26)	11	136.00	32.38%	15.2	1.17
Third level (26–67)	3	134.00	31.90%	15.0	9.60
Sum	47	420.00	100.00%	47	26.43

Table 6. Calculations of the independence weights of the environmental factors for all of the citadels.

	Multiple Correlation Coefficient R	Reciprocal Multiple Correlation Coefficient 1/R	Weights
Slope change rate	0.255	3.925	11.38%
Aspect change rate	0.118	8.469	24.55%
Horizontal distance	0.276	3.618	10.49%
Vertical distance	0.054	18.479	53.58%

Table 7. Calculations of the independence weights of the environmental factors for the coastal citadels.

	Multiple Correlation Coefficient R	Reciprocal Multiple Correlation Coefficient 1/R	Weights
Slope change rate	0.276	3.623	20.04%
Aspect change rate	0.185	5.414	29.95%
Horizontal distance	0.338	2.956	16.35%
Vertical distance	0.164	6.087	33.66%

(a) The following original hypothesis H_0 was proposed: the distribution of the Wei and Suo citadels is unrelated to the environmental factors;

(b) The statistics X^2 were calculated under the premise of H_0. According to the calculation formula:

$$X^2 = \sum \frac{(Qi - Ei)^2}{Ei} \tag{1}$$

where the slope change rate of X^2 is 29.80, the aspect change rate of X^2 is 8.16, the horizontal distance of X^2 to the nearest hydrological point is 54.80 and the vertical distance of X^2 to the nearest hydrological point is 26.43. Since the four environmental factors were divided into three levels, they obeyed the chi-squared distribution with the degrees of freedom 3 – 1 = 2;

(c) According to the standard X^2 function, the distribution table shows that at the significance level of 0.05, the chi-squared value of 2 degrees of freedom is 5.99, which is less than the X^2 of the four environmental factors. Therefore, at a level of significance of 0.05, we rejected the original hypothesis and assumed that the locations of the Zhejiang Wei and Suo citadels were related to the four environmental factors.

2.3.4. Calculation of Environmental Impact Weights

After the correlation analysis of the four environmental factors, the chi-squared test proved that the site selection of the coastal defense citadels was related to the environmental factors. Still, it did not explain the degree of correlation. Therefore, it was necessary to use the weight analysis tool to make an objective and quantitative analysis of the effect of the environmental impact factors. We used an objective weighting calculation, the independence weight method, to determine the index weight according to the data of the various environmental factors and the strength of collinearity between them [50].

In the calculation of the independence weights, in the case of indicators $X_1, X_2, \ldots, X_m$, when the complex correlation coefficient between X_k and the other indicators is more significant, it means that the stronger the co-linearity between X_k and other indicators, the more repeated information and thus, the smaller the weight of that indicator. The inverse of the negative correlation coefficient R (1/R) was obtained to calculate the results and then the value was normalized to obtain the weights [42].

$$R = \frac{\Sigma(\mathrm{y} - \overline{y})(\hat{y} - \overline{y})}{\sqrt{\Sigma}(y - \overline{y})^2 \Sigma(\hat{y} - \overline{y})^2} \tag{2}$$

A specific environmental factor that strongly correlates with the other factors indicates a significant overlap of information, which means that the factor has a relatively low weight. On the contrary, an environmental factor that is weakly correlated with the other factors indicates that the amount of information carried by that indicator is relatively large and the factor has a high weight. The analysis of the factor weights enabled a more objective judgment of the environment in which the citadel is located so that the site selection and layout characteristics of the ancient military citadels could be clearly restored in conjunction with historical documents.

3. Results

Three weight calculations were carried out for the environmental impact factors of the coastal defense citadels in the regional environment of Zhejiang, which were divided into: the calculation of the environmental impact weight of all of the citadels in the region; the calculation of the environmental impact weight of the coastal citadels; and the calculation of the environmental impact weight of the inland citadels. Then, it aimed to judge the overall environmental adaptation tendency of the region and the sub-defense types for the environmental adaptation.

