

Retraction

Retracted: Extraction of Spatial Distribution Characteristics of Jiangnan Urban Landscape under the Influence of Geomorphology

Complexity

Received 15 August 2023; Accepted 15 August 2023; Published 16 August 2023

Copyright © 2023 Complexity. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This article has been retracted by Hindawi following an investigation undertaken by the publisher [1]. This investigation has uncovered evidence of one or more of the following indicators of systematic manipulation of the publication process:

- (1) Discrepancies in scope
- (2) Discrepancies in the description of the research reported
- (3) Discrepancies between the availability of data and the research described
- (4) Inappropriate citations
- (5) Incoherent, meaningless and/or irrelevant content included in the article
- (6) Peer-review manipulation

The presence of these indicators undermines our confidence in the integrity of the article's content and we cannot, therefore, vouch for its reliability. Please note that this notice is intended solely to alert readers that the content of this article is unreliable. We have not investigated whether authors were aware of or involved in the systematic manipulation of the publication process.

Wiley and Hindawi regrets that the usual quality checks did not identify these issues before publication and have since put additional measures in place to safeguard research integrity.

We wish to credit our own Research Integrity and Research Publishing teams and anonymous and named external researchers and research integrity experts for contributing to this investigation.

The corresponding author, as the representative of all authors, has been given the opportunity to register their agreement or disagreement to this retraction. We have kept a record of any response received.

References

- [1] S. Wang and A. Qin, "Extraction of Spatial Distribution Characteristics of Jiangnan Urban Landscape under the Influence of Geomorphology," *Complexity*, vol. 2021, Article ID 5545112, 12 pages, 2021.

Research Article

Extraction of Spatial Distribution Characteristics of Jiangnan Urban Landscape under the Influence of Geomorphology

Shuhua Wang¹ and Anhua Qin² 

¹LandscapeArchitecture, Zhejiang Gongshang University, Hangzhou, Zhejiang 310000, China

²LandscapeArchitecture, Zhejiang Sci-Tech University, Hangzhou, Zhejiang 310000, China

Correspondence should be addressed to Anhua Qin; qah@zstu.edu.cn

Received 2 March 2021; Revised 1 June 2021; Accepted 10 June 2021; Published 17 June 2021

Academic Editor: Zhihan Lv

Copyright © 2021 Shuhua Wang and Anhua Qin. This is an open access article distributed under the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

This paper presents an in-depth study and analysis of the spatial distribution of urban landscapes in Jiangnan cities under the influence of geomorphology and extracts the characteristics to explore the construction mechanism from the perspective of spatial functionality based on the analysis of the process and content of landscape construction. The construction of cities and ponds originated from political influence, environmental constraints, and architectural techniques; the landscape pattern of the combined shape and complementary potential originated from the creation of various types of gardens in various dynasties; the complementary planning of landscape, the traffic creation of the plain and water network, and the production factors of agriculture and sanitation influenced the construction of the countryside landscape; the traditional view of feng shui, poetry and painting, the eight scenes of the city and countryside, and other humanistic intentions influenced the overall situation of the town and the landscape. This paper extracts and analyzes the spatial distribution characteristics of Jiangnan city landscape from several perspectives, and the results can clearly show the distribution of landscape features under the influence of geomorphology and can give the best layout suggestions. From the perspective of spatial variability, the main features of traditional landscape construction in Jiangnan are analyzed through three levels: the characteristics of the process of humanized landscapes evolving into natural landscapes, the comparative analysis of similarities and differences in the construction of cities and towns, and the characteristics of the system of regional landscape construction. Finally, the changes in the landscape pattern of the region under the influence of globalization are analyzed through the changing characteristics of landscape architecture.

1. Introduction

Historically, the Yangtze River estuary had a vast water surface, significant tidal action, and significant coastal accretion [1]. In terms of both agricultural production and flood prevention, the construction of canals and other artificial water facilities played an extremely important role in the development of the region [2]. The Jiangnan region has the geographical advantage of forming a complete study area and is a distinctive and unique research vehicle for the study of regional town systems and urban development, as well as an important research value and a good research database. Suzhou, Nanjing, and Hangzhou are the three central cities in the study area and the three important Jiangnan capitals

in China's history [3]. The interaction between the concept of grand urban patterns for political needs and the natural topography makes these three cities typical and special in terms of morphological changes. The specific object of this dissertation is the process of urban morphological changes and the evolutionary mechanism of the abovementioned cases, where urban morphology refers specifically to the physical spatial form that is the general concern of urban planning and architecture [4]. The urban morphological changes are of comparable value in similar geographical, vocational, and political contexts. The study focuses on the period when the case cities served as capitals to highlight the dual role of power and natural environment on the development of urban construction, as well as to conduct a

comparative analysis, feature refinement, and pattern summary of the three cities. Using the Jiangnan Canal and its water network as a link to connect these cities, the study aims to sketch a picture of the development of the cities in Jiangnan.

The process of building any traditional settlement has taken a long history and has gradually grown into a very rich form of settlement space, and the wisdom of the ancestors of traditional settlements is indispensable in this process. Even the formation of spontaneous natural settlements implicitly involves the management of the social organization and control [5]. The wisdom of traditional settlements in terms of geographical environment and time course is demonstrated by “making use of local conditions and materials” and “using wisdom more than force.” As a result, it has a unique regional research value and precious records and has attracted strong interest and sustained attention. The current emphasis on traditional settlements reflects the promotion of the cultural roots rooted in traditional settlements and the enhancement and self-improvement of traditional Chinese culture [6]. This paper aims to reveal the interaction and mutual influence between the development of traditional settlements and the evolution of regional ecological environment from the perspectives of practical significance, theoretical significance, and empirical significance.

To realize the coupling development of the landscape inheritance value and renewal protection of the traditional water village in Jiangnan, the traditional settlement is a relatively independent spatial system or a relatively independent society, so based on the influence of various factors, the settlement presents a variety of characteristics. Traditional settlements carry the role of cultural treasures inherited for thousands of years, objective carriers of urban cultural development, and paradigm samples of today's regional and ecological landscapes. Facing the strong intervention influence of urbanization, how should the modern settlement landscape settle down? How to inherit the traditional local culture, how to renew the traditional village landscape, and how to change the mediocre and tasteless situation of the new village landscape today are the practical problems that must be faced in the process of renewing and developing the traditional village landscape.

2. Related Studies

Li examines visible physical cultural landscapes and the memory of vernacular heritage and traditions to develop the concept of cultural identity [7]. Jiang calls for the promotion of landscape culture as a powerful tool for effective control of urban space. Jiang et al. propose the applied science of landscape, including the fields of landscape design, architectural design, and planning [8]. Li points out that landscape should be a multidisciplinary cross-sectional science and proposes a holistic concept of landscape spatial structure, which is dedicated to the study of the broad and deep ecological, cultural, spiritual, perceptual, and aesthetic values of human beings through innovative and integrated approaches [9]. The regional settlement landscape focuses on the comprehensive study of the type of landscape view,

the nature of the regional landscape, and the connotation of the regional landscape in the regional space of human settlement and related behaviours [10]. Compared to urban landscapes, territorial settlement landscapes are less subject to human interference and therefore have stronger natural properties [11]. In the western landscape architecture of the settlement landscape compared to the purely natural landscape, the settlement landscape has a certain artificial atmosphere, is the main influence of human activities under the production of landscape and settlement-specific culture and life landscape, and embodies the “complex” and “multiple values” double meaning. Whether it is natural landscape or cultural landscape, what it contains is the diversity of regional landscape. However, different people or groups may perceive and describe the same landscape completely differently, so it is a common study among Western scholars that the settlement landscape is conceived or “invented” by the perceiver, and the landscape is endowed with rich diversity and meaning in the process of being perceived, described, and displayed [12].

