The Chinese Grand Canal World Heritage Site: living heritage in the 21st century?

By:

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Abstract

The Chinese Grand Canal, contrived in the late thirteenth century to provide a safe route to the capital Beijing from the south of China for the imperial grain tribute, during the sixteenth century became the main trade artery. This canal consisted of a linear network of linked rivers and lakes, often improved to enable barges to pass and interconnected with sections of canals. In order to pass the undulating topography the watercourses were adapted with sluices of various kinds, and over its existence the main challenge was to negotiate droughts and flooding that often required new courses to be adopted and/or innovative methods in order to preserve water or circumnavigate flood damaged areas. During the twentieth century it had gradually fallen in disuse and became neglected. Yet during the Mao era sections were revived for shipping coal and were re-made sometimes on the course of the old canal, sometimes elsewhere. Other sections were removed and materials quarried for other uses. Remarkably at the same time the concept of the Grand Canal was also celebrated. By the time the Canal was inscribed on the UNESCO World Heritage Register in June 2014 there was little left of the historic fabric. In the years running up to this nomination there had been efforts to re-create some of the heritage, with the government focussing on the canal as a tourist destination. When it was finally inscribed the International Council on Monuments and Sites (ICOMOS) expressed concerns about the state of the original fabric and the 'modern' heritage created.

However, the state government still holds a rose-tinted view of the various issues relating to the condition of the canal, and the propaganda and economic initiatives by the government have made it very difficult to voice criticisms. As a result canal heritage continues to be treated inappropriately with little respect for the final fragments of original fabric that still survive. This thesis aims to identify the values of the Grand Canal through a critical assessment of its historical development, and surveys the various issues relating to the heritage using the Shandong section as a case study and then explores the appropriateness

and effectiveness of the current methodologies and approaches, as to whether the canal meets the criteria as a World Heritage Site; whether perhaps other designations would be more suitable; and that perhaps the canal heritage should form the basis for an alternative development methodology, addressing a new agenda regarding sustainability, climate change and mounting health problems.

Foreword

I first started studying in the University of Sheffield as a Masters student six years ago, and wrote my dissertation about Chinese traditional villages and rural landscape with Dr. Jan Woustra as my supervisor. This was when I started researching traditional villages, especially those which are not in the list of Historic Villages and Towns of China, which means they are not protected or given any special attention. These villages might disappear at any time under the pressure of rapid urbanization.

I was lucky to be able to continue this research as a PhD student with the same supervisor, as a good working relationship had been established, and with his support to be able to develop my research skills. For a doctoral study, a more specific topic was needed. I immediately thought of the Grand Canal, as I grew up in a canal-side city, and at the time the Grand Canal was under increased focus as it was preparing for the World Heritage Site nomination. This south-north axis used to be one of the most developed features, but fell into decline after the canal stopped serving as the main route of imperial grain transport. I was fascinated by how the field patterns along the canal changed throughout time, and wanted to raise awareness for the conservation of these traditional villages. So we came up with this idea to study canal-side rural settlements. But after a year, my supervisor Jan and I both realized this topic was very difficult to continue.

The biggest difficulty was that there was not enough written evidence to provide sufficient support for an argument, and my research experience was understandably not able to provide me an alternative way to find data. After a lot of uncertainty, Jan suggested that I change topic, and that even though this would provide the gigantic challenge of starting again there should still be enough time to succeed. It was a very hard decision for me to make, because it meant my almost twenty months of hard work might be wasted. And I even started to doubt myself, questioning why I could not make my topic work out when the study of other PhD students, who started at the same time with me, seemed to go very smoothly.

After weeks of consideration, I accepted the reality and decided to change topic, because I understood that the longer I waited, the less time I had to start afresh. When we were trying to think of a new topic that would make much more sense than the old one, we thought why not switch the focus from the canal-side rural settlements to the Grand Canal itself? Because after a long time of collecting data, we found out that there was much more data on the waterway. And most importantly, while still studying the previous topic, we were always very surprised about how the Chinese government could nominate a historical site for a World Heritage status when there was so little heritage left. What is the value of the Grand Canal and for whom? It seems to me that the conservation approaches taken for the canal are more like the development and planning approaches.

Under this context I started the new topic (which is the topic of this thesis), in the second half of my second year, to explore the historic values and conservation issues of the Grand Canal. There were considerably more material for me to review, and I realized the last twenty months of work was not a waste at all. It taught me how to look for data and analyse it, and how to choose material more selectively.

However, there was another difficulty, I was not critical enough when I presented my argument. The Chinese education system does not really encourage students to question things, and after I was taught not to doubt until I was 22 and came abroad, it did take a long time for me to change the way I think. At first I found it difficult to bring up problems about the Chinese government directly, because of the propaganda I was used to listen to. And I remember when I first talked about my research to my parents, they immediately became worried and said ‘it is not appropriate to doubt the policy and authority in such a public way.’ Admittedly and interestingly, I believe they are still worried now.

But I appreciate that I am able to voice criticism, although I am still learning how to do it now, I am proud that my research will bring up more issues than most other research about the Grand Canal, and I am able to contribute something different, which is probably what it is urgently needed. Many people asked me why I chose to do a China-based study abroad, and some of them said that might be because it is easier to study something you already knew. But I want to say that they are wrong, and it is much more difficult to introduce something from your own culture and background, because you might find it harder to be a spectator.

The main reason I chose to study Chinese heritage is because I was concerned about the current trend of heritage conservation, which is full of lack of regard to historical values and the pursuance of private interests. The more I looked into the issues, the more problematic they seemed to me. Sadly, however, there is so little awareness on this subject both in China and abroad. So I wished through studying more effective conservation methods from a western context, where the heritage conservation is better developed, that more lessons and experience could be applied to improve the current legislation framework on protection heritage sites in China to an international standard.

It is hard to believe that I am already at the very end of my PhD journey, and I can not say how grateful I am to be able to have this experience. There have been many difficulties on the way, and there were moments were I wanted to give up. But I am glad I did not give up and overcame these difficulties one by one, which made me not only become a stronger person, but also a more skilled researcher compared to four years ago. This journey is just like the history of the Grand Canal: there were never ending problems for it to become functional and fit for purpose, but it continued and became one of the most significant waterways in Chinese history. There will always be obstacles in one’s life journey, and this four years’ experience taught me how to always face them and overcome them, and in the end they turn to precious treasures to accompany you for life.

Acknowledgement

This thesis would not have been completed without support from many people. Firstly, I would like to thank my supervisor, Jan Woudstra, who has been supporting me and giving my guidance since I was a Masters student in the Landscape Department. I would not be able deal with the fact of changing topic without his encouragement and support, and he has always given me advice of how to think critically and how to be a good researcher. I also want to thank Colin Roth, who has helped correct my grammar, and given me useful advice on academic writing. And Cilla Hollman who has provided training on English writing and helped me with language problems.

I also would like to thank my colleagues who are also my closest friends, Liyuan Gu, Josepha Richard, Gulsah Bilge and Megan Waller. They have supported me with their company and friendship, and helped me go through hard times. And all my colleagues who shared their experience with me and gave me great memories in the Arts Tower 9th floor. I also want to thank all the staff of the Department of Landscape at Sheffield University, who have always been supportive and created a pleasant environment for my research. Especially Dr. Nicola Dempsey who gave me the opportunity to teach in the department, and the interesting discussion of waterways studies.

This research project would not be completed without the various people in China who have helped me collect data and provided useful materials for my study. This include the local residents who I had interviews with. I found their stories highly informative and appreciated how welcoming and kind they were to me. And to the government officials who provided me with documents I required so generously.

My deepest appreciation goes to my dear parents, who support me unconditionally, and have always believed in me whenever I doubt myself. And also to my partner, Daniel De Arriba, who has always listened to me, been proud of me, and put up with me when I was stressed or emotional. Thanks to everyone I met on this journey, it has been a great one.

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on the map) were constructed around the junction area between the Xiao Wen River and the canal, to discharge water during the flooding season and to supply the canal as necessary during the dry season. Willow trees were planted around the lake boundary in 1541 to prevent the land from being cultivated by local people. Source: State Administration of Cultural Heritage of People's Republic of China, p. 293 199

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Glossary

This glossary only includes the technical terminology relating to traditional river engineering, common terms such as the names of places or imperial-reign periods are not listed here.

Term	**Definition**
ai zha 隘闸	A lock used specifically for measuring canal barges
ao zha 澳闸	A lock with chain-pimps mounted on pontoons
ba gua 八卦	Chinese eight trigrams
bei chen 北辰	Pole Star
bian dan 扁担	Carrying pole
bian liu 编柳	Willow-knitting method
biao gan 标杆	Ruler
cao chuan/cao fang 漕船/漕舫	Grain-shipping barge
cao he/cao qu 漕河/漕渠	Grain shipping river
cao yun 漕运	Grain transport
cha 锸 or 臿	Shovel
Cheng Huang 城隍	The Town God
chuan bang 船帮	Boatmen gangs
chuan gong 船宫	Ship-making palace
chuan yang 船样	Ship model
chuan 川	River
da cang 大仓	Great granary
da hang 大夯	Big ramming
da yun he 大运河	The Grand Canal
di liu 低柳	Delay planting method
di zhi 地支	Earthly Branch

ding yi bian er 丁一扁二	Flemish bond, one technique of brickwork
dou men 斗门	Flash lock
du lun che 独轮车	Wheelbarrow
Du Shui Jian 都水监	The Director of the Department of Waterways
duan shui liang 断水梁	‘Cut-water’ bulkhead of a boat
duo 舵	Rudder of a boat
fu shi 伏狮	The beam of a barge, literally means the lion tamer
fu zha 复闸	Double-gate lock
gao liu 高柳	Strengthen bank by willow roots method
gou 沟	Channel/canal
gu 谷	Valley
Guan Di 关帝	The god of war
guo tou 裹头	The end part of a lock
he gong 河工	River engineering
he long men 合龙门	Closing the Dragon Gate
he zhuan 河砖	River brick
hua gai 华盖	Imperial baldachin star
hui guan 会馆	Provincial guild hall
hun jiang long 混江龙	River rolling dragon
jian 涧	Ravine
jiao guan shi 绞关石	Stone crane arms
jiao ni chuan 绞泥船	Dredger
jiao 角	Parts
Jie Du shi 节度使	Regional military governors
jie huang xing yun 借黄行运	Assist the Grand Canal by borrowing the course of the Yellow River
jin men 金门	The space between the two abutments of a lock
jiu shui zhu di 就水筑堤	Build the embankment in the water

ji 箕 or *ben* 畚	Basket
Jiao 窖	Cellars of granary
jun chuan pa 浚船耙	River-dredging Harrow
Jun Tian Zhi 均田制	Land-equalization system
jun tun 军屯	Military Farms
(juan) sao (卷)埽	Fascine bundle
kan tang 瞰堂	A platform attached on both sides of barge
kai zhong fa 开中法	The Middlemen Method
lan suo 缆索	Cordage
liang tou 梁头	Bulkheads of a boat
long chuan 龙船	Dragon boat
long kou liang 龙口梁	'Dragon's mouth' bulkhead
Long Wang 龙王	Dragon King
long wei sao 龙尾埽	Dragon Tale Bundle
lou chuan 楼船	Battleship with fortified upper-works
luo pan 罗盘	Compass
lu 橹	Oars of a boat
lv di 缕堤	Summer dyke
ma tou sao 马头埽	Horse Head Bundle
ma ya zhuang 马牙桩	Horse teeth piling
man liu 漫柳	Willow-in-water method
mao 锚	Anchors of a boat
mei hua zhuang 梅花桩	Plum blossom piling
min zhu mo li 民逐末利	Chase after commercial benefits
mo fan 模范	Model worker
nan shui bei diao 南水北调	South-north water transfer project
niu dai 牛埭	Ox-hauling
nong tian shui li jian she 农田水利建设	Farm and water conservancy construction

pai zhuang 排桩	Line-up piling
peng 蓬	Sails of a boat
po si jiu 破四旧	Destruction of the Four Olds
qian dian hou zhai 前店后宅	Shops in the front yard and residential area in the backyard
qian fu 浅夫	Dredging man, one of the types of river worker
qian pu 浅铺	Dredging station
qian sheng 纤绳	Hauling cables
qian xing han 牵星板	Guiding star stretch-boards
qian xing shu 牵星术	The guiding stars method
qiu 丘	Hill
qu 渠	Channel/canal
Quan He 泉河	Canal of spring
ren ding sheng tian 人定胜天	Man's determination can subdue Heaven
san he tu 三合土	Soil mixed with lime and loess
sao gong 埽工	Fascine bundle technique
shan 山	Mountain
shang bang 商帮	Merchant group
shang guo tou *上裹头*	The end part of the lock wings at the upstream
shang ying shui yan chi 上迎水雁翅	The wings on the ends of a lock at the upstream
shen liu 深柳	Further-to-water willow planting method
shi chuan di 石船堤	Embankment made of stone-filled boats
shi feng liang 使风梁	'Wind-using' bulkhead of a boat
shi gong 石工	Stonework
shu jun 疏浚	Dredging
Shu Shui Gong Sha 束水攻沙	Restrict the current to attack the silt
shui ci cang *水次仓*	Water-side granary
shui gui 水柜	Water reservoir
shui zha 水栅	Water palisades

shui 水	Water
shun qie 顺切	Stretcher bonded stonework
si lei 耜耒	Ancient Chinese digging tool
su tu 素土	Natural soil
tian gan 天干	Heavenly Stem
Tian Hou 天后	The Heavenly Mother
tian 田	Fields
tie guan 铁官	Department of iron production
tie ju kou 铁锔扣	Iron nails
tie zhui 铁锥	Pointed iron stick
Tu Di 土地	The Earth God
tu gong 土工	Earthwork
tuo 橐	Ancient name of ‘basket’
wan nian fang 万年枋	The support underneath the lock gate
wang dou 望斗	Dipper observer
wang tong 望筒	Sighting tube
wei 桅	Mast of a boat
wo 硪	Flapper
wo liu 卧柳	Willow-laying method
xia fen shui yan chi 下分水雁翅	The wings on the ends of a lock at the downstream
xia guo tou 下裹头	The end part of the lock wings at the downstream
xian 弦	Halyards of a boat
xiao hang 小夯	Little ramming
xuan men 悬门	Hanging gates
yan chi 雁翅	The wing on each end of the abutment of a lock; literally means the wings of wild goose
yan dai 堰埭	Double Slipways
yao di 遥堤	Winter dyke

ye 叶	Leaf; also means the blade part of a shovel
yi 翼	Wings
yin huang ji yun 引黄济运	Supply the Grand Canal by receiving the water from the Yellow River
yin yang zhu 阴阳竹	Bamboo tiling of a boat
Ying Tian 应天	In response to Heaven
Yu Huang 余皇	An early type of Chinese *Lou Chuan* 楼船(battleships with fortified upper-works)
yue he 月河	The moon-shaped branch of a canal
zha 闸	Lock
Zha He 闸河	River of the Locks
zhao 招	Bow-sweep
zhen shui shou 镇水兽	Water-taming beast
Zhen Wu Da Di 真武大帝	The Mysterious Supreme Emperor of Heaven
zhi liu liu fa 植柳六法	Six Methods of Planting Willows
zhi nv 织女	Weaving girl star
zhi shen 直身	The two abutments of a lock
zhi 指	Finger-breadths
zhong nong yi shang 重农抑商	Agriculture rather than trading
zhu long 竹笼	Bamboo gabion
zhuan gong 砖工	Brickwork
zhuang gong 桩工	Piling

Table showing the conversion from the traditional Chinese measuring system to the modern measuring system

The units of measurement, weight and capacity of China were following the traditional system before the late twentieth century. The units used in this thesis relating to the designing detailing of the Grand Canal also followed the traditional system. The table below shows the conversion from the traditional Chinese measuring system to the modern measuring system.

Traditional Chinese system (length)	Modern system
cun 寸	Approx. 0.03 metre
chi 尺	Approx. 0.3 metre
zhang 丈	Approx. 3 metres
li 里	Approx. 550 metres
na 拿 (meaning the distance between the thumb and index fingers)	Approx. 0.15 metre
pi 匹	Approx. 1.2 metre

Traditional Chinese system (weight)	Modern system
dan 石	Approx. 53 kilogram
liao 料	Approx. 53 kilogram
liang 两 (the basis of traditional Chinese silver currency)	Approx. 0.038 kilogram
liang 两	Approx. 0.042 kilogram

Traditional Chinese system (cubic measure)	Modern system
fang 方	Approx. 3 cubic metre

Chapter One. Introduction

The Chinese Grand Canal 中国大运河 is an elongated water artery composed of rivers and lakes that have been repeatedly improved, regularized and canalized, and connected with sections of canals. The original purpose of the canal was to provide a safe route to the capital for the imperial grain, transported from the productive agricultural areas in the south;[1] at that time, water transport was the easiest way to transport heavy bulk goods. The canal also became the main trade artery of China between the sixteenth and eighteenth centuries,[2] until its gradual fall from use in the early twentieth century.[3]

On 22 June 2014, the Grand Canal was inscribed on the UNESCO World Heritage List as the 'world's largest and most extensive civil engineering project prior to the Industrial Revolution'.[4] However, the International Council on Monuments and Sites (ICOMOS) thinks the authenticity of this property is a concern, mainly because of the large number of features which have been re-created with the aim of emphasizing the Canal's historic appearance, and the poor record of preserving heritage during the rapid process of urbanization.[5] By the time it was nominated to be inscribed as a World Heritage Site (WHS), most of the Canal's original fabric had disappeared. So there are important questions to ask: what is the value of the canal as a heritage site, and what is there left for us to conserve?