In the results of the calculation of the environmental factor weights of all of the citadels in the Zhejiang region (Table 6), it can be seen that the vertical distance related to the hydrological factor in the holistic area accounted for 53.58%, while the second largest weight was the slope variability, i.e., the planar curvature of the terrain, which reached 29.95%. The latter two influence weights were similar at about 10%. The overall weight of the hydrological factors was 64.07%, which was much larger than that of topographical factors (35.93%) in calculating the overall regional weight.

From the independence weight analysis of the environmental factors for the coastal defense citadels (Table 7), several environmental factors related to hydrology were observed. The weight of the horizontal distance was 16.35%, the weight of the vertical distance was 33.66% and the overall weight of the hydrological factors was 50.01%. Among the terrain-related environmental factors, the weight of the slope change rate was 20.04% and the weight of the aspect change rate was 29.95%. The total weight of topographical factors was 49.99%.

The calculation results of the independence weights for the inland defense citadels (Table 8) show that the topographic environmental factor weights were: 38.41% for slope change rate and 21.18% for slope change rate. The overall weight of topographic environmental factors reached 59.59%. The weight of horizontal distance of hydrology-related environmental factors was 17.83%, the weight of vertical distance was 22.58% and the overall weight of the hydrology factors reached 40.41%.

Table 8. Calculations of the independence weights of the environmental factors for the inland citadels.

	Multiple Correlation Coefficient R	Reciprocal Multiple Correlation Coefficient 1/R	Weights
Slope change rate	0.212	4.708	38.41%
Aspect change rate	0.385	2.596	21.18%
Horizontal distance	0.458	2.185	17.83%
Vertical distance	0.361	2.767	22.58%

4. Discussion

Combining the influence weights of the environmental factors obtained from the final calculation results with the table of the number share of the distribution of citadels in the classification of environmental factors (Table 9), we can see that the overall layout of citadels within the study area was influenced by hydrological factors much more than topographical factors (64.07% > 35.93%). Firstly, from the historical background, the leading foreign enemies of Zhejiang in the Ming dynasty came from the eastern coast and the hydrological environment of Zhejiang was more vulnerable to foreign invasion [51]. Secondly, among the hydrological influence factors, the vertical distance of the citadel from the coast (53.58%) became the most influential factor. Combined with the unique geographical environment of Zhejiang, the coastal area comprised primarily plains. Occupying a favorable vertical hydrographical distance, from the defense perspective, would simultaneously provide a broader view and enable quick strikes on enemies on the water from a high place.

Table 9. Statistical table of the number of citadels and environmental factors.

Classification	Grade	Number of Coastal Citadels	Proportion	Number of Inland Citadels	Proportion	Total Number of Citadels	Proportion
Slope change rate	Level 1 (0–1.82)	32	80.00%	6	85.71%	38	80.85%
	Level 2 (1.82–4.25)	7	17.50%	1	14.29%	8	17.02%
	Level 3 (4.25–6.69)	1	2.50%	0	0	1	2.13%
Aspect change rate	Level 1 (0–23.32)	11	27.50%	1	14.29%	12	25.53%
	Level 2 (23.32–46.64)	12	30.00%	6	85.71%	18	38.30%
	Level 3 (46.64–78.56)	17	42.50%	0	0	17	36.17%
Horizontal distance	Level 1 (47.92–1351.27)	18	45.00%	4	57.14%	22	46.81%
	Level 2 (1351.27–3355.45)	14	35.00%	0	0	14	29.79%
	Level 3 (3355.45–6856.25)	8	20.00%	3	42.86%	11	23.40%
Vertical distance	Level 1 (0–9)	28	70.00%	5	71.43%	33	70.21%
	Level 2 (9–26)	11	27.50%	0	0	11	23.40%
	Level 3 (26–67)	1	2.50%	2	28.57%	3	6.38%

Calculating the weights of the environmental influences on coastal citadels showed that topography and hydrology had nearly the same effect (49.99% and 50.01%). However, the weight of vertical distance related to hydrology was more influential (33.66%). Combined with the grading quantity statistics in Table 9, 70% of the citadels were distributed in the area of vertical distance 0–9 m. Combined with historical records of the small size of the enemy ships, which sailed mainly by wind [51], and under the premise of ensuring no flood damage, a smaller vertical distance could be more quickly and effectively struck in the field.