According to Professor Gao, landscape architecture is a complex system discipline that focuses on the construction of human outdoor living environment, integrating art, science, and engineering technology, with emphasis on the planning and design of various environments, involving landscape design to the management of natural resources in the national territory [13]. From the perspective of geography, Mr. Hu, a famous human geographer, proposed that a settlement landscape is a complex with a consistent physical geographic basis, a similar degree of utilization and development process, similar morphological structure, and functions, and interconnected and coordinated elements in the settlement area [14]. Settlement landscape is a mosaic of different land units under the constraints of natural environmental conditions and the dual influence of human management activities and management strategies, and the mosaic of different land units into the territorial scope of the settlement, size, shape, and configuration of the mosaic has a large heterogeneity, both economic value, social value, ecological value, and aesthetic value [15]. In recent years, the research on the spatial distribution characteristics and influencing factors of rural settlements in architecture and planning disciplines have become increasingly in-depth, involving a wider range of disciplines and specialties [16–18]. Cities are the most active areas in the land market, and the study of the spatial structure of urban land prices has been a classic proposition in geography, which is important for promoting the healthy development of urban land markets and increasing the scientific planning. The importance of interdisciplinary research and quantitative analysis has been gradually highlighted when it comes to geography, sociology, economics, and other aspects [19–21]. A large number of scholars have begun to draw on the research methods and tools of other disciplines and combine their research results to explore the methods of classifying rural settlement types based on the research needs of their disciplines and to discuss the influence of various factors such as climate, topography, geomorphology, hydrology, resources, economy, institutions, technology, population, and culture on the spatial distribution of rural settlements in a comprehensive manner [22–24].

The aerial photography and satellite images of all samples during the three socio-economic transformations since modern times were obtained and corrected, and key elements were extracted, and a GIS database was established for multidimensional quantitative analysis. Based on the needs of the practice of rural settlement planning and design in the Jiangnan area, we propose strategies and suggestions for specific practice at different levels and reflect and summarize.

3. Geomorphologically Influenced Landscape Spatial Distribution Characteristics Analysis

3.1. Geomorphological Impact Analysis. This chapter gives an overview of the regional situation from the delineation of the location and regional extent of the Hangjia Lake Plain, focusing on the formal geomorphology, hydrological conditions, climatic conditions, and soil conditions for the discussion. The scope of Hangzhou-Jiaxing Lake is large or small. The large one is the territory of the three ancient and modern provinces, while the small one refers exclusively to the three provinces, specifically the area where the three provinces of the Hangjiahu Plain in the Taihu Lake Basin are located. The surface forms of plains, hills, low mountains, and high mountains are the basic forms of landforms [19]. The area is long from east to west and narrow from north to south, with the eastern part of the area being low and flat, dominated by the vast water network plains formed by the Quaternary loose accumulation, and the southwest being scattered with some mountains and hills of small volume, mainly dominated by Tianmu Mountain and Mogan Mountain Range. In the north of Jiaying and Jiashan, Deqing and Huzhou are surrounded by many lakes and swells, with elevations above and below 2 m, while around Dongxiang along the Qiantang River and Hangzhou Bay, the ground south of Linping is higher, with elevations of 5-6 m, and the water network along Haiyan and Pinghu becomes thin, with ground elevations above 3 m. Because of the special geomorphology of Hangzhou-Jiaxing Lake Plain, this paper delineates the geomorphological regions of Hangzhou-Jiaxing Lake Plain according to Table 1 as follows.

The mountainous area is the upper part of the Hangjia Lake basin, and low hills are scattered in the middle of the area. The mountains are mainly formed by geological tectonic uplift and can be divided into high mountains, middle mountains, low mountains, and hills according to height and form. The high mountains and the middle mountains refer to the Tianmu Mountains in the southwest of the region, which are the largest in scale, with the main peaks 1000 m above the sea level. Low mountains are distributed in the west of the region, mainly in the Mogan Mountains, with the main peaks mostly at 400-700 m. The hills are scattered and isolated, with thin mountains, generally between 100 and 300 m in elevation:

TABLE 1: Basic morphological indicators of the plain landforms.

Basic form type	Relative height (m)
Alpine	>800
Zhongshan	600-800
Low mountain	100-600
Hill	10-100
Plain	<10

$$M(x) = \lim_{n \rightarrow \infty} \sum_{i=1}^n w_i^2 \sigma(w_i x), \quad (1)$$

$$\delta = \ln\left(\frac{2^x + 1}{2^x - 1}\right), \quad (2)$$

$$J = M(x, \{w_i\}) + x^2. \quad (3)$$

The plain area has high topography in the southwest and low topography in the northeast. The lowland landforms in this area are in the northern part of Lunan area and east of the Jiangnan Canal to Hangzhou, forming a marine plain. The shoreline of Qiantang River is uplifted due to long-term seawater support, and the terrain is mostly flat and high, with an altitude of 4.5-7.5 m. The coast (river) is protected by sea ponds or embankments from lake water, and the embankment is an Ebb Tide Beach; the area west of Hangzhou and east of Tianmu Mountain is composed of hills and hilly submerged alluvial deposits. The area to the west of Hangzhou and east of Tianmu Mountain is composed of flooded alluvial materials of hills and mountains, with an elevation between 5 and 10 m. The impact lake plain has flat ground, around Jiaying and Dongxiang, with an elevation between 3.5 and 5 m. Long-term human activities make the terrain large flat and small uneven, and the ground height varies. The terrain of the lakefront is low and flat, and the elevation of the ground around Huzhou Linghu is only 2.8-3.5 m, locally only 2 m or less, and most of the ground is below the flood level. The distribution of lakes in the area is concentrated, the rivers are wide and deep, and the water area accounts for more than 20% of the area of the region. The water and dry fields on both sides of the Grand Canal are interspersed, the surface is uneven, the elevation is 3.5-4.5 m, and it consists of large alluvial plains and lake flats, mainly in the eastern and northern parts of the area, with an area of about 6860 km²; a small number of lake flats are distributed in the Hangjiahu Plain near Taihu Lake; the elevation is less than 3 m, basically around 2 m.

The water of Hangjiahu Plain is the source of thousands of rocks and ravines of Tianmu and Baiji mountain ranges in the west, and the East Sea is the commission of Hangzhou Bay in the east. The basin is the largest plain river network within the Taihu Lake basin and is a typical plain water network area. It includes the Campsis River Basin and Changxing Plain, which is the upper part of Taihu Lake

Basin. The mountainous water system in this area is mainly composed of rivers such as East Campsis and West Campsis, which are characterized by short sources and rapid flow and stormy floods. The central and eastern plains are dominated by artificial river networks, with flat terrain and rivers, and the water surface rate of the river network in the Jiahu Plain is as high as 11.6% and 14.8% in the northern lakeside area. The southern part of the Hangzhou Bay area has shallow and narrow rivers and dense water network, and the water area accounts for about 57% of the total ground surface. Most of the ground surface is above the flood level, where the average groundwater level in the lowland plain area is 1.0–2.0 m below the surface and locally exceeds 3.0 m, which is recharged by rainwater and farmland irrigation back to the pore diving in the underground surface layer. According to the 2019 data statistics, the total area of the wetlands of Hongjie Lake is 128.35 km² (excluding the area of paddy fields). The river current slope drop in the area is very small, the influence of tidal top support is prominent, the flow velocity is slow, the phenomenon of reciprocal flow is prevalent, and the hydraulic conditions are exceptionally complex, as shown in Figure 1, which shows the relationship of geomorphic influence factors.

