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## Effects of Floods, Droughts, and Water System Changes on the Rise and Fall of China's Ancient Capitals within the Yellow River Basin

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### Abstract

In China, cities are normally built along rivers. The capital of China has changed several times since the establishment of the Xia dynasty, the first dynasty of China. However, most of the capital cities were located along the middle and lower reaches of the Yellow River. The Yellow River system, composed of the Yellow River and its tributaries, has exerted huge effects on the rise and fall of the ancient capitals. Xi'an, Luoyang and Kaifeng are known as the most important, the most famous and the longest-serving capitals of ancient China along the middle and lower reaches of the Yellow River. Focusing on the three historical capitals, this study investigated how changes in the Yellow River system, floods and droughts, and the development of water transport had affected the courses of development of China's ancient capitals.

**Keywords:** The Yellow River system, ancient capitals, floods and droughts, water transport, capital relocation

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### LITERATURE REVIEW

Scholars have studied the history of the ancient capitals of China from different perspectives. Jiao Haihao argued that in different dynasties the location of the capital city, Luoyang, had moved along the Luo River, a tributary of the Yellow River, in order to gain access to more water sources (Jiao, 2014). Duan Pengqi et al. have analyzed the changes in the location of Luoyang based on the geography of Luoyang Basin and the hydrology of the Luo River (Duan 1999). Wang Wei suggested that the construction of the Grand Canal (hereafter cited as the Grand Canal) in the Sui and Tang dynasties brought great prosperity to Luoyang, which has been a hub on the Grand Canal. However, as water transport later faded, the city of Luoyang began to decline (Wang 2014). Many scholars believed that Emperor Xiaowen of the Northern Wei dynasty relocated the capital to Luoyang in order to seek cultural legitimacy. The emperor could only demonstrate his cultural legitimacy by establishing the national capital in the Central Plain (Xiao 1987, Wan 1987).

The prosperity and decline of Kaifeng were more closely associated with the Yellow River (Zhang 2002). The prosperity of Kaifeng was attributed to its developed water system and its well-established water

transport network. In particular, the occupation of a strategic location on the Grand Canal allowed the city to become a hub for grain transport through waterways connected by the Yellow River (Li 1988). After the Northern Song dynasty, the Yellow River moved closer to Kaifeng by frequently changing its course, which stretched sometimes south of the city and sometimes north of it. By the Jin dynasty, the Yellow River passed through Kaifeng and often flooded it. This caused serious negative impact on the city's development. In particular, the river submerged the city in its entirety several times, creating an archeological site in present-day Kaifeng, which features 'a stack of ruins of different ancient cities' (The city stacked city refers to the city stacked sights of different ancient cities. Archaeologists in China found that 6 ancient cities were stacked up and down under the Kaifeng ancient capital. It's all caused by the flood of the Yellow River). Kaifeng emerged relatively later than nearby cities due to its low-lying terrain. Its status also varied, due to the Yellow River often bursting its banks and changing its course (Zhang 2002). The Yellow River affected the natural setting and ecology of Kaifeng in the following ways: the channel silted up and became unnavigable; annihilated lakes; caused soil salinization and desertification; ecological

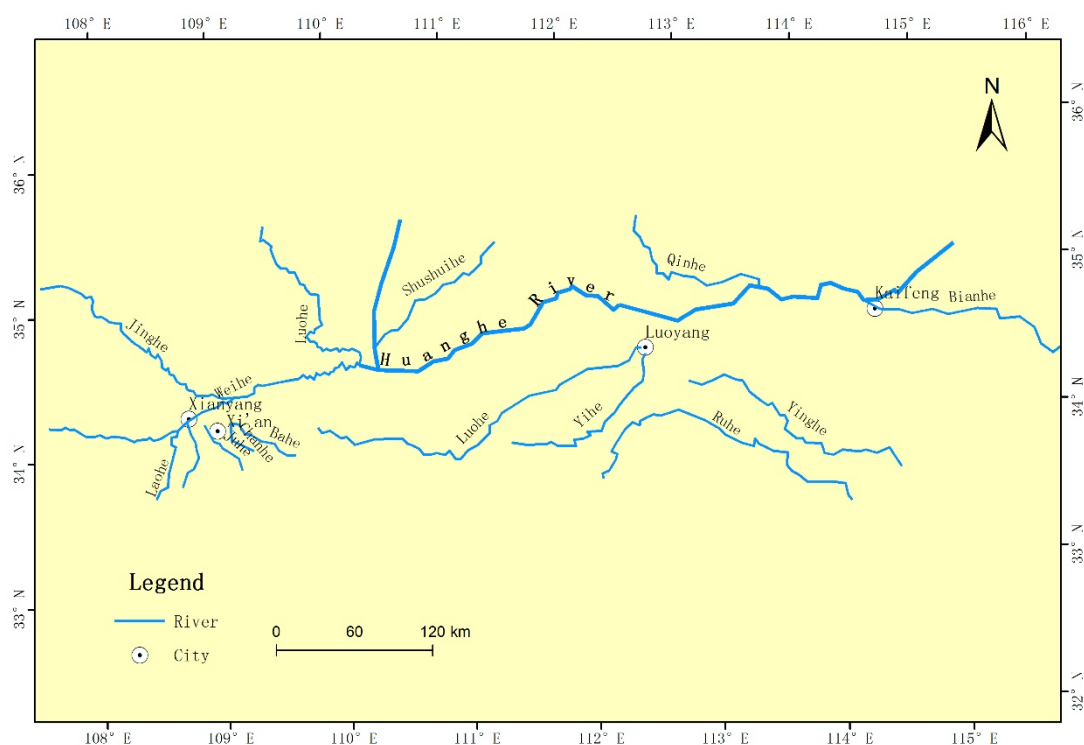
degradation exacerbated natural disasters such as floods, droughts and sandstorms (Huang 1983, Li 2006).