The vertical rate of change of terrain (slope variation) became the core influence factor (38.41%) and the vertical distance of inland rivers became the second most important factor (22.58%) in the influence weight for the site selection of inland citadels. Once the enemy broke through the defensive network at the mouth of the river during a Ming dynasty sea defense war, they would move up the river with the help of the wind, so interception at the beginning of the key branches of the river network became the key to defense [51]. Unlike coastal site selection, while the river network route could predict the enemy's path in advance, the inland landscape was complex, more mountainous and not conducive to building a citadel, so the vertical rate of terrain change was considered more in site selection. It is shown in Table 9 that the number of citadels was larger in areas with lower slope variability (the lower the value of slope variability, the lower the rate of change of terrain profile). The reason for this is that firstly, a site with a gentle slope was suitable for the construction of defensive works and secondly, soldiers needed to live inside the citadel.

During the Ming dynasty, the construction of China's coastal defense system reached its peak and most of the battles took place along the southeastern coast, where Japanese invasion was most frequent. This research has shown that the overall layout of the coastal defense forts in Zhejiang, the essential defense area, was highly spatially relevant to the coastline and the inland river network, but with different emphases on topography and hydrology between the coastal and inland areas, thus indicating that the layout of ancient Chinese military forts was based on a close combination of defense needs and the spatial environment.

Ancient military citadels with a vital military role differed from general ancient settlements. Their spatial layout was based on the directional selection of offensive and defensive characteristics and the use of the environment to form a reasonable configuration under specific military needs. There was a large-scale military cultural heritage in ancient China. We attempted to typify the spatial distribution of military sites using geospatial strategies to study the military defense system of the Great Wall of China [52], but the study of military defense abroad is more of a historical lineage and political context study [53,54].

The core issue of a GIS as a method of digital heritage research should fall on the excavation of heritage value. Deepening the study of regional heritage characteristics using the idea of multidisciplinary intersections could improve the overall knowledge of different military forts and enhance the historical and cultural value of ancient military heritage [55]. By deepening the excavation of historical materials and the collection of spatial information, a complete database of military heritage sites has been built up, which also could be used to realize a comprehensive overview of its site-building characteristics to lay a solid foundation for the conservation and utilization of cultural heritage diversity. The excavation of heritage resources using modern digital technology can better protect, develop and utilize existing historical and cultural heritage [56]. Ancient cultural heritage not only can lead to the development of regional tourism and other economic, social and environmental benefits, but it is also a base for scientific research and education and a source of knowledge for exploring human wisdom, the trajectory of civilization and cultural heritage.

In the digital conservation of ancient heritage, the digital archives of specific heritage sites become a prerequisite for the further development of heritage values. In this study, the 3D modelling of the corresponding ancient environment in digital research was of particular significance for studying the spatial environment of ancient heritage. At the same time, the digital conservation strategy of 2D ancient map was attempted. The digital conservation of heritage sites is also gradually developing a consensus on standardized preservation and dissemination mechanisms around the world [57]. Additionally, 3D modelling is used for geospatial studies of modern urban safety and for exploring new models of future cities [58,59]. Digital studies based on ancient citadel defenses are of great value for constructing 3D city models for modern city security and protection.