There are various factors that led to the loss of the heritage value of the Grand Canal: the main one of which is the extensive modification which started in the second half of the twentieth century, designed to achieve the economic goal of becoming a modern China. The government's inappropriate approach to the conservation of the canal in the present century, especially because a policy of developing heritage tourism has been so vigorously followed, has also added to the negative impact on its maintenance. Even today the Chinese government, as well as local authorities, still hold a rose-tinted view of the various issues

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1 Wei Zheng, *Sui Shu* (Book of Sui) (er shi si shi ben, 1644), Di Ji (Annals), Gao Zu Shang (Gaozu Part One). Wiki Source https://zh.wikisource.org/wiki/隋书/卷01 [accessed 16th June 2016]

2 Li Quan and Wang Yun, *Shandong Yunhe Wenhua Yanjiu (Studies of the Canal Culture of the Shandong section)* (Jinan: Qilu Shushe, 2006), p. 144.

3 Zhang Zhaodong, 'Qing Dai Cao Yun Yu Nan Bei Wu Zi Jiao Liu (The Tribute Grand Transport in the Qing Dynasty and the North-South Trade)', *Studies of the Qing History*, 3(1992), 67-73 (pp. 71-72).

4 World Heritage Committee, 'Four New Cultural Sites Inscribed on World Heritage List', *UNESCO Official Website* (2014) <http://whc.unesco.org/en/news/1157/> [accessed 14 June 2016] (para. 3).

5 ICOMOS, Evaluations of Nominations of Cultural and Mixed Properties, 38th Ordinary Session, Doha, June 2014, pp. 116-117.

relating to the condition of the canal, and inappropriate approaches to preserving its heritage still continue. At the same time propaganda and economic initiatives by the government have created a climate in which it is difficult to voice criticisms. So before the last fragments of original fabric are lost, it is necessary to take a more critical approach to the conservation needs of the canal, which reviews and compares conservation objectives with conservation values and sets out to provide a balanced review.

Theoretical underpinning

Cultural heritage

In order to achieve the research aims of this study, which are to examine the historical values of the Chinese Grand Canal as a World Heritage Site and the approaches taken for its conservation, the meanings and definitions of terms such as 'cultural heritage' and 'heritage' need to be explored. As the Grand Canal was given the World Heritage Status by UNESCO, the principles and approaches of this organization will be used; although the guidelines from other organizations, such as the ICOMOS and the Historic England (former English Heritage), will be explored too, as a comparison of the different assessments of heritage sites.

The Grand Canal was inscribed as a Cultural Heritage on the UNESCO World Heritage list in 2014. The original definition of 'Cultural Heritage' was defined by UNESCO as 'work of man or the combined works of nature and man, and areas including archaeological sites which are of outstanding universal values from the historical, aesthetic, ethnological or anthropological point of view'.[6] This definition was at first adopted by the World Heritage Convention in 1972, when the concept of 'heritage' was officially expanded into two types: cultural heritage and natural heritage.

The reason for this split was due to the consideration that parts of the cultural and natural heritage that are of outstanding interest should be preserved as part of the World Heritage of

[6] World Heritage Committee, 'Convention Concerning the Protection of the World Cultural and Natural Heritage', *UNESCO Official Website* (2017) <http://whc.unesco.org/en/conventiontext> [accessed 02 June 2017] (I. Definition of the Cultural and Natural Heritage, Article 1).

mankind as a whole,[7] as UNESCO had been trying to seek recognition and protection for the valuable historic monuments and buildings around the World.[8] Although it has been criticised that this kind of split in fact is the separation of humankind and nature, which is thought to be influenced by Western attitudes.[9]

Being defined as 'work of man or the combined works of nature and man', however, this concept of 'Cultural Heritage' was not provided with any further details or even mentioned in the *Operational Guidelines for the Implementation of the World Heritage Convention* developed in 1977, which serves as the supplementary documents for the *Convention*. This causes a certain level of ambiguity for introducing this newly defined heritage type.

Interestingly, instead of using 'Cultural Heritage', the term 'cultural properties' is often used to refer to the former in the *Operational Guidelines*. This again causes confusion, as it could be argued that the term *Cultural Property* is too limited to describe all the possible elements.[10] And in some international reports the term 'cultural property' was in fact seen as an element within the 'cultural heritage'. For instance, the 'cultural property' is defined as 'movable or immovable property of great importance to the cultural heritage' by the UNESCO in *The Hague Convention* in 1954,[11] which clearly indicates that the former is a sub-group within the latter. The inconsistency in defining 'cultural heritage' by UNESCO itself brings difficulty in understanding this concept, and we probably will have to assume the two terms to have the same meanings in the *Operational Guidelines* within this context. It is also noted that due to the fact that the Grand Canal was nominated and inscribed as a Cultural Heritage Site, the study of this particular heritage type will be the focus of this thesis.

The *Operational Guidelines* (1977) also provides full details of the criteria for the inclusion of Cultural Heritage List, of which according to the definition of 'Cultural Heritage' above,

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7 World Heritage Committee, 'Convention Concerning the Protection of the World Cultural and Natural Heritage', *UNESCO Official Website* (2017) <http://whc.unesco.org/en/conventiontext> [accessed 02 June 2017] (para. 6).
8 Douglas Pocock, 'Some Reflection on World Heritage', *The Royal Geographical Society*, 29(1997), 260-268 (p. 261).
9 Plachter Harald and Rossler Mechtild, 'Cultural Landscaps: Reconnecting Culture and Nature', in *Cultural Landscapes of Universal Value. Components of a Global Strategy*, ed. by Placher and Rossler (New York: Gustav Fischer Verlag, in cooperation with UNESCO, undated), pp. 16-17.
10 Janet Blake, 'On Defining the Cultural Heritage', *The International and Comparative Law Quarterly*, 49(2000), 61-85 (p. 66).
11 UNESCO, *Hague Convention for the Protection of Cultural Property in the Event of Armed Conflict and its two Protocols*, 1954, p. 9.

we know it equals to the 'Outstanding Universal Values'. There are in total six criterions, the submitted property has to meet one or more of them.[12]

The emphasis on the forming of *universal* heritage implies the globalization of the inscribed properties, however, there was a severe imbalance between the European inscriptions and the rest of the world during the 1990s. For instance, it has been revealed that by 1999, fifty percent of UNESCO World Heritage Sites were located in Europe.[13] What is more, the numbers between the inscribed cultural and natural heritage also showed some level of discrepancy, this was not only reflected by the considerably larger overall number of Cultural Heritage Sites,[14] but also by the requirement to meet more criterions for the inclusion as cultural heritage in comparison to natural heritage (based on the 1977 *Operational Guidelines* there were only four criterions for the inclusion of natural heritage compared to six for cultural heritage).

The UNESCO intended to rebalance this situation, of which the period 1992-1999 is sometimes referred to as the 'readdressing' period.[15] The World Heritage Committee made the decision of merging the six cultural and four natural criteria into a single list, in order to readdress the imbalance in the original list, announced in their *Sixth Extraordinary Session* in 2003.[16] In this way, although the inscriptions for the world status were still dependent on each type, the tangible heritage was no longer seen isolated, instead, the emphasis started to be placed on the notion of human expression.[17] This may also explain the intention of the amendment of the criterion (vi),[18] with the addition of 'artistic and literary works', and suggests that this criterion should be used in conjunction with other criteria.[19] This thesis uses the aforementioned amended list as the basis for the approach used to examine the historic values of the Grand Canal.

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12 Operational Guidelines for the Implementation of the World Heritage Convention, 1977. Establishment of the world Heritage List, p. 3. For details of each criterion please see the same page.

13 Marie-Theres Albert and Birgitta Ringbeck, *40 Years World Heritage Convention-Popularizing the Protection of Cultural and Natural Heritage* (Berlin: Walter De Gruyter, 2015), p. 72.

14 There were 260 cultural heritage sites inscribed compared to only 78 natural heritage sites by the year 1991. Source is from *40 Years World Heritage Convention-Popularizing the Protection of Cultural and Natural Heritage,* Table 4, p. 60.

15 Albert and Ringbeck, p. 72.

16 World Heritage Committee, *Sixth Extraordinary Session of the World Heritage Committee*, Paris, 2003, Section II: Establishment of the World Heritage List, p. 7.

17 Albert and Ringbeck, p. 73.

18 The original texts of criterion (vi) is 'be most importantly associated with ideas or beliefs, with persons, of outstanding historical importance or significance.'

19 *Sixth Extraordinary Session,* p. 8.

Heritage

Before the concept of 'heritage' was expanded, this term had already been discussed in various international events. *The Hague Convention* (1954), as mentioned earlier, brought up the definition of 'cultural property'.[20] Interestingly, this term was sometimes understood as equivalent to 'heritage',[21] which is a misleading interpretation; as we have discussed above, it tends to be used to refer to a sub-group within the cultural heritage under that particular context.

The definition of 'heritage' is thought to be mentioned for the first time in the *International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter)*, in 1964, prepared by ICOMOS. Heritage is defined as 'ancient monuments', which are 'imbued with a message from the past, the historic monuments of generations of people remain to the present day as living witnesses of their age-old traditions'.[22] It is also worth noting that this Charter uses the 'cultural significance' as an important criterion to judge heritage,[23] although it did not give any further details of its meaning.

The details of cultural significance was explained in *The Australia ICOMOS Charter for the Conservation of Places of Cultural Significance (The Burra Charter)* in 1981, which defined 'cultural significance' as 'aesthetic, historic, scientific or social value for past, present or future generation.'[24] According to this criterion, heritages reflect the above values are desirable and to be preserved.

The definition of 'heritage' was broadened by the ICOMOS's *Charter for the Preservation of Quebec's Heritage* developed in the following year. Here heritage was defined as 'the combined creations and products of nature and man, in their entirety, that make up the

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20 ICOMOS, *Final Act of the International Conference on the Protection of Cultural Property in the Event of Armed Conflict*, Hague, 14 May 1954, pp. 9-10.
21 Marilena Vecco, 'A definition of cultural heritage: from the tangible to the intangible', *Journal of Cultural Heritage,* 11(2010), 321-324 (p. 322).
22 ICOMOS, *International Charter for the Conservation and Restoration of Monuments and Sites* (The Venice Charter 1964), Introduction.
23 Ibid., Article 1.
24 ICOMOS, *The Australia ICOMOS Charter for the Conservation of Places of Cultural Significance* (The Burra Charter 1981 version), Definitions, Article 1.

environment in which we live in space and time.' [25] This charter emphasized that heritage should not cover only buildings created in the distant past, because heritage should not be seen limited in time, but is often being renewed and enriched.

This point was further developed by another ICOMOS Charter prepared in 1999: *the international cultural tourism charter managing tourism at places of heritage significance*. It stated that heritage is a broad concept including both natural and cultural environment, and records and expresses the long processes of historic development which is a dynamic reference point for growth and change.[26] Although at this point there did not seem to have been a generally agreed definition of 'heritage' between the various conventions, even though they were all prepared by the ICOMOS, it can be seen that the understanding of 'heritage' had been enriched from its earlier definition-'ancient monuments'. Heritage is henceforth no longer seen as buildings that only existed in the past, but a dynamic process of development.

To make the meaning of 'heritage' even more diverse, UNESCO developed its own definition. Although the World Heritage Committee relies on the ICOMOS as one of the advisory bodies,[27] their judgments of heritage seem to be rather different. The 1972 *World Convention* defined the 'World Heritage List' as 'a list of properties forming part of the cultural heritage and natural heritage…which it considers as having outstanding universal values in terms of such criteria as it shall have established.'[28] This clearly shows the focus being on seeking the 'universal heritage' which meet the 'outstanding universal value' criteria.

Apart from the international organizations such as UNESCO and ICOMOS, this study also explores the assessment of heritage of Historic England, as their guidelines are also significant in understanding the meaning of 'heritage'. Historic England defined heritage as 'all inherited resources which people value for reasons beyond mere utility', and with the concept of 'cultural heritage' being 'inherited assets which people identify and value as a

[25] ICOMOS, *Charter for the Preservation of Quebec's Heritage* (Deschambault Declaration), 1982, Definition of Heritage and Preservation.
[26] ICOMOS, *The International Cultural Tourism Charter Managing Tourism at Places of Heritage Significance*, 1999. Introduction.
[27] ICOMOS, 'The role of ICOMOS in the World Heritage Convention', *ICOMOS official website* (2017) <http://www.icomos.org/en/what-we-do/image-what-we-do/268-he-role-of-icomos-in-the-world-heritage-convention> [assessed 5th July2017] (para. 2).
[28] World Heritage Committee <http://whc.unesco.org/en/conventiontext> (III. Intergovernmental Committee for the Protection of the World Cultural and Natural Heritage, Article 11).

reflection and expression of their evolving knowledge, beliefs and traditions, and of their understanding of the belief and traditions of others.'[29]

It can be seen that there are two common focus of these two definitions: the idea of inheritance and people's value. It is obvious that the idea of inheritance is considered as a premise of their heritage judgment, which means the heritage or cultural heritage should be a valuable resource inherited by current generations from past ones and which is also to be passed on to future generations.

Additionally, it is clear that how much a place[30] is valued by people is also important criteria for heritage judgment by Historic England. This brings the importance of identifying who are the 'people', to value a place, as different people are likely to value the same place in a variety of ways. According to Historic England, people who are owners, and communities that are likely to attach heritage values to a place, should be identified. It also should include specialists with sufficient knowledge of the place, as they are able to decipher the inherent values requiring understanding and articulation.[31]
It is also important to understand what Historic England means by 'value'. 'Value' itself, is defined as 'an aspect of worth or importance, here attached by people to qualities of places'. However, as 'value' in the definition of heritage is used as a verb, it can be understood that people who think a place of worth or importance should be considered as a heritage site. Moreover, the 'historical values' refers to 'value deriving from the ways in which past people, events and aspects of life can be connected through a place to the present.'[32]

Historic England has for the first time properly discussed the 'who' question, of which both the UNESCO and ICOMOS failed to offer a straightforward answer. While using 'values' to judge heritage has already become a globally agreed criterion, English Heritage gives a clearer context of 'who' values: the people and communities. Both the ideas of inheritance and people's value reflect their respect for people's perception and attachment to a place,

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29 English Heritage, *Conservation Principles-Policies and Guidelines for the Sustainable Management of the Historic Environment* (London: English Heritage, 2008), p. 71.
30 The word 'place' is used by the English Heritage to refer to 'any part of the historic environment, including under the ground or sea, that people perceive as having a distinct identity.' See the *Conservation Principles-Policies and Guidelines for the Sustainable Management of the Historic Environment,* p. 13.
31 English Heritage, p. 36.
32 Ibid., p. 72.

which would no doubt encourage more public participation in the conservation process, as people tend to care more about a place if they understand the place's history and importance, as well as making it more likely that this understanding of the place is taken into consideration for policy making.

Therefore, although this thesis will mainly use guidelines developed by UNESCO and ICOMOS to examine the historic value of the Grand Canal as a World Heritage Site, the Historic England's conservation principles are highly valued and will be used as a mirror to examine the conservation approaches taken by the Chinese government. The Historic England's approaches will also be taken into account while making recommendations for the canal's future management, especially the encouragement of public participation, as this is what the Grand Canal's management severely lacks at the moment.

Authenticity and integrity

Authenticity

To be inscribed as a World Heritage Site, a property must not only meet one or more Outstanding Universal Value criterions, but also the conditions of integrity and/or authenticity.[33] However authenticity is not considered to be a value itself, which means a property would not be inscribed to the World Heritage status simply because it has great authenticity.[34] The integrity and authenticity will be studied in this session to help examine the historic values of the Grand Canal, especially with the fact that its authenticity is questioned by the ICOMOS using their evaluation process.

The original test of authenticity only included four attributes, which were all related to physical forms: design, material, setting and workmanship.[35] One very interesting fact about the origins of authenticity is that it was actually developed from *integrity*. In 1953, the American National Park Service Administrative Manual proposed the concept of integrity, which is 'a composite quality connoting original workmanship, original location, and

[33] *Operational Guidelines*, 2016, p. 18.
[34] Herb Stovel, The Operational Guidelines, UNESCO World Heritage Centre version prepared by the Advisory Bodies (unpublished), 2003. Annex 4.
[35] *Operational Guidelines*, 1977, p. 3.

intangible elements of feeling and association.'[36] It was then adopted and amended by the World Heritage Committee, and renamed it authenticity, which can be realized from the definition of authenticity in the *Operational Guideline* (1977) mentioned above. The reason for this adoption by the UNESCO is unclear, although it is almost certain that some ambiguity between the two terms prevailed at this stage. This might explain why there is no further mention of integrity in the *Operational Guidelines* until 2005, given that the two terms were not really distinguished before then.

Varied interpretations of authenticity started to arise from the 1980s, which partly resulted in the organization of *Nara Conference on Authenticity* in 1994 to explore this issue. This conference was in fact extended from the *Venice Charter,*[37] although no details of authenticity were given in the Charter. Different understandings of authenticity were brought up in the conference, and for instance, some argued that the original material of a property is more important, even if it is incomplete; while others retorted that authenticity should represent a complete image, even if this means the usage of new material.[38]

The above disagreement can be seen as the difference between cultures and values, as a result one statement made in the Nara document is that it is impossible to make judgments of authenticity using fixed criteria, as judgments about values and related information sources differ from culture to culture. Therefore, the Nara document suggested that heritage properties should be judged within their own cultural contexts.[39] This concept is adopted by the UNESCO and added to the *Operational Guideline* in 2005.[40]

It is also argued that the original criteria of authenticity is too materialistic, which is thought to be lacking of recognition of non-western cultural contexts that often contain non-materialistic and spiritual creation in their cultural heritages.[41] Taking this into consideration,

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[36] Herb Stovel, 'Origins and Influence of the Nara Document on Authenticity', *Association for Preservation Technology International*, 39(2008), 11-14 (p. 12). Originally from E. A. Connally's personal notes (untitled) on UNESCO document CC-76/WS/25, World Heritage Advisory Bodies and World Heritage Committee representatives in Morges, Switzerland, 1976.