Chinese scholars have clarified the history of Xi'an and its vicinity. It stretched from the Zhou dynasty when King Wen and King Wu established the capitals Fengjing and Haojing respectively, and it continued through the Tang dynasty when the area was the world-famous Chang'an city (ancient name of Xi'an). Then it continued to the later dynasties when the area became a major metropolis in Northwest China (Zhu and Xiao, 2005). Through an analysis of the hydrology of the Wei River and the changes in the river's course, Yin and Huang studied the siting and relocation of ancient cities within the Guanzhong Plain, represented by Xi'an (Yin and Huang, 2006). In a study of the water environment of the historical capital Xi'an, Li et al. analyzed the characteristics of the eight rivers that encircled Chang'an, as well as the related water projects (Li et al. 2000). Another study investigated groundwater pollution in ancient Xi'an and its effects on the city's development (Gun et al. 2007).

Investigations on effects of ecological changes on cities' development can provide an important insight into the development of ancient capitals. Among these investigations, the natural disaster, especially flood and drought, is an important breakthrough point. Zou et al. believed the relocation of the capital from Pingcheng to Luoyang in 494 CE should be considered as an adaptation to climate change and a mitigation of its effects by the Northern Wei dynasty (Zou et al. 2017). Li et al. associated climate change, floods, and droughts with the alternation of the capital location between Xi'an, Luoyang and Kaifeng. They suggested that during wet periods, the capitals were usually established in the relatively arid Chang'an, rather than the flood-prone Luoyang. In dry periods, the rulers were more inclined to choose Luoyang or Kaifeng as the capital due to their wetter climate (Cheng 2014, Li et al. 2007). Ecological changes promote the relocation of a country's capital, which in turn affects the ecological environment of cities (Cheng 2014, Lu 2009, Wang and Li 2002). Using statistics, Yin et al. analyzed the historical flood and drought disaster frequency on Guanzhong Plain and obtained the conclusion of synchronization between flood and drought. They believed on the one hand, the flood and drought disasters are related to the climate change of the Guanzhong Plain, on the other hand, it is closely related to the urban construction and development and the population growth (Yin and Huang 2008). They especially conducted a comparative analysis of the frequencies of floods and droughts in

Chang'an and Luoyang during the Western and Eastern Han dynasties. In both cities, they found that floods and droughts were much more frequent in the periods when they served as the capital than in other periods. Also, the two types of disasters happened simultaneously. This phenomenon may be linked not only with climate change, but also with the population increase, as well as urban construction and development (Yin et al. 2007). Zhang (2007) studied the climate records of Kaifeng area during the Northern Song Dynasty, and thought that the climate in Kaifeng area began to cool in 1100. During the Northern Song Dynasty, the climate changed from warm to cold, and the climate had short periodic fluctuations in large cycle. A study which focused on the relationship between climate change and natural disasters in Kaifeng during the Tang and Song dynasties showed that the frequencies of floods and droughts in this area were markedly higher in the centuries after the 10th century AD than in the preceding centuries. Also, the 10th century marked a transition from a warm and humid climate to a cold and dry climate (Cheng 2002). Zhou and Zhang (2006) revealed a close correlation between floods and climate anomalies in the Guanzhong Plain area. They also found that cooling was an important factor contributing to the frequent occurrence of droughts (Zhou and Zhao 2008).

This study evaluated the advantages of three ancient capitals (Xi'an, Luoyang and Kaifeng) in terms of physical and economic geography. Then the study analyzed how environmental factors, especially changes in the courses of the Yellow River and its tributaries, had affected the development of these ancient capitals. The frequencies of floods and droughts were estimated in the three historical capitals over the period from the Western Han to the Yuan dynasty. (This study selected the data from the West Han to the Yuan dynasty because the three cities were greatly developed during this period, and the dynasties after the Yuan, these cities began to decline, especially the city of Kaifeng). The results revealed the relationship between the occurrence of disasters and climate changes. Moreover, the study also provided an analysis of the effect of water transport on the development of these capitals, as well as their rise and fall after shipping became a lifeline for the country. The findings of the study suggested that a city's advantages in economic geography determined whether it could become a capital. Also, the resulting political status controlled the speed and scale of its development.



**Fig. 1.** Water system sketch map of Xi'an, Luoyang and Kaifeng  
The figure is modified from Tan (1982) and Li et al. (2007).

### EFFECTS OF CHANGES IN WATER SYSTEM

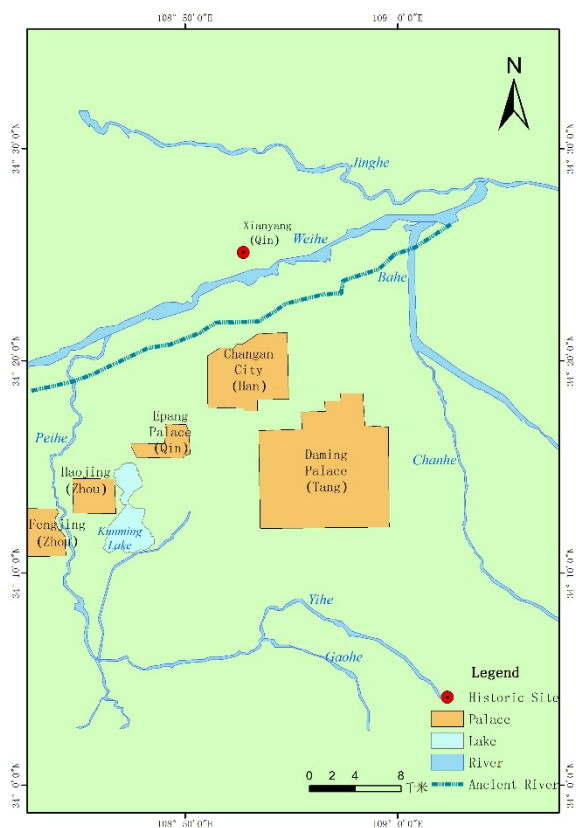
Water is the lifeblood of cities, especially in ancient times when most cities arose from the vicinity of rivers. The favorable locations of cities near rivers enable convenient water supply, drainage and shipping traffic.