5. Conclusions

Digital research and the sustainable conservation of historical and cultural heritage sites require innovative approaches, such as geospatial strategies and statistical methods, and the interdisciplinary integration of historical and cultural studies, which play an increasingly important role in uncovering the intrinsic value of cultural heritage. This study combined the qualitative analysis of historical information and the quantitative analysis of environmental factors by establishing a set of GIS-based historical environmental models and performing environmental data mining and research.

This study has proved that the site selection for coastal defense citadels in Zhejiang was closely related to hydrological and topographical elements. in contrast, the location of inland coastal defense citadels was more closely associated with topographical environmental factors and the selection of hydrological characteristics was the most important for coastal defense citadels in Zhejiang. This also shows that the location of ancient Chinese coastal defense military citadels was closely related to the environment and formed a particular defense system based on each unique environment.

Cultural heritage sites show intrinsic organizational and spatial characteristics, especially for military settlements [8]. The site selection of the citadels within the region had group characteristics. At the same time, within the subdivided regions, the selected sites of the citadels had relatively independent factors. In the era of big data, technology has been used to establish 2D and 3D models of regional heritage sites, which are used to realize characterization studies and the sustainable conservation of the overall heritage. The environmental adaptation study of historical heritage sites forms a closed-loop research process, from data collection, model construction and information extraction to the final inference of conclusions using an interdisciplinary approach to heritage research. In future research, we will conduct data collection and 3D model construction for ancient Chinese military heritage sites in the coastal defense system and establish a more comprehensive database of heritage sites for subsequent sustainable research and conservation.

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Appendix A

Table A1. Statistical table of the coordinate data of the Zhejiang coastal defense citadels during the Ming dynasty.

Citadel Level	Citadel Location	Citadel Name	Longitude	Latitude
Wei citadels	Inland	Hangzhouqianyou	120.210000	30.260000
		Taizhou	121.108000	28.850000
		Chuzhou	119.920000	28.433000
	Coastal	Haimen	121.44403	28.679615
		Dinghai	121.71367	29.955885
		Wenzhou	120.67881	27.993588
		Jinxiang	120.60692	27.43469
		Shaoxing	120.58158	29.995105
		Guanhai	121.40296	30.177875
		Changguo	121.93543	29.25664
		Songmen	121.60372	28.347391
		Panshi	120.82425	27.996998
		Haining	120.94274	30.516412
		Linshan	120.99277	30.153312
Suo citadels	Inland	Huzhou	120.08424	30.89674
		Yanzhou	119.04954	29.621097
		Quzhou	118.95494	28.979436
		Jinhua	119.66551	29.101268
	Coastal	Taozhou	121.53527	28.828642
		Haining	120.69387	30.524508
		Lihai	120.75859	30.118907
		Pingyang	120.55448	27.665305
		Sanjiang	120.60997	30.116364
		Sanshan	121.22855	30.19212
		Longshan	121.55673	30.079402
		Ruian	120.62538	27.783753
		Panshihou	120.97509	28.124736
		Haimenqian	121.44856	28.700208
		Chumen	121.29314	28.219957
		Ningcun	120.84326	27.927669
		Kanpu	120.89119	30.391685
		Pumen	120.44211	27.237786
		Zhoushan	122.10124	30.021193
		Kuoqu	122.03381	29.85146
		Zapu	121.08672	30.60608
		Xinhe	121.45102	28.48067
		Dachong	121.77873	29.709639
		Puqi	121.05243	28.165679
		Chuanshanhou	121.94455	29.884339
		Aiwan	121.39621	28.28647
		Haian	120.72769	27.832075
		Qiancang	121.96584	29.599117
		Zhuangshi	120.51607	27.275745
		Jiantiao	121.62586	29.045836
		Juexi	121.94556	29.47635
		Shayuan	120.64055	27.729199
		Shipu	121.94026	29.21348

Appendix B

Table A2. Statistical table of the extraction data for the environmental factors of coastal defense citadels during the Ming dynasty.

