Part II Waterway Scaling on Regions

In this part, it tries to summarize the motivation about how to build the large-scale Grand Canal in a very long history. And then the Grand Canal has two crucial elements, one is the route of waterway that is the linear character to link regions; the other is the region of waterway, they are the articulations to support the long waterway working. Both of them are all show us a dynamical condition under the territorial and urban development.
Chapter 5  Motivations, the Yellow River migrants and the capital relocated

5.1 Introduction

The route of waterway in the Grand Canal efficiently links different destinations, normally it would have more than hundreds kilometres long, but how it could be built as a large project, and then to change the landscape? There is one evidence is the rivers migrations and floods in the lower plains, it generates building the irrigation works to avoid the natural rivers disasters, particularly the Yellow river frequently have migrated and destroyed large areas of farmlands and towns. Moreover, the Grand Canal have to borrow the water from natural rivers when it was used as the water transportation between the capital and southern economic centre. Therefore, the canal’s administrators and canal builders have to maintain the water also avoid the flood damaged the artificial canal, they should consider about many conditions in the site which canal passed through, such as the landform, soil and vegetation, hydrology, etc. In this process of learning the land and rebuild the natural environment, the route of the Grand Canal had evidently experienced many changes in its scale, form, function and position. The Chapter 5 would analysis the changes of the route under the view of the cultural landscape, discover the principal motives of the changes, and how people built the large scale artificial river year by year.

The river regions are a cultural landscape where people settle down there for developing the city, town and village. In the regions of a river, there were many distinctive forms and structures formed by the water and urban area, their functions could be irrigation, water transportation, commercial area, flood prevention work, etc. The region of canal also showed a dynamic land and water using, under a multi-layers of functions, the historical heritages, irrigation works, transportation, ecological corridor, they are forming a new identity of Grand Canal in the beginning of 21st century.

The urban blocks of canal in chapter 7, it would emphasize the scale of blocks and its relevance between urban area and water routes, how about thematic units in urban scale changing and new life of modern city. The urban block of canal is a basic unit in the long Grand Canal, but it also experienced long time transforming under a violent change of
The water courses great swing moved in eastern of China in more than two thousand years, it’s recorded by river’s event chronicles in ancient time.

Source: Geography, 3822. Colorado University.
http://www.colorado.edu/geography/class_homepages/geog_3822_f09/CourseResources.htm

China’s Sorrow, the Germany geologist, scientist, Ferdinand von Richthofen48, he wrote this nickname for the Yellow River, because of its tendency of the devastating flood that once occurred regularly in its lower course. In its history, the main course of Yellow River had migrated many times in lower plain in the eastern of China.

Actually, the natural river always influenced the forming in artificial river, they not only described the a large scale of the river basin area with many cities and natural landscapes, also record the detail of the water projects to prevent the flooding from the China’s Sorrow, Yellow River. But on the other side, we could observe the water transferred from the big river to Grand Canal for maintaining a navigable condition in the dry season, that means the relationship between the Yellow River and Grand Canal, or the natural river and artificial river are more complicated to explain. Due to the flood prevention work was the most important requirement, the Yellow river considered as the one of the most significant motives in forming the large scale Grand Canal.

The Yellow river has influenced its down-

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48 Ferdinand von Richthofen, he is noted for coining the terms the Silk Road in 1877, is wrote in his book “China; Ergebnisse eigner Reisen und darauf gegründeter Studien”.
streams, on one side, it provided the water for canal and farmland; the other side, it needed the water channels for control the flood. In this Chapter, we could see how the Grand Canal formed in fighting with the powerful Yellow river migrations, and lastly became a unique artificial water route from Beijing to Hangzhou.

Yellow river originated from north-west of China, has 5464 kilometres long. Its upstream passes from the north-west dry mountainous regions to the eastern flatlands. By the geological and geographical situation of the river regions, it has two major characters, one is the high silt content\(^49\), which caused the river could be choked with silt, then overflowed as flood in the flatland and migrated itself route; The other thing is that the Yellow river turned into aboveground river after people built the embankment along the river, because the sedimentation in the bottom of river would lead to riverbed rising. The embankment would easily be destroyed when the flood peak coming, then heavily damaged the farmland and human settlements, even the cities and towns in the flatland. In the history, from Sui dynasty, people began to learn from the Yellow migrations, how to control it river channel and reinforce its embankment. Along with the Yellow river migrations, the artificial river in the land gradually linked together with a natural river, to form a Grand Canal all over the country by its functions of transporting goods and materials from economic area to capital.

The cultural landscape theory described how the human work changed the nature and the transforming from natural to cultural landscape under the long-term human intervention. The people who lived along Yellow did the work to control flooding and planned the new water channel, which was used in flooding prevention, adjusting the water level, save water resource and remove silt. We could say that the Yellow river migrations and flooding were the crucial motive for creating a cultural landscape of Grand Canal.

We should realize that the cultural landscape of Grand Canal has formed in a long time process, from the first step it was a result to resist the natural disaster and threaten. The people could manage natural environment well, and then provide a good condition for their survival in the large route of natural river and canal.

By the records in historical documents of the

\(^{49}\) By the statistic, the Yellow River had maximum amount of sediment load per year which reached three billion and nine hundred million ton, and the maximum sediment concentration had 920 kilogram per cubic meter water. Resource from: Yellow River Conservancy Commission of the Ministry of Water Resources.
irrigation and flood prevention works, it showed that Yellow river has migrated many times. My work considered that Yellow river migrations were crucial motive to develop the cultural route of canal, which could be concluded in five steps to generate the transformation of the route:

First, the period before 12th century, the Yellow river passed through the north plain of China where developed many cities and towns in the flooding area, in that time the Sui-Tang empire used the Grand Canal as an irrigation work and transporting route in hundreds of years;

Second, from 12th to 15th century, Yellow river turned into Jiangsu plain in the east of China, since lack of water in the northern section of Grand Canal and flooding area moved to the south China, Yuan empire had to discover water resource for new water channel, at the mean time, it needed to protect the southern agricultural area, then transport goods and materials to the new northern capital.