Xi'an, historically known as Chang'an, has a dense water system and is located in the Weihe plain in the central portion of the Guanzhong Plain. Historically, the city had been encircled by eight rivers, namely the Wei and Jing Rivers to the north, the Feng and Lao Rivers to the west, the Jue and Hao Rivers to the south, and the Chan and Ba Rivers to the east. These rivers flowed around Xi'an and formed part of the Yellow River system. Luoyang lies in the Yiluo Plain along the middle reaches of the Yellow River. It is surrounded by four rivers (Yi, Luo, Chan, and Jian Rivers) within the Yellow River system, all of which join the Yellow River. There is an old saying that Luoyang is fortified with eight passes, enclosed by mountains on all sides, and surrounded by five rivers. These geographical conditions made the city an important hub on the Grand Canal. Kaifeng, previously called Bianjing or Dongjing, is situated in the central Henan province within the Yudong Plain, a part of the Huanghuai Plain. It borders the Yellow River to the north and is adjacent to the Bian River (see **Fig. 1**).

### RELOCATION OF CHANG'AN

Fengjing and Haojing were established by King Wen of the Zhou dynasty and his son King Wu, respectively. They were the earliest capitals in the Guanzhong Plain. The two capitals were built on the broad, low-lying southern bank of the Wei River and separated by the Feng River, which is a tributary of the Wei River. The topography of this area, together with its proximity to water sources, made it a favorable human settlement in China's early history.

The Qin dynasty chose Xianyang as its capital city. Xianyang was close to the Wei River, a tributary of the Yellow River, and acted as a hub for both land and water transport due to its geographical advantages. The rise of this capital depended upon the Wei River. However, it was also restricted by the river. This river affected the city's development in two ways. First, the Wei River had constantly migrated northward at an average rate of 1.74-2.17m/a (Gan et al. 2002, Yin and Huang 2006). The course change created a narrow space for the city's development. Worst of all, having been subjected to strong, long-term erosion during the process of channel migration, the northern river bank became susceptible to instabilities, such as bank caving. Second, with a higher drainage density than the northern bank (**Fig. 2**),



**Fig. 2.** Layout of Chang'an of the Han and Tang dynasties

The figure is modified from State Administration of Cultural Heritage (1998), Zhu and Xiao (2005) and Yin and Huang (2006).

the southern bank of the Wei River could provide an access to more water sources. Moreover, the city's water supply and drainage largely depended on the Wei River. As a result of such a heavy load, the river's water quality deteriorated. For these reasons, the rulers turned to the southern bank of the Wei River, beginning with the Qin dynasty. They constructed a number of palaces there, including the Epang Palace, Ganquan Palace, etc.

The Han dynasty located its capital at the northwest foot of Longshou Mountain, which corresponded to present-day Longshouyuan. In this dynasty, in order to approach the water sources and make full use of the Wei River's status as a path for grain shipment, the city of Chang'an extended to the southern shore of the Wei River. In order to be adapted to the topography of the southern river bank, the city wall was constructed in the shape of a funnel. Therefore, Chang'an of the Han dynasty was also called a funnel-shaped city (**Fig. 2**). Rainwater and sewage also drained into the Wei River, just like in Xianyang of the Qin dynasty.

After receiving sewage discharge for a long period of time, the water of the Wei River and the groundwater

nearby were so heavily contaminated that they became unsuitable for drinking by the end of the Han dynasty. Moreover, the river's function as a waterway declined. The capital's proximity to the river also made it susceptible to flood attacks. After considering these factors, the rulers of the Sui dynasty built the capital Daxing at the southern foot of the Longshou Mountain on the vaster southern bank of the Wei River. In the Tang dynasty, Daxing grew to be the magnificent capital city of Chang'an. During this period, Chang'an was endowed with plentiful water sources and came to be known as a city encircled by eight rivers. Meanwhile, it reached its prime.

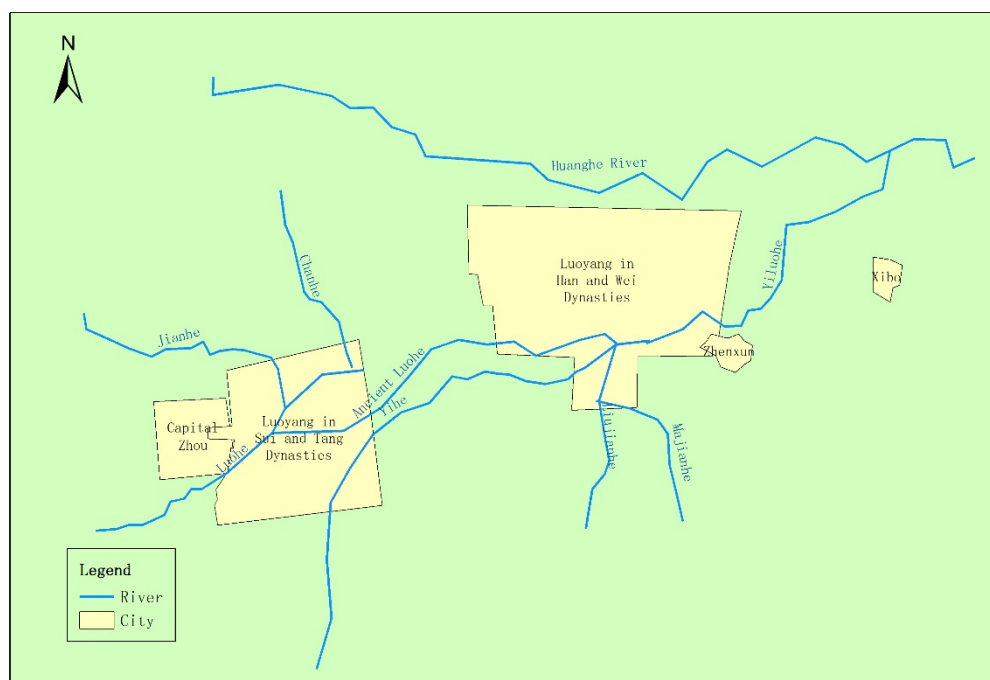
Over several dynasties, drainage and sewage from this city have caused serious deterioration in the quality of the Wei River's water, as well as the groundwater nearby. According to a historical account from the beginning of the Sui dynasty, 'this city has existed for eight hundred years since the Han dynasty and the local water now becomes salty and unsuitable for drinking' (Wei 1999). Additionally, this area had no advantage in terms of economic geography. For these reasons, the area corresponding to present-day Xi'an and its vicinity has never served as a national capital in the centuries that followed the Tang dynasty.