Citadel Level	Citadel Location	Citadel Name	Topographical Factors		Hydrological Factors	
			Slope Change Rate	Slope Change Rate	Horizontal Distance, m	Vertical Distance, m
Wei citadels	Inland	Hangzhouqianyou	0.669664	44.596024	3901.6843	4
		Taizhou	0.7558207	3.11113	47.927699	1
		Chuzhou	0.7885823	45.254868	1340.659	41
	Coastal	Haimen	3.5724006	51.601288	3355.4587	7
		Dinghai	2.1777849	16.459736	3219.3106	2
		Wenzhou	0.9465877	33.176353	2954.7325	6
		Jinxiang	0.7105875	70.268372	2684.9816	12
		Shaoxing	1.1673558	44.760635	2371.4165	2
		Guanhai	0.4442534	47.119057	2143.0773	5
		Changguo	0.4692367	16.720602	1689.1674	26
		Songmen	1.6680751	21.794237	720.87957	9
		Panshi	1.7300882	73.250183	678.25884	3
		Haining	0.7745829	45.970673	579.04414	6
		Linshan	0.0687636	6.2567263	512.55565	2
Suo citadels	Inland	Huzhou	1.5646946	45.941711	5161.8495	7
		Yanzhou	1.6236714	25.253431	3730.7982	67
		Quzhou	1.9896249	41.571838	115.40968	0
		Jinhua	0.7481772	46.307236	976.56784	5
	Coastal	Taozhou	0.5852164	63.99604	4240.7995	5
		Haining	0.1075148	58.029366	4229.8702	8
		Lihai	0.744231	57.800529	4172.2348	2
		Pingyang	0.9382679	39.871872	4084.4722	7
		Sanjiang	1.8963953	42.950676	3934.9429	18
		Sanshan	1.6236714	25.253431	3730.7982	67
		Longshan	1.8255669	37.536446	3168.3311	7
		Ruian	0.1893582	17.682531	2902.0686	9
		Panshihou	0.3494952	4.1706333	2476.7875	10
		Haimenqian	0.4160346	15.963297	1847.1529	4
		Chumen	0.3452938	56.312111	1829.487	6
		Ningcun	2.0378096	41.552288	1607.5621	5
		Kanpu	2.5462048	58.636772	1351.2705	1
		Pumen	0.3656081	69.29718	1124.7173	12
		Zhoushan	0.1591306	44.238449	976.92715	5
		Kuoqu	0.7481772	46.307236	976.56784	5
		Zapu	1.0470433	52.264217	750.65857	2
		Xinhe	1.302976	68.975128	738.31371	12
		Dachong	0.3378592	30.785543	641.65193	6
		Puqi	0.4975092	64.781921	539.69368	14
		Chuanshanhou	1.2190069	69.902962	488.57848	8
		Aiwan	1.6231538	65.231125	466.63108	8
		Haian	0.9300938	47.985771	334.13237	8
		Qiancang	1.7762289	30.262856	199.70398	6
		Zhuangshi	0.4152234	14.021348	149.47235	10
		Jiantiao	1.6800536	63.259232	135.66561	19
		Juexi	1.9896249	41.571838	115.40968	0
		Shayuan	0.3559955	26.837242	112.09619	0
		Shipu	2.1145847	20.731102	51.444186	11

References

1. Yang, J.; Fan, Z. *A History of Chinese Maritime Defence*; Ocean Press: Beijing, China, 2005; pp. 57–387.
2. Tan, L.; Zhou, J.; Zhang, Y. Argument for linear cultural heritage of Ming Dynasty coastal military settlements. *Chin. Cult. Herit.* **2019**, *2*, 4–13.