Third, from 16th to 19th century, Yellow river occupied the course of Huai river, passed the Jiangsu plain then entered to eastern sea, the route of Grand Canal began to separate from Yellow river to avoid the disaster from flood peak. The Grand Canal has experienced a busy working time, from capital Beijing to south economic centre Hangzhou, even many cities fast expanded urban area as a port city of the inner river, such as Lin Qing, Ji Ning, Xu Zhou, Yangzhou, etc.

Fifth, from 19th to 20th century, the Grand Canal broke in middle age of 19th, due to Yellow river caused a heavily damaging flooding in 1855, then return to its original route in the north plain of China and directly destroyed the waterway of canal. The other indirect reason was the north to the south railway, more convenient and efficient land transportation replaced the waterway.

Sixth, from 20th to beginning of 21st, Grand Canal would be considered as various new social functions, developed multi-use artificial waterway, especially after become the World Heritage in 2014.
5.2 Before the 12th century: Variations in the watercourse of the previous Yellow River motivating people to build an artificial waterway.

Niu Zhong Xun published his book about Yellow migrations and water development in history, who described the relationship between Yellow river and ancient canal, their urban condition in the natural environment, water irrigation work and geographical situations in its downstream of the big river\(^\text{48}\). He thinks that the Yellow river migrations in the north plain of China should be considered as an important motive to generate social and economic activities when he traced the migrations of Yellow River.

The Yellow river changed in a large-scale geographic range, from central China, properly to say, the area of Zhengzhou city was a starting point, the river went into flatland then reach the coast to produce an alluvial plain. The Shangshu. Yugong recorded the earliest Yellow river course that was named Yu river, its upstream passed mountainous area to Meng Jin city, almost kept the same course as nowadays. But its downstream frequently changed the course which started from Zhengzhou and Mengjin, after converged the many branch river, it turned to the northeast of He Nan province, then entered Xingtai city and passed the big lakes in that time, at last, separated into some more branches went to the ocean. Niu Zhong Xun redrew the map of Yellow river migrations, he defined this was a period of steady and continuous movement on the northern plain until the 12th century. A large amount of silt brought from Yellow river produced the alluvial area in the river mouth. The flatland had to experience the disaster caused by flooding water, so that where people lived there began to build the embankment to protect their homeland from the flood. But people couldn't completely prevent the flood from damaging farmland and settlement. Before the 12th century, Yellow river three times heavily burst its bank, which generated people created flood control works, such as built the artificial river.

\(^{48}\) NIU Zhong Xun(2009), Yellow River: migrations and water development, China Water Power Press Beijing.
From 7th BC to 12th century AD, Yellow River suffered three major water migrations that was a crucial motivation to develop the artificial river in Yellow River flood area.

The first major migrations of the Yellow River in recorded history occurred in in Zhou dynasty, 602 BC. According to "Han Shu. Di Li Zhi" (Han dynasty. Geography) recorded, the Yellow River dam burst in Liyang (now Junxian) Xukou, occupied the Luo river then northeast went to Pu Yang, passed through north plain, flew to south of Tian Jin into the sea. Its course maintained almost five hundred years until the next changed its route. In BC 132, it burst again bank near south-west of Pu Yang and separated into two branches, the major river course and the other new one Tun Shi river which joined the original water route after passed through Guantao, Lin Qing, Wu Cheng and Gucheng.

In 11 AD, Yellow river entered a turbulent period for sixty years until the Eastern Han dynasty. A famous water and inner river expert, Wang Jing, managed the irrigation work for Yellow River's 800 years long stable river course, which was situated from Xing Yang went to Xin Xiang, Hua and Xun county, then turned to Puyang, Gao Tang county and went to the sea in Gao Qing county of Shan Dong province.

From 602 BC to 11 AD, the Yellow River migrations resulted in two landforms changing, on the one hand, the changes of the Yellow River left the old waterways for canal and provided a foundation and facilitated excavation of the artificial river routes, on the other hand, Yellow River provided a water channel for running artificial river in the rainless North China Plain.

Before 12th AD century, human intervened the natural river in various purposes. The early literature described a natural river was used as the offensive and defensive tactics in the war, which was man-made factors affecting the natural river migrations. For example, the war of vassal states in the Spring and Autumn Period, 359 BC, when the army of Chu State attached Wei state, they broke embankment and pour Yellow River into Changyuan city, which showed the people had basic grasp of natural water flow and velocity, learnt from floods and its heavy disaster. In the battle, the artificial flood could hinder the enemy's attack, or damaged the enemy camp and town, even destroyed the enemy's equipment and logistics support. This is small scale tactics by using natural rivers. Here, we can know that the ancient people had carried out their intervention into a natural river.

Human factors directly affect the Yellow River burst diversion, in addition to the aim of the attack on a war, the main purpose was to control the river for water conservancy, which also meaningfully affected the natural landscape of the river and the surrounding urban planning.

Before the 12th century, the Yellow River stream passed North China Plain, urban settlements had to sit close to river for human use, such as provided water to the agricultural and urban area, conversely, the Yellow River often caused flooding brought to these cities huge disaster in a long time. According to information from historical maps, I drew out all the artificial river which associated with events of Yellow River flood, could show how forming a large-scale national canal from local and cross-regional areas.

5.1.1 Spring-Autumn Period (770-476 BC), Earlier water channels were well developed under regional motivation.

A water channel was early recorded in a historical book. The Han Gou was a transport water channel. Wu state had to dig the Han Canal, when it had the artificial waterways in the Tai Lake basin, developed communication in rivers and lakes, for transporting food, goods and troops; In 486 BC, Han Canal was completed for military forces and first connected its north Jiang Su Plain where was in the northern area of Wu state. Four years later, they opened the other He Canal to reach further north of Huai river basin, which its water route extended for conquest another vassal state by military expedition. Moreover, in the south of Yangtze River, Wu state also had many water channels communicated to the capital city Suzhou; father south the waterway could even reach the bay of Hangzhou. In Figure 5.8, the most eastern area of ancient China had a waterway passed from south-east to north-east, which could connect the two Huai and Yangtze River. In a regional view, since the Han Canal ran from a north-south route, which connected the Yangtze and Huai River, the local state not only built a transport channel in its region, also opened a route to participate the political and economic activities in the most land of ancient China.