### Relocation of Luoyang

The term 'Yang' in the Chinese names of places often indicates places that are located south of a mountain and north of a river. Luoyang is so named due to its location residing north of the Luo River in the Luoyang Basin, which is in the western Henan province. Luoyang has an indissoluble bond with water from its name. The surrounding rivers, Yi River and Luo River, and its tributaries Jianhe and Chanhe, make a communication system with the Yellow River.

Five archeological sites of ancient capitals were discovered in the Luoyang area. Like all the early Chinese historical cities as Xi'an, the earliest city sites found near Luoyang were also on the highlands of the Luohe River. The purpose was to take water and use the convenience of water transportation. The Erlitou Site in Yanshi and the Xibo Site were found on the northern bank of the ancient Luo River. The Erlitou Site near Luoyang is where the ruins of the Xia dynasty's capital Zhenxun were unearthed. It is recognized as the most ancient city site in China. The Xibo Site was the site of the Shang dynasty's capital. It was located west of the confluence of the Yi and Luo Rivers.

The Western Zhou dynasty relocated its capital from Haojing to Luoyi. The new capital was not in the eastern



**Fig. 3.** Water system and ancient capital sites in Luoyang

The figure is modified from State Administration of Cultural Heritage (1998) and Li et al. (2007).

part of the Yiluo Plain where the capitals of the Xia and Shang dynasties were sited. This was because that area seemed to be too narrow to support the development of an expanding capital city. Moreover, this area was low-lying and prone to flooding by the Yi and Luo Rivers. Therefore, King Cheng of Zhou turned to the broader western portion of the Yiluo Plain. The site of the Eastern Zhou's capital is located east of the confluence of the Luo and Jian Rivers. It is surrounded by the Jian River to the west and the Chan River to the east. Part of the western city wall was built on the western bank of the Jian River. This was a preliminary effort to extend the city across the Jian River. The capital's closeness to the Jian and Luo Rivers allowed easy access to water. However, floods exerted great influence on its development. The Site of Chengzhou, a capital of the Eastern Zhou dynasty, was found in the open, flat bed of the Luo River, which is located on the east side of the Chan River. Located relatively far from the Luo River, this capital was not threatened by flooding. However, the high terrain of this capital made it difficult for the city to obtain water (Duan, 2014).

The city of Luoyang in the Han and Wei dynasties was built based on the Chengzhou of the Eastern Zhou dynasty. It has experienced rises and falls as a result of regime changes. After crossing the Luo River, the city extended to the northern bank of the Yi River, covering the area between the Yi and Luo Rivers. After a

westward shift, Luoyang served as the eastern capital of the Sui and Tang dynasties. It was to the east of the Eastern Zhou's capital and occupied both the northern and southern banks of the Luo River (**Fig. 3**). The capital Luoyang of the Sui and Tang dynasties was the product of great improvement in the human ability to control water and rivers. The four major rivers (the Yi, Luo, Chan, and Jian Rivers) in the Luoyang Basin, were interlinked and connected to the Yellow River, which formed a network of waterways in a crisscross pattern. All of these channels joined the Luo River. Moreover, in the Sui and Tang dynasties, Luoyang acted as a hub for water transport along the Grand Canal. The canal section south of Luoyang served as the route for transporting grain and goods from regions south of the Yangtze River to the northern regions. The northern canal section provided a passage to the area east of the Liao River. In this period, the city of Luoyang experienced its greatest prosperity in its ancient history. However, the growing prosperity and soaring population growth led to a rapid reduction in available land. This forced a large crowd of residents to move to the lower parts of river valleys, which put them at risk of river flooding. After the An Lushan Rebellion in eighth-century China, the Grand Canal connected the Bian River to Chang'an via the Wei River without passing through Luoyang. As a result, Luoyang lost its position as the center of the canal and fell into a decline.

### **Kaifeng and the Yellow River**

The rise and fall of ancient Kaifeng was completely determined by water. During the Warring States period, the State of Wei built its capital Daliang in this area. It was the first capital here, and the city entered its first glorious period. The Honggou canal system, first constructed in the Warring States period, was a water transport network linking the lower reaches of the Yellow River to the middle and lower reaches of the Huai River. With its center in Daliang, this canal system made a great contribution to Daliang's growth and prosperity. It enhanced the flood discharge capacity and improved irrigation in this area. This greatly promoted local agricultural production and economic development (Li et al. 2006). However, Honggou also contributed to the decline of this capital. In 225 BC, Wang Ben, a general of the Qin dynasty, inundated Daliang with water diverted from Honggou. As a result, the State of Wei was annihilated. After this devastating damage, Daliang suffered a drastic decline in its position.