Topography is influenced by lithology, i.e., tectonics. The influence of lithology on the geomorphology of an area is mainly manifested in the difference of physicochemical properties of rocks, which leads to different resistance to weathering, for example, the chemical composition of chert is calcium carbonate, which is easily eroded by water solution, and it is this chemical weathering that leads to the formation of karst landscape. For example, when quartz sandstone and mudstone are interbedded, the mudstone is more susceptible to weathering and denudation, which is called differential weathering, thus forming a landscape like “a line of sky.” The main influence of lithology on the topography is the external dynamic geological effect, that is, weathering. We analyzed the relationship between the division of geographical types in the southern Jiangsu area and their respective research problems in related studies, developed a geographical type area division method suitable for this study, divided the southern Jiangsu area into five types of geographical type areas: mountainous, hilly, plain, lake, and polder, and initially delineated the boundary of each geographical type area based on the satellite image map of the southern Jiangsu area. Subsequently, according to the delineated territorial type zones, typical cities within the type zones and at the junction of the type zones are searched for, and research is conducted on these cities and their surrounding areas to further deepen the boundary information of the territorial type zones, and additional buffer zones are established. Finally, we select suitable sample areas within each geographic type area, obtain aerial and satellite image maps of three historical periods, and carry out correction processing, element extraction, and data analysis. In the following section, the distribution characteristics, evolutionary characteristics, and generation mechanism of urban space in each period will be studied:

$$GJ_{ik}^{jint} = Fini_k + Fini_l + Fini_r. \quad (4)$$

This chapter focuses on an overview of the topography, climatic conditions, soil conditions, and other natural conditions of the Hangjiahu Plain. The geomorphology and hydrology of the Hongjie Lake Plain are based on the basic framework of the northwest-southeast fracture structure. Different geological activities have shaped the mountains, lakes, and wetlands in the Hangjiahu Plain. The Qiantang River enters the sea from west to east along the southern shore of Hangzhou-Jiaxing Lake and is often frequented by sea tides. The Campsis River originates in Tianfu Mountain, the highest mountain in Zhejiang, and flows south to north into Taiho Lake, while nourishing the farmland and water network of the Hangzhou-Jiaxing Lake Plain [22]:

$$GJ_{ik}^2 = \frac{GJ_{ik}^{jint}}{\lim_{n \rightarrow \infty} \sum_{i=1}^d GJ_{ik}^{jint}}. \quad (5)$$

The combination of subtropical monsoonal climate and topography makes the spatial and temporal distribution of precipitation in the region seriously uneven. This has directly led to the intermingling of frequent floods and droughts in the Hangjia Lake Plain, which had certain restrictions on agricultural production in the ancient Hangjia Lake Plain, but also provided opportunities for the renewal of land use and human exploration and management. In short, the good location and natural conditions provided the basis for agricultural production and, at the same time, providing a quality place for the ancient people to flourish.

The early regional culture of the Hangjiahu Plain shows interruptions and transitions in the process of historical layering. In ancient times, the area was prone to sea invasion, waterlogging, and erosion; therefore, the cultural reproduction process showed that the prosperity was sharply damaged and even destroyed, and then, a new cultural pattern was formed again. 7000 years ago, there were ancestors in Majiabang in Jiaying who cultivated, harvested, fished, and hunted here; during the period of Great Yu's water control, the Fengfeng clan established the Fengfeng state in Deqing, Huzhou. At this time, the Yang Shao culture, Longshan culture, and Bronze culture formed along the Yellow River basin showed continuity and transition, and the cultural development process in Hangzhou, Jiaying, and Lake was far behind the Yellow River basin. The area, as the East China Sea edge end of the Chinese land, was considered in ancient times to be the land of the zephyr and the place of barbarism, and the establishment of ancient civilization was trapped by the strong impetus of the natural environment that was difficult to sustainably maintain, and the Liangzhu culture, as the most representative civilization origin of the Hangjiahu Plain, was maintained for nearly a thousand years, after which it suddenly broke off.

3.2. Analysis of Spatial Distribution Characteristics of the Urban Landscape. According to the above analysis, there are certain similarities in the urban scale, morphology and boundaries, and spatial distribution characteristics of cities in each geographical type zone based on the obvious

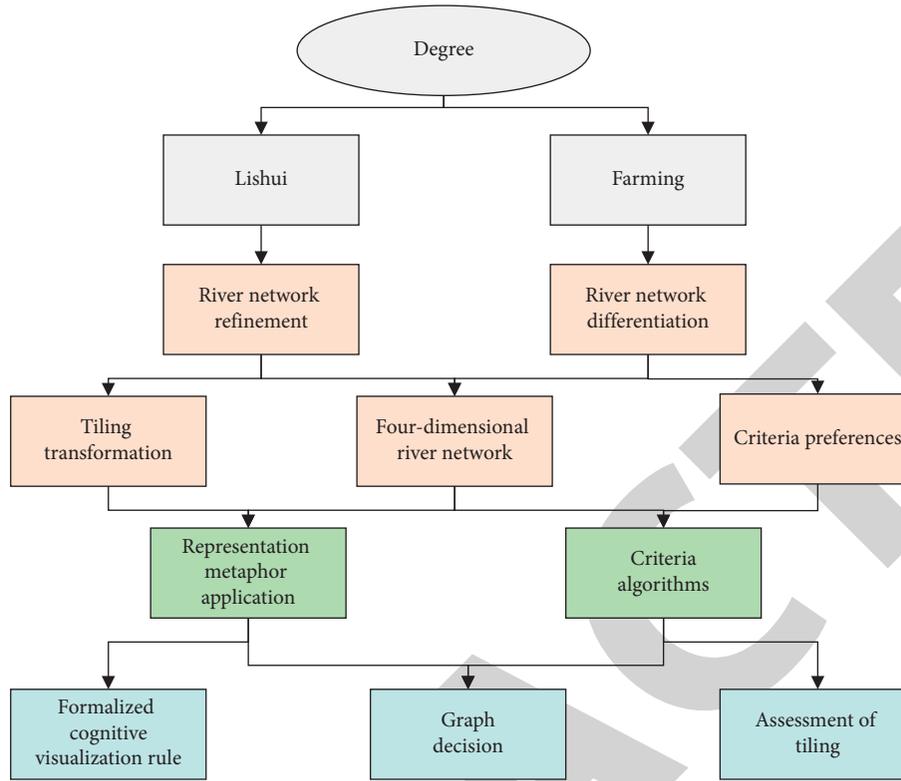


FIGURE 1: Geomorphic influence relationship map.

distinction of categories. Based on a single overall trend, there are also certain contradictions with the overall trend. Natural geographic conditions are the substrate for the selection of urban residence sites and the conduct of villagers' production and living, and there are many restrictions, while providing various types of resources. Also, factors such as industrial patterns, transportation conditions, and farming radius are ways in which physical geography indirectly influences urban spatial distribution. Due to the large number and age of cities in the sample area covered in this paper, enough socio-economic data could not be obtained, and proper quantitative analyzes could not be made only by the prescriptions, villagers' oral accounts, and municipal-level statistics, and the shortcomings, too, will be improved in further studies of the subject. This section takes the socio-economic policies and local industrial patterns obtained from the background data as the entry point and combines them with physical geographic elements to explore the mechanisms that produced the spatial distribution characteristics of cities during the traditional agricultural period:

$$P(y_i) = p_i^{y_i} \left(1 - \frac{1}{p_i}\right)^{1-y_i}, \quad (6)$$

$$CI = \lim_{m \rightarrow \infty} \sum_{j=1}^m \frac{a_j^2 CI_j}{1 + a_j^2 CI_j}. \quad (7)$$