Wei State, since 361 BC, it opened a waterway for transporting in central China, when the Hong Canal (Figure 5.8) conducted water from Yellow River, it could connect Huai River, and eastern Ji and Si river. Through these various transporting route, basically, the country realized waterway from Qiantang Rive to the north Yellow and Ji River.
Yellow River could flow to the northern basin of Hai River. Now the sections of canal became a waterway from Jiangsu plain to Shandong Peninsula.

5.1.2 From Qin(221-207 BC) to Han(202BC-220AD) dynasties: the cross-regional waterway built along the route of the natural water course of the Yellow River.

The cross-regional waterway built in two ways the north-south and the west-east routes, they connected many cities in a different geographical condition in ancient China, especially worked with the Yellow River.

Firstly, the west-east water way, was opened in Qin state, had a short waterway which was connected by a natural river and few artificial river, such as Yellow and Wei River and canals. This route was inherited by Han dynasty in the next one hundred years. When Chang An became the capital, the transport volume had raised to three or four million tam from hundred thousand tam. But the Wei river always stopped by lacked water to maintain navigational level, so that the state opened a new canal to replace the natural river transport, which could reach Tong Guan to Yellow River from capital Chang An. From this time on, the canal from Chang An to Tong Guan joined the water network from west to east, passed through Yellow River, Hong Canal, Bian Canal, Si River, Han Canal, reached a length of four thousand kilometres. The natural river was principal waterway also needed provided water to the canal in rainless central regions of China. In a cross-regional view, after this water control project completed, although capitals in Qin and Han's dynasty located near the midstream of Yellow River, they could transport abundant goods by ships with this west-east waterway.

In 69 AD, Han dynasty, the west-east waterway had been reinforced in Han Dynasty, for defending flood area in the Yellow River basin. After the first large-scale water control project, the mainstream of Yellow River had a meaningful period of water stability in its downstream area for hundreds of years. The Yellow River had the most detail documents about its migration in the north of China in AD 11, it burst the bank near Da Ming city had damaged the land in sixty years until AD 69. The water management official Wang Jing fixed a new waterway from Ma Jia River then went into the sea from Li Jin town. The difficulty of the new channel was necessary to ensure the Yellow River could

50 The unit of weight one tam (石) equal to 31 kilos in Han dynasty.

51 Ban Gu(25-220 AD).The history of former Han dynasty, Biography of Wang Mang.
Figure 5-4 Early artificial rivers were built in China before Qin Dynasty Period (221BC).
In this chart, it shows the natural and artificial rivers linked as a water route, which was used in transporting in history, because the ancient people basically used water source for developing new canal from Yellow River, Huai and Yangtze River.
Redrawing from: Yao Han Yuan, An introduction of water conservancy in China.
smoothly flow to plain and directly access to the sea, and secondly, also need to kept not caused the burst of embankment after riverbed rising, which requires river has a role of draining sand and silt, but more importantly, the Yellow river needs to transfer water to the artificial river for maintaining adequate water level, kept shipping unobstructed. Wang Jing treated the new water channel as a comprehensive renovation, especially setting water gates to adjust water flowing, and then reduced the rate of downstream siltation, resulting in the Yellow River the long-term safety flow situation. The river is relatively stable for nearly 600 years.\footnote{Fan Ye (298-445 AD). Book of the Later Han Dynasty, Biography of Wang Jing.}

Wang Jing worked in building the embankment along the Yellow River and, From the west Xingyang of He Nan province to east Gaoqing of Shandong province, almost six hundreds long kilometres, which was a grand project worked under a strong collaboration through many cities and towns in the flooding area of Yellow River. Wang Jing realized that the elevated river caused by the downstream sediment accumulation, the water could overfly the embankment and burst it when the flood peak coming. Therefore, Wang Jing constructed a new water channel to lead the big Yellow River into a sea and reinforced its river embankment. This new channel had widened its riverbed, reduced its distance of the route so that it could firstly keep the riverbed lower than outside ground and slow down the rate and amount of silt sediments. It was the major long-term safety measures after a flood of Yellow River, by embankment construction and fixed riverbed.

Next Wang Jing led another project to transfer water from Yellow River to Bian canal. Bian canal was a new waterway connected Huang and Huai River, which opened in BC 403 to 221, one section of Hong canal. It worked as the main waterway to link the capital to south-east agricultural productive area. Wang Jing planned a new channel for Bian canal so that it could avoid the frequently flooding area from Yellow River, also could well be used as the transport route. That's means open or close the water gate could adjust the water level of the canal, even without sediment. In history, it was a creation made by Wang Jing in water conservancy measure. This measure also practiced in other water branches of Yellow River, for water distribution, draining sediment, and resisting flood peak by drain off water to the canal. In this period, many people worked along the river to protect their farmland and city, meanwhile the irrigation work and control the water level needed the cooperation from cities of flood area
so that these cities could develop more urban area under water importing and more agricultural area for planting their crop.

After the Yellow River conservancy project by Wang Jing, many cities built some important inner-river port for commodity trading, which also developed their urban form with water transport route. Even more, these cities had to protect themselves from the unexpected flood, they constructed city moats, water channels to prevent flood hit them. Chang An (BC 202- AD 25) was capital from Han dynasty had considered the canal to convenient transport goods in its city area.

AD 204, many canals had connected the north flowing Yellow River and other local streams to form a north-south waterway, from the northern Hai River Basin, went to Yellow River midstream basin, and then to the south-east plain of China.

