Research on Nanjing Ancient Urban Morphology Evolution Based on Climate Adaptability

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Abstract: Evolution mechanisms and rules of urban morphology were explored mostly from cultural, historical and geographical aspects, but rarely from the aspect of climate adaptability. From the aspect of historical geography, the transition of the Nanjing city came out as the layout changes of the natural and social phenomenon, and combined with the gambling and impelling of the relationship between the human and the nature. The research takes the ancient Nanjing city as an example to analysis the climate adaptability from the site selection and change of the urban morphology., the change of site selection and urban river system were caused by the climatic change, which aroused the continuous change of the urban morphology.

1. Introduction

Researchers of Urban morphology mostly had been doing researches based on cultural, historical and geographical sights to explore the evolution of urban morphology, rarely based on the climate adaptability. Schlüter (1899), Sauer (1925) and Conzen (1960) made fundamental contribution to the research of urban morphology.[1] Whitehand treated the research of urban morphology as to explore the relationship between the physical form and the function of urban society.[2][3] Although most area of urban are covered with green space, they obtain less attention from the aspect of urban morphology with the growing acknowledge of their importance. In historical process, climate adaptability existed in the formation and evolution of urban morphology. [4] Researches have explored the spatial relationship between the temperature and morphology of urban green space,[5] This research intends to settle the relationship between the urban morphology and climate adaptability in history. The method and content of urban morphology have not been settled down in academia. [1] The concern of urban fringe belt in China have been increased prominently in recent decades, which proved its weakness in worldwide. [6] According to this research, the change of fringe belt in Nanjing urban morphology-the river bank has certain relevance with the climatic change. The paper attempts to reveal the evolution of urban morphology and the climate adaptability, takes Nanjing as an example and tries to find the relationship between these two items.

2. Material and Methods

2.1 Climate adaptability in site selection

The cite selections of cities in ancient China contained multiple dimensions of wisdoms. The profitable cite selection was “Hidden from the wind and enjoying the water”, and was benefit for the eco-system, also was an urban morphology harmonized with topography, climate, ecology and landscape. Wu Qingzhou has concluded the thoughts of cite selection to be: choosing the sky, like the sky and benefit situation. Situation superiority was the consideration of geographical elements, natural environment,
and built the city in the cite which was most benefit of defense and production. The city of Nanjing is more suitable for the situation superiority because of the special geographical morphology in the process of being a capital and prefectural city.[7]

The urban planning system of the cities in ancient China was roughly in shape in the early period of Xi Zhou (11th century BC). In the late years of Spring and Autumn period, the official documents of Qi-<Book of Diverse Crafts>, one chapter <Craftsman. Planning the City> had overall recorded about the construction of city for the first time.[8] “Craftsman planned the city, nine miles in square, three entrances by the side, nine longitudes and nine latitudes in the middle, nine tracks in the road, ancient temple in the east and altar of land and grain in the west, palace in the front and market in the back.” These ancient planning systems have not been proved by archaeological evidences, but the cites like Jin Houma, Yan Xiadu and Zhao Handan had palaces as their core and had streets in order which can prove the <chapters of craftsman>’s truth.[9]

2.2 the climate adaptability of Nanjing’s Cote selection



Figure1. The world temperature undulating during the past 1700 years and the period when Nanjing Settled as the capital of China

Figure2. The historical sites of Nanjing and the relationship with the water system

There has been a long time for ancient citizens to utilize the natural resources of the mountains and rivers for the urban planning of the Nanjing city. There were many examples to choose the cities’ settlement based on the geographical and topographical advantages, Nanjing was a tropical one. [3] As recorded in <Jing Ding Jiankang Zhi>:” The city of Jinling (Nanjing) was located along the Yangze River and took advantage of the terrain. The western part of the city occupied the Stone Mountain and connected to the Changan Mountain.” [10]When Zhu Yuanzhang settled Nanjing as the capital of Ming Dynasty, he was trying to utilize the natural resources to construct the city which was advised by Liu Ji. [11](Figure1. The world temperature undulating during the past 1700 years and the period when Nanjing Settled as the capital of China, Figure2. The historical sites of Nanjing and the relationship with the water system)

3. Results

3.1 The evolution of Qinhuai River

3.1.1 The change of the Qinhuai River’s width
Qinhuai River was quite broad in the ancient times, but was used to be called “small river”. In the period of Three kingdoms, there were lots of troops stationed in Nanjing because of the broad of Qinhuai River. The high density of population, intensified efforts made the width of Qinhuai River become narrow continously. According to the archaeological discoveries, the distance between the wharfs in two sides was 100 meters approximately in the Six Dynasties, and the width of one side became five meters narrower in Southern Tang Dynasty, the wharf became lower than what in the Six Dynasties; the river’s width became narrow roughly, about 20 meters by one side, and the river’s mud revetment was one meter lower than in Southern Tang Dynasty. Because of the dry season, the width of Qinhuai River became only 50 meters left. The empty revetment was occupied by the citizens and became narrower to be 20 meters.[12] The change of the Qinhuai River’s width and the decline of water level were relevant to the chilling in the 12th century in ancient China. [9] (Table1. The width of Qinhuai River in history)

| Dynasty                  | Six Dynasty | Southern Tang Dynasty | Song Dynasty | Recent |
|--------------------------|-------------|-----------------------|--------------|--------|
| The distance between the two revetments | 100         | 90                    | 50           | 20     |
| The height of the ground | Slightly lower than in Six Dynasty | One meter lower than in Southern Tang Dynasty |