There are two types of areas within each geographic type area: areas that are suitable for the creation of cities and areas that are unlikely to create cities. For example, areas with large slopes in mountainous and hilly areas and within large-scale water bodies in each geographical type area are areas that are not likely to generate cities. The proportion of the area suitable for city generation to the total area of the geographical type area is an important consideration for land productivity. In terms of the possibility of city location, polder-type and plain-type areas are the best, except for the interior of large-scale water bodies, which are suitable for cities; lake-swept areas are the second-best, with more large-scale lakes in the interior; hilly areas are the second-best, with no cities in areas with large elevation and slope or in large-scale water bodies; mountainous areas are the worst, except for a small portion of areas with suitable elevation and slope, which are unlikely to produce cities.

Also, the pattern of the partitioning of areas that are unlikely to produce cities to areas that are suitable for producing cities within an arbitrary range leads to a pattern of urban distribution. When there are no areas where cities are impossible to be generated and the distribution of land and water resources is uniform, cities are distributed randomly with the closest neighbor index of 1. Among the five types of geographical areas, the most likely pattern are plain and polder areas; when the areas where cities are impossible to be generated account for the majority and the areas where

cities are suitable to be generated, the distribution of cities tends to be aggregated, and the more cities there are in the area suitable for cities, the greater the degree of aggregation, and the most likely model is the mountainous area; when the area suitable for cities in the majority and the area not suitable for cities cannot be completely separated, the distribution of cities tends to be discrete, and the most likely model is the hilly and lake-swept area:

$$\varphi_{a,b}(t) = \frac{4}{\sqrt{a_i^j}} \varphi^2\left(\frac{t - b_i a_i^j}{b_i^j}\right). \quad (8)$$

The conditions of land resources are the best in the plain, lake, and polder areas, which are flat and have the least difficulty in construction and land reclamation; the hilly areas are slightly higher in elevation and slope and have the second-best conditions; the mountainous areas have the worst conditions and are affected by elevation and slope, and even in the internal areas suitable for urban development, the cost of production activities is very high. In terms of water resource abundance, the lake and polder-type areas have the best conditions, and the internal water resources are abundant and evenly distributed; within the plain type areas, hilly type areas, and mountain type areas, the abundance of water resources and the evenness of distribution decrease in that order. In addition to the abundance of water resources, the accessibility of water resources should be taken into consideration. The polder-type areas have the best conditions, and the internal network of polders is dug by the river pickers according to the actual needs. According to the productivity in the traditional agricultural period, the arable land area, urban area, population, cultivation radius, water consumption, and other factors in each network match moderately, and the width and distribution of the polders are extremely uniform, so the water resources can be irrigated to all farmland precisely, which is most suitable for agricultural production; the overall distribution of internal water bodies is more uniform, and small-scale linear water bodies are suitable for urban production and domestic water intake, but the shape is tortuous, and the scale of surface water bodies varies greatly, resulting in the degree of access to water resources in local areas being affected; the scale and uniformity of internal water bodies in plain and hilly areas are different, and the conditions are same; mountainous areas have the most difficult access to water resources. Finally, in terms of the probability of natural disasters, the mountainous type area is prone to geological disasters; around the large-scale lakes in the hilly-type and lake-swept type areas, floods are prone to occur; the polder-type area is farther away from the Yangtze River, and the elevation is much higher than the river, so the probability of floods is smaller; the plain-type area has no obvious disaster-prone types, as shown in Figure 2.

The difference between the scale characteristics of cities in the traditional agricultural period is produced under the action of a single level of land productivity. That is, in areas with high land productivity, resources are abundant and evenly distributed, and the resistance to urban development is low, resulting in the simultaneous increase of various

factors such as land development intensity, single urban area, and the number of cities; however, in areas with low land productivity, resources are scarce and unevenly distributed, and the resistance to urban development is high, resulting in the backwardness of various factors such as land development intensity, single urban area, and several cities. The level of resistance to urban development can also be reflected visually in the degree of difference between the shape of the density and quantity of urban distribution line graphs based on altitude and slope. The greater the difference between the two, the more it means that the area suitable for urban generation in that geographical type area does not overlap with the area with the largest proportion. In the relationship between urban spatial distribution and elevation, the smallest difference between the shape of the number line diagram and the density line diagram is the plain type and the hilly type, and the largest difference is the mountain type; in the relationship between urban spatial distribution and slope, the smallest difference between the shape of the number line diagram and the density line diagram is the polder type and the lake-swept type, and the largest difference is the mountain type. Accordingly, it can be learned that the conditions of the mountainous-type cities played a great role in hindering the production and construction activities in the traditional agricultural period.

4. Analysis of Results

4.1. Analysis of the Results of the Generation Mechanism of Distribution Characteristics. Among the elevation and slope characteristics of city sites, it can be found that most of the cities are located in areas with relatively low elevation and slope within the geographical type area, reflecting the characteristic of “choosing low.” Undoubtedly, this characteristic is due to the consideration of reducing the difficulty of production and construction and avoiding the danger of possible geological hazards in mountainous and hilly areas. This feature is also evidenced in related studies, as shown in Figure 3. However, in lake-swept areas, cities are located in areas with a gentle slope and moderate elevation, for two reasons: firstly, to avoid the risk of flooding, as lake-swept areas have a large area of water bodies and complex water conditions, and the risk of flooding is higher; secondly, to facilitate farming, as lake-swept areas have mainly washed fields (paddy fields), and the lower terrain is used for farming to ensure the storage of water. Therefore, the distribution of lake-swept cities is “higher” for safety reasons and as a concession to production.

In Figure 3, we can see that the trend of the changes in the corresponding values is consistent across these three years, which also indicates the stability and generalizability of the results. In the relationship between urban spatial distribution and water bodies, it is obvious that there are polarized differences, that is, the “pro” of small-scale water bodies and the “sparse” of large-scale water bodies; the reason for this difference is that the city’s daily production, domestic water, large-scale water bodies, and function of small-scale water bodies are very different. The role of small-scale water bodies is mainly for the direct intake of water,