In later Eastern Han Dynasty, Cao Cao, a monarch planned to unify the north China, he was opening up new shipping channel to northern plain. In AD 204 to 206, three canals had been opened, Bai Canal, Ping Lu canal, Quan Zhou canal which connected to many streams in the basin of Hai River. The north-south canal could start from Luan River, through the Yellow River, south to Qiantang, but due to lack of rainfall and large areas of silt sediment, its efficiency is lower than the west-east navigable canal. In AD 213, Cao Cao rebuilt the Ye City as capital and opened water channel to Bai canal for transport. Ye City became the inland river port in the north region, it promoted greater changes in ancient urban structures by using a waterway separated the capital in two parts. Canal flew into the city's commercial area also leading to the formation of the marketplace. After the water was transferring into the urban area, they planned artificial lake for conserving water, but also was leisure venues and public place for people and the nobility; In addition, the city of Ye used the lake to storage water in a dry season and drainage it in flood season.

5.1.3 Sui dynasty (581-619 AD): created the national waterway system of artificial and natural waterways.

In Sui dynasty, its famous capital, Chang An, was known as the largest city in that time, learnt from the urban planning of Ye city, it was a new political centre of the state in Sui dynasty, which could directly link the north and south China, by using the transport waterway combined with south-north and west-east canal network. This national waterway had imported grain and tribute to Chang An, by natural and artificial rivers. The Sui empire
completed opened three main canals, the Guang Tong, Tong Ji and Yongji, and recovered Han canal renamed it to Shan Yang Canal, only spent several decades years. The Tong Ji Canal based on the old west-east canal was particularly carefully designed the navigational route for transporting grain and tribute from the southern agricultural area. It had two sections in Tong Ji canal, one part was the old reconstructed Bian canal between Xing Yang and Kai Feng, the other part was a new canal flowing from Kai Feng to Chen Liu, Qi county, Shangqiu, Yong Cheng, Si Xian, Xu Yi, then joined the Huai River\textsuperscript{53}. The new waterway had forty paces(Bu) width, the royal road in both sides of canal which were planted full of willows\textsuperscript{55}. The Tong Ji canal had a more convenient and fast navigational route than before. In AD 608, Yong Ji canal connected to Yellow River with the help of Qin River then reached the north Zhuo Jun city (now it's near to Beijing), due to the frequent flood of Yellow River, it was hard to maintain the navigation capacity. At last, the Grand Canal completed its route in China, it was from the central area, the capital Chang An, also a second capital Luo Yang, they developed rapidly under the

water transport, as they kept advanced their urban drainage ditch and flood control system.

5.2 12th to 14th Century: Yellow River re-migration and capital relocation, both of them promoted to build Grand Canal on the established empire.

Before the 12th century, since the construction of the waterways in previous dynasties, the Yellow River largely burst dyke again in 1128, due to long terms war in central China, the waterways are not promptly repaired which caused downstream river siltation heavily. Followed by the Yuan Dynasty, 13th century, it ruled China, had moved its capital city the far north of the North China Plain, Da Du (Beijing), which needed construct a new canal to connect south regions of China. From 12th to 14th century, Grand Canal reshaped itself under the motive of Yellow River migration and its capital northern moved.

5.2.1 1128 AD: The result of natural forces. The Yellow River migrates across the southern plain of China, threatening the transport route of the Grand Canal.

East Capital of Song dynasty was located in Kai Feng, in 1128, for stopping the enemy troops, one
military officer Du Chong had to order excavated opening the levee, which led the river flew to east Shang Dong and He Nan provinces, then went into Si and Huai River, lastly to the sea. It was the main cause that Yellow River began to southern flow to Huai River, but was unsuccessful tactics didn’t stop the troops from the northern state. The next 40 years, not only the old Bian Canal near Kai Feng capital completely had broken stream, the Yellow River overflow without fixed river course in the basin of Huai River, even the destructive river cut off the connection between north and south China. The main route of Grand Canal, completed in Sui dynasty, had broken off its different sections in the flood area. How to repair the water transport route in Yuan dynasty, was became a crucial problem to recover collecting national revenue for new capital, Da Du (Beijing).

5.2.2 1272 AD: The result of cultural forces. Da Du(Khanbaliq), the new capital relocated in the furthest northern area is linked to the economically developed regions in the South

After about 150 years continuing war broke out in China up to Yuan Dynasty established, the Sui- Tang dynasty Grand Canal route had been devastated in the war without maintaining and restoring. Therefore, in the beginning period of Yuan, the north capital Da Du (Beijing) had to hardly suffered the old and ruined navigational canal, which transported grain and tribute from Shan Yang canal (Han canal) to north rivers, join the natural unstable Yellow and Huai River, then passed a few old northern sections of Sui-Tang Grand Canal, but in this route, they must make use of the land transport by carriages which cost much labour and materials, a fully difficult way. The first emperor Kublai Khan accepted the proposal from an official Bo Yan, who proposed that the state should open a new north-south Grand Canal as a national water route, in which the ship carried more goods and cost fewer labours than land carriages. Meanwhile, Bo Yan suggested that the new capital city needed to build a waterway

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network as the urban areas in southern China, such as Hangzhou, where water channels could free linked to the city centre, rural area, around towns and villages, for well-transporting goods by private and official commercial purpose.

In the feudal history of ancient China, the first governor of Yuan Dynasty located the new imperial capital in farther north plain, surrounded by Yan mountain ridge, compared to former capitals, Chang An, Luo Yang, o Kai Feng, the Da Du was much more far from Yellow River.

Da Du capital selected a good place. It was ringed on three sides by mountains, located in a flatland opened to south-east. Liu Bing Zhong and Xie Zhong Wen planned and built the capital, the palaces, dwelling and official districts, city wall and moat. They also considered developing waterway and inland city port, storehouses near the palace, to receive and collect the tributes by canal from all over the country. Otherwise, because of the canal was stopped by Yellow River migration, in 1272 Da Du had to further use ocean shipping by Tian Jin port city, in decades years. In these years, they discovered many shipping routes in the east sea of China, set an official institution for administer the maritime transportation by sea in 1287. The official route passed the Zhen Zhou, in the north bank of Yangtze River, and south of Yang Zhou, near the old Han Canal, then it went into the east sea, also developed few seaport along a coastline, such as Tong Zhou (Zhe Jiang province), Jiao Zhou, etc. It could reach 3 to 4 million tams transport capacity per year, which depend on good condition of hydrology and wind direction. In 1363, the way of ocean shipping temporarily stopped by civil strives in Zhe Jiang provinces, meanwhile, Yuan dynasty gradually opened new canal for transporting more and more tributes rather than only depended on sea shipping.