[37] World Heritage Committee, *Report on the Conference on Authenticity*, December 1994, p. 14, Preamble.

[38] Amareswar Galla, 'Authenticity: Rethinking Heritage Diversity in a Pluralistic Framework', in *Report on Nara Conference on Authenticity*, ed. by Knut Einar Larsen (Trondheim: Tapir Publishers, 1995), pp. 312-315.

[39] Galla, p. 15.

[40] *Operational Guidelines*, 2005, p. 92, Annex 4.

[41] Julie Williams Lawless and Kapila D. Silva, 'Towards an Integrative Understanding of 'authenticity' of cultural heritage: an analysis of World Heritage Site designation in the Asian Context', *Journal of Heritage Management*, 2(2017), 148-159 (p. 151).

the Nara Conference expanded the criteria of authenticity to also include intangible attributes such as 'spiritual and feeling',[42] and the *Operational Guidelines* adopted this expansion in its 2005 version. [43] In this way physical fabric was no longer the only focus that should be safeguarded, and countries from non-western cultural contexts were encouraged to submit more nominations of their cultural heritage sites. This could also potentially help readdress the imbalance regarding the numbers of Cultural Heritage Sites between Europe and the rest of the world.

Since there seems to be international consensus that judgments of authenticity vary from culture to culture, state parties have the corresponding liberty to decide in what form they would like to present their properties, based on the available evidence and sources. This has of course on one side encouraged more nominations, on the other side, however, it is not always easy for the World Heritage Committee and advisory bodies to make judgments, since there are no fixed criteria. This could potentially result in gaps in the judgment between the state parties and the World Heritage Committee, as there is no universal standard to test authenticity. This could be part of the reason why the Grand Canal is still given the World Heritage Status even though its authenticity is being highly questioned by the ICOMOS.

Although the judgment of authenticity differs from culture to culture, the *Operational Guidelines* makes it clear that reconstruction of archaeological remains of historic buildings is acceptable only on the basis of complete and detailed documentation, and no conjecture should be allowed.[44] This is an important guideline to reflect on the conservation of the Grand Canal, as there appeared to be large amount of reconstruction along its towpaths and on the waterway which had undoubtedly been recently adapted. Interestingly, most of these adaptations have been conducted to a very low professional standard. More details of these approaches, with the corresponding assessment of them, will be given in later chapters.

Furthermore, Historic England also advices that any deliberate change to a significant place should be distinguishable, which means the difference between new and existing of any

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[42] Galla, p. 16. The full list of expanded attributes includes: form and design, materials and substance, use and function, traditions and techniques, location and setting, and spirit and feeling, and other internal and external aspects of information sources.
[43] *Operational Guidelines*, 2005, p. 92, Annex 4.
[44] Ibid., p. 19.

repair or restoration should be made obvious.[45] As a national organization, Historic England focuses on the protection of historical buildings, monuments and sites within England, which because of dealing with just one cultural context, has made its judgment of authenticity much simpler compared to international organizations. The Historic England attributes of authenticity mainly include: design, function and fabric,[46] which are mostly related to physical evidence, which, as discussed, are more common elements for heritage in western contexts. Therefore, Historic England's guidelines regarding authenticity are not entirely applicable for the study of the Grand Canal, but could be seen as supplemental guidance to examine its conservation approaches.

Integrity

The ICOMOS considers that the condition of integrity of the Grand Canal is met for the inscription, although there exists doubts and paradox of its large numbers of discontinuous sections, for which continuity is seen as an essential value for cultural heritage sites.[47] Therefore, the value of integrity is also worthy of exploration, in order to examine the historic values and conservation approaches of the Grand Canal.

As mentioned above, the criteria of integrity is not included in the *Operational Guidelines* in its earlier versions. It is officially introduced as a qualifying criterion in 2005, although it had been discussed by ICOMOS previously as a condition for natural heritage sites only.[48] Being used for judging cultural heritage sites also, the criteria given in the *Operational Guidelines* seemed to be limited and rather vague: it required that the physical fabric and/or significant features of the nominated properties need to be in good condition, and should be able to *convey* the property's significance. However, it is argued that this requirement's only purpose is to ensure that all the elements necessary to support the property's Outstanding Universal Value are present, but not for a property to express or support the significance.[49]

The central idea of integrity is the 'wholeness and intactness' of heritage and of its

45 English Heritage, p. 45.
46 Ibid.
47 ICOMOS, Evaluations of Nominations of Cultural and Mixed Properties, p. 116.
48 Herb Stovel, 'Effective Use of Authenticity and Integrity as World Heritage Qualifying Conditions', *City & Time,* 3(2007), 21-36 (p. 22).
49 Ibid., p. 24.

attributes.[50] The ‘wholeness’ can be understood as whether all the elements of the property are presented to tell the full story of the site, and whether the property has adequate size to ensure the complete representation;[51] while ‘intactness’ is in relation to the condition of the property as in whether its existence is threatened.[52] In other words, integrity can be seen as the ability for a heritage site to secure or maintain its significance over time.[53]

In comparison, Historic England has a slightly different approach in defining integrity, of which its central idea is ‘wholeness and honesty’. [54] While the word ‘honesty’ is present, it is not difficult to link it to ‘authenticity’. It can be understood that authenticity and integrity are often seen as combined criteria, which implies that they are considered to be a supplement element for each other. However, Historic England’s Conservation Principles do not seem to provide further explanation of this idea of ‘honesty’, apart from the examples given that integrity can apply to ‘a structural system, a design concept, the way materials or plants are used, the character or a place, artistic creation, or functionality.’[55]

Despite the limited explanation of the concept of integrity, the Historic England advice is that any recovering and reconstruction of any aspects of integrity must be based on a comprehensive understanding of the values of the sites, especially those values which are likely to be lost in the process of repairing.[56] This guideline could again be used to assess the conservation approaches taken for the Grand Canal, where large amounts of reconstruction have taken place for the purpose of restoring a level of integrity. More details of this analysis and assessment will be given in later chapters.

Qu 渠, gou 沟 and Yun he 运河 (Canal)

The canal system was formed by gradually building and linking its various sections, and they were not conceived as a whole at the outset, so each section has its own name. These names do not include the modern term for canal, *yun he* 运河 but rather *qu* 渠 and *du* 瀆’[57], the

50 *Operational Guidelines*, 2005, p. 22.
51 Ibid.
52 Stovel, p. 25.
53 Ibid., p. 21.
54 English Heritage, p. 45.
55 Ibid.
56 Ibid.
57 Si Maguang, *Zi Zhi Tong Jian* (Comprehensive Mirror in Aid of Governance) (Taipei: Taiwan World Press, 1985)

original names for artificial or canalized waterways. For example, all the four sections of the Sui Canal, which was completed in the early seventh century[58] and was the original basis of the Grand Canal, are named *Tong Ji Qu* 通济渠, *Guang Tong Qu* 广通渠, *Yong Ji Qu* 永济渠 and *Shan Yang Du* 山阳渎. The name *yun he* 运河 appeared in the early eleventh century,[59] but was still not in common use when what is now the Grand Canal was being built. From the fifteenth century, *cao he* 漕河 (grain-shipping river) or *cao qu* 漕渠 (grain-shipping channel) were used to refer to the canal, at a time when the tribute grain shipments were much better.[60]

The name *yun he* 运河 only came in common use in modern times. In 1958 the Huaxin Tobacco Factory, which is located along the canal, named one of their products the *da yun he* 大运河 (Grand Canal) brand, which quickly became very popular in the northern Jiangsu Province.[61] In the meantime, the 大运河工程指挥部 (Headquarters of the Grand Canal Projects) were established in all of the canal-side cities responsible for the various canalisation reconstruction projects which were to be carried out along its course[62] as part of the new China's water management plan.[63] The name *da yun he* started to be used as the unitary name for the canal, relatively recently in the canal's history.

Chapter 180, Sui Ji Si (History of Sui, Part 4).

58 Denis Twitchett and John K. Fairbank, *The Cambridge History of China, Vol 3, part 1* (Cambridge: Cambridge Univeristy Press, 1979) p. 135.

59 Toqto'a and Alutu, *Song Shi* (History of Song) (er shi si shi ben, 1644), He Qu Zhi (Annals of Rivers and Canals)

60 Wang Qiong, *Cao He Tu Zhi* (An Illustrated Account of the Grand Canal) (hong zhi jiu nian ben, 1496). Vol. 8.

61 Gu Lijuan, 'Historical Names for Beijing-Hangzhou Grand Canal', *Journals of Zhejiang Ocean University (Humanities Science)*. 31:4 (2014), 101-103 (p. 102).

62 Such as the 济宁运河工程指挥部 (Jining Headquarters of the Grand Canal Projects) in the Shandong Province.

63 Chi Wenshun, 'Water Conservancy in Communist China', *The China Quarterly*, 23(1965), 37-54 (p. 37).

Figure 1. 1 The cover of the *da yun he* 大运河 brand tobacco produced in the Huaxin Tobacco Factory in 1958. There are also pictures of both the Tiananmen Square of Beijing and the West Lake of Hangzhou on the cover, implying that the Grand Canal links these two cities at its ends. Source: Unknown, 'da yun he xiang yan (the Grand Canal cigarette)', *7788 Online Auction Site* (2016), <http://sb.7788.com/a_140_11173624/> [accessed 16 June 2016]

He Gong 河工 (river engineering)

The building and maintenance of the Grand Canal was entirely done by hand until the mechanical aids became available in the late twentieth century. To enable the canal to negotiate the often difficult topography, various methodologies of *he gong* 河工 (river engineering) were used. River engineering in ancient China largely depended on accumulated experience, which manifested considerable scientific and historic value and served as a key contribution to the development of the Grand Canal.

A good example of river engineering is provided by the large number of *zha* 闸 (locks) that were built on the Shandong section of the canal. They were designed to save water, in locations where the challenging topography made it difficult to retain sufficient water to enable the boats to sail.[64] These locks evolved from the ancient *yan dai* 堰埭 (double slipways), which had been the most common device to raise the water level before locks, but which were rather dangerous for canal barges to pass across.[65] The first lock was invented by Qiao Weiyue, who served as the Assistant Commissioner of Transport for Huainan, in 984.[66] It was mostly constructed of large stone, with horizontal timber beams serving as the lock gates in the middle. They could then be moved by the *jiao guan shi* 绞关石 (crane arms) on both sides.[67] This was the basic structure of the canal locks, which gradually evolved to a more sophisticated technology involving brickwork, earthwork, stonework and piling techniques.[68]

The most prominent characteristic of traditional river engineering was the low-cost achieved by using local materials, especially important when the need arose for emergency repair of the embankment due to damage from floods. Because it shared part of its course with the Yellow River, the Grand Canal was often threatened by that river's devastating floods,[69] so practical methods of repairing the embankment and blocking breaches had to be developed. The most common material used to repair the embankment were willow in the south and kaoliang (sorghum or tall mullet) stalks in the north.[70] The most common technique to block breaches was *sao gong* 埽工 (fascine bundle technique), which involved kaoliang or willow stalks, earth, bamboo ropes and stones. They were rolled into a large sausage shape and placed where the breaches of the embankment had occurred.[71] These structures were cheap

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64 Yang Shiqi, 'Ping Jiang Bo Zhui Feng Ping Jiang Hou Yi Gong Xiang Cheng Gong Xuan Shen Dao Bei Ming (Inscription of Chen Xuan being awarded as the Lard of Pingjiang)', in *Guo Chao Xian Zheng Lu (Evident Worthies of Our Dynasty)*, ed. by Jiao Hong, 1620, Chapter 9. Wikisource, <https://zh.wikisource.org/zh-hans/國朝獻徵錄/卷之九> [accessed 15th June 2016]

65 Shi Xiaolei, 'Using Image as Historical Evidence- an Extinct Technology of Dragging boats to Pass over the Dams along Old Canals', *Journal of Changsha University of Science and Technology*, 4:4(2012), pp. 28-33 (p. 29).

66 Joseph Needham, *Science and Civilisation in China*, *Volume 4, Part 3* (Cambridge: Cambridge University Press, 1971), p. 351.

67 Hu Su, *Wen Gong Ji* (Collection of Wengong), 1778, Chapter 35. Universallibarary Online Archive https://archive.org/details/06051102.cn [accessed 15th June 2016]

68 Wang Biwen, 'Qing Dynasty for the Designing of the Locks and Culverts', *BSRCA*, 6:2(1935), 51-72 (pp. 51-54).

69 Tim Wright and Ma Junya, 'Sacrificing Local Interests: Water Control Policies of the Ming and Qing Governments and the Local Economy of Huaibei, 1495-1949', *Modern Asian Studies,* 47:4 (2013), 1348-1376 (pp. 1356-1357).

70 Li Denan, 'Gong Cheng, Huan Jing, She Hui: Ming Qing Huang Yun Di Qu De He Gong Ji Qi Ying Xiang (Engineering, Environment, Society: the River Work and its Impact along the Yellow River and the Grand Canal during the Ming and Qing Dynasty)' (published doctoral thesis, Fudan University, 2008), p. 56.

71 'Juan Sao (Fascine)', in *He Fang Tong Yi (A General Discussion of the Protection Works along the Yellow River),* ed. by Zhan Si (zhi zhi yuan nian ben, 1321), pp. 30-50 (pp. 31-32).

to make but extremely effective, and most importantly they were very flexible in terms of size and function, according to the needs of the specific circumstances.[72]

Historiography of the Grand Canal

As mentioned before, the concept 'Grand Canal' has only been commonly applied in modern times; in historical writings, it was hardly regarded as a whole, but instead was seen as a number of specific independent waterways serving the area which they covered. When the first sections of it were developed, the Grand Canal was not the only or most significant waterway for grain shipment. Between the thirteenth and fourteenth centuries, the sea route was the main distribution artery.[73] The pioneer section of the canal was *Han Gou* 邗沟, which was built to link the Yangzi River to the Huai River further north, for the shipment of military supplies for the State of Wu (twelfth century-473 BC)[74]. It made use of several natural lakes, and the aim of building it was not yet for grain transport, which would be the canal's main function for imperial China.

When the Sui Dynasty (581-619) completed the first nation-wide canal system, it consisted of several separated waterways, among which the southern sections, the *Tong Ji Qu* 通济渠 and *Shanyang Du* 山阳瀆 linking the capital Luoyang to Hangzhou were given the most attention. For the first time, they provided a safer and easier route by which the Sui emperor could visit the southern Yangzi region.[75] Most importantly, these waterways helped to ship tax grain and supplies collected from the eastern and southern fertile lands to the capital and the northern frontier, ensuring sufficient supplies for the dynasty. This was the first time imperial China used the canal system to ship tax grain, and the artery would be modified each time the location of the capital was changed by different dynasties.

The original canal route formed in the early seventh century was modified in the late thirteenth century. Kublai Khan of the Yuan Dynasty (1271–1368) settled the capital in *Da Du* 大都 (present Beijing) in order to be closer to his homeland in the Mongolian Steppe.[76]

72 Zheng Zhaojing, *He Gong Xue (Studies of River Engineering)* (Shanghai: Shang Wu Yin Shu Guan, 1935), p. 282.
73 Song, http://ctext.org/wiki.pl?if=gb&chapter=625167#p4 [accessed 30 June 2016]
74 Sima, <http://so.gushiwen.org/guwen/bookv_116.aspx> [accessed 20th June 2016]
75 Wei, <https://zh.wikisource.org/wiki/隋書/卷 24> [accessed in 30 June 2016]
76 Denis Twitchett and Herbert Franke, *The Cambridge History of China, Volume 6: Alien Regimes and Border States,*

Two new waterways, *Tong Hui* River 会通河[77] and *Hui Tong* River 通惠河[78] were built with the aim of linking Beijing directly to southern China. The court was expecting to benefit from these waterways because they would provide a reliable route for grain transport. They were expected to save annual costs, spent on land transportation, of over four hundred thousand liang (the basis of traditional Chinese silver currency, 1 liang roughly equals 38 grammes).[79] However, due to the difficulty of finding water sources, the canal route was almost abandoned during the time of the Yuan dynasty. Instead, sea transport was developed rapidly; Boyan, the Prime Minister, said that 'the effort of hauling the canal barges is saved, and the state is rich because of the large amounts of grain stored, how can you say this (sea transport) is not the best way for our generation?'[80] So although the Grand Canal was given its current form during this period, it was not regarded as an important waterway at the time. The canal only became the main means of transporting tax grain from the sixteenth century, when the difficulty of providing adequate water sources for the *Hui Tong* River had been overcome and the central government could benefit directly from its management. By the late eighteenth century, the amount of grain that was shipped to Beijing every year had increased to more than eight million dan (Chinese traditional unit of weight, 1 dan roughly equals 53kg), and the three provinces on the northern frontier had a total of twenty million dan of grain stored in their granaries annually.[81]

As mentioned above, during this period the Grand Canal was more often called *cao he* or *cao qu* (grain-shipping canal), and new names were developed for its seven sections: *bai cao* 白漕 (from Tongzhou to Tianjin, named after the Bai River); *wei cao* 卫漕 (from Tianjin to Linqing, named after the Wei River); *zha cao* 闸漕 (from Linqing to Tai'er Zhuang, so named because it had the largest number of locks); *he cao* 河漕 (from Tai'er Zhuang to Huaiyin, named after the Yellow River); *hu cao* 湖漕 (from Huaiyin to Yangzhou, named after the various lakes); *jiang cao* 江漕(from Yangzhou to Suzhou named after the Yangzi River) and *zhe cao* 浙漕 (from Suzhou to Hangzhou, named after the Province's name,

907–1368. (Cambridge: Cambridge University Press, 1994), pp. 454-455.