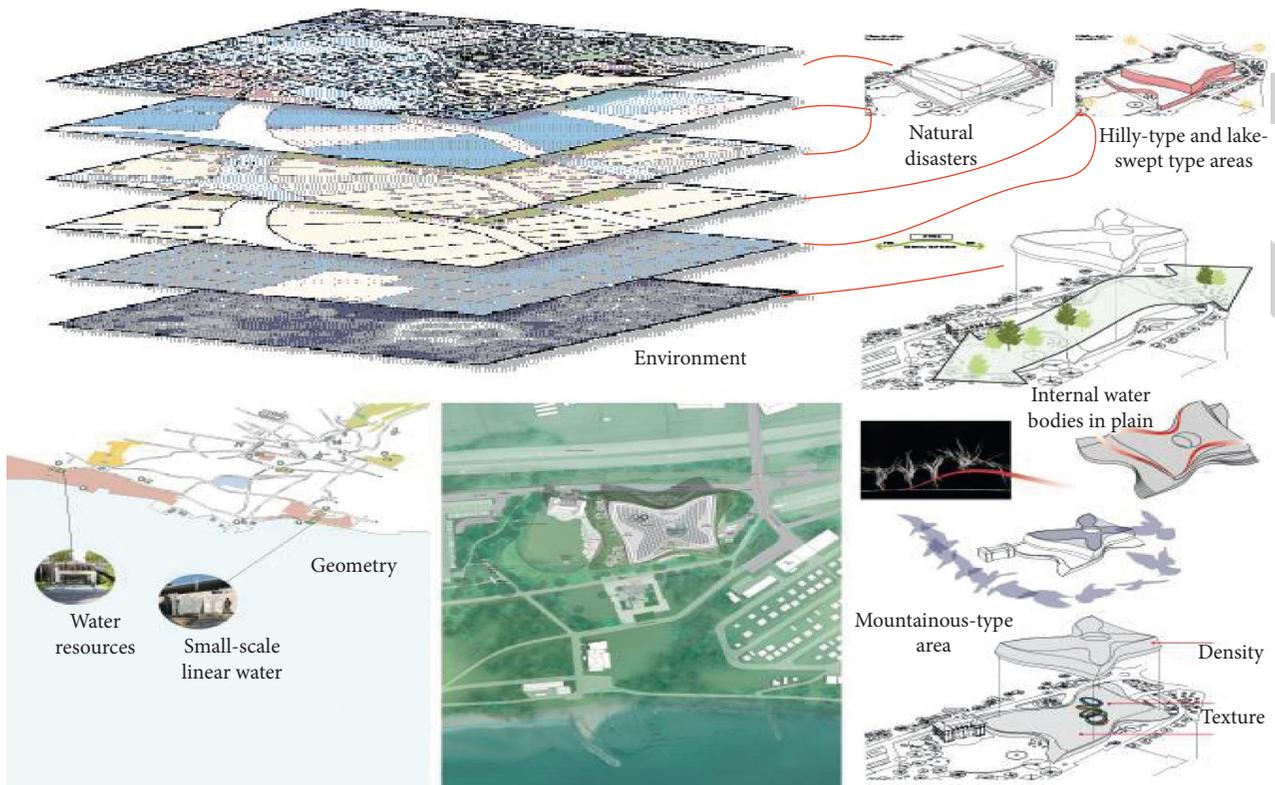


FIGURE 2: Spatial distribution characteristics of the urban landscape.

such as drinking and laundry, in addition to the polder-type and lake-swamp type areas and transportation functions; the role of large-scale water bodies are mainly for the production of water; its direct service is the development of arable land or fisheries. Also, the probability of various floods and the hazards caused by large-scale water bodies is much higher than those of small-scale water bodies. Therefore, in the process of urban siting, cities are generally located close to small-scale water bodies; however, for large-scale water bodies, cities are built based on ensuring that they are located within the radius of cultivation, and the surrounding terrain is high.

Two distinct “linear patterns” can be found in the distribution of urban nuclei density in each geographical type zone in southern Jiangsu. One is the concentration of urban distribution along with small-scale linear water bodies, and the other is the development of cities along narrow foothills in mountainous areas. Almost all the peak areas in the nuclear density distribution map are concentrated around the linear elements, as shown in Figure 4. These linear elements not only influence the spatial distribution of cities but also the scale characteristics of cities. In the lake-swept and polder-type areas, the small-scale linear water bodies interspersed with each other facilitate the traffic between villages, which in turn leads to the development of cities along the direction of water bodies, thus forming a strip-like urban form. In the polder-type areas, the water bodies are crisscrossed and the “linear pattern” is further developed into a “network pattern,” which leads to convenient transportation between cities and rapid urban development

with great density. Beyond the control of linear water bodies in plain and hilly areas, cities often choose to occupy small point-shaped water bodies or occupy higher ground around large point-shaped water bodies, thus completing the “surface area control” of the surrounding land within the radius of cultivation.

During the traditional agricultural period, the dominant industrial pattern of each geographical type area was determined by the natural geographical environment. For example, the plain, lake, and polder-type areas have fertile land and abundant water resources, and agricultural production is dominated by rice cultivation. In contrast, mountainous and hilly areas are relatively scarce in land and water resources, resulting in crude agricultural production and complex crop varieties.

Due to the constraints of productivity level, human beings in this period had little possibility to actively choose or change industrial patterns and could only passively “adapt.” Therefore, the economic development of plains, lakes, and polder areas was relatively fast, while the economy of mountainous and hilly areas was relatively backward. With the development of history, the working people in the relatively affluent regions chose to modify the natural environment by appropriate methods to better utilize the advantages of the natural geographical environment and industrial patterns in the regions and to improve crop yields. This is shown in the polder-type areas where the polder is artificially cut and spread in a network along both sides of the river, as shown in Figure 5, bringing water into the interior of the land and increasing the coverage of water

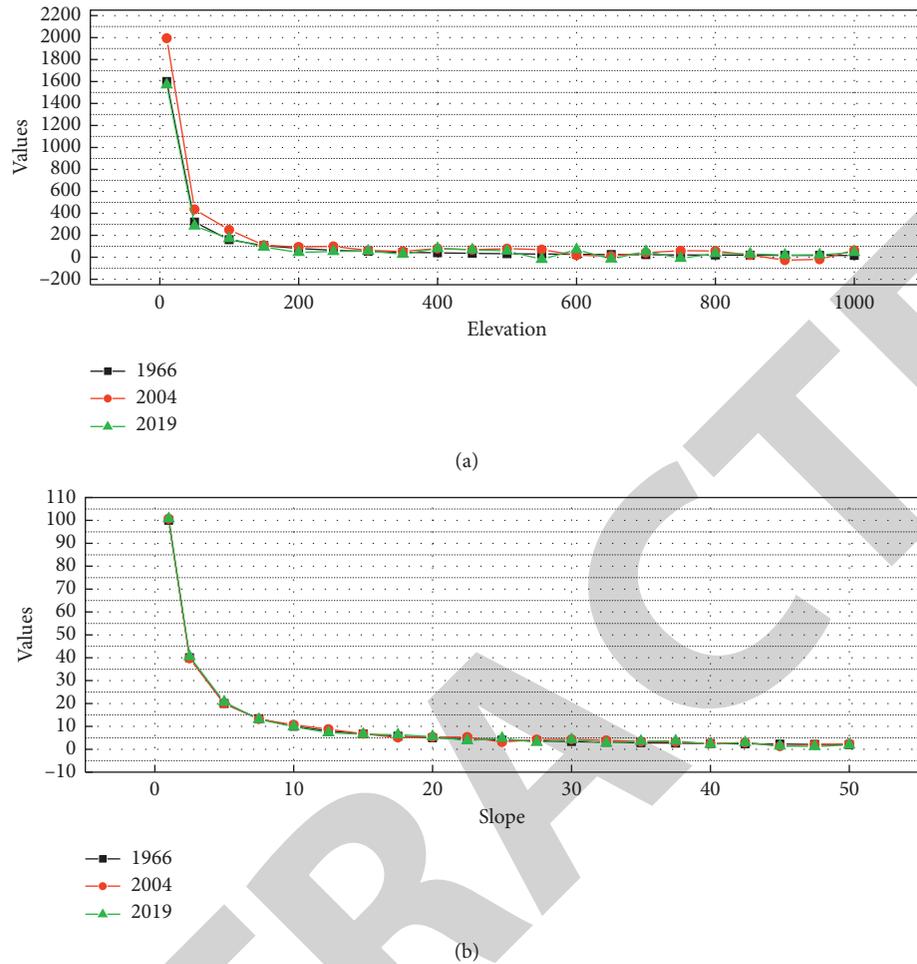


FIGURE 3: City size variation with elevation and slope.