5.2.3 Developed new waterways in northern areas to avoid the destructive power of the Yellow River.

From 1266, Yuan dynasty began to restore the ruined Yong Ji Canal. In 1266, Yuan dynasty started the project for restoring the old Yong Ji Canal. A local water official had investigated the awful situation of Yong Ji canal, said that water course of Yong Ji canal was not suitable for navigation, its section had been choked with heavy silt from south of Qing Zhou to north of Jing Zhou, there were no officers responsible for its waterway, so that the farmers arbitrary dug the levee for watering their cropland. 58 The old Yong Ji Canal had an important

role in the waterway of Sui-Tang Grand Canal, Yuan dynasty attempted to transport tributes, but its ships had to take a long way around in order to reach the capital port, even the worse thing was the heavy sediment in the water course, caused less transport capacity. From 1283, a new artificial river, Ji Zhou Canal was built to connect Ji Ning to Dong Ping. Ji Zhou canal was completed in 1283, had 75 kilometres. The historical book "Yuan Dynasty History. Rivers" recorded the detailed content of the canal project, which built a dyke-dam to conserve water from Wen River in the area of Tai An, and redesigned the water course flew to Ji Ning, also joined another water resource from Si River in the area of Yan Zhou city. At last, the main water course could divided into two streams, they flew in two ways, from north and south of Ji Ning, which supported water for navigation in the canal.

Due to open Ji Zhou canal, it offered a navigational waterway much shorter than former section that had to go to Huai River and south section of ruined Yong Ji canal. But in the other side, it also needed waterway directly join the north section of Yong Ji canal, if not the goods should be trans-shipped by carriages in almost 100 kilometres land route, then reached Lin Qing city and once again entered into north section of Yong Ji canal to capital Da Du. It wasn't an efficient way which cost thirteen thousand families worked per year. They planned to dig another waterway to connect Lin Qing and Dong Ping.

Hui Tong canal was built for Dong Ping to Lin Qing waterway, had great significance in connecting the whole north-south Grand Canal in Yuan dynasty. The "Yuan Dynasty History. First Emperor" recorded that, in 1289, Kublai Khan agreed to open the Hui Tong canal, followed the suggestions from local water officials' geographical and hydrological investigations. Hui Tong canal had it's almost about 120 kilometres route from Dong Chang city to Shou Zhang county, then got to Lin Qing, with thirty-one water locks to adjust the water level, and controlled ships' volumes of traffic. Although the Hui Tong canal great shorted the transported distance, it couldn't pass wide boats because of low depth of water. However, the last section was Hui Tong canal, the water route had to pass through Tong Zhou city and turning west to the last stop, the capital Da Du.

Tong Hui Canal had replaced about twenty-five kilometres overland route. In 1291, Guo Shou Jing, a scholarly expert in hydrology, mathematics and astronomy, who suggested to Kublai Khan open waterway from Da Du to its east city Tong Zhou, also it could be used for irrigation. He conducted water from many springs in north-west mountains, firstly opened up the course to inner city of Da Du from its west water gate, then flew into a south lake as an inner port in capital, Ji Shui Tan, finally went east to Tong Zhou and joined Grand Canal. Due to Da Du had twenty metres higher than Tong Zhou, Guo Shou Jing designed many new water docks, to solve the different elevation between the two cities. It's largely convenient for ships directly transporting goods to capital from waterways on the land and overseas.

Yuan dynasty chose Da Du as capital, where unavoidably built its lifeline to southern agricultural plain and manufacture areas, such as Yang Zhou, Su Zhou, Hang Zhou, etc. In this way, Grand Canal had to suit the new requirement of transporting, a complicated water network worked under natural and artificial rivers, a large-scale lakes, which maintained water route quite more safe and convenient. North cities of canal developed fast under the busy waterways, they built the port and inner lake for mooring ships, promoted new urban commercial area and functions.

5.3 14th to 19th Centuries: Sustained effort to maintain the Grand Canal against flooding.

About six hundred years, Grand Canal had to use the navigable section of Yellow River, but at the same time, it kept precaution to defend the flooding from this big river in the southern river basin.

The migrations of Yellow River first happened in the basin of Huai River, threaten not only the south section of Grand Canal but although the widespread farmland in the plain of Jiang Su and south Shan Dong province.

How to harness the Yellow River helping water transport in Grand Canal? In the period from 14th to 19th century, people had experienced a process to solve the problem.

First, after borrowing water from another local river, Grand Canal considered built a new section of Hui Tong canal to avoid the Yellow river.

The old Hui Tong canal built in Yuan Dynasty, but in a long time it could not work well due to the

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water level was unstable, there was a deficient design. So that in Ming dynasty, from 1411, local official Pan Shu Zheng of Ji Ning city, he proposed that Hui Tong Canal could be rebuilt immediately to dredge water course. With a detailed surveying and some important advice from a local respectable elder, Bai Ying, they built a new dam for keep water flowing to Nan Wang town which located in the north-west of Ji Ning, where it was the highest elevation in the whole water route. From here, the river distributed forty percent water flowing to south section, sixty percent of the water flowing to north section. Therefore, the new water point and local Wen River helped watering old Hui Tong Canal. Even more, they widened riverbed of Hui Tong Canal, which largely increased its transport capacity. Moreover, they opened new river course for Hui Tong canal which was eastern moved twenty-five kilometres to Shou Zhang; the other was that they dug an old channel to borrow water from Yellow River near Xu Zhou city.

Second, Grand Canal had gradually separated from waterway of Yellow River.