The Tongji Channel was the most important section of the Grand Canal constructed in the Sui and Tang dynasty. Located in a strategic location on this channel, Bianzhou naturally gained an increasingly higher status. Over the Sui and Tang dynasties, Kaifeng had grown into a city of strategic importance in the Central Plain area.

In the Northern Song dynasty, the city of Kaifeng was hundreds of kilometers away from the Yellow River and thus unsusceptible to flooding caused by levee breaches. Conversely, the Yellow River and its tributary, the Bian River, provided many benefits to the city. The Bian River connected to the Yellow River in its upper reaches and to the Huai River in its lower reaches. As a key section of the Grand Canal, the Bian River delivered food, goods and materials, as well as wealth and prosperity to Kaifeng. Furthermore, this river also offered plenty of water for agricultural, domestic, and industrial use, thereby boosting local development.

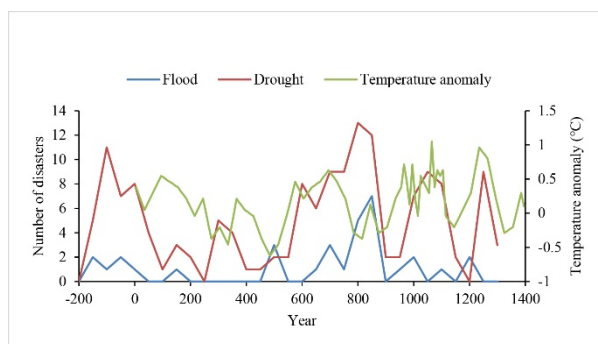
However, Kaifeng was still plagued by siltation and floods of the Yellow River and Bian River. At the beginning of the Jin dynasty, the Yellow River shifted its course southward and captured the Huai River, bringing Kaifeng close to a dangerous section of the Yellow River. During this period, the unstable Yellow River was subject to frequent course changes. As a result, Kaifeng was devastatingly hit by seven recorded major floods.

The flood disasters caused by the Yellow River gradually injured Kaifeng's status. It dropped from a national capital to a provincial capital, and then to a regional city. Frequent flooding, heavy siltation and wars destroyed the city over and over, leaving ruins of Daliang (the Wei dynasty's capital), Bianzhou (the Tang dynasty's strategic city), Dongjing (the Northern Song dynasty's capital), Bianjing (a regional city of the Jin dynasty), and Kaifeng (a regional city of the Ming and Qing dynasties) buried successively in silts. The successive burials created a peculiar archeological site where ruins of different ancient cities were vertically stacked. On the other hand, the Yellow River's silts have protected these ruins from damage caused by subsequent wars and natural disasters. This allows them to be well preserved and presented to us as a precious cultural heritage.

### **EFFECTS OF FLOODS AND DROUGHTS**

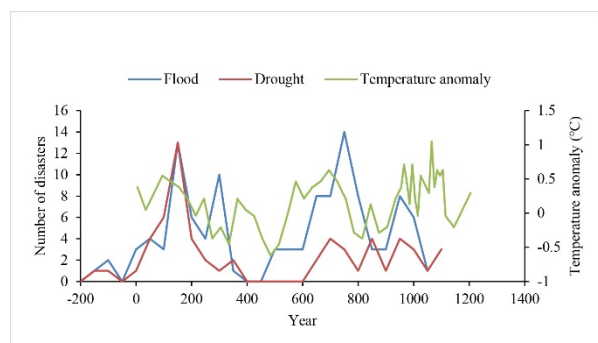
In a sense, selecting a capital city is akin to finding a suitable ecological environment that can support both production and life. Topography, drainage systems, climate, disasters and other natural factors are important considerations in selecting sites for capitals. Most of the dynasties before the Yuan dynasty located their imperial courts in Xi'an, Luoyang and Kaifeng, alternately. As the three capitals were built on the banks of the Yellow River or of its important tributaries, their development was deeply influenced by floods and droughts, river course changes, and river flow, as well as sediments in the drainage basin of the Yellow River. Therefore, the destinies of the three ancient capitals were tightly bound to the Yellow River.

In this study, the frequency of floods or droughts was calculated as the number of floods or droughts per 50 years. **Figs. 4-6** show that, from 202 BC to 1279 AD (corresponding to the period from the Western Han to Song dynasty), Xi'an and Luoyang saw an increase in the frequency of floods over time. The available records of floods and droughts occurring in the Song dynasty's capital of Kaifeng were detailed. However, related records from earlier dynasties were relatively brief. Therefore, only the statistics in the period from 581 AD to 1279 AD (corresponding to the period from the Sui dynasty to the Song dynasty) were used.



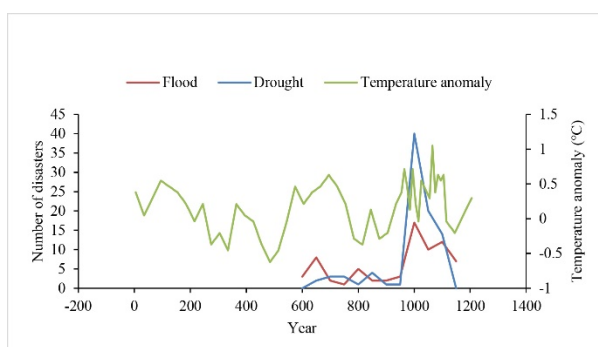
**Fig. 4.** Occurrence of floods and droughts in ancient Xi'an

The data statistics are from the following references (Data Editing Group of Institute of History 1988, Ge et al. 2003, Ge et al. 2010, Meng 1999, Shaanxi Historical Natural Disaster Brief Documentary Editorial Committee 2002, Song 1992, Wang 2005, Yin and Huang 2008).