77 Song, <http://ctext.org/wiki.pl?if=gb&chapter=548553&searchu=%E4%BC%9A%E9%80%9A> [accessed 30 June 2016]

78 Wu Zhong, *Tong Hui He Zhi (Annals of Tong Hui River)* (jia jing san shi qi nian ben, 1558), Chinese Texts Project Online Ebook, <http://ctext.org/library.pl?if=gb&file=94877&page=26&remap=gb> [accessed 30 June 2016], pp. 6-7.

79 Wu, http://ctext.org/library.pl?if=gb&file=94877&page=3&remap=gb [accessed 30 June 2016]. Preface.

80 Song, http://ctext.org/wiki.pl?if=gb&chapter=625167#p4 [accessed 30 June 2016]

81 Zhao Erxun, *Qing Shi Gao* (Draft History of Qing), 1927, Chinese Texts Project Online Ebook, <http://ctext.org/wiki.pl?if=gb&chapter=844552&remap=gb#p18> [accessed 30 June 2016] (Chapter 96).

zhe).[82] This tells us that rather than being seen as a whole, each section of the Grand Canal had a unique name referring either to its functions or local geographical features. These names disappeared from use when the grain transport stopped.

Between the sixteenth and eighteenth centuries, the grain transport was so important for the state that almost all its water management policies were made with the Grand Canal in mind, sometimes at the sacrifice of the common people's wellbeing. For example, while trying to control the continuing flooding of the Yellow River, Zhang Baixing, the Director-general of River Conservancy in the early eighteenth century, said that 'the most important concern of the state is *cao yun* (grain-shipping)'.[83] The importance of the grain shipments was reflected in all the leading policies of the time, and as a result the course of the Yellow River was often deliberately directed to the northern Jiangsu Province, to avoid interruption to the grain shipments to northern China. However, this has shifted the flood threats to northern Jiangsu area and devastating flood often occurred here.[84]

A similar attitude was evident when the Qing government decided to prevent peasants from using canal water for irrigation. Wen Chong, the Governor of River Management in the early nineteenth century, said that 'the *cao yun* (grain-shipping) is more important than the peasants, and that fields, the private locks and channels linking the canal should all be temporarily shut down to secure *cao yun*'.[85]

We know from historic texts mentioning the Grand Canal that it was not seen as a significant north-south waterway for its first thousand years, in fact many of its sections were often left silted up. However for the canal to be sold to modern tourists as a key heritage site, its long history dating back to the fifth century BC and its significance in imperial China must be presented persuasively. Unfortunately, some information is over-emphasized and even exaggerated to the point of distortion. The words 伟大 (great or grand) or 最伟大 (greatest) have been used to refer to the canal in order to increase the appearance of its historical value

82 Zhang Tingyu, *Ming Shi (History of Ming Dynasty)* (ying wu dian ben er shi si shi, 1784), Chapter 61, He Qu San (Rivers and Canals Part 3). Chinese Texts Project Online Ebook, <http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb> [accessed 1 July 2016]
83 Zhang Penghe, *Zhi He Quan Shu (Complete Account of Water Regulation)* (Hand copied book, 1703), Chapter 1.
84 Tang Zhongmian, *Jia Qing Hai Zhou Zhi Li Zhou Zhi* (Gazetteer of Haizhou Subprefecture) (Woodcut Edition, 1811), pp. 12:2b-3a.
85 Zhao, http://ctext.org/wiki.pl?if=gb&chapter=480945#p12 [accessed 30 June 2016], Chapter 120.

in order to achieve WHS recognition. This issue will be critically reviewed in this thesis

The conservation of the Grand Canal: policy framework

The main economic policy of the first few decades after communist China focused on achieving progress in terms of modernization and agricultural production.[86] The price that had to be paid for this was a severely dilapidated environment and a disregard for heritage. The Grand Canal encountered massive modifications during this period, which aimed to upgrade it to a standardized modern waterway to serve for the coal transportation from the cities of Shandong, such as Zaozhuang and Jining, to the south of China.[87]
The 'modernization' of the canal meant the removal of much of the historic infrastructure such as the locks and the original towpaths. When economic progress was the only goal, this damage was given little consideration or attention. Awareness of the value of heritage conservation was expressed until the 1980s, when China became a signee of the *Convention Concerning of the Protection of the World Cultural and Natural Heritage* in 1985,[88] and immediately nominated a large number of heritage sites for inscription, including the Great Wall and *Tai* Mountain.[89]

In the meantime, further studies carried out by various institutes, such as the Peking and Tongji University, revealed the cultural and historical significance of the Grand Canal,[90] and the canal gradually came to be seen as a potential WHS. In 2009, the local government of all the eight provinces along the Grand Canal formed the Grand Canal WHS nomination committee aiming for WHS inscription.[91]

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86 Fu Chunli, *The Fiver Year Plan for the Development of National Economy, 1953-1957* (Beijing: Foreign Languages Press, 1955), p. 161.
87 Xu Congfa, Li Baohua and Han Yunchen, *Jing Hang Yun He Zhi (Annals of the Grand Canal)* (Shanghai: Shanghai Social Science Press, 1998), pp. 127-128.
88 World Heritage Committee, 'Convention Concerning the Protection of the World Cultural and Natural Heritage,' *UNESCO Official Website* (2016) <http://www.unesco.org/eri/la/convention.asp?KO=13055&language=E> [accessed 17 June 2016]
89 Yu Kongjian, *The Grand Canal Heritage and Ecological Corridor of China* (Beijing: Peking University Press, 2012), p. 51.
90 Ibid.
91 Shen Lingmin, 'Ba Ge Sheng Shi Lian He Fa Qi Zhong Guo Da Yun He Shen Yi Ji Ru Dao Ji Shi (The Countdown of the Nomination of the Chinese Grand Canal Supported by Eight Provinces)', *Chinese News*, 27 August 2012, <http://www.chinanews.com/cul/2012/08-27/4137089.shtml> [accessed 17 June 2016] (para. 3).

The Operational Guidelines for the Implementation of the World Heritage Convention

The WHS nomination of the Grand Canal is based on the Operational Guidelines for the Implementation of the World Heritage Convention (which were revised in 2015), which set up procedures for the inscription of properties on the World Heritage List and the List of World Heritage in Danger, as well as International Assistant granting and the protection and conservation of World Heritage Properties.[92]

It sets out clear criteria for the inscription of properties, including: 'nominations to the World Heritage List are not considered unless the nominated property has already been included on the State Party's Tentative List.'[93] The entire course of the Grand Canal had been added to the China's World Cultural Heritage Tentative List by 2012.[94] The Operational Guideline says that the nominated property must meet one or more of the ten criterions of Outstanding Universal Value (OUV), together with the conditions of integrity and/or authenticity.[95]

The Chinese State Party has made a statement of the Outstanding Universal Value of the Grand Canal which meets the ICOMOS criteria (i), (iii), (iv) and (vi):
Criterion (i): represent a masterpiece of human creative genius. '…the Grand Canal represents the greatest masterpiece of hydraulic engineering in the history of mankind, because of its very ancient origins and its vast scale, along with its continuous development and its adaption to circumstances down the ages. It provides tangible proof of human wisdom, determination and courage. It is an outstanding example of human creativity, demonstrating technical capabilities and a mastery of hydrology in a vast agricultural empire that stems directly from Ancient China'.

Criterion (iii): bear a unique or at least exceptional testimony to a cultural tradition or to a civilization which is living or which has disappeared. '…the Grand Canal bears witness to the unique cultural tradition of canal management via the caoyun system, its genesis, its flourishing, and their successive capitals, and then its disappearance in the twentieth

92 World Heritage Centre, *The Operational Guidelines for the Implementation of the World Heritage Convention*, p. 1.
93 *The Operational Guidelines for the Implementation of the World Heritage Convention*, p. 14, Article 63.
94 State Administration of Cultural Heritage of People's Republic of China, Nomination documentation submitted to the World Heritage Convention Cultural Heritage, p. 603.
95 The Operational Guidelines for the Implementation of the World Heritage Convention, pp. 16-17, Article 77 and 78.

century. It consisted of an imperial monopoly of grain transport and storage, and a taxation system. It contributed to the fundamental link between the peasant economy, the imperial court and the supply of food to the population and troops. It was a factor of stability for the Chinese Empire down the ages'.

Criterion (iv): be an outstanding example of a type of building, architectural or technological ensemble or landscape which illustrates (a) significant stage(s) in human history. '…the Grand Canal is the longest and oldest canal in the world. It bears witness to a remarkable and early development of hydraulic engineering. It is an essential technological achievement dating from before the Industrial Revolution. It is a benchmark in terms of dealing with difficult natural conditions, as is reflected in the many constructions that are fully adapted to the diversity and complexity of circumstances. It fully demonstrates the technical capabilities of Eastern civilizations'.

Criterion (vi): be directly or tangibly associated with events or living traditions, with ideals, or with beliefs, with artistic and literary works of outstanding universal significance. '…the Grand Canal is a demonstration of the ancient Chinese philosophical concept of the Great Unity, and that it was an essential element for the unity, complementarity and consolidation of the great agricultural empire of China. It is also the birthplace and setting for the development of a way of life specific to the populations on its banks, and is seen by them as a maternal influence'.[96]

The Operational Guidelines also say that nominated properties should establish boundaries of effective protection, which are 'drawn to incorporate all the attributes that convey the OUV and to ensure the integrity and/or authenticity of the property'.[97] Buffer zones should also be provided, 'an area surrounding the nominated property which has complementary legal and/or customary restrictions placed on its use and development…this should include the immediate setting of the nominated property, important views and other areas or attributes that are functionally important as a support to the property and its protection.'[98]

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[96] ICOMOS, Evaluations of Nominations of Cultural and Mixed Properties, 38th Ordinary Session, Doha, June 2014, pp. 117-118.
[97] The Operational Guidelines, p. 20, Article 99.
[98] Ibid., pp. 20-21, Article 103 and 104.

To satisfy this criterion, the state party set boundaries to cover the canal of Sui and Tang Dynasty (618–907), the Grand Canal (Beijing-Hangzhou section), the hydraulic remains of the Zhedong Canal, all associated historical relics, historic blocks and towns and villages, as well as the associated environmental landscape and things of this type. This includes 31 individual properties of the Grand Canal, which is formed by 85 major heritage items (27 canal sections and 58 cultural heritage sites).[99] Detailed information on the property boundaries and buffer zones is shown in Fig. 1.2 below.

The operational guideline also required that 'legislative and regulatory measures at national and local levels should assure the protection of the property…State Party should also assure the full and effective implementation of such measures.'[100] Related national laws on protection the of the Grand Canal have been made by the Chinese government to meet this criterion, however, because there was very little regulation or laws about the conservation of the canal before this, most of the original fabric disappeared before the regulations were issued.

A management plan to ensure the protection for each nominated property is also essential, which must specify how the OUV is preserved.[101] Two management plans of the Grand Canal were made by the state party, the General Master Plan (2012-2030) and the Grand Canal Management Plan.[102]

99 ICOMOS, Evaluations of Nominations of Cultural and Mixed Properties, p. 111.
100 The Operational Guidelines, p. 20, Article 98.
101 Ibid., p.21, Article 108-110.
102 ICOMOS, Evaluations of Nominations of Cultural and Mixed Properties, p. 122.

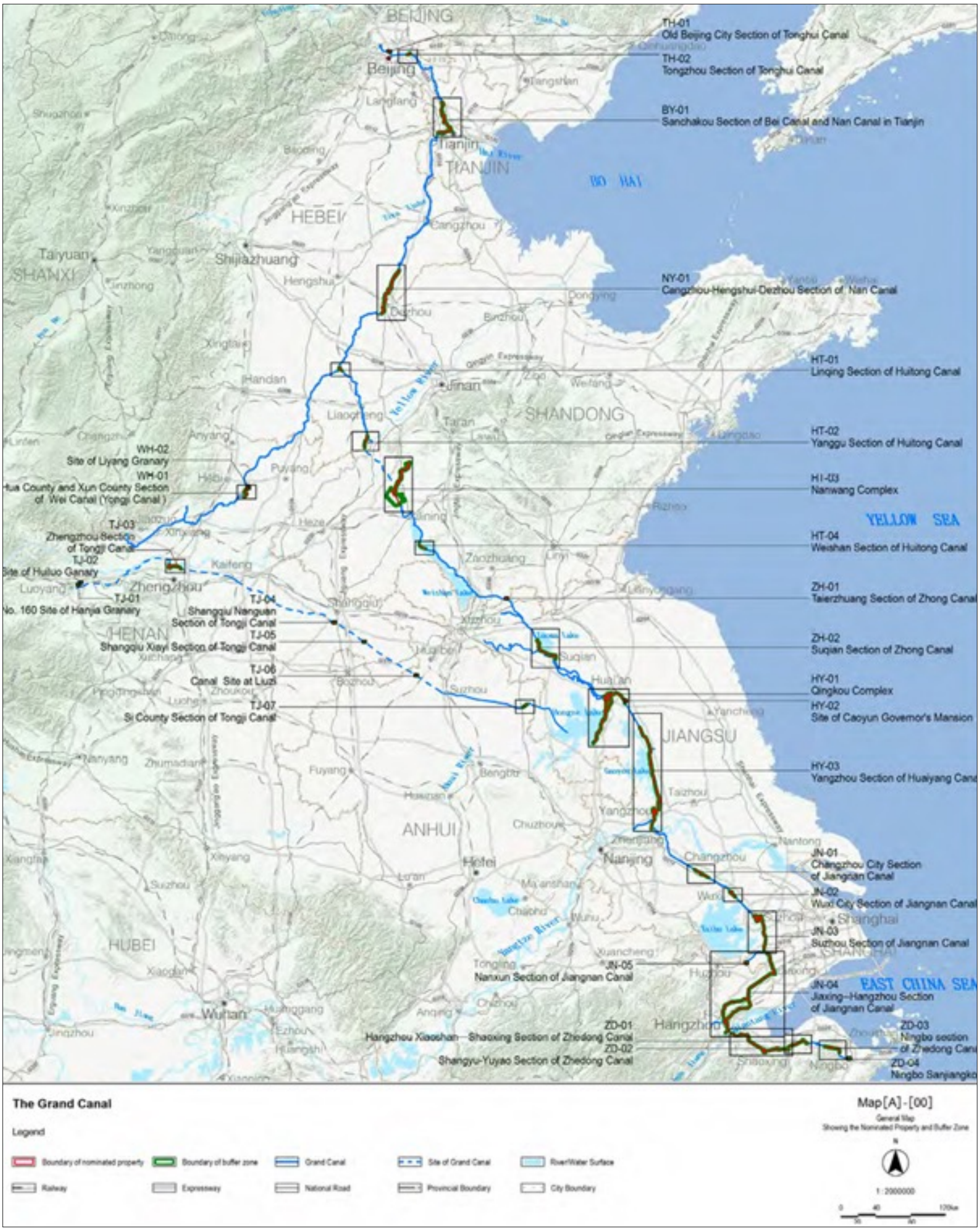

Figure 1. 2 The map shows the boundaries (shown as red lines within rectangles) of all the nominated properties of the Grand Canal (blue lines). The buffer zones within the green boundaries (shown bordering the red lines) can also be seen, which cover the adjacent areas and related landscape components to ensure effective control over the canal surroundings. For more detailed information of the boundary of each section please see Figures 6.15-21 in Chapter 6. Source: State Administration of Cultural Heritage of People's Republic of China, Nomination documentation submitted to the World Heritage Convention Cultural Heritage, 2013, p. 54.

Legislation on the protection of the Grand Canal

The state party has set up the objective for conservation of the Grand Canal. 'Truly and completely protect the historical information and all the value of the Grand Canal's heritage, continue and promote the vitality of the Grand Canal to play an important role in boosting the harmonious evolution of culture, society, economy and ecology in the heritage sites.[103]

The protection and conservation measures that aim to achieve this objective apply to all the canal heritage. The Grand Canal was not legally protected before 2000 because there was no legal framework to enable this to happen (Table 1.1), though *The Law of the People's Republic China on the Protection of the Cultural Relics* was issued in 1982 and strictly prevents 'construction of additional projects or such operation as blasting drilling and digging may be conducted within the area of protection for a historical and cultural site',[104] it did not apply to the canal until the twenty first century, as the canal was not considered as relics at then.

Since 2008, various national laws and regulations in accordance with *The Law of the People's Republic China on the Protection of the Cultural Relics* have been passed to protect all the nominated properties, and part of the elements within buffer zones. All the properties of the canal are protected under five main protective designations, China's World Cultural Heritage Tentative List, Important Priority Protected Site, Areas of Waterway Management and Dike Protection, Historical Cities, Towns and Conservations, and Nature Reserves[105].

[103] State Administration of Cultural Heritage of People's Republic of China, p. 2-c-38.
[104] Laws of the People's Republic of China on the Protection of the Cultural Relics, Article 17.
[105] State Administration of Cultural Heritage of People's Republic of China, p. 602.

Table 1. 1 List of major relevant laws and regulations. Source: State Administration of Cultural Heritage of People's Republic of China. Nomination documentation submitted to the World Heritage Convention Cultural Heritage, pp. 669-677.