After dug two new water channels, Nan Yang and Jia, Grand Canal had completely separated from Yellow River. In July of 1565, Yellow River again burst its levee in Pei county caused about fifty kilometres ruined waterway by heavy sediment. Two years later, the water officials Zhu Heng dredged a waterway in 20 kilometres, from Pei County to Nan Yang, built eight ship docks to Nan Yang. Nan Yang canal successfully improved the waterway in the section of Hui Tong canal, because that its higher elevation to prevent from the flood of Yellow river.

Jia canal was the other new waterway opened in one hundred thirty kilometres, eleven ship locks, could accept two-thirds of transportation capacity in all of Grand Canal. By record, the year 1605, it had more than eight thousand ships passing here. The local official Li Hua Long commented the advantages of Jia Canal, said that it was well-avoiding disaster from Yellow River flood, partly shorter transport distance, the most important was that it could be used

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as a drainage channel when the flood peak coming.  

Although the waterway had prevented from the flood in hundred years, but it had to solve another tricky problem, the raising riverbed of Yellow River which threatened Grand Canal at their intersection point also would cause heavy flood into south-east area. So in almost two hundred years of Qing Dynasty had focused most their water work on the intersection among Yellow River, Huai River, and Grand Canal, where it was a place named Qing Kou.

Cen Zhong Mian, he thought the water projected focused on solve the problem in Qing Kou, which protected the Grand Canal and dredged Huai River to pass the intersection in Qing Kou, moreover, water administers learnt from former dynasty to reinforce the bam along the river, to maintain a prosperous transporting waterway”. They had a common view in water management, that was defended the downstream course of Yellow River, to protect the northern section of Grand Canal from Yellow River flood. But from 1662 to 1820, the riverbed of Yellow River raised they had to cost a large number of labour force and finance in heightening and reinforce dykes. In 1851, an uncommon heavy flood went to both Yellow and Huai River, finally caused south embankment of Hong Ze Lake burst, the flood water rushed into south Yangtze River in three flooding branches. Four years later, 1855, Yellow River once again met a rainy season and broke of dyke in its central section near Lan Kao, then it returned to old north watercourse and essentially broke end the water transportation of Grand Canal.

5.4 19th-20th Centuries: Grand Canal transport links are disrupted between northern and southern regions by heavy flooding along the Yellow river.

From 19th -20 the century, Yellow River had burst the levees heavily two times, which caused serious disasters. In 1855, the Yellow River north migrated after 700 hundred years and went into the north plain of China. In Qing Dynasty, the last empire repaired the levees to keep stable and safe water course from 1875 to 1885.

After 1855, the section of Grand Canal in Shan Dong province was destroyed heavily by the flood of Yellow River, the Qing Dynasty had to begin to reuse the tribute transport by the sea route. In 1872, the Ship Business Soliciting Bureau was established in Shanghai, it made use of the seagoing

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ships to transport tributes for capital Beijing. The official canal transportation was formally ended in 1904. Seven years later, in 1911, the railway from Tian Jin to Pukou (Nan Jing) was constructed as the cross-regional railway, it connected the north capital and southern cities, from Beijing to Tianjin, then reach the Nanjing in the south bank of Yangtze River. The steam train and modern railway had replaced to the Grand Canal, both in functions of transporting tributes and passengers. During the Sino-Japanese War, in 1938, the retreating army of China Nationalist Government broke out the levee of Yellow River in an attempt to halt the rapid advance of Japanese forces, in Hua Yuan Kou, a town of He Nan province. The Yellow River south-east flew over into branches of rivers, and flood water gushed into Hongze and Gaoyou Lake and went into Yangtze River. The Yellow River back to its former route in March 1947, after repaired its levee in Hua Yuan Kou. But the damage area reached in fifty-four thousand square kilometres in east of China.

5.5 20th Century: the Grand Canal seeks to reinvent itself as a multi-use artificial waterway.

After the establishment of People's Republic of China, due to a long-term flood monitoring and embankment repairing levees, the Yellow River has a stable water course from 1949. In 1955, July 5th, a General Planning of the Yellow River Basin was completed and signed off by first People's Congress.

From this time, the government began to consider harnessing the Yellow River in comprehensively general planning, more integrated way, to solve the problem from flood and silt sediment.

In the south region of Grand Canal, they tried to irrigate farmland in Jiang Su province by using old water channel.

The ministry of transport was suggested to follow a principle, which designed new waterways and ports closed to the city but not crossed it. Such as the developing a section of Grand Canal in Jiangsu province from 1958 to 1981, most of the water conservancy projects were promoted far from the urban centre to protect urban heritages, also avoided resettled a large number of inhabitants. There was a well know example, the Zhen Guo Temple Pagoda and its ancient architectural complex were preserved well in 1956 in the west of Gao You Town, where Grand Canal needed be widened here. The new

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72 Recorded by United Nations Relief and Rehabilitation Administration.
waterway made way to this temple. The urban heritage of canal was recognized as important part of the Grand Canal.

Water also was borrowing from south Yangtze River and Huai River, to irrigate north agricultural plain of Jiangsu province.

From 1982 to 1989, the southern section of Grand Canal, from Xu Zhou to Yangzhou still was a busy waterway, and would be improved to 2nd shipping level. It was planned to build 70 metres width of the canal bed, and 4 metres depth, 52,4 kilometres long. From 1990 to 2003, the Water Traffic Interchange Project was successfully built in Huai'an, this large water hub construct a water channel go straight to the sea for Huai River, but also built a new upper waterway for Grand Canal transport, which the natural and artificial rivers had separated in vertical level, they crossed each other in two level. The Grand Canal gradually achieved more and more benefit by better stabilisation. Now, Grand Canal is an eastern waterline in South-North Water Transfer Project in China.

A new opportunity is bidding for the world heritage for Grand Canal, which stimulated a top-down effort aims to protect various heritages along China Grand Canal, its great many of historical cities relation to the artificial river, abundant intangible and tangible heritages.