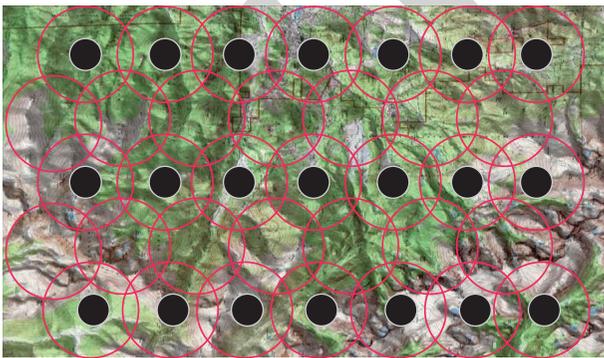


FIGURE 4: Schematic of the linear pattern.

resources, while avoiding the risk of flooding in large-scale water bodies. Such “changes” form a virtuous circle, which also causes the polder-type cities to far exceed the other four types of geographic areas in the statistics of urban scale characteristics.

It is worth noting that the productivity in the traditional agricultural period could not transform the regional physical geographic elements on a large scale, but the small-scale adjustment has made the development of polder-type cities

far ahead. In the next two periods after the “Southern Jiangsu Model” and the “New Southern Jiangsu Model,” the magnitude of the influence of policies, industrial patterns, and subjective human will on urban spatial distribution increase significantly with product development. Similarly, the inherent advantages and disadvantages of physical geographic factors will change in different periods with different production demands.

4.2. Urban Spatial Distribution Evolutionary Characteristics.

Under the condition of relatively constant natural geographical conditions, the change of rural settlements over time is a meritocratic process based on the continuous development of economic, industrial, and transportation factors and is a direct manifestation of changes in productivity and production patterns, except for a small number of areas influenced by macroregulation. The urban patches in the three periods of 1966, 1990, and 2019 within the sample of each type area are superimposed. The changes in individual cities can be broadly categorized into three basic patterns: staying the same, increasing in size, and decreasing in size. The probability of occurrence of these three basic patterns for the two periods 1966 to 1990 and 1990 to 2019 is

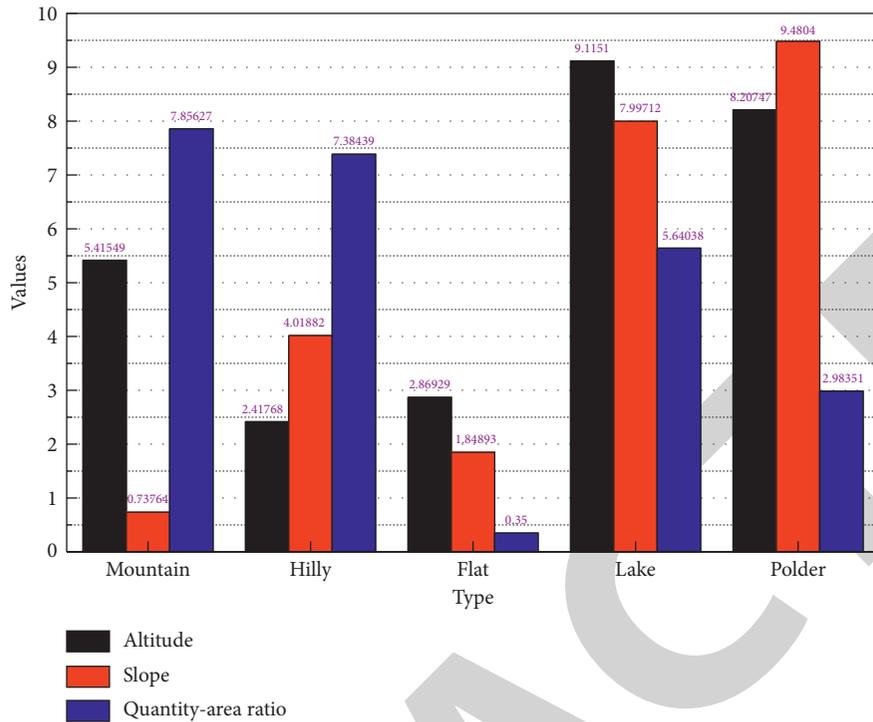


FIGURE 5: Sample area.

shown in Figure 6 for a total of 2135 urban patches (in 1966) in the five geographic type areas.

From 1966 to 1990, the development pattern of cities was dominated by scale growth, with an overall share of 87.3%, and the share was more than 80% in all geographical type zones and up to 93% in hilly cities. From 1990 to 2019, the trend of urban scale growth in each geographic type zone slowed down significantly, and the number of urban scale decreases increased significantly and even exceeded that of scale increases in the polder-type cities. It is worth mentioning that, from 1966 to 1990, the five types of zones with the lowest percentage of increase in size in the polder-type cities jumped to the first and the only geographic type zone that exceeded 60% from 1990 to 2019.

By combining the seven urban change patterns in the entire southern Jiangsu region in two intervals from 1966 to 1990 and 1990 to 2019 in the order of their occurrence and removing the logically impossible cases, the development of urban patch change within the sample area can be divided into 38. The percentage of each type is shown in Figure 7.

From the three rooms and two corridors' layout in various forms, the local dwellings are generally set up with a patio, and the ground of the patio is set as low as possible below the foundation of the house, and there are also open drains around the edges. Such settings, in addition to lowering the water table, can be timely rainwater and domestic sewage and another drainage to the lane in the nullah, but also can effectively use the patio to change the microclimate. The nullahs in the lane are connected to the river gorge to facilitate smooth drainage and avoid increasing humidity. As for the interior of houses, people commonly laid floor tiles with strong water absorption. In a patio house,

for example, the end is the patio, which is the part of the courtyard surrounded by high eaves. Rainwater usually flows down the eaves into the patio, then flows along with the patio in a circle or half a circle, and then drains away to the sewer in the alley outside the house. On one side of the patio, there is a sink, stove, cupboard, and other daily utensils; however on the other side, there are usually simple slabs that serve as bathrooms and toilets. It is believed that there are two main purposes for setting up a patio: first, to increase the light of the house, which is narrow and small, making the house, especially the rooms, quite dark; second, to change the microclimate by adjusting the microenvironment, to facilitate the cooling and draining of humidity in the house. Although the details of the three rooms and two corridors' dwellings are different from each other, there is considerable consistency in architectural style and internal layout, while the organization of indoor flow, division of indoor space, and internal traffic space have their focus.

The kernel method was applied to generate kernel density maps of urban distribution in 1966, 1990, and 2019 for each study area, and they were overlaid with the elements of cities, market towns, industrial areas, and roads in the region and compared with each other, as shown in Figure 8.