Field	Type	Name	Implementation scope of protective measures	Authority	Time of issue
Cultural heritage	Laws	Laws of the People's Republic of China on the Protection of Culture Relics	Property area, buffer zone and environment	Standing Committee of the National People's Congress of the People's Republic o China	Revised in 2007
Water conservancy	Administrative regulations	Regulation for the Implementation of the Law of the People's Republic of China on the Protection of Cultural Relics	Property area, buffer zone	State Council	2003
		Regulations on the Protection of Famous Historical and Cultural Cities, Towns, and Villages			2008
	Departmental regulations	Measures on the Protection and Management of WHS		Ministry of Culture	2006
		Administrative Measures for the Conservation of Grand Canal Heritage			2012
		Measures for the Administration of the Grand Canal			2012
	Laws	Flood Control Law of the People's Republic of China		Standing Committee of the National People's Congress of the P.R. China	Revised in 2009
		Water Law of the P. R. China			Revised in 2002
		Water Pollution Prevention and Control law of the P. R. China			Revised in 2008
	Administrative regulations	Regulation on River Administration of People's Republic of China		State Council	1988
		Flood Control Regulation of the P.R. China			Revised in 2005
		Hydrology Regulation of the P.R. China			2007
	Departmental regulations	Measures for the Administration of Water Conservancy Scenic Resorts		Ministry of Water Resource	2004
Shipping	Administration regulations	Chinese Regulation of on Water Transport		State Council	2012
Construction	Administration regulations	Scenic Area Regulations		State Council	2006
Forestry		Regulation of the P.R. China on National Reserves			1994
Others	Laws	Environmental Protection Law of the P.R. China		Standing Committee of the National People's Congress of the P.R. China	1989
		Land Administration Law of the P.R. China			Revised in 2004
		Urban and Rural Planning Law of the P.R. China			2007
		Water and Soil Conservation Law of the P.R. China			Revised in 2010

The entire Grand Canal was added to the China's World Cultural Heritage Tentative List in 2006 and 2012,[106] and the Important Priority Protected Sites in 2013.[107] All the heritage sites included in the Tentative List are protected and managed according to the *Measures on the Protection and Management of World Cultural Heritage* (2006) issued by the Ministry of Culture. The *Administrative Measures for the Monitoring and Inspection of World Cultural Heritage* issued by the Sate Administration of Cultural Heritage (SACH) in the same year also regulated the protection and management requirements of cultural heritage sites that are included in the Tentative List[108]. As a Priority Protected Site the canal is protected under the *Law of the People's Republic China on the Protection of the Cultural Relics*.[109]

The waterway management and dike protection elements of the Grand Canal are covered by the regulation on *River Administration of the People's Republic of China* issued in 1988, and other specific measures are designated through local relative regulations, such as the regulations of the *Beijing municipality for the Protection and Management of Hydraulic Engineering Works* (revised in 1997) and *Measures of Shandong Province for the Implementation of Regulation on River Administration of the People's Republic of China* (revised in 2004).[110]

The historic cities, towns and villages along the canal are protected under the *Regulations on the Protection of Famous Historical and Cultural Cities, Towns, Villages and Conservation Areas* issued in 2008, which ensures the highest degree of national protection. There are six conservation areas which are all in national level, including four historic cities, Wuxi, Hangzhou, Shaoxing and Suzhou, one historic town-Nanxun, and one conservation area, Pingjing.[111]

One property, the Nansihu Provincial Natural Reserve of the Weishan section, is protected under the *Regulations of the People's Republic of China on Natural Reserves* (1994).[112]

[106] The updated China's World Cultural Heritage Tentative List was released in 2012.
[107] State Administration of Cultural Heritage of People's Republic of China, p. 603.
[108] Ibid., p. 602.
[109] Ibid., p. 615.
[110] Ibid., pp. 616-617.
[111] Ibid., p. 618.
[112] Ibid., p. 620.

Apart from these five designations on the protection of the Grand Canal, there are also specific policies that apply directly to canal heritage. For example, in 2008 an advanced protection plan for cultural heritage was initiated by the Ministry of Culture and the State Authority, together with all the eight provincial governments along the canal. By 2012, this document-, the *Joint Agreement for the Protection of the Grand Canal*, was signed by all the local governments to set out the basis for cooperation between the cities.[113] *Administrative Measures for the Conservation of Grand Canal Heritage* (2012) were issued to regulate the utilization of the Grand Canal's heritage, which aims to strengthen its conservation.[114]

Management Plan

The Management Plan for the heritage of the Grand Canal has aimed for its inscription on the World Heritage List, as well as the conservation of its OUV. This has included a General Master Plan (2012-2030) and a Management Plan for Component Parts; the latter provides management guidelines specifically for the purpose of the World Heritage nomination. The Plan was made under the certification of competent governmental authorities in cities and provinces where the properties are located, and was approved by the interprovincial and ministerial consultation conference.

The Plan sets out measures on protection, conservation and management of the canal to be taken by municipalities and provinces, including the application of legal protection rules and the associated regulatory decisions. The 2013-2015 Management Plan specifically defined its purpose as WHS nomination, to be met through the improvement and reinforcement of conservation, the enrichment and standardization of management measures, and a short-term action plan to improve knowledge of the property. Tourism development may only take place in clearly identified places, currently including historic urban sites, associated gardens, hydraulic facilities, lakes, parks, and archaeological sites.

A long-term plan up to 2030 has also been applied through the General Master plan, which includes five historic town conservation plans, eight provincial land use plans, 24

113 ICOMOS, Evaluations of Nominations of Cultural and Mixed Properties, p. 120.
114 *Administrative Measures for the Conservation of Grand Canal Heritage*, Article 1.

urbanization plans for towns along the canal, and a specific plan for the scenic Shugang-Slender West Lake. This has been divided into 35 sector conservation plans.[115]

These plans have aimed to cover all necessary aspects of Grand Canal protection, but the various laws and regulations still show gaps. For example, the buffer zone of protection area is rather small, partly because of a conflict of interest between the Sate Administration of Cultural Heritage and other departments such as the Bureau of Water Conservancy and Department of Transport. The southern section of the canal is still in use, as is the long-established 南水北调 South-north Water Transfer project[116] which makes use of the entire canal route, and the departments concerned would like conservation work to have as little impact on the utilization of the canal as possible. In addition, the ordinary sections of the canal which do not have specific attributes are not protected in the same way as the historic sections: except for its banks, all other elements of the ordinary sections such as footpaths and trees are not protected by the current buffer zones.[117]

Apart from the gaps in the current policy, the implementation of these measures by local authorities are also a matter for concern. In order to meet the criteria of being a WHS, large scale emergency restoration was undertaken to tackle the loss of the original fabric of the canal, which had long since disappeared or been severely damaged. Most of this work was completed in an extremely unprofessional way, for various reasons including a lack of professional knowledge and the pursuance of private interests. A large number of canal-side residential houses, which represented the original canal-side dwellings, were demolished in order to construct large-scale replica towns and relic parks to develop tourism.[118]

It is a fact that the profile of the Grand Canal has been widely increased and its legal protection is more comprehensive than ever before due to its WHS inscription. However, its value for most of the authorities involved is its standing as a tool to attract attention and

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115 State Administration of Cultural Heritage of People's Republic of China, pp. 713-719.

116 This project aims to transfer water from the Yangzi River to the northern China supply the industrial production and daily use, and the annual amount of water arrives to the north is set to be 44.8 billion cubic metres. The idea was first brought up by Mao Zedong in 1952, and the whole outcome is expected to be achieved by 2020. And the course of the Grand Canal is utilized as the eastern route of the project.

117 ICOMOS, Evaluations of Nominations of Cultural and Mixed Properties report for the World Heritage Committee, p. 120.

118 Ruan Yisan and Wang Jianbo, 'Jing Hang Yun He De Shen Yi Xian Zhuang, Jia Zhi He Bao Hu (The Nomination of the Grand Canal for the World Heritage Site and its Values and Conservation)', *China Ancient City*, 8(2009), 8-15 (p. 14).

develop tourism in order to increase revenue, rather than as a monument of historic and cultural significance. What is even worse is that this point has not been raised as a serious issue; although a few researchers have expressed their concerns, they have tended not to be critical, and have failed to offer effective and appropriate methods to improve this situation. So it is urgent to raise awareness of the current situation of the canal's heritage conservation through this thesis, and through it to discuss more suitable approaches and procedures.

Within this context, this thesis aims to provide a critical assessment of the history of the development of the Grand Canal, set within a landscape context, and examine its historical values as a WHS. It will then proceed with a critical examination of the approaches taken for the conservation of the canal and its environment, using the Shandong section, which features the most profound level of hydraulic engineering of the Grand Canal, as a case study. Subsequently there will be an exploration of how the canal has been adapted to modern requirements and of how it could be preserved for the future, concluding with recommendations as to appropriate conservation approaches and procedures.

Research questions

- What are the historical values of the Grand Canal?
  - How was the Grand Canal constructed?
  - What are the design detailing of the Grand Canal?
- What has happened to the canal and surrounding landscapes in recent decades?
  - What is the appropriateness and effectiveness of the management of the Grand Canal?
- How can research of the development of the Grand Canal informed conservation policy?
  - What policies might be introduced that would help preserve historic values?

The exploration of the history of the development of the Grand Canal will be introduced from Chapters two to five, with the making of the Sui Canal, of great interest as it was the original form of the Grand Canal, discussed in Chapter two. This chapter will focus on exploring the social and political context, examining why such a waterway was needed and how this nation-wide canal system was first created, together with the introduction of the ancient techniques and tools in use. I will also explore how this early form of the Grand Canal was managed and served as a route for grain transport between the seventh and thirteenth centuries. During this period there were no substantial changes in the route of the canal, but there was a substantial development in hydraulic engineering with the invention of the first *fu zha* 复闸 (double-gate lock) which made possible significant progress in the functioning of the canal.

Chapter three is focused on the significant change to the Grand Canal's route in the thirteenth century, when the capital of the Mongol Yuan dynasty (1271-1368) was moved from central China to Beijing, with a corresponding modification of the canal route. The chapter looks at the design and detailing of the new route, including its locks, embankment and canal-side plants. Unexpected events are explored, including the failure to solve the problem of sourcing water in the northern section: the canal route was not as successfully put to use during this period as was hoped at the time. This led to a requirement for an alternative means of grain transport for the Yuan court-which resulted in the use of sea transportation and a need for corresponding nautical technology.

The Grand Canal did not operate steadily until the Ming Dynasty (1368–1644) when the shortage of water supply was finally solved by the establishment of the Nanwang water division point. The amount of grain transported along the canal increased remarkably and it became the lifeline of imperial China between the sixteenth and eighteenth centuries; its development during this time will be explored in Chapter four. It was also the heyday of hydraulic engineering development: a detailed account of the building of locks and the maintenance of the canal will be provided, together with the designing of *cao chuan* 漕船 (grain-shipping barge). The relationship between the canal and the Yellow River and the surrounding environment is also discussed, to identify the position of the canal within the local environment.

Chapter five gives an account of the development of the Grand Canal in modern times, from when it was neglected after the tribute grain shipment was stopped in 1902, to when it was gradually upgraded to a modern waterway after communist China was founded in 1949. The social and political context is explored, in order to investigate how the policies of the time affected the management of the canal, and how its heritage was slowly eroded. The modern standard for the design of the canal, as well as its associated facilities, will also be introduced.

In Chapter six there is a critical examination of the changing attitudes and approaches to the Grand Canal after it began to be used not only as a coal transport route but also as a heritage site in the twenty first century. This chapter focuses on the conservation context of the Shandong section, which is taken as a case study, in order to explore how its heritage with unique cultural and historical characteristics have been preserved. Through this case study we will be able to identify what local residents value about the Grand Canal as a WHS, and what approaches have been taken to preserve it, in order to bring up the various issues that have had negative impacts on the heritage of the canal. This will be followed by a discussion and recommendations of more appropriate and effective conservation approaches for the Grand Canal in the last chapter.

Sources

This study has made use of both published sources and manuscript documentation. Additionally, first-hand material has been collected via fieldwork to explore the recent development of the Grand Canal, and through informal interviews with local residents and politicians an exploration of people's values and attitudes towards the conservation of the canal has been obtained.

Published sources

The published materials have been reviewed to explore the theoretical underpinning of this study, as well as the development of the Grand Canal and its hydraulic engineering aspect. This included texts, illustrations and manuscripts of both western and eastern literature, mainly extracted from the University of Sheffield library, online sources, local governmental offices and museums.

In order to examine the historical development of the Grand Canal, The *zheng shi* 正史 (Standard Histories) of each Imperial Chinese dynasty, such as *Ming Shi* 明史 (History of Ming)[119] and *yuan shi* 元史 (History of Yuan),[120] have been used to study the socio-

[119] Zhang, <http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb> [accessed 30 June 2016]
[120] Song, <http://ctext.org/wiki.pl?if=gb&res=603186> [accessed 30 June 2016]

political context of the making of the canal, mainly from the online digital library 'Chinese Text Project'.[121]

Books on the ancient hydraulic engineering have aided the exploration of details of traditional hydraulic techniques and methods, such as the flood control methods which is summarized in *he fang yi lan 河防一览* (General View of Water Control)[122] and *zhi zheng he fang ji 至正河防记* (Memoir on the Repair of the Yellow River Dykes in the Zhizheng Region-period),[123] and the lock building techniques summarised in *da qing hui dian 大清会典* (Collected Statute of the Great Qing)[124] and *an lan ji yao 安澜纪要* (Summary of Flood Control),[125] as well as the hydraulic tools in the book *he gong qi ju tu shuo 河工器具图说* (Illustrations and Explanations of the Techniques of Water Conservancy and Civil Engineering).[126] These were mainly photocopies of original books obtained from the online library 'Internet Archive'.[127]

Western travellers' accounts have also been important sources from which to identify the design details of the Grand Canal and its surrounding landscapes. A greater amount of foreign travellers' accounts started to appear from the thirteenth century and their description and sketches of the canal landscape provided a more comprehensive picture of what the canal looked like. Examples of such traveller accounts include Marco Polo's *The Description of the World*[128] and George Staunton's *An Authentic Account of an Embassy from the King of Great Britain to the Emperor of China*.[129] These were taken mainly from the University of Sheffield Library resources and 'Internet Archive'.

121 The Chinese Text Project homepage 中国哲学书电子化计划, <http://ctext.org/>, it is an online open-access digital library for researchers around the world.
122 Pan Jixun, *He Fang Yi Lan* (Imperial Collection of Four: General View of Water Control) (Qin Ding Si Ku Quan Shu Ben, 1780)
123 Ouyang Xuan, 'Zhi Zheng He Fang Ji (Memoir on the Repair of the Yellow River Dykes in the Zhizheng Region-period)', in *Quan Yuan Wen* (Collected Works of the Yuan Dynasty), ed. by Li Xiusheng (Nanjing: Fenghuang Press, 2004)
124 Yun Tao, *Da Qing Hui Dian* (Collected Statute of the Great Qing) (Si Ku Quan Shu Ben, 1747)
125 Xu Duan, *An Lan Ji Yao* (Summary of Flood Control) (qing dao guang er shi er nian 1842)
126 Lin Qing, (ed.) Pengju Cheng, *He Gong Qi Ju Tu Shuo* (Illustrations of Tools for River Works) (Zheng Zhou: He Nan Education Press, 1994)
127 Internet Archive online digital library homepage <https://archive.org/>.
128 Marco Polo, A.C. Moule and Paul Pelliot (ed.). *The Description of the World* (London: Routledge, 1938)
129 George Staunton, *An Authentic Account of an Embassy from the King of Great Britain to the Emperor of China* (London: printed by W. Bulmer and Co. for G. Nicol, 1797)

In addition, modern eastern and western contemporary literature on the history and development of the Grand Canal has also been studied, helping to provide supplementary information. These sources have included *jing hang yun he shi 京杭运河史* (The History of the Grand Canal)[130], in which Yao chronologically introduced the development of the canal from the year 482 BC until the time when the royal transport system was stopped in the early twentieth century; the electronic version of the book was available on Baidu Cloud. And the series of *Cambridge History of China,*[131] from which the author was able to look at the context of the canal from a western point of view, to help gain a more balanced perspective of the true history of the Grand Canal; the text was accessed through a hardcopy available at the University of Sheffield Library and an electronic version obtained from the Cambridge University Press Online resources.[132]

Various relatively recent studies focusing on ancient hydraulic technology, and presenting their findings using modern language, have also been valuable sources. These include western published books such as *Science and Civilization in China*,[133] and *River, Lake and Land Conservancy in Portions of the Provinces of Anhui and Kiangsu, North of the Yangtze River,*[134] which helped to look at the traditional Chinese techniques through a western scientific point of view, and most importantly they have contributed to the translation of the technical terms from ancient Chinese to English in this thesis. The former is available at the University of Sheffield Library, and the latter was purchased by the author through publisher Forgotten Books.

The Chinese published materials include the book *he gong xue 河工学* (Studies of River engineering)[135] and the journal article *qing guan shi shi zha ji shi han dong zuo fa 清官式石闸及石涵洞做法* (Official Regulation of the Qing Dynasty for the Designing of the Locks

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130 Yao Hanyuan, *Jing Hang Yun He Shi* (The History of the Beijing-Hangzhou Grand Canal) (Beijing: Shui Li Shui Dian Chu Ban She, 1998)

131 Denis Twitchett (ed.) *The Cambridge History of China* (Cambridge: Cambridge University Press). This thesis mainly used the volumes in relation to the history of the Imperial China, which are volumes 3 to 11, published between 1979 and 1980.