3. Yin, Z.; Zhang, Y.; Tan, L. Study on the coastal defence hierarchy and settlement system in Ming Dynasty. *Archit. Cult.* **2016**, *1*, 104–105.
4. Shi, J. Experimentation on the layout of coastal guardhouses in Zhejiang during the Ming Dynasty. *Mil. Hist.* **2012**, *5*, 23–28.
5. Bi, J. Spatial Analysis of Ming Haiphong Military Settlement System and Weihai Area. Doctoral Dissertation, Tianjin University, Tianjin, China, 2012.
6. Tan, L.; Liu, W. A Comparative Study of the Ming Liaodong Sea Defense Military Settlement and the Great Wall Military Settlement. *City Plan. Rev.* **2015**, *39*, 87–91.
7. Li, Y. A Study of Military Defensive Settlements in the "Nine Frontier" Towns of the Ming Great Wall. Doctoral Dissertation, Tianjin University, Tianjin, China, 2007.
8. Tan, L.; Zhou, J.; Zhang, Y.; Liu, J.; Liu, H. Correlation between the Construction of Zhejiang Coastal Military Settlements in the Ming Dynasty and the Natural Terrain. *J. Coast. Res.* **2020**, *106*, 381–387. [CrossRef]
9. Tan, L. A Study of the Coastal Defense System in the Ming Dynasty. *J. Nanjing For. Univ.* **2012**, *12*, 100–106.
10. Benjamin, J. Submerged prehistoric landscapes and underwater site discovery: Reevaluating the 'Danish Model' for international practice. *J. Isl. Coast. Archaeol.* **2010**, *5*, 253–270. [CrossRef]
11. Chang-Martínez, L.A.; Mas, J.F.; Valle, N.T.; Torres, P.S.U.; Folan, W.J. Modeling Historical Land Cover and Land Use: A Review from Contemporary Modeling. *ISPRS Int. J. Geo-Inf.* **2015**, *4*, 1791–1812. [CrossRef]
12. Fischer, A. Submerged stone age-Danish examples and North Sea potential. *CBA Res. Rep.* **2004**, *141*, 21.
13. Fitch, S.; Gaffney, V.; Thomson, K. In Sight of Doggerland: From speculative survey to landscape exploration. *Internet Archaeol.* **2007**, *22*, 1–10. [CrossRef]
14. Wood, J. The Geomorphological Characterisation of Digital Elevation Model. Doctoral Dissertation, University of Leicester, Leicester, UK, 1996; pp. 10–26.
15. Willey, G.R. Prehistoric settlement patterns in the Virú; Valley, Peru. *Bur. Am. Ethnol. Bull.* **1953**, *155*, 1–453.
16. Micle, D.; Torok-Oance, M.; Maruia, L. The morpho-topographic and cartographic analysis of the archaeological site Cornesti "Iarcuri", Timis County, Romania, using computer sciences methods (GIS and Remote Sensing techniques). *arXiv* **2009**, arXiv:0906.1644. Available online: https://hal.archives-ouvertes.fr/hal-00393960 (accessed on 29 November 2021).
17. Liu, B.; Zhang, H. A Study on the Characteristic Factors of Man-land Relationship between Neolithic Sites in Chanhe Basin. *J. Xi'an Univ. Arts Sci. Nat. Sci. Ed.* **2005**, *8*, 10–15.
18. Luo, Z. *The Great Wall*; Qinghua University Press: Beijing, China, 2008.
19. Jing, A. *History of the Great Wall of China*; Shanghai People's Press: Shanghai, China, 2006.