**Fig. 5.** Occurrence of floods and droughts in ancient Luoyang

The data statistics are from the following references (Data Editing Group of Institute of History 1988, Ge et al. 2003, Ge et al. 2010, Meng 1999, Song 1992, Wang 2005, Wang 2010, Wang 2003, Yin and Huang 2008).



**Fig. 6.** Occurrence of floods and droughts in ancient Kaifeng

The data statistics are from the following references (Cheng, 2002, Ge et al. 2003, Ge et al. 2010, Meng 1999, Song 1992, Wang 2005, Zhou 1992).

The statistics show that, in the three cities, floods and droughts were much more frequent in the periods when they served as the capital than in other periods. High flood frequencies accompanied high drought frequencies. This indicated a simultaneous occurrence

of the two types of disasters. These findings are consistent with those of a previous study (Li et al. 2007). The drought frequency was generally higher than flood frequency in the Xi'an area, while the reverse was true in Luoyang. In contrast, both disasters were frequent in Kaifeng, especially in the latter half of the 10th century when the city became the capital of the Northern Song dynasty, as indicated by the more detailed and plentiful records.

Chinese imperial courts attached greater importance to capital cities and recorded more details about these cities. These included detailed records of floods and droughts occurring in the capital cities and their surrounding areas. This is one reason for the higher frequencies of floods and droughts in the periods when the cities served as the capital. The level of detail in the records of disasters in a city reflects the city's political and economic status at that time. A city's political status determined the scale and speed of its development (Wu 2013). There were plenty of records about Xi'an in Chinese ancient documents from all periods because this city was still a strategic and influential city of China, even when it was not the national capital. Luoyang had long been the center of the world in the eyes of ancient Chinese. It had played an extremely important role in shaping the course of China's ancient history before it fell into decline after the Yuan dynasty. Therefore, the dynasties before the Yuan dynasty have documented sufficient information about this city. Kaifeng thrived in the Warring States period when it was the capital city Daliang. However, after the Warring States period, it went through a long period of time as a small, generic city until it began to rise with the development of water transport in the Tang dynasty. After it reached its heyday as the capital of the Northern Song dynasty, it experienced a prolonged decline and ultimately became a small or medium-sized, generic city. Therefore, available historical records of various disasters in this city are very scanty.

If a city was chosen as a national capital, it must be a city with a livable environment, abundant water sources, fertile soil and productive land, thick vegetation, and dense forest cover. Its population would increase to match economic development and ecological support. However, the combination of the constant development of the handcraft industry and other economic sectors, as well as a rapidly growing population, tended to overburden the city's ecological system. In order to increase grain production, farmland then expanded toward floodplains adjacent to rivers and inevitably became susceptible to river flooding.

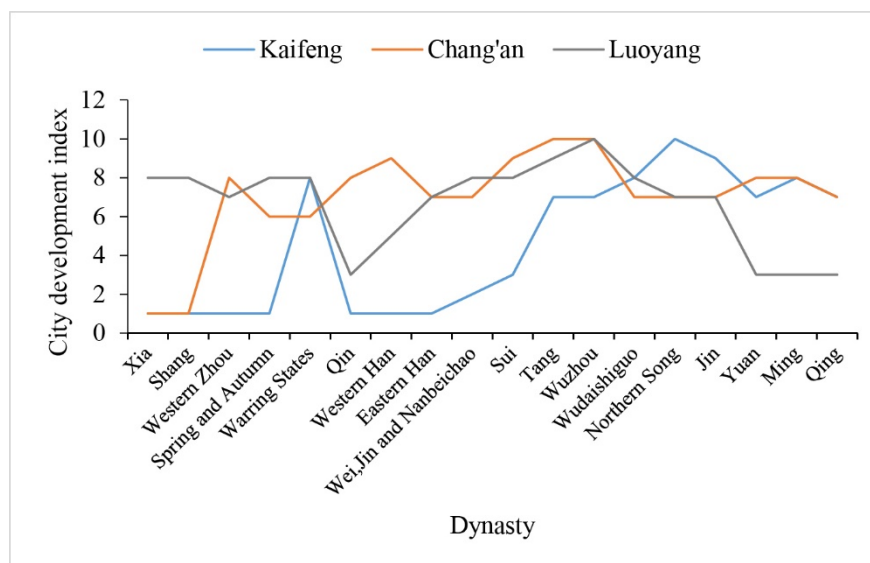
Moreover, excessive deforestation and conversion of grassland for the purpose of reclaiming farmland were bound to exacerbate soil erosion by water. Since urban architecture in ancient China is primarily characterized by wooden structures, construction of buildings consumed huge volumes of timber and led to over-cutting of trees in originally dense mountain forests. Soaring population growth not only pushed up water consumption, but also increased discharge of wastewater into surrounding rivers. This resulted in a serious pollution of the river water. All these factors contributed to huge ecological damage and thereby the occurrence of floods and droughts. Therefore, ecological damage caused by rapid development was also a major reason why a city that had served as a capital for a long time was subjected to more frequent floods and droughts. As Mr. Shi Nianhai said, 'from the choice and determination of the seat of the capital, people are using and transforming nature' (Shi 1986).