132 Cambridge University Press online resources, the 'Cambridge History of China' session, <https://www.cambridge.org/core/series/cambridge-history-of-china/A4D3D77A97EACA3F903136BBF64B9169#>.

133 Joseph Needham, *Science and Civilization in China*, *Volume 4* (Cambridge University Press, 1965)

134 Charles Davis Jameson, *River, Lake and Land Conservancy in Portions of the Provinces of Anhui and Kiangsu, North of the Yangtze River* (London: Forgotten Books, 2015)

135 Zheng Zhaojing, *He Gong Xue* (Studies of River Engineering) (Shanghai: Shang Wu Yin Shu Guan, 1935)

and Culverts), [136] which have been valuable sources to help understand the Chinese traditional river work, especially the illustrations which are generally clearer than the ones in ancient books. The former was purchased by the author from Chinese online shop Taobao, and the latter was obtained from Chinese online resources Baidu Cloud.[137]

Historical maps have been important sources to establish how the canal course has been changed and adapted to the surrounding landscape through time. Most of these have been collected from historic books published between the fifteenth and early twentieth century, such as the *黄运河口古今图说* (An Illustrated Essay on the Yellow River-Grand Canal Confluence from Former Times to the Present)[138] and *漕河图志* (Illustrated Account of the Grand Canal),[139] which were mainly available in 'Internet Archive'. Regional maps were also taken from 地方志 (Local Annals), some of which were photocopied from interviewees' private collections, and others which were kindly given to the author by the village or town committees. The *水道寻往—天津图书馆藏清代舆图选* (Collection of the Maps of the Qing Dynasty)[140] published by the Tianjin Library, in 2007, provided a collection of important maps of the nineteenth century showing the relationship between the Grand Canal and its various water sources. This was obtained from the Chinese online resource Baidu Cloud.

Contemporary maps and photographs have enabled a reference basis showing when changes and development took place in modern times. A number of maps were provided in the documents used for the nomination to the WHS, which were available on the UNESCO official website.[141] The Liaocheng Grand Canal Museum Office and Tai'er Zhuang Grand Canal Exhibition Committee supplied electronic versions of many valuable photographs from the early twentieth century, showing the state of the Grand Canal at the time. Various propaganda books, aimed at western countries, published in the 1950s by the new communist

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136 Wang Biwen, 'Official Regulation of the Qing Dynasty for the Designing of the Locks and Culverts', *BSRCA*, 16:2(1935), 49-72.

137 The article is available for access through the Baidu Cloud official website <https://login.bce.baidu.com/?redirect=http://ticket.bce.baidu.com>.

138 Lin Qing, *Huang Yun He Kou Gu Jin Tu Shuo* (An Illustrated Essay on the Yellow River-Grand Canal Confluence from Former Times to the Present) (dao guang er shi nian ben 1840)

139 Wang Qiong, *Cao He Tu Zhi* (Illustrated Account of the Grand Canal) (hong zhi jiu nian ben 1496)

140 Tianjin Library, *Shui Dao Xun Wang- Tianjin Tu Shu Guan Cang Qing Dai Yu Tu Xuan* (The Collection of the Qing Dynasty Maps at the Tianjin Library) (Beijing: Renmin University Press, 2007)

141 State Administration of Cultural Heritage of People's Republic of China, Nomination documentation submitted to the World Heritage Convention Cultural Heritage.

government also provide images of the massive-scale water management projects undertaken in the new China, and their propaganda policies that resulted in the extensive modification of the canal during that period; these books include the *Water Conservancy in New China*[142] and *China's Big Leap in Water Conservancy,*[143] which are both available at the University of Sheffield Library. Additionally, a number of valuable photographs and hand drawing plans from the American journal article *China's Ol's Man River*[144] presents a very detailed account of the condition of the Canal and the Yellow River in the 1930s as well as the traditional river work, by the American engineer Oliver J. Todd who came to China to aid the flood control projects; this article was purchased by the author through the Scientific American Online resource.[145]

Finally, national laws, regulations and guidance in terms of heritage preservation have been reviewed in order to build up a policy framework and to identify the strengths and weaknesses of these policies. Most of these documents are available on the National People's Congress of the P. R. China website,[146] details of others could be found in the nomination documents of the Grand Canal.[147] The conservation guidelines prepared by international organizations such as UNESCO, ICOMOS and English Heritage were also reviewed, not only to provide a theoretical unpinning of this study, but also to examine variance from international standards. It was also intended to set a reference point to help develop national conservation policies. These were all collected from their official websites.[148]

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142 The Ministry of Water Conservancy, *Water Conservancy in New China* (Peking: The Ministry of Water Conservancy,1956)
143 Gu Lei, *China's Big Leap in Water Conservancy* (Beijing: Foreign Language Press, 1958)
144 Oliver J. Todd, 'China's Ol's Man River', *Scientific American*.,1937, 5–9.
145 The Scientific American E-articles <http://www.scientificamerican.com/>
146 The homepage of the National People's Congress of the People's Republic of China, <http://www.npc.gov.cn/englishnpc/news/index.htm>.
147 State Administration of Cultural Heritage of People's Republic of China, Nomination documentation submitted to the World Heritage Convention Cultural Heritage.
148 All the documents including convention reports and different versions of Operational Guidelines are available at UNESCO official website <http://whc.unesco.org/en/about/>. All the ICOMOS Charters are available at ICOMOS official website <http://www.icomos.org/en/charters-and-texts>. And the Conservation Principles can be found at the Historic England official website <https://content.historicengland.org.uk/images-books/publications/conservation-principles-sustainable-management-historic-environment/conservationprinciplespoliciesguidanceapr08web.pdf/>.

Archives

With the intention to collect more comprehensive material to help construct the history of the Grand Canal, three archives located in the Shandong Province were initially selected for this thesis; the Shandong Archive, Jining Wenshang County Archive and Tai'er Zhuang Archive. However, after close inspection, there seemed to be very limited documentation available in these archives in relation to the Canal, apart from the Shandong Archive. Therefore, this study only used material collected from this archive. These included governmental documents produced between the 1950s and 1960s, showing the details of the water conservation policies made by the state at that time, and the government's attitude towards local residents. These comprised policies regarding the migration plans of local residents due to the reconstruction of the Hanzhuang section of the canal, as well as records of the land use due to the same project.[149]

In addition, governmental reports from the 1960s, in relation to construction details of the canal waterway, as well as the standards required for barges travelling on the canal were consulted from the Shandong Archive.[150] This provided valuable material to help identify the modifications made for the canal around that time, and the government's intention to upgrade it to a standardised coal transport waterway.

Fieldwork

Three fieldwork visits have been carried out along the Shandong section in the winters of 2013, 2014 and 2015. The fieldwork mainly took place in the canal-side villages and towns,[151] and aimed to collect first hand materials of the recent development and current

[149] Specific documents include: 枣庄市运河韩庄台儿庄段新移民工作计划 *The Migration Plan of the Hanzhuang and Tai'er Zhuang section.* 关于韩庄运河工程枣庄地区移民迁占安置计划的批复 Reply to the Resettling Plan of the Migrants of the Hanzhuang Canal Reconstruction project. Department of Shandong Water Conservancy, 10 June 1963. 山东省济宁专员公署交通局为补送 济宁运河大桥桥头改线工程土地青苗赔偿费单据清核拨尾款的报告 *The Report of Compensation of Cultivated Lands Occupied by the Project of the Modification of the Jining Grand Canal Bridge,* the Department of Transportation, Jining, Shandong. (60) zhuan jiao lu zi No. 070. 7th October 1960. 运河占用土地情 The Areas of Lands Occupied by the Reconstruction of the Grand Canal. 24 October 1960. All from the Shandong Archive.

[150] Such as the 山东省航运管理局 (Shandong Shipping), 关于京杭大运河山东段航道现状和规划运河航道现状调查报告 (*Report of the Current and Planned Condition of the Course of the Shandong Section of the Grand Canal*). A087, 01, 008, 1962. From the Shandong Archive. From the Shandong Archive.

[151] The canal-side settlements that were visited by author during fieldworks include: Qiji Town, Yanggu Town, Tai'er Zhuang Town, Zhangqiu Town, Nanzha Village, Shangzha Village, Jining City, and Nanwang Town.

condition of the Grand Canal, with such information being hard to access and scarce in written documents, especially since many governmental policies and reports relating to canal management tend to not be available to the public or lack transparency.

During the three visits, the author witnessed the very concerning situation of the conservation of the Grand Canal. For example, there are various repair projects that had been abandoned half-way through, and many tourism projects appeared along the canal which contained large amounts of re-created features which were proclaimed as the original to the canal.[152] It was attempted to experience this first hand to provide a clear understanding of the issues. First hand data collected during fieldwork includes photographs, the author's own sketches and plans, and video recordings.

Informal interviews

Informal interviews with local residents have also been conducted during the fieldwork, which provided valuable oral history where written data was scarce or restricted. It was also the intention that this data should be used to identify people's attitudes towards the conservation of the Grand Canal and what communities value about the Canal, to help inform future conservation policies.

The initial design of the interviews included the participation of both local residents and politicians. However, after interviewing the Head of the Tai'er Zhuang Planning Bureau in February 2015, who was in charge of the construction of the Tai'er Zhuang Replica Town, as part of the local heritage tourism development plan, it became apparent that it was difficult to gain the real opinions of governmental officials, due to the propaganda environment created by the central government. As a result, the materials from this interview were not considered to be reliable. Due to this eventuality, the participation of local residents and communities became the focus instead, and the material collected from these groups were used in the thesis.

152 Examples of these projects include the Tai'er Zhuang Replica Town and Nanwang Relic Park. More details of these projects are introduced in Chapter Six.

The people who participated in the interviews were mostly local residents, but also included a local scholar from Zhangqiu Town, and the head of the community at Nanzha Village. The interviewees were mostly selected with the help from local community offices, who knew potential participants who were involved in the development of the Grand Canal or had knowledge of the canal in general. As the interviews were conducted informally, the length of conversation with each resident varied between 10 to 60 minutes, depending on the number of different stories told and the local's level of understanding of the Grand Canal. The forms of interviews were varied, also including one group-interview of 8 people in Nanzha Village in the Winter 2014, where the purpose was to reconstruct the old appearance and location of the village (Figure 1.3).

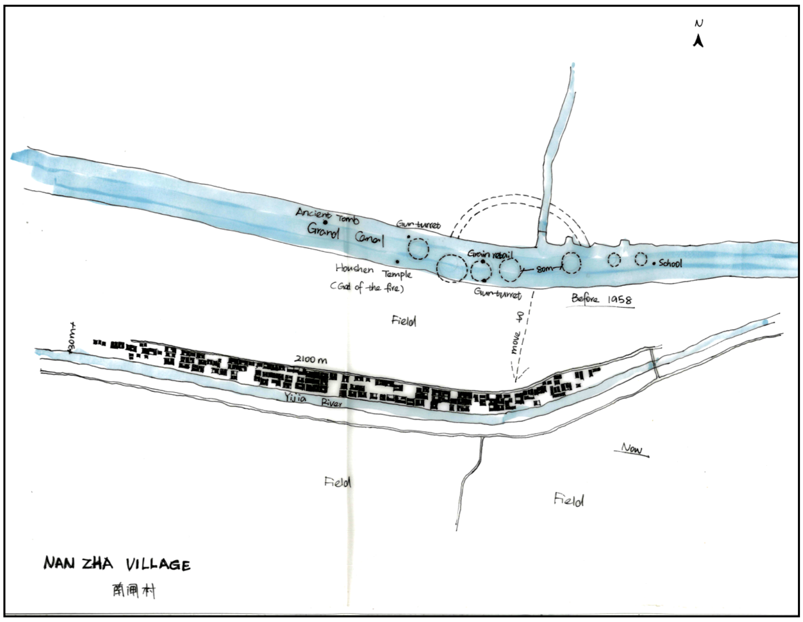

Figure 1. 3 the photograph above shows a group interview conducted in Nanzha Village in 2014, during which the author attempted to reconstruct the historic appearance and location of the village, in order to investigate the impact of the modification of the Grand Canal. The author met this group of local elderly residents on the street, who gathered regularly to play poker. They revealed an extensive amount of information of the old village, which enabled the author to produce a detailed present (the plan underneath) and past plan (the plan on top), to show how the whole village was moved further south after 1958, when the canal channel was modified. This information, though highly interesting, was not included in the main body of the thesis due to the need for brevity and relevance.

The result from interviews with local people was invaluable. On one hand, some very useful data regarding the history of the Grand Canal was uncovered. For example, the son of a local lock keeper living in Shangzha Village described how his father used to open and close the lock gate, and that the traditional lock gates of the canal were actually made with separate planks, instead of one whole piece of timber gate. This information is not found on any historic or modern written documents. The author was able to illustrate the appearance of a traditional canal lock based on this detailed description, which makes an important contribution to the technical details of the traditional canal engineering.[153]

On the other hand, however, it came as a surprise that most of the local residents did not seem to have many opinions towards the Grand Canal being inscribed as a World Heritage Site, neither did they seem to be well informed of the canal conservation plans. What they did appear to be very upset about was that they were, will or may be forced to move away from the canal-side villages, to free the land to build tourism infrastructure. During the fieldwork interviews, it is acknowledged that residents of three canal-side settlements: Qiji and Nanwang Town, and Xinglong Village had already been relocated; and according to the community head of the Nanzha Village, he was planning to relocate the whole village to use the land to develop canal-related tourism.

The informal interviews with local communities provided valuable information that could not be found elsewhere, especially the reality of the exclusive conservation policies that led to the more distant relationship between the residents and the canal. The data has been recorded on notebooks and digital devices; most of this evidence was used for assessing the conservation approaches taken for the Grand Canal in Chapter Six. The data has been securely stored and may only be used for academic purposes.

References and bibliography

This thesis is using the MHRA (Modern Humanities Research Association) referencing style to cite and reference sources, as well as to compose the bibliography.

A large number of sources that are used in this research are Chinese sources. As the order to address Chinese names (family name first, followed by the given name) is different from the

153 The illustration made by author according to the interview is located in Chapter 2, Figure 2.24.

Western one, the references of this thesis will preserve the original Chinese naming order while listing Chinese author's names.

Research ethics

A research ethics review was submitted and agreed by the Ethics Committee of the University of Sheffield in February 2013. The development of questions and people's involvement in this project has been sensitively handled: the participants' confidentiality and anonymity has been ensured, and all participation in the research was totally voluntary. All the information relating to interviews was recorded in both notebook form and digital devices, and will not be published for other purposes.

Chapter Two. From Han Gou to the Sui Canal

This chapter introduces the earlier history of the development of the Grand Canal, from the fifth century BC to the eleventh century, with a particular focus on when the first nation-wide canal system was completed during the Sui Dynasty (581-619). This covers a very detailed account of the early water engineering technology, which includes the building of the waterway, the development of tools, the barges, the canal-side granaries, the plants, and the water-saving facilities such as *yan dai* and the early version of canal locks.

To achieve the above, various sources were used to aid the completion of this chapter. For historic sources, Chinese historic books of each dynasty (with the focus on the Sui, Tang and Song Dynasty), such as *sui shu* (Book of Sui) (1644),[154] *shi ji* (The Records of the Grand Historian) (2010),[155] *zi zhi tong jian* (Comprehensive Mirror in Aid of Governance)(1985)[156] and *song shi* (History of Song) (1644)[157] were studied, to explore the social-political context of the building of the canal. In addition, the historic book *tang hui yao* (Institutional History of the Tang Dynasty) (1778)[158] supplied written evidence of tree planting records along the canal. And the early twelfth century painting *Along the River During the Qingming Festival*[159] provided important pictorial evidence of tree forms. Additionally, two historic engineering books: *he gong qi ju tu shuo* (Illustrations of Tools for River Works) (1994)[160] and *meng xi bi tan* (The Dream Pool Essays) (1975)[161] were significant sources to comprehend traditional river work.

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154 Wei Zheng, Sui Shu (Book of Sui) (er shi si shi ben, 1644), Di Ji (Annals), Gao Zu Shang (Gaozu Part One). Wiki Source https://zh.wikisource.org/wiki/隋书 [accessed 16th June 2016]

155 Sima Qian, (ed.) Han Zhaoqi, *Shi Ji* (The Records of the Grand Historian) (Beijing: Zhong Hua Shu Ju, 2010).

156 Sima guang, *Zi Zhi Tong Jian* (Comprehensive Mirror in Aid of Governance) (Taipei: Taiwan World Press, 1985). Chapter 180, Sui Ji Si (History of Sui, Part 4) Chinese Text Project Online Ebook, <http://ctext.org/wiki.pl?if=en&chapter=571928&remap=gb#p46> [accessed 30 June 2016]

157 Toqto'a and Alutu, *Song Shi* (History of Song) (er shi si shi ben, 1644), He Qu Zhi (Annals of Rivers and Canals). Wikisource Online Library, <https://zh.wikisource.org/wiki/宋史/卷 307> [accessed 30 June 2016]

158 Wang Pu, *Tang Hui Yao* (Institutional History of the Tang Dynasty) (si ku quan shu ben, 1778), Vol 80. Chinese Texts Project Online Ebook, <http://ctext.org/wiki.pl?if=gb&chapter=977376&remap=gb#p26> [accessed 30 June 2016].