20. Zhu, X. *Survey Report on Ming and Qing Dynasty Coastal Defense Sites in Shanghai*; Shanghai University Press: Shanghai, China, 2016.
21. Tan, L.; Yu, J.; Zhang, Y.; Zhou, J. Study on the spatial layout of defensive military settlements in coastal defense of Guangdong in the Ming Dynasty. *Chin. Cult. Herit.* **2020**, *3*, 103–109.
22. Mertel, A.; Ondrejka, P.; Šabatová, K. Spatial predictive modeling of prehistoric sites in the Bohemian-Moravian Highlands based on graph similarity analysis. *Open Geosci.* **2018**, *10*, 261–274. [CrossRef]
23. Barabasi, A.L. The origin of bursts and heavy tails in human dynamics. *Nature* **2005**, *435*, 207–211. [CrossRef]
24. Balsa-Barreiro, J.; Morales, A.J.; Lois-González, R.C. Mapping Population Dynamics at Local Scales Using Spatial Networks. *Complexity* **2021**, *2021*, 8632086. [CrossRef]
25. Freire, S.; Aubrecht, C. Integrating population dynamics into human mapping exposure to seismic hazard. *Nat. Hazards Earth Syst. Sci.* **2012**, *12*, 3533–3543. [CrossRef]
26. Bi, S.; Wang, J.; Ji, H.; Shen, X.; Ling, D. Analysis on Environmental Driving Factors of Prehistoric Settlement Sites in Zhengluo Area. *Geogr. Geogr. Inf. Sci.* **2017**, *33*, 115–120.
27. Shi, J. Research on the Construction of Zhejiang Coastal Defense in Ming Dynasty. Master's Thesis, Zhejiang University, Zhejiang, China, 2011.
28. Tan, L.; Zhou, J. Research on the Military Construction of Zhejiang Coastal Defense in Ming Dynasty Based on Fractal Theory. *Contemp. Archit.* **2020**, *1*, 141–142.
29. Yin, Z. A Study on the Coastal Settlement System of the Ming Dynasty. Doctoral Dissertation, Tianjin University, Tianjin, China, 2016.
30. Zheng, R. *Chou Hai Tu Bian*; Zhonghua Book Company: Beijing, China, 2007.
31. ASTER GDEM Global Elevation Data. Available online: https://yceo.yale.edu/aster-gdem-global-elevation-data (accessed on 4 April 2021).
32. Song, X.; Xiu, X. *A Courseon Geographic Information System Practice*; Science Press: Beijing, China, 2007; pp. 105–110.
33. Wang, M. Application of ArcGIS and DEM in Hydrological Basin Simulation. *Groundwater* **2011**, *33*, 159–161.
34. Kamermans, H.; Leusen, M.; Verhagen, P. *Archaeological Prediction and Risk Management. Alternatives to Current Practice*; Leiden University Press: Leiden, The Netherlands, 2009.
35. Font, M.; Amorese, D.; Lagarde, J.L. DEM and GIS analysis of the stream gradient index to evaluate effects of tectonics: The Normandy intraplate area (NW France). *Geomorphology* **2010**, *119*, 172–180. [CrossRef]
36. Pan, W.; Man, Z. Grid reconstruction method of historical river network density in the Great River Delta—A study in Qingpu District, Shanghai from 1918 to 1978. *Theor. Chin. Hist. Geogr.* **2010**, *25*, 5–14.