Climate change was another important factor that affected the occurrence of floods and droughts in these cities. A comparison of the temperature variation through 2000 years in the mid-eastern part of China (Ge et al. 2003, Ge et al. 2010) with the variations in the frequencies of floods and droughts in Xi'an (**Fig. 4**) revealed an obvious correlation between variations in temperature and the frequencies of floods and droughts: each temperature rise or drop coincided with an increase or decrease in the frequencies of floods and droughts. This may be associated with the geographical position of Xi'an. This city was located on the second and third terraces of the Wei River in the central portion of the Guanzhong Plain. It was surrounded by the Longshou Mountain to the north and the Qinling Mountains to the south. Due to its inland location, the city's temperature and precipitation were not influenced by oceans. Also, the Qinling Mountains acted as a barrier against the entry of moist air (Deng and Shi 1991). Furthermore, local precipitation was unevenly distributed throughout the year. These climate conditions, together with the high terrain and low average discharge of the Wei River (the major river of Xi'an), contributed to the frequent occurrence of droughts in periods of warmer-than-average temperatures. A moist and warm climate would certainly increase the probability of precipitation and river flooding. The description above explains why the frequency of the floods was high but still below that of droughts over the same period. Additionally, the area along the Wei River was low-lying relative to Xi'an and the city had been remote from the river since the Sui

and Tang dynasties. As a result, this city was not heavily influenced by flooding. According to the limited available statistics, in Kaifeng, the period of most frequent floods and droughts corresponded to the period of most significant climate fluctuations (**Fig. 6**). In Luoyang, the variations in the frequencies of floods and droughts were also generally simultaneous with climate changes (**Fig. 5**). Due to its geographical position, floods were more frequent than droughts in this city. Consistent with historical accounts, Luoyang was subjected to more floods than Xi'an at similar latitudes. There are two reasons behind this phenomenon. First, Luoyang had a more humid climate because it was relatively closer to the eastern coast of China. Thus, its climate featured stronger oceanic influence. Second, the Luo River, the major river of this area, began to pass through Luoyang in the Sui and Tang dynasties, which put the city at an extremely high risk of flooding.

The transition zone between farming and grazing areas constantly shifted northward as a result of climate fluctuations, surging population, and an increase in reclaimed farmland. Climate fluctuation affected agricultural production in southern regions dominated by the Han Chinese. Furthermore, it also posed a threat to the living environments for northern nomadic peoples. These changes, together with local environmental deterioration, forced the nomadic peoples to invade the southern regions for more living space. This gives rise to social turbulence, or even regime changes. A regime change necessitated reselection and relocation of capital, which in turn affected the status and fate of a city.





**Fig. 7.** Development cycles of Xi'an, Luoyang and Kaifeng

The vertical axis in **Fig. 7** represents a city's status in history. The status of the three cities in history were rated on a scale of 1 to 10, where 10 represents the heyday of a city (the Northern Song dynasty for Kaifeng, the Wu Zetian's Zhou dynasty for Luoyang, and the Tang dynasty for Xi'an); 1 indicates a generic city or county; 2 is a district (an ancient administrative division corresponding to today's province); 3 is a relatively developed city; 5-6 is a developed city; 7-8 is an important city, provincial capital, or regional administrative center; and 8-9 is a national capital.

### EFFECTS OF WATER TRANSPORT

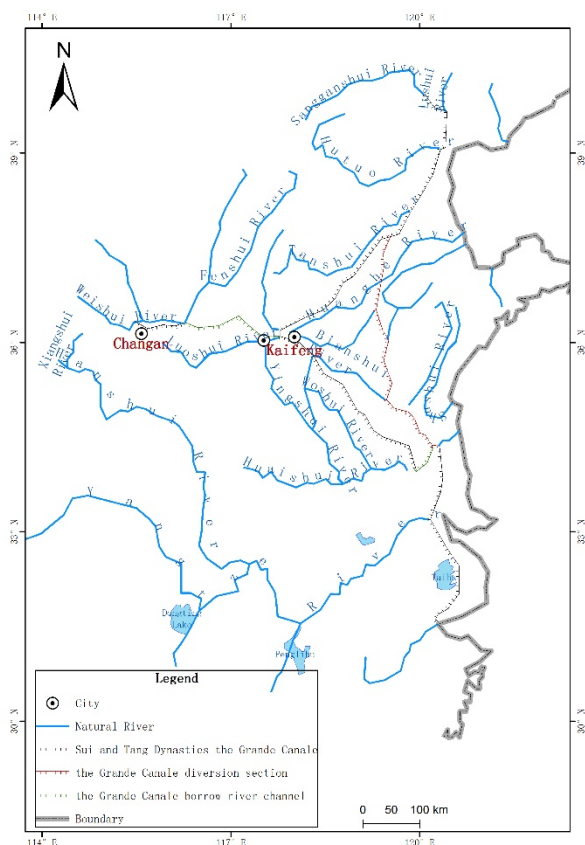
In ancient China, transport of materials heavily depended on shipping. This meant that a city's geographical convenience and ability to develop water transport determined its advantage in economic geography, and thereby its political status in China's history.

In the middle of the Tang dynasty, China's economic center moved southward from the middle and lower reaches of the Yellow River to the middle and lower reaches of the Yangtze River. Goods and materials demanded by the capital were primarily supplied by the southern part of China. In this context, shipping became the lifeline for the country. Furthermore, production in the Guanzhong Plain area was far below the demands of the capital with a rapidly expanding central authority and a surging population. At this point, the Grand Canal's status became increasingly important as a link between the south and north of China.

Development of water transport in Chang'an has long been beset with the difficulty of shipping through three dangerous gorges on the Yellow River in today's Sanmenxia area. At the beginning of the Tang dynasty, materials and goods were often shipped first to Luoyang. Then they passed these gorges by land transport and were finally delivered by the Wei River to Chang'an. The navigability of the Yellow River along these gorges had not been improved until channels were dug through mountains in the Tianbao Period of the

Tang dynasty. The difficult and labor-intensive grain shipment in the Sanmenxia area always upset the Li family of the Tang dynasty. As a result, Luoyang, as a transit center for materials transported between the south and north of China, was given a high status as an alternate capital in the Tang dynasty. The Hanjia Granary, located in the eastern part of Luoyang, was the largest granary of China. It was also capable of storing about a half of China's grain reserves. According to historical accounts, Tang dynasty's emperors and their imperial families moved to Luoyang for food several times due to severe shortages of grain in the capital Chang'an. In this period, Luoyang reached its peak in China's feudal history.