159 Unknown, 'quan juan qing ming shang he tu (the full length Along the River During the Qingming Festival)', *China Lizhi Website* (2016) <http://www.zhlzw.com/lz/yis/793213.html> [accessed 30 June 2016]

160 Lin Qing, (ed.) Pengju Cheng, *He Gong Qi Ju Tu Shuo* (Illustrations of Tools for River Works) (Zheng Zhou: He Nan Education Press, 1994)

161 Shen Kuo, *Meng Xi Bi Tan* (The Dream Pool Essays) (Beijing: Wenwu Press, 1975).

In terms of modern sources, the book entitled *Cambridge History of China* (1979)[162] provided a different perspective to enable examination of the construction of the canal, and helped to gain a more balanced understanding of what happened to the Grand Canal in its early period. Joseph Needham's *Science and Civilization of China* (1971)[163] was a very valuable resource, it not only explained the traditional river work using modern approaches, such as the construction of the canal locks, but it was also a helpful reference for the translation of the traditional Chinese language to English, although it sometimes contained inconsistent translation of terms between the two languages.[164] The archeological reports, from Wang Xiaoxi (2002)[165] and Zou Yilin (1974)[166], respectively, were also reviewed, to identify the early river work tools and the construction of canal-side granaries. In addition, the chapter used Zhu and Feng's article (2015)[167] to help identify some of the plants species in the painting *Along the River During the Qingming Festival,* mentioned earlier.

Although a number of both western and eastern sources were reviewed in this chapter, gaps were identified in the literature regarding the canal's early history. Therefore, a considerably amount of the author's original work, through a critical analysis of what literature was available, contributed to this chapter. Originally, the author contributed by uncovering extensive details of the planting along the Grand Canal and discovered that trees had been used to signal pathways along the water course as early as the eighth century. Moreover, the author also corrected the ancient misconception that the trees planted along the canal were usually weeping willows. Through mainly pictorial evidence (to be introduced in a later chapter) the author observed that in the northern section of the canal, it was in fact the Chinese willow that was used instead of the weeping willow, with the former being planted to resist the harsher climate of the north (see Figure 2.22 as an example).

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162 Denis Twitchett and John K. Fairbank, *the Cambridge History of China* (Cambridge: Cambridge Univeristy Press, 1979), Vol 3.

163 Joseph Needham. *Science and Civilisation in China.* Volume 4, Part 3 (Cambridge: Cambridge University Press, 1971)

164 For example, the lock type 斗门 (*dou men*) is translated ambiguously as 'sluice gates' (p. 321) and 'dipping gates' (p. 349); and the term 'flash-lock gates' is used to refer to both the lock types 水门 (*shui men*) and 立门 (*li men*) (p. 346).

165 Wang Xiaoxi, 'Cong Ma Wang Dui Han Mu Chu Tu Wen Wu Kan Han Dai De Nong Ju- Tie Kou Cha (The study of Han agricultural tools through the relics discovered from the King Ma's Mound)', A*gricultural Archaeology*. 1(2002), 191-194.

166 Zou Yilin, 'Cong Han Jia Cang De Fa Jue Tan Sui Tang Shi Qi De Cao Yun He Liang Cang (the Discussion of Tribute Grain Transport and Granaries in Sui and Tang period with the Discovery of Relics of Han Jia Granary)', *Cultural Relics*, 2(1974), 57-66.

167 Zhu Liangliang and Xue Feng, ''Spring' in Life along the Bian River at the Qingming Festival', *Journal of National Museum of China*, 1(2015), 93-102.

In addition, as for the traditional river work tools, the author corrected the misunderstanding that iron tools were used as early as the seventh century BC. After having carefully reviewed various historic literatures and archaeological reports, the author revealed that iron tools did not become common tools until the first century BC. Before this, people were using tools made of wood or animals' bones to dig and lift earth.

Finally, the author reconstructed the pound lock (Figure 2.24 and 2.25), which had been invented in 984 and afterwards became the most common form of lock used on the Grand Canal. Due to the lack of pictorial information of early canal locks, the author for the first time provided clear illustrations of its appearance and structure. Most importantly, as aforementioned, the author uncovered the construction details of canal gates, which were based on information from interviews with local residents. This information was not found in any written records and is therefore an original contribution.

485 BC: the construction of the Han Gou channel, the oldest canal section

The socio-political context

There are no written documents that record with certainty when people started building artificial waterways for transport. The first motive for the ancient Chinese to excavate watercourses was probably an attempt to combat floods. In the time of the legendary emperor Yao (c. 2356 – 2255 BC) there were devastating floods. Gun (? -2325 BC), who was appointed to solve the problem, tried to control the water by building dykes, but after nine years of trials, his efforts failed.[168] Later, his son Yu (c. 2200 – 2100 BC), who was also known as Yu the Great, decided to take over his father's unfinished task. He worked on it for some thirteen years and found a way of successfully controlling the floods by digging new courses to direct the flood water to rivers, and eventually to the four seas.[169]

[168] Sima, p. 4.
[169] Sima, p. 16.

It is believed by many scholars that the two methods, used by Gun and Yu respectively, show the two different attitudes of the ancient Chinese to nature: one is to confine nature, the other is to let nature be the way she is, and even to assist her. The praise for Yu's success suggests that the concept of going along with nature, traditionally thought to have come from Daoism,[170] had greater support in ancient China, and also had a great impact on policy-making for water control in later dynasties. We shall explore this in later chapters.

These techniques of digging artificial channels were also used for agricultural irrigation In the earliest known body of Chinese writing (Shang Dynasty c. 1600 –1046 BC), people had already started using the character '甽', which was formed by 田 (fields) and 水 (water), meaning the ditches in between fields. These ditches were straight and man-made, and were placed both vertically and horizontally around the fields, serving as their boundaries.

[170] Needham, p. 249.

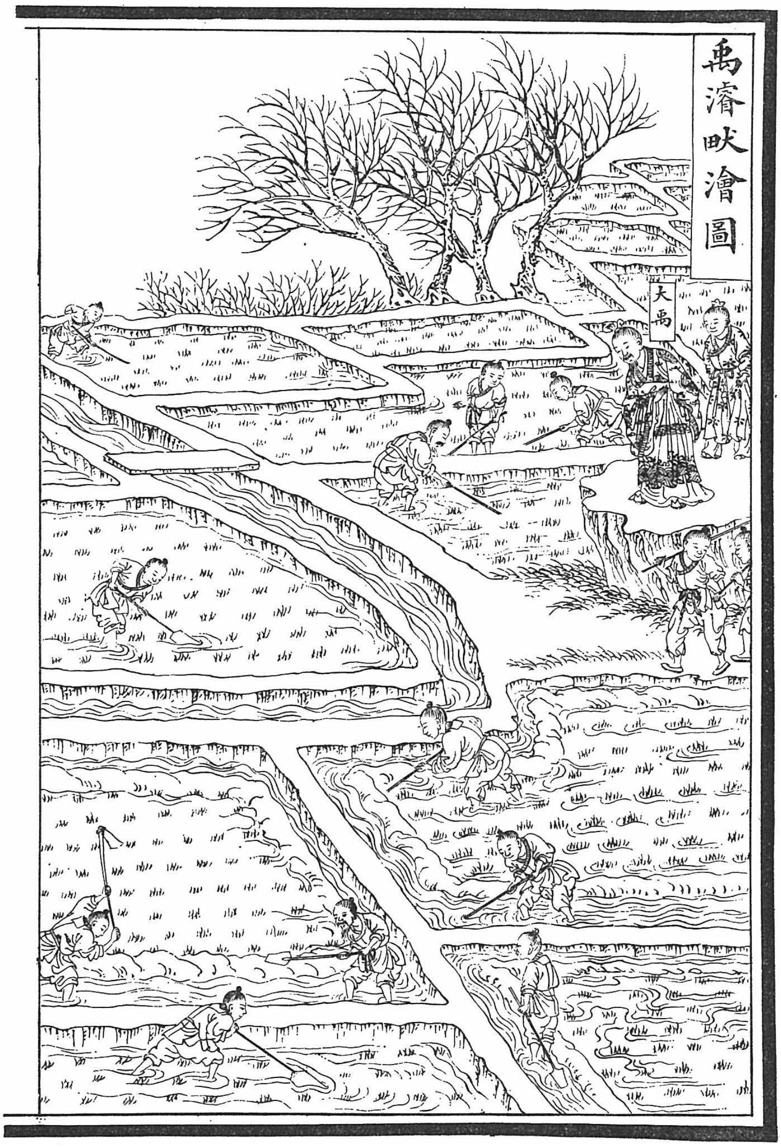

Figure 2. 1 The *Yu Jun Quan Kuai Tu* 禹浚甽浍图 (Yu the Great caused the channel and canals to be dug and deepened) shows that Yu the Great (right) was standing on the raised platform to investigate and explain to workers how to dredge the channels that were in between the cultivated fields. It also gives some idea of the relationship between ditches and fields, as well as the tools people used at that time. As the picture was produced in the later nineteenth century, we cannot be sure that the information it provides, for example the form of the tools, is fully accurate. Source: Sun Jiading and Zhang Baixi, *Qing Ding Shu Jing Tu Shuo* (imperial illustrated edition of the Historical Classic) Beijing: Jiao Jing Shi Da Xue Tang Bian Shu Ju, 1905, Chapter 5.

Nature has always been admired by the Chinese: they studied it and had specific terms for different landforms before the eleventh century BC, including *shan* 山 (mountain), *gu* 谷

(valley), *qiu* 丘 (hill), *chuan* 川 (river), *jian* 涧 (ravine), and *gou* 沟 (ditch). The limits in their technology meant that the artificial courses of this period were rather narrow and shallow, and were only for irrigation, not transport.[171]

So when were artificial rivers first used for transport? In fact people had already started using rafts made of wood or bamboo as early as Neolithic times. Chinese navigation developed rapidly but was limited to natural waterways until the 'Spring and Autumn Period' (770-476BC). The salient feature of this period of China was the number of internal conflicts between independent states, all of which attempted to strengthen their forces to compete with their neighbours. At the time, the easiest way to ship large quantities of military supplies was certainly by water.[172]

Of all the states, that of king Fuchai (reigned 495-473BC) of Wu (twelfth century-473BC) in the Yangzi region in the south had the best geographical opportunity. The Wu lived by the Yangzi River, and their army was so familiar with water that boats and oars were to them just like carts and horses to other armies.[173] In 494 BC, Fuchai had just beaten the State of Yue (? –222 BC) in one of the wars between them. He was ambitious and also wanted to conquer the State of Qi (eleventh century-221 BC) in the Shandong region in the north, but without a waterway to transport all the military supplies, it would be impossible for the armies to survive the war.

As the terrain in China is of higher altitude in the west and lower in the east, most rivers, including the Yellow and Yangzi, flow from the west to the east. So in order to have a waterway to the north from the south, there seemed to be no other way but to create an artificial one. As a result, a north-south artificial waterway, Han Gou, was made in 485 BC,

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171 Li Quan and Wang Yun, *Shandong Yunhe Wenhua Yanjiu (Studies of the Canal Culture of the Shandong section)* (Jinan: Qilu Shushe, 2006), p. 2.
172 Ibid., p. 3.
173 Zhao Ye, 'Wu-Yue Chun Qiu (Spring and Autumn of Wu and Yue)', in *Sui Shu (Book of Sui)*, ed. by Wei Zheng (er shi si shi ben, 1644), Wiki Source https://zh.wikisource.org/wiki/隋书 [accessed 16th June 2016] The original Chinese sentence is '以船为车，以辑为马'.

which helped King Fuchai beat the State of Qi the following year.[174]

While making this waterway, various natural lakes such as Sheyang and Baima Lake was used, with short artificial channels connecting them, meandering all the way to the Huai River in the far north. With a length of approximately 185 li (Chinese traditional unit of measurement, 1 li roughly equals 550 metres) Han Gou connected the Huai River to the Yangzi River for the first time.[175] This is traditionally seen as the pioneer section of the Chinese Grand Canal. There is no clear written record of how many labourers were involved in this project, and although it was not entirely an artificial river, it is almost certain that without either advanced water conservancy knowledge or efficient tools, the number of people working on the canal would have been considerable.

There is no clear evidence, either, what the dimensions of this artificial waterway were, but it must have been wide and deep enough to be able to accommodate the Wu's battleships. As mentioned above, the State of Wu's location by the Yangzi River and their navigational skills meant that they had the most advanced navigation industry in China of that period. A *Chuan Gong* 船宫 (ship-making palace) was established to make their own ships, including the battleships. The first battleship type made by Wu was called *Yi* 翼 (wings), intended to suggest that the ship could travel as fast as flying with wings. There were three sizes of *Yi* battleships- large, medium and small: the largest, Great *Yi*, was 12 *zhang* (Chinese traditional unit of measurement, 1 *zhang* roughly equals to 3 metres) long and 1.6 *zhang* wide. It is said that it could hold 91 soldiers, including 50 sailors, 26 warriors and 12 well-armed soldiers as well as a conductor and paddlers.[176]

Another battleship used in the war by Wu against Qi was *Yu Huang* 余皇 an early type of Chinese *Lou Chuan* 楼船(battleships with fortified upper-works) (Figure 2.2). It could be

174 Li and Wang, p. 3.
175 Sima, Online ebook: <http://so.gushiwen.org/guwen/bookv_116.aspx> [accessed 20th June 2016]
176 Li Fang, *Tai Ping Yu Lan (Imperial Readings of the Taiping Era),* 5th edn (Beijing: Zhong Hua Shu Ju, 1995), p. 1450.

10 zhang high, and was noted for its multi-layer decks, which greatly increased its capacity for soldiers on board. However its remarkable height meant that this type of ship was thought to be more suitable for battles on rivers rather than at sea, due to its poor stability. There are no specific records of the size of this ship, but the earliest record of a measurement of a *Lou Chuan* is of that designed by official Wang Jun of Western Jin (265-316), whose length was some one hundred and twenty bu (Chinese traditional unit of measurement, 'bu' literately means pace, and 1 bu equals to the length of two steps, which is 6 chi).[177] The ship type *Yu Huang* could be smaller than this, but was certainly larger than the Great *Yi*. To be able to accommodate both *Yu Huang* and Great *Yi*, *Han Gou* would have had to be at least 1.6 zhang wide, an enormous size for an artificial canal in fifth century BC China.

[177] Li, p. 3408.

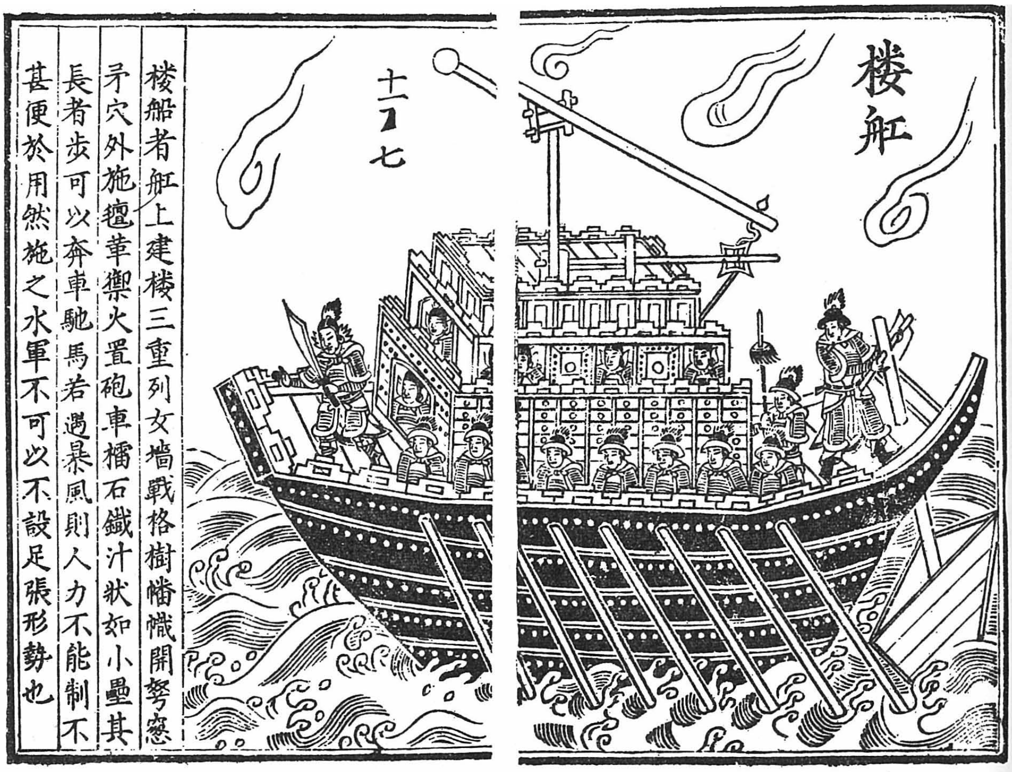

Figure 2. 2 Drawing from 1044 showing the appearance of Lou Chuan. The text on the left can be translated as follows:

Lou Chuan: these ships have three decks equipped with bulwarks for the fighting lines, and flags and pennants flying from the masts. There are ports and openings for crossbows and lances, and at the sides there is provided felt and leather to protect against fire, while (on the topmost deck) there are trebuchets for hurling stones, set up (in appropriate places). If a violent wind is encountered, (such ships are likely to) get out of human control, so they were judged inconvenient in practice. But the fleet cannot fail to be furnished with such ships, in order that its intimidation power may be heightened.[178]

Although the drawing fails to show the masts and sails clearly, it gives some idea of the structure of this type of battleship. Source: Needham, p. 426, Fig. 949. The drawing is originally from *Wu Jing Zong Yao* (Collection of the most Important Military Techniques).

[178] Translation originates from: Needham, p. 685.