In June 2006, the Beijing-Hangzhou Grand Canal was listed in National Important Heritage Site, issued by the State Council. In March 2008, "Grand Canal and World Canal Heritage Protection Working Conference" was held in Yangzhou by the State Cultural Relics Bureau. This meeting had established the Cities Alliance of China Grand Canal Heritage, obtained a " Yangzhou consensus of China Grand Canal Heritage Protection." It was also integrated Sui and Tang Grand Canal from Chang'an and Luoyang city. At the same time, The "Beijing-Hangzhou Grand Canal Bidding for World Heritage " was renamed to "China Grand Canal Bidding for World Heritage "which involved the 33 cities most relation to the water route. In 2013, Eastern Canal of Zhe Jiang province and Sui-Tang Grand Canal joined to the listed Beijing-Hangzhou Grand Canal, to form a national protected heritage, an integrated large scale Grand Canal.

In June 22nd, 2014, China Grand Canal was successfully listed in World Heritage in Doha 38th World Heritage Committee, thanks to many scholars who insisted on it and love this artificial river, they are from historian, artist, architect, archaeologist and so on.
Figure 5-6 221BC-220AD century artificial rivers were built in China
Figure 5-7  581-619AD century artificial rivers were built in China
Figure 5-8  12th-14th century artificial rivers were built in China, Yuan dynasty
Figure 5-9 14th-19th century artificial rivers were built in China
Part II  Waterway Scaling on Regions

Figure 5-10  19-20th century artificial rivers were built in China
Part II  Waterway Scaling on Regions

Figure 5-11  20th century artificial rivers were built in China
Figure 5-12 21th century waterways are developing in China
5.6 The seven capitals along the Grand Canal take great advantage of national waterways across the territory

Before the 20th century, people had to harness the artificial river, Grand Canal was one transport line for capital, to avoid be destroyed by Yellow River was their crucial work. In any dynasties of ancient China, whatever the capital relocated many times, they always looked for a waterway directly link to the water transport network, a lifeline for their capital city and imperial governance.

From this view, I tried to make one definition as the capital of Grand Canal, these capitals are not only the political centre, they were capitals considering how to use the waterway in maintaining national governance, how to administer the tribute transporting. The waterway has importance in building a capital.

Waterway has highly influenced the urban plan and the structure of capital city, especially when the waterway entered into the inner city as one urban river. One creation was that city planner was using waterway to collect water to be an inner-city lake. The other side, lakes would develop to be an inner port for ships bringing large treasure, foods, handicrafts from all over the country to capital. That is one season, why the governor needed the Grand Canal and had to maintain it year by year.

Seven capitals are from different periods which have differences in the waterway and urban structure, the image has compared their waterway length, the size of inner-lake, location of palace, market, and residence, etc. Through analysis of city and waterway, I could understand how the waterway intervenes in urban structure, and what kind of urban elements would be linked by waterway.

Chang'an, Han dynasty (202 BC-220 AD)

Chang'an city dig a water channel connect the Wei river to Yellow river. One waterway had 8 kilometres flowing from east to west of the inner city, passing through the southern area of the capital, where located many buildings such as palaces, temples, other ritual monuments. The waterway almost belonged to royal family or nobility, upper class, they could directly obtain the tributes from water transporting. Another waterway was used for transporting goods for two big markets near the north city walls. From archaeological documents has concluded that the southern area palaces, built royal gardens with different scales lakes, for artificial scenery both supplying fresh water. Waterways were
used separately to public citizen, and royal family and upper class.

**Ye Cheng, emperor Cao Wei (220-265 AD)**

Ye Cheng, it was a rectangular plan city, six kilometres east to west width, four kilometres and seven hundred meter south to north length, an inner waterway had almost 4 kilometres. Planner of Ye Cheng borrowed water from its north-west river to dig a water channel into the city which flowing from west to east and then went into the national waterway. Ye Cheng had only one main waterway which had passed northern half parts of the walled capital, which included royal gardens and inner artificial lake for training water army, the central area as the group of palaces, and area for upper-class residences. Ye Cheng was a political centre which developed north-south central axis beginning from royal palace to south wall gate. The image shows that waterway has been divided into two parallel sections in the eastern area closed to wall gate. Historical documents have mentioned Ye Cheng developed water-street for commercial trading not only used the water transport. Governors have completely controlled the main waterway which firstly served the royal family and upper class.

**Chang'an, Sui & Tang dynasty (589- 907AD)**

Chang'an, was a big capital built in Sui dynasty and inherited by next dynasty Tang, it had built a water network include almost 50 kilometre long waterway, 84 square kilometres and 36.7 perimeters walled city. The planner Yu Wen Kai designed this capital in three parts that separated by the wall, they are an area of royal family, imperial city and outer city. A waterway named Cao Qu, was main water supplying channel for the capital, meanwhile other three urban water channel used for transporting and domestic water. Cao Qu passed inner city from west to east, compared to Ye Cheng, it flowed through two biggest markets in the capital but not enter the royal family or palace areas. Every market has 1 square kilometre, which would benefit from the waterway. Cao Qu was one urban river used for the public. The waterway had been developed to be a commercial and trading line. Except to Cao Qu, there were two more water channel south - north going into capital, and coming out from north water gate flowing into Kun Ming Hu Canal, which is one section of national waterway network.

**Luo Yang, Sui & Tang dynasty (589- 907AD)**

Luo Yang was once the second capital except to Chang'an, or named as East Capital, also located on the Grand Canal. From Sui and Tang dynasties, governors planned Luo Yang capital, because it had
the more convenient situation to accept tributes from the national waterway. Luo Yang had its palaces area on the north-west of city which had opened its southern water gates to the riverbank of Luo River. Luo river was one natural river but dredged by people to keep it as a safety waterway. There were other urban rivers connected to Luo river: Cao canal northern passed through urban area and went into imperial palaces, which transferred goods and tributes to imperial grain depots, where was 5 square kilometres large area to store hundreds of granary for capitals; Tong Ji Canal, had connected a public west market near south water gate and port; Li Cheng Canal flew closed to north market; the Yun Canal connected the south market. From the plan, there is at least four artificial rivers in the urban area to support transportation and water supplying. Luo Yang is considered as water network planned capital, who has natural river and six urban rivers as branches to structure its urban area.