37. Kang, Y.; Liang, Q.; Zhang, D.; Cheng, R. Research on the Changes of Zhejiang Water System and the Spatial and Temporal Distribution of Towns in Historical Period. *J. Huzhou Teach. Coll.* **2019**, *41*, 59–67.
38. Affek, A. Georeferencing of historical maps using GIS, as exemplified by the Austrian Military Surveys of Galicia. *Geogr. Pol.* **2013**, *86*, 375–390. [CrossRef]
39. Tan, Q. *China Historical Atlas*; China Cartographic Publishing House: Beijing, China, 1982; pp. 68–69.
40. Tarboton, D.G. A new method for the determination of flow directions and upslope areas in grid digital elevation models. *Water Resour. Res.* **1997**, *33*, 309–319. [CrossRef]
41. Zhang, H. *GIS and Archaeological Spatial Analysis*; Peking University Press: Beijing, China, 2014; pp. 171–180.
42. Zhao, Y.; Huang, Y.; Qiu, D. Research on the Threshold Value Problem in the Extraction of River Networks in Digital Watersheds. *J. Xinyang Norm. Univ. Nat. Sci. Ed.* **2008**, *2*, 232–235.
43. Sanderson, B.M.; Wehner, M.; Knutti, R. Skill and independence weighting for multi-model assessments. *Geosci. Model Dev.* **2017**, *10*, 2379–2395. [CrossRef]
44. Ni, J. Prediction model of archaeological sites in the upper reaches of the Shuhe River in Shandong. *Geogr. Sci. Prog.* **2009**, *28*, 489–493.
45. Yan, L.; Shi, Y.; Lu, P.; Liu, C. A Study on the Relationship between Settlement Site Selection and Water System in the Prehistoric Period of Huan Songshan Area. *Reg. Res. Dev.* **2017**, *36*, 169–174.
46. Tang, G.; Yang, X. *A Tutorial on Spatial Analysis of ArcGIS*, 2nd ed.; Science Press: Beijing, China, 2012; pp. 1–579.
47. Chen, T. *Quantitative Archaeology*; Peking University Press: Beijing, China, 2005; pp. 100–170.
48. Tan, L.; Liu, H.; Zhou, J.; Zhang, Y.; Liu, J.; Shen, S.; Li, T.; Wang, C.; Lin, W. A GIS-Based Modeling Approach for Determining the Efficiency of the Traffic System between Ancient Military Castles. *Discret. Dyn. Nat. Soc.* **2021**, *2021*, 6329935. [CrossRef]
49. Chen, J.; Yang, S.; Li, H.; Zhang, B.; Lv, J. Research on geographical environment unit division based on the method of natural breaks (Jenks). *Int. Arch. Photogramm. Remote Sens. Spat. Inf. Sci.* **2013**, *3*, 47–50. [CrossRef]
50. Jin, X.; Li, Y. Comparative Study and Application of Priority Diagram and Analytic Hierarchy Process in Determining Weight. *China Health Stat.* **2001**, *2*, 55–56.
51. Li, S.; Liu, X.; Guo, W. Research on the Distribution and Morphological Characteristics of Health Posts in Zhejiang Coastal Areas in Ming Dynasty. *Landsc. Gard.* **2018**, *25*, 73–77.
52. Du, Y.; Chen, W.; Cui, K.; Guo, Z.; Wu, G.; Ren, X. An exploration of the military defense system of the Ming Great Wall in Qinghai Province from the perspective of castle-based military settlements. *Archaeol. Anthropol. Sci.* **2021**, *13*, 46. [CrossRef]
53. Parrott, D. The utility of fortifications in Early Modern Europe: Italian princes and their citadels, 1540–1640. *War Hist.* **2000**, *7*, 127–153.
54. Bakhodir, D. Formation And Development Of Military Architecture In Fergana (Antiquity, Early Middle Ages). *Turk. J. Comput. Math. Educ.* **2021**, *12*, 106–109. [CrossRef]
55. De Marco, R.; Galasso, F.; Malusardi, C. Digital documentation of fortified urban routes in Pavia (Italy): Territorial databases and structural models for the preservation of military ruins. *Defensive Archit. Mediterr.* **2020**, *10*, 349–356.
56. Sun, K. *Introduction to World Cultural and Natural Heritage*; China University of Geosciences Press: Wuhan, China, 2005.
57. Koller, D.; Frischer, B.; Humphreys, G. Research challenges for digital archives of 3D cultural heritage models. *J. Comput. Cult. Herit.* **2010**, *2*, 1–17. [CrossRef]
58. Wolff, M.; Asche, H. Geospatial modelling of urban security: A novel approach with virtual 3D city models. In *International Conference on Computational Science and Its Applications*; Springer: Berlin/Heidelberg, Germany, 2008; pp. 42–51.
59. Glander, T.; Döllner, J. Abstract representations for interactive visualization of virtual 3D city models. *Comput. Environ. Urban Syst.* **2009**, *33*, 375–387. [CrossRef]