Among the natural environment characteristics of the five geographical type zones, the mountain type and polder type have two distinct advantages and disadvantages, develop rapidly when they match with each other in terms of economic and industrial patterns, and develop slowly on the contrary; the hilly type, plain type, and lake-swept type have balanced conditions in all aspects and are in the middle of the transition area in terms of altitude and terrain, or the richness of water resources. Therefore, it has strong

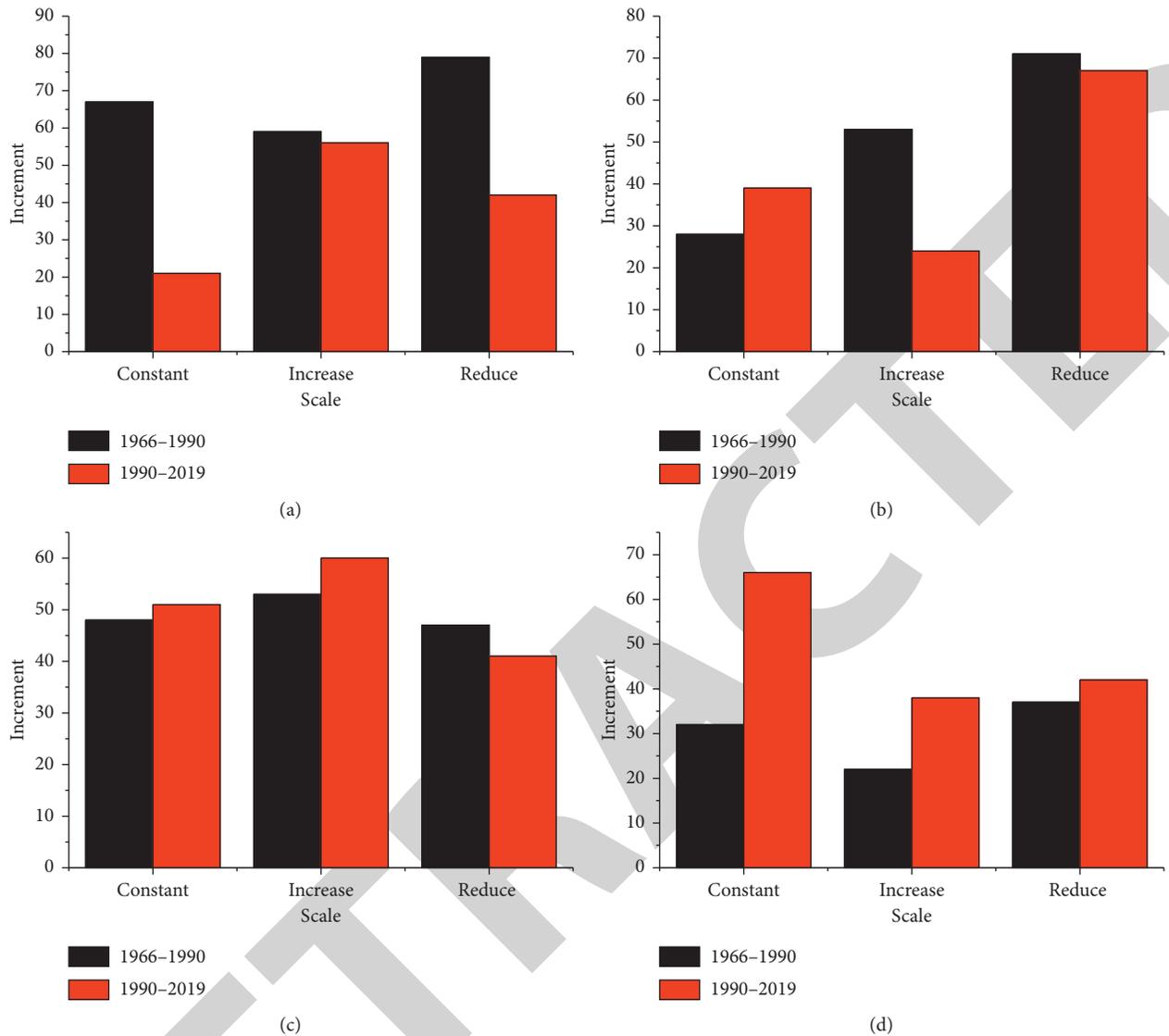


FIGURE 6: Statistics of the three basic patterns of urban development in each geographical type zone. (a) Mountain. (b) Hilly. (c) Flat. (d) Lake.

adaptability to various industrial models and does not produce strong rejection. It is highly adaptable to various socio-economic systems and industrial models and can maintain development under various models. This is demonstrated by the relatively smooth changes in the evolution of its urban scale, whether it is increasing or

decreasing in size, while the changes in the mountainous and polder types are much larger. Thus, the frequent fluctuations in the mutual quantitative relations of various indicators between the mentioned zones of different geographical types are mainly due to such characteristics of mountainous and polder-type areas.

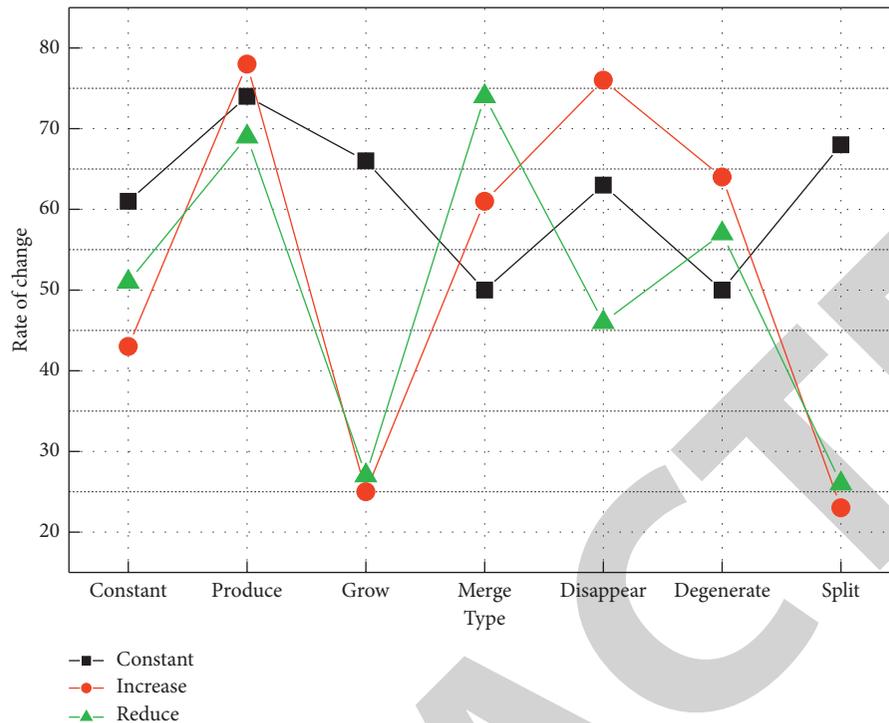


FIGURE 7: Statistical chart of the percentage of urban development in each geographical type zone.

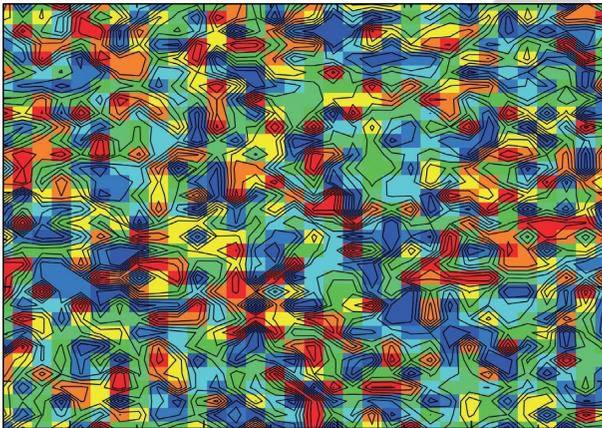


FIGURE 8: Urban nuclear density map.