3.1.2 The urban morphology changes in both sides of Qinhuai River
Before the beginning of modern times, waterway transportation was in the domain place, the urban morphology was influenced by the waterway mostly, road network was related with the river. There was intense waterway transportation network in Qinhuai River, some of the waterway vanished and some of them became road network. [13] With the development of the transportation, the relevance with the waterway became less until it vanished finally. (Figure6. The urban morphology of the riverside of Qinhuai River in Nanjing in 1927. 2 kilometers X 2 kilometers grid. Figure7. The urban morphology of the riverside of Qinhuai River in Nanjing in 2010. 2 kilometers X 2 kilometers grid.)
3.2 The transformation from Lake to farmland in Xuanwu Lake

3.2.1 The origin of the Xuanwu Lake

In the end of Quaternary period, the surface of the Nanjing was rolls-and-swells, there were obvious basins. The center of northern basin was in the present position of Xuanwu Lake, and was slightly close. There were two water outlsets in different directions in Xuanwu Lake, which were the reflection of the ancient water relics. The natural drainage of Xuanwu Lake recorded in <Tong Zhi Liang Jiang Zhi> and <The Chorography of the Capital> were: “One of the water was along Lalong Mountain to Yangtza River, another one flew to the city through the water gate in Taicheng. There were four waterlocks which were controlled by the water level.”

3.2.2 The changing of the morphology of Xuanwu Lake

Xuanwu Lake was formed in ancient times, the morphology and function were changed a lot because of the climate. In the cold period of Northern Song, Wang Anshi thought “Xuanwu Lake was just a place of interests for the former period, but was empty in this time, and there was no meaning to observe it.” The magistrate of Shenzhou-Ding Wei had submitted documents about the scale of Xuanwu Lake. According to the record in <History of the Song Dynasty. The chorography of waterways>, the water was dried up which was the record of the dry up for the first time. Parts of the lake surface turn into farmland after drought. After the proposal of Ding Wei, Xuanwu Lake was swept again and became free life pond in 1020.[14]

The morphology change of Xuanwu Lake was related to the floods caused by the increased precipitation. According to the record in local chronicles, the first flood happened in 1118, 42 years after the abolish of the Xuanwu Lake in Northern Song Dynasty. The second flood was happened in 1163, about 87 years after the abolish of the Xuanwu Lake. As to the natural disaster like flood, Xuanwu Lake could not protect itself. Xuanwu Lake was dredged only in 1301 and 1342 in Yuan Dynasty (1271-1368), and remained to be as an abolish pool.[13] The record in <Jing Ding Jiankang Zhi> in Southern Song Dynasty was not good about Wang Anshi’s abolish of Xuanwu Lake: “The production in land could benefit less people, while the situation in hydraulic engineering benefit most.” Which meant compared with the flood, the production made by the lake’s transition into the farmland was very little. (Figure 8. The section change of Xuanwu Lake in history)

3Wang Anshi (1021-1086), a famous ideologist, politician, litterateur in Northern Song Dynasty (960-1127). Wang Anshi had been the magistrate of Jiangning Province (Nanjing) after he retired as a prime minister.
3.3 The morphological change of the river bank
The morphological change of the Yangtze river bank was influenced by the joint effort by the deposit and construction. Because of the deposit, there were several islands formed along the area of river bank. People built several rafts to get into the island in order to take advantage of the islands. The rafts piled up along the river bank which could form the giant island[6] (Figure 9. The morphology comparison of Nanjing river bank according to the Wu region map in <Jinling Gu Ji Tu Kao>, <Jinling Tu Kao>, Jiangning city in <Jiang Nan Tong Zhi> in Qianlong period.)

4. Discussion
The climatic change in the ancient times was one of the reasons why Nanjing was chosen as the capital of China for several times. Wu (2000) once pointed out that the cite selection was a comprehensive research which contained the knowledge of astronomy, geography, culturology, religious studies, geology, meteorology, hydrology, hydraulics, shipping, biology, ecology, military science, science of disaster. [7]

In the evolution of city, there was natural force like the deposit to change the shape of the river bank in Nanjing. There were ten functions in city water system: military defense, water supply, improving the city environment, transportation, irrigation, preventing the flood, and avoiding the wind and waves, greening and entertainment. [15] This paper takes Nanjing as an example and discusses the climate adaptability in the evolution of the ancient city and the changing rules during the change of the climate.

5. Conclusions
The natural resources influenced the cite selection and construction of the Nanjing city, and formed the unique view of its landscape. During the past thousands years, Nanjing was choses as the capital of ancient China for ten times because of the climate changes. This paper tries to explore the climate
adaptability from the changes of the width of Qinhuai River, the change of the Xuanwu Lake and the river bank of the Yangtze River in morphological aspect

The paper also tries to analyze the effort between the city and the nature and tries to explore the ancient ecological philosophy inside. In the process of the city’s development, the cite selection and the morphological change based on climate adaptability should be considered. Exploring the innovation and rules of the city from the aspect of climate adaptability could also provide advice for the future’s urban constructions.

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