**Kai Feng, North Song dynasty (960-1127AD)**

Kai Feng, a capital in North-Song dynasty, which had three circled walls, it was a city with the central axis and three parts, the imperial palaces area, inner city, and outer city. Kai Feng used four natural rivers to build moat, transport goods and supply fresh water. Bian river, the main waterway transporting tributes for central palaces, it was most prosperous commercial streets; other three rivers, supporting different urban areas, the Jin Shui river supplying water for the royal area, Wu Zhang and Cai rivers were used for the south and north residence areas. Kai Feng was experienced an open streets periods in history, it reformed the urban area which combined the markets and traditional residence communities to form a new urban model, where the waterway passing through districts could be used for trading also dwellings. Royal gardens were built outside of capital next to the upstream river, such as the Jin Ming lake on the south bank of Bian River.

**Da Du, Yuan dynasty (1271-1368 AD)**

Da Du (Khanbaliq), the capital moved to the northern area of China, but it still built a waterway to connect the national water transport network to obtain tribute from south-east developed areas. The ancient book described that planners had a priority to design the waterways and then constructed the urban area and its city walls because the inner port of capital constructed to anchor royal ships. The urban planner was Liu Bing Zhong, and designer of the waterway was Guo Shou Jing, they considered that the capital had three hierarchies of an urban area like traditional capital cities, the imperial palaces, inner imperial city, and outer city, they all are walled
cities. Two water systems served for citizens and upper class, one was the water transport combined by the Tong Hui canal and Hai Zi lake, this waterway passed through royal and inner city, most of foods and tributes came from the southern canal, and finally official ships could stop in the lake, where the waterfront urban area became the commercial streets and trading markets; the second water system was mainly used for supplying fresh water to inner cities, to build royal gardens with big lake. Gou Shou Jing design the big lakes as water reservoirs that could adjust waterline for ships passing the water gates, this was a creation of Da Du water network.

Bei Jing, Ming & Qing dynasty (1368-1912 AD)

Bei Jing was based on Da Du original site to expand its urban area in Ming and Qing dynasty. Bei Jing inherited the water network of Da Du. It developed four circled walled cities. The imperial cities covered three lakes, and two more lakes in the inner cities. In the middle of 16th century, a new walled city expanded from south original Da Du wall, so that the new outer walled city could protect the suburban residences and commercial areas, and part of Tong Hui canal. The outer city had rapidly become another big market in the central south area of the inner port of Bei Jing, where collected a large number of goods from private and official ships.

5.7 Conclusion

The idea of Grand Canal is formed by two reasons, one is natural motivation that the big rivers migrations and floods in the lower plains which have generated building the irrigation works to avoid the natural rivers disasters, particularly the Yellow river frequently have migrated and destroyed large areas of farmlands and towns; the other reason is cultural motivation that the national capitals relocated and needed develop the waterways of Grand Canal to connect the southern economic areas in China, meanwhile those capitals planned their urban structure to suit for water network.

From the redraw plans of capitals which all were benefited from waterway to connect national water transport system, they also used the waterways as inner part of urban structure which influenced social and economic activities in different sections of waterway:

Waterway and area of imperial palaces, this section was firstly used by the royal family who needed occupying waterway as the water-supplying channel and transport line. Chang’an of Han dynasty, royal family and upper class began to build water landscape gardens, in other words there is an imperial waterway which only belonged to governance; Ye
Cheng, it imperial waterway partly opened to the public to form water commercial streets, and then the following capitals developed more market area and commercial streets on the waterfront.

**Waterway and road**, this is a section that shows us how the waterway combined with the road system. Kai Feng digs four water channels almost parallel to principal roads which had their four urban functions, the Bian river transport a large number of goods and tributes, Jin Shui river supplied fresh water for palaces area, other two rivers served for the outer walled city. Luo Yang and Chang'an capitals of Tang dynasty had similar waterway and road network were used for transportation.

**Waterway and commercial area**, the capital began to administer trading market in Tang dynasty. Generally speaking, there were two crucial market rules in ancient capital, one was the centralized market developed in Chang'an of Tang dynasty, the two west and east markets were biggest commodities trading centre for the merchants all over the world, Luo Yang had the same situation; but from Song dynasty, waterway and riverfront formed another commercial street model, where was a more open street spread kilometres and divided different sections for certain commodity, this open street also was inherited in Bei Jing, it included the streets of consumption goods for upper class in the northern area of Ji Shui lake, and other commercial streets for normal merchant near the south water gates.

**Waterway and inner lake**, it was a section proved that people control water by use hydrological knowledge. Da Du was first capital who could using water to build reservoir which supported urban rivers could pass through ship locks. Tong Hui canal could pass through different elevation to Bei Jing, because of ten important ship locks built for adjusting the height of water, so that many ships could arrive in Bei Jing even in the dry season.

**Waterway and a central axis of capital**, the waterway never had the same important symbol as the central axis that was a political centralized axis. The waterway although was an imperial water transport line, it only had a realistic value not a spiritual symbol. Waterway was one part of urban functions, it works as a transport method or hydraulic engineering. The space of water did not generate any political energy in urban space. Waterway was constructed by people, administered by governors, and was used as one physical condition.

After I analysis the seven capitals on ancient China, we could clearly understand why capital planners needed the waterway to maintain the
political centre city, how these capitals were benefited from national water transport network. The capital cities relocated in a different geographical situation where formed the new urban structure with water network. The waterway has become a public water network from only occupied by single social hierarchy, the royal family or upper class. Urban planners and hydrologist worked together to make that a water channel could transport a large amount of goods for official grain depots, forming water commercial streets for trading, and large area artificial public and royal lake for recreation. Certainly, if there were no artificial river, capital city could not be built on a large scale to protect millions of people, and governed large scale territory.
Figure 5-13 seven capitals once built in China relied on the waterways of Grand Canal
Chart 5-1 capitals migrations and Grand Canal forming in ancient China.
Chart 5-2 The scales of waterway and capitals.
Chart 5-3 Analysis prototypes show waterway joining in urban form in different capitals.