5. Conclusion

In this paper, representative sample cities were selected within and at the boundaries of the preliminary delineation of geographic type zones, and field research was conducted in the sample villages and the surrounding areas to deepen the delineation of geographic type zones. Through comparative analysis, case study, quantitative analysis, common time and ephemeral analysis, and other research methods, the distribution characteristics, evolutionary characteristics, and generation mechanisms of urban space in each geographical type area in southern Jiangsu are summarized, providing feasible methods for future related research and making suggestions for practice. Under the policy background of attaching importance to the urban historical

landscape and strengthening cultural inheritance, this paper takes urban historical mapping as the core research method to organize and transform descriptive historical documents into quantifiable and visualized spatial data conforming to GIS data structure as much as possible. The value of this paper is that, by looking at the distribution of the landscape layout in different years and the corresponding prediction of the results, our findings can be used to guide the layout in the future. Based on the macrolevel and microlevel and using points, lines, and surfaces as the basic elements of spatial analysis, we have conducted a more in-depth study on the development of the town network, the metropolitan system of the capital city, and urban morphological changes in the Jiangnan region before the 14th century and have gained a certain understanding of the morphogenesis process of the case cities in the Jiangnan region. The study also summarizes the patterns and influencing mechanisms of the case cities during the study period.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Acknowledgments

This work was supported by Zhejiang Gongshang University.

References

- [1] J. Li, L. Yang, R. Pu, and Y. Liu, "A review on anthropogenic geomorphology," *Journal of Geographical Sciences*, vol. 27, no. 1, pp. 109–128, 2017.
- [2] I. Boomer, N. Aladin, I. Plotnikov, and R. Whatley, "The palaeolimnology of the Aral Sea: a review," *Quaternary Science Reviews*, vol. 19, no. 13, pp. 1259–1278, 2000.
- [3] T. Wu, C. Zhou, N. Jiang et al., "Stability analysis for high-steep slope subjected to repeated blasting vibration," *Arabian Journal of Geosciences*, vol. 13, no. 17, pp. 1–12, 2020.
- [4] Y. Wu, X. Fang, S. Liao et al., "Crustal evolution events in the Chinese continent: evidence from a zircon U-Pb database," *International Journal of Digital Earth*, vol. 13, no. 12, pp. 1532–1552, 2020.
- [5] N. Jiang, H.-B. Li, M.-S. Liu, J.-Y. Zhang, and J.-W. Zhou, "Quantitative hazard assessment of rockfall and optimization strategy for protection systems of the Huashiya cliff, southwest China," *Geomatics, Natural Hazards and Risk*, vol. 11, no. 1, pp. 1939–1965, 2020.
- [6] J. X. You, J. N. Li, Y. J. Zhao et al., "Effect of spring soil moisture in Indo-China Peninsula on summer precipitation over the South China Sea and surrounding area," *Acta Scientiarum Naturalium Universitatis Sunyatseni*, vol. 57, no. 3, pp. 34–43, 2018.
- [7] Z. F. Li, X. Meng, J. N. Qin et al., "Advances in application of plant growth regulators in walnut production," *Guizhou Agricultural Sciences*, vol. 45, no. 9, pp. 31–33, 2017.
- [8] N. Jiang, L. Q. Wang, Z. L. Li et al., "Inhibitory effect of ozone on the growth and mycotoxin production of *Alternaria*," *Shipin Kexue/Food Science*, vol. 40, no. 21, pp. 51–57, 2019.
- [9] Z. L. Li, N. Jiang, L. Q. Wang et al., "Study on degradation of 3 kinds of alternaria toxins by short-wave ultraviolet treatment," *Journal of Food Safety and Quality*, vol. 10, no. 7, pp. 2033–2037, 2019.
- [10] H. Han, Q. Ma, and Y. Li, "Urban growth boundaries of the Hangzhou Metropolitan area based on ecosystem service," *International Review for Spatial Planning and Sustainable Development*, vol. 5, no. 2, pp. 4–16, 2017.
- [11] D. L. Long, J. N. Wen, M. Wang et al., "Automated incubation system in vitro: venting pressure less than 19 kPa did not affect fermentation characteristics," *Chinese Journal of Animal Nutrition*, vol. 29, no. 11, pp. 4171–4179, 2017.
- [12] T. Wu, Z. Chuanbo, J. Nan et al., "Study on the mechanical cumulative damage model of slope fault fracture zone under the cumulative effect of blasting vibration," *Periodica Polytechnica Civil Engineering*, vol. 64, no. 3, pp. 845–858, 2020.
- [13] H. Gao, N. Jiang, Y. J. Xia et al., "Dissection of grain yield differences between japonica rice in northeast China and in Japan," *Chinese Journal of Rice Science*, vol. 32, no. 4, pp. 357–364, 2018.
- [14] K. Hu, Q. Luo, K. Qi et al., "Understanding the topic evolution of scientific literatures like an evolving city: using Google Word2Vec model and spatial autocorrelation analysis," *Information Processing & Management*, vol. 56, no. 4, pp. 1185–1203, 2019.
- [15] X. Fei, Z. Lou, G. Christakos, Z. Ren, Q. Liu, and X. Lv, "The association between heavy metal soil pollution and stomach cancer: a case study in Hangzhou City, China," *Environmental Geochemistry and Health*, vol. 40, no. 6, pp. 2481–2490, 2018.
- [16] J. Wu, Z.-Y. Wu, H.-J. Lin, H.-P. Ji, and M. Liu, "Hydrological response to climate change and human activities: a case study of Taihu Basin, China," *Water Science and Engineering*, vol. 13, no. 2, pp. 83–94, 2020.
- [17] J. Bao, S. Gao, and J. Ge, "Salt and wetland: traditional development landscape, land use changes and environmental adaptation on the central Jiangsu coast, China, 1450–1900," *Wetlands*, vol. 39, no. 5, pp. 1089–1102, 2019.
- [18] J. Xie, X. Jin, Y. Lin et al., "Quantitative estimation and spatial reconstruction of urban and rural construction land in Jiangsu Province, 1820–1985," *Journal of Geographical Sciences*, vol. 27, no. 10, pp. 1185–1208, 2017.
- [19] Y. Zhang, S. Cheng, and X. Ji, "Structural analysis of green infrastructure in Suzhou Dushu Lake higher education district," *Journal of Landscape Research*, vol. 11, no. 5, pp. 59–69, 2019.
- [20] W. Jiang, L. Wang, L. Feng, M. Zhang, and R. Yao, "Drought characteristics and its impact on changes in surface vegetation from 1981 to 2015 in the Yangtze River Basin, China," *International Journal of Climatology*, vol. 40, no. 7, pp. 3380–3397, 2020.
- [21] X. G. Zhao and L. Fan, "Spatial distribution characteristics and convergence of China's regional energy intensity: an industrial transfer perspective," *Journal of Cleaner Production*, vol. 233, pp. 903–917, 2019.
- [22] M. Chen, S. Lu, and Q. Liu, "Uniqueness of weak solutions to a Keller-Segel-Navier-Stokes system," *Applied Mathematics Letters*, vol. 121, Article ID 107417, 2021.
- [23] J. Yang, J. Wen, Y. Wang et al., "Fog-based marine environmental information monitoring toward ocean of things," *IEEE Internet of Things Journal*, vol. 7, no. 5, pp. 4238–4247, 2019.
- [24] B. W. Yan, H. Y. Yang, Y. J. Cai et al., "Synthesis of γ -glutamyl dipeptides in lactic acid bacteria and its influence on the taste of steamed bread," *Shipin Kexue/Food Science*, vol. 40, no. 16, pp. 91–96, 2019.