In late Tang, the economic gap between the Yellow River basin and the Yangtze River basin widened considerably. As the Tang dynasty increasingly depended on finances and taxes collected in southern China, the Tongji Channel (i.e. the Bian River), which connected the Yellow River to the Huai River, became a particularly important section of the Grand Canal. Moreover, the imperial court of the Tang dynasty reformed the grain shipment system by setting up granaries at nodes along the waterways in order to divide the transport into segments. In this way, the materials from the Yangtze River and Huai River basins no longer needed to stop at Luoyang. Luoyang then gradually lost its status as a transit center and its advantage in economic geography. In contrast, Bianzhou (corresponding to today's Kaifeng) became a new transit



**Fig. 8.** Changes in the course of the Grand Canal

station on the Grand Canal due to its strategic location on the Bian River. It rose as an important hub for water transport.

Kaifeng's significant function in water transport gave it an absolute advantage in economic geography. This enabled it to replace Xi'an and Luoyang as the capital of the Song dynasty. The city reached its heyday in its ancient history when it served as the capital. Because the capital Kaifeng still relied on materials supplied by the Yangtze River and Huai River basins, the grain transport along the Bian River became a more important part of the economy in the Northern Song dynasty. Furthermore, the river saw a significant increase in its grain transport volume in the Song dynasty as compared to the Tang dynasty, as described in *A Summary of the History of Yellow River Conservancy* (The Yellow River Water Conservancy Commission of Ministry of Water Resources 1982).

In the Yuan dynasty, a new grand canal was built in eastern China to connect the capital city Beijing and the regions south of the Yangtze River. This canal allowed more efficient shipment of goods from the southern regions with a shorter and more direct course than the Grand Canal constructed in the Sui and Tang dynasties.

As a result, both Luoyang and Kaifeng lost their status as a water transport hub and slid into a decline (**Fig. 8**).

## CONCLUSION AND DISCUSSION

This paper has examined how environmental factors, especially changes in the courses of the Yellow River and its tributaries, had affected the development of these ancient capitals. Water is not only the cradle of life, but also the cradle of civilization. The ancients normally chose to live near water. In ancient China, most of the famous cities arose from the vicinity of water sources and acquired water, their lifeblood, from nearby rivers. Therefore, physiographical factors, especially water resources, were important considerations in site selection for a capital in ancient times. Locations near water sources allowed for easy acquisition of water for agricultural use and agricultural development supported population growth. A dense river network facilitated the transport of materials and thereby accelerated the development of handicrafts and commerce. Furthermore, rivers formed a natural defense system for cities. From both economic and military perspectives, areas that were rich in water resources were suitable locations for large cities, especially capital cities. Our investigations indicate that the Yellow River, the cradle of the Chinese nation, has given birth to many cities and brought prosperity to them. The areas along the Yellow River and its tributaries were preferred by ancient Chinese rulers as capital locations. Variations in the hydrology of these rivers and the geology of their basins also altered the layout and development of nearby cities and even determined their rise or fall. Abundant water resources and the sound water environment of Xi'an, Luoyang and Kaifeng offered huge support for their emergence and development. Hydrologic conditions also affected the layout, locations, and development courses of the three cities.

Natural disasters were also important factors affecting the development of capital cities. Xi'an, Luoyang and Kaifeng were located along the middle and lower reaches of the Yellow River. Their structures and development were significantly influenced by the Yellow River and its tributaries. The associated floods and droughts left a special imprint on the history of the three cities. In Kaifeng, floods have created a peculiar archeological site featuring 'a stack of ruins of different ancient cities'. The frequencies of floods and droughts were estimated in the three historical capitals over the period from the Western Han to the Yuan dynasty. The

results revealed the relationship between the occurrence of disasters and climate changes.

In ancient China, poor transport made it essential and necessary to locate capital cities in major grain-producing areas. Regions along the middle and lower reaches of the Yellow River were characterized by loose and fertile soils. Therefore, the locations of ancient Xi'an, Luoyang and Kaifeng became leading agricultural areas across the country. Floods and droughts had a crucial influence on agricultural production. Climate changes exacerbated the two types of disasters. This led to poor harvest or even total crop failure, thereby affecting the survival of a capital. All capital cities were livable, ecologically healthy and advantageous for development in their early years. However, as the demand for land grew with the social and economic development, rapid population increase and growing agricultural production, the transition zone between farming and grazing areas constantly shifted northward. This posed a threat to the living environments for northern nomadic peoples. Human impact also promoted alterations of natural environment and thus affected the livability and development course of a city. The environmental deterioration resulting from climate changes forced the nomadic peoples to invade the southern regions for better production space. This consequently caused social turbulence or even regime changes. Consequently, this necessitated the reselection of capitals.

In addition, we have argued that in a traditional, agricultural society, the political center had obvious advantages in development over other areas. Political factors had a direct effect on the development of a city.

Xi'an, Luoyang and Kaifeng experienced their greatest prosperity when they served as the capital. However, once their political positions declined, the cities then turned into a decline. This is because a relocation of a country's political center will inevitably lead to a rise of the new capital and a decline of the former one. When a city served as a capital, the ruler tended to place more emphasis on the local water development and use, as well as flood control, river dredging, channel construction, water conservancy, and improvement in surrounding water environments. Consequently, these efforts would promote agricultural and economic development of the city and deliver prosperity. However, once the city was no longer the capital, less importance would be paid to local water development. The resulting water resource degradation was then followed by a decline of the city. The development courses of Luoyang and Kaifeng clearly demonstrated the interaction between water resources and the environment of a city and its political status. The prosperity, peak and decline of the two cities were closely associated with variations in water resources in the drainage basins of the Yellow River and its tributaries. More importantly, their political status was deeply affected by the development of water transport. As a city's political status changed, the amount of government's emphasis on its water development and use changed, thereby affecting a city's structure and development.

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