Early Tools for River Work

Building the canal was an enormous project, which necessitated huge numbers of labourers working continuously. As there were no mechanical aids the watercourse had to be dug entirely by hand, using basic tools to lift and move earth. The digging tools were made of iron, and came into common use from the first century BC, although iron-melting techniques had been achieved as early as the seventh century BC.[179] Before then, the tools were made of wood.[180]

It is believed that the digging tools used for this early river work were the same as those used for early agricultural activities, which originated as far back as China's Mythological Period (2852-2070 BC). It was said that the Shennong, one of the three Chinese Sovereigns known to have taught people about agriculture and the use of herbal drugs, also used tools to aid agricultural cultivation. He invented the tool *Si Lei* 耜耒: by chopping wood to make the blade then burning one end of the wood to make it possible to bend it, and so act as a handle.[181]

[179] Xu Zhongshu, 'Si Lei Kao (The Study of Silei)', *Guo Li Zhong Yang Yan Jiu Yuan Li Shi Yu Yan Yan Jiu Suo Ji Kan (Bulletin of the Institute of History and Philosophy, Academia Sinica)*, 2:1(1930), 65-74 (p. 73).
[180] Yu Haoliang, 'Han Dai De Sheng Chan Gong Ju-Cha (The Mean of Production of the Han Dynasty-Cha)', *Archeology*, 8(1959), 440-441 (p. 440).
[181] *Yi Jing* (I Ching), (Beijing: Dai Zhi Ge Online Historical ebooks) <http://wenxian.fanren8.com/01/01/25/8.htm> [accessed 28th June 2016].The original Chinese texts are 神农氏作，所木为耜，揉木为耒.

Figure 2. 3 This mural painting from the Han dynasty (221–206 BC) shows Shennong cultivating the fields using the tool *Si Lei* 耜耒. It can be seen that the form of *si lei* is very similar to a modern-day shovel. Source: unknown, 'shen nong shi', *Guangming Online* (2016), <http://reader.gmw.cn/2011-12/11/content_3150097.htm> [accessed 28th June 2016]

There is no evidence that agricultural tools changed much over the following two thousand years, at least not the materials used for making them. Even during the Western Han dynasty (202 BC-8) when many more iron tools were available, wooden tools were still the most common ones used because of the cost of iron at that time.[182] As *Si Lei* was the most common tool used for digging in agriculture, it must have been used for river work too, as it was unlikely that new tools would be invented especially for canal making when the tasks was so similar. It is said that while Yu the Great was tying to control the flood, he dredged rivers with a *tuo* 橐(basket) and *si* 耜 (by hand).[183] If *si* was used for river work for over four thousand years, it seems certain that the *Han Gou*, which was made during the fifth century BC, was also dug with this or other similar wooden tools. The other tool mentioned in the text, *tuo*, was a basket-like container used to hold earth moved by *Si*. It is hard to find out what materials were used to make these baskets, but according to records from later dynasties, similar ones were woven from bamboo or willow branches.

[182] Huan Kuan, ed. by Chen Hongzhi, *Yan Tie Lun (Discourses on Salt and Iron)* (Taipei: Taiwang Gu Ji Chu Ban Gong Si Yin Xing, 2001), p. 491.

[183] Fang Yong (ed.), *Zhuang Zi* (Beijing: Zhong Hua Shu Ju, 2007), p. 45. The original Chinese texts are 禹亲自操橐耜, 而九杂天下之川.

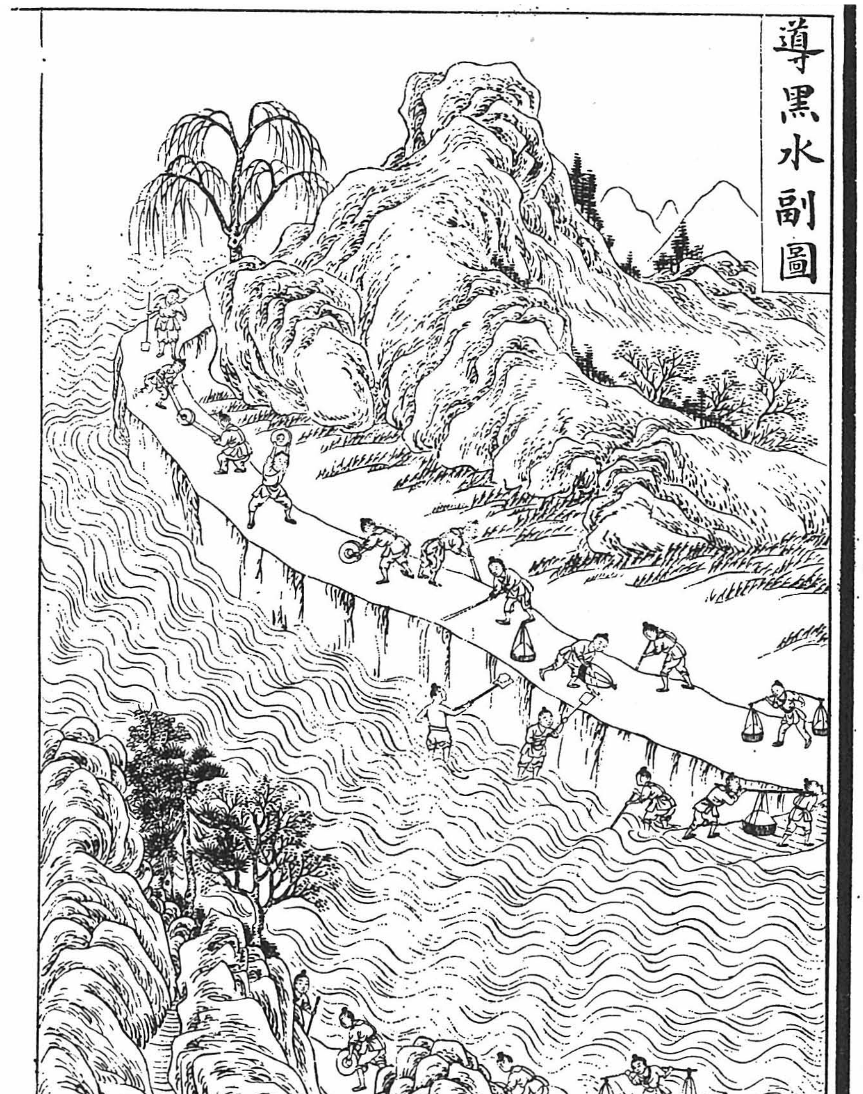

Figure 2. 4 A late Qing (1644-1912) picture shows Yu the Great (c. 2200 – 2100 BC) leading people to strengthen the dyke of the Hei River. The digging tools and baskets are seen in use. It also shows some roller-like tools to compact the earth, but it is impossible to be sure that the old tools are accurately represented. Source: Needham, p. 233, Figure 865.

Early Water Engineering Technology

After mastering the technology of making water run along certain ways, on a large and small scale, the ancient Chinese had to deal with the problem of how to control water in different circumstances, for example at varying altitudes and when there was an insufficient supply of water. With hindsight we now expect to see some kind of temporary obstruction that can be moved easily, like our modern locks. The lock with flexible gates had not yet been invented at this early stage of hydraulic engineering development in China, and the first strategy employed was to create an unmovable earth obstruction built over the watercourse, which could be used to raise the water level when the water of some channels was too shallow to carry bigger barges.[184]

It was called *Yan Dai* 堰埭 (double slipways); the two characters both signify the earth ridges that were made to stop the water flow, though *Yan* 堰 itself sometimes specifically refers to the bank.[185] A *Yan Dai* simply consisted of two slipways made of earth masonry, with a gradient of approximately forty degrees from the horizon (Figure 2.5). To make it possible for boats to pass, a beam with a smooth surface was positioned on top of the structure, so that the boats could pass over it.[186]

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184 Needham, pp. 344–345.
185 Song Wenbing, 'Shuo Dai (Discussion of Dai)', *Zhong Guo Dian Ji Yu Wen Hua (Chinese Classics and Culture)*, 1(2003), 90–92 (p. 91).
186 Shi Xiaolei, 'Using Image as Historical Evidence- an Extinct Technology of Dragging boats to Pass over the Dams Along Old Canals', *Journal of Changsha University of Science and Technology*, 4:4 (2012), 28-33 (p. 28).

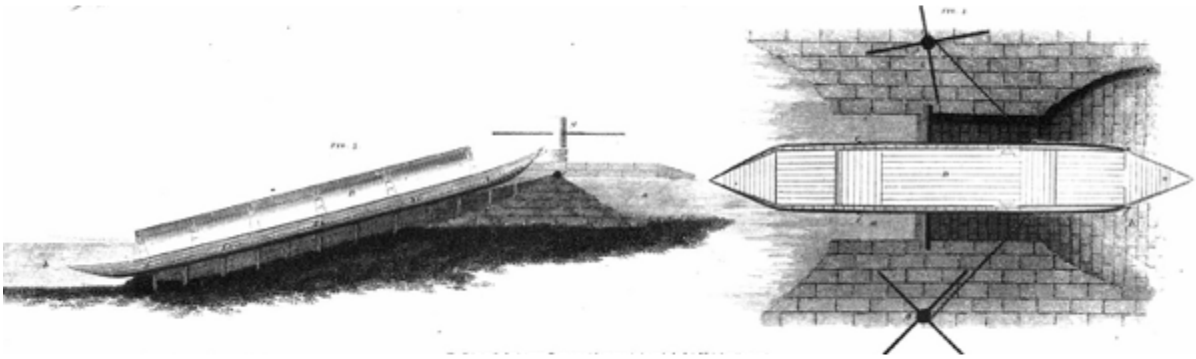

Figure 2. 5 These nineteenth century sketches show the section and plan of a *yan dai* (double slipway) on the Grand Canal. It can be seen that by that time the main structure was made of stone slabs instead of earth, and two capstans have been installed to rotate the ropes attached to the stern of barges, in order to pull them over. Source: Needham*,* Plate 364, Figure 920, the sketch was originally drawn by Alexander William.

Figure 2. 6 An early nineteenth century painting shows a canal barge passing over the double slipway. It also shows the structures on both sides of the slipway, which were made of stones and timber. Source: Alexander William, 'Front View of a Boat, Passing over an Inclined Plane or Glacis', in *The Costume Of China: Illustrated In Forty-eight Coloured Engravings* (London: William Miller, 1805)

The first record of *Yan Dai* appeared in the ancient book *Wu Lu* (Records of Wu) written between the third and fourth centuries. It says that in the year of 245, Sun Quan, who founded the Eastern Wu dynasty in the Yangzi region, wanted to link his capital in Jianye (present

Nan Jing) to the southeastern area of China by waterway. A new channel connecting Xiaoqi (present Jurong) to Danyang was built involving some thirty thousand soldiers, and was named Pogang Du. Because of the differences in the altitude of the riverbed, it could not be successfully put in use at first, so fourteen *Yan Dai* were built on its watercourse.

More records of *Yan Dai* were made later which give us a more detailed account of how a barge passed over them. While going to the lower stream, two capstans, set on each side of the bank, were used to rotate ropes attached on barges. Ropes from each capstan would be hung on the stern of the barge, and in order to prevent the ropes from falling off, a piece of wood would be thrusted into the noose. After the ropes were positioned, men rotated the capstans to pull the boat to the top of the double slipway, allowing it to go down into the lower stream.[187] To prevent water from getting into the barges when they crashed into water in a high speed, a piece of knitted mat with a wooden structure would be attached tightly to the front of each barge. It is hard to know whether the capstans were already in use when *Yan Dai* were first invented, and it is possible at first, the barges might have been hauled by people. There are records of boats being hauled by oxen (Figure 2.7), described as *niu dai* 牛埭 (ox-hauling).[188]

[187] Alexander William, 'Front View of a Boat, passing over an Inclined Plane or Glacis', in *The Costume Of China: Illustrated In Forty-eight Coloured Engravings* (London: William Miller, 1805)
[188] Needham, p. 352.

Figure 2. 7 An early twentieth century picture shows a barge being pulled over a double slipway by ox. Source: Liaocheng Canal Museum.

To pass over a double slipway is quite dangerous, and required a great deal of effort. Barges were frequently damaged or lost goods, and they were subject to attacks in which workers might collaborate with bandits hidden nearby.[189] Going from the lower stream to the higher one was even more difficult, and a large boat requires some hundred men to pull it over.[190] Although passing over a double slipway demanded so much human effort, it was still quicker than passing through a lock, so they remained a widely used facility on the Grand Canal until the early twentieth century.

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189 Toqto and Alutu, Wikisource Online Library, https://zh.wikisource.org/wiki/宋史/卷307 [accessed 30 June 2016] (para. 2)

190 Shi, p. 29.

Figure 2. 8 A photo taken in 1926 shows that double slipways were still in use at that time. Source: Liaocheng Canal Museum.

Besides the double slipways, there is evidence to show that the technique of building temporary movable obstructions to control water might have been achieved by the first century, in the invention of *dou men* 斗门 (flash lock). The first record of them appeared in year 70, when an official of the Eastern Han dynasty (25-220), Wang Jing, suggested that the Emperor Ming (reigned 57-75) should restore the *dou men* along the ancient *Bian Qu* which links central China to the southeast.[191] Although there are no written records of how the *dou men* was first invented, we know about its structure from later accounts. A *dou men* consisted of two abutments with a stop log in between, so that it could be readily opened by lifting the log. It was built where there were different water levels, and when it was necessary to save the water of an upper stream.[192] Textual evidence of it survives from the Tang dynasty, probably when it was put into common use; we shall discuss it in more detail later.

[191] Fan Ye, *Hou Han Shu (Book of the Later Han)* (si ku quan shu ben, 1780), Wikisource Online Library <https://zh.wikisources.org/wiki/後漢書/卷 2> [accessed 30 June 2016]
[192] Needham, p. 347.

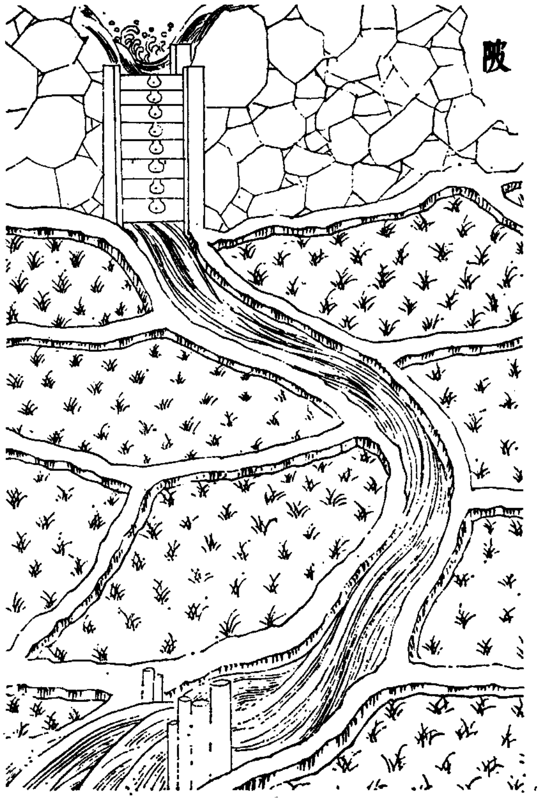

Figure 2. 9 A seventeenth century drawing shows a *dou men* with a stop log built on a narrow channel. From the fields along it we can deduce that the channel was part of an irrigation system rather than a waterway, though the structure of the *dou men* would be the same for both. Source: Needham, p. 348. Figure 919.

Sui canal- the completion of a nation-wide canal system

The socio-political context

China had been politically fragmented for a very long time before the Sui dynasty (581-619) was established, and unified the northern and southern dynasties. Apart from the climate and geographical factors, the lack of unity had become part of the reason led to China's diversity in terms of culture. The southern region (areas along the middle and lower Yangzi River) had always been better developed and richer because there were more readily available resources, which gradually contributed to a more luxurious lifestyle for its inhabitants. Northern China was often ruled by non-Chinese like the Hunnish people in the fourth century, which led to a very different culture and lifestyle in comparison.[193]

These differences in culture and political power resulted in the appearance of the distinct Southern and Northern Dynasties (420-589). At the time the northern area was often a battleground between different political powers and rulers, although internal wars also took place in the south, where society was more stable with an economy which grew steadily. The situation in the north improved after the Northern Zhou (557-581) beat the Northern Qi (550-577) and unified northern China.[194]

Yang Jian, a member of Northern Zhou's Guan Long aristocracy based in the north-west, became the founder of the Sui dynasty when he took the throne from the last emperor of Northern Zhou. He was then known as the Emperor Wen (reign 581-604) of Sui. Because the throne had been taken by force, loyalists remaining in Northern Zhou and other regions of China, wouldn't support Yang Jian, and prepared for war to remove him from power. The conflict forced Yang Jian to stay at his base in central China, where his army was positioned. He made Chang'an, now known as Xi'an, his capital: it had been the capital and administrative centre of northern China since the mid-sixth century. Within nine years of founding his regime Yang Jian reconquered southern China and pacified the rebellions, reunifying China.[195]

After achieving political stabilization, Emperor Wen started taking economic development into consideration. The food supply to the capital, which relied on the regular grain shipments from the south-east, was inadquate, and a more reliable waterway was needed to replace the silty Wei River, which flowed to the east and joined the Yellow River.[196] Improving water transportation was an effective way to resolve the perils of food shortage, especially when as

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193 Denis Twitchett and John K. Fairbank, *The Cambridge History of China Vol 3, Part 1* (Cambridge: Cambridge Univeristy Press, 2002), pp. 49-50.
194 Ibid., pp. 60-61.
195 Ibid., p. 57. It needs to note that although the Sui Dynasty unified the north and south China, its territory was much smaller than today's China, it mainly covered the central and southeast region of China today.
196 Ibid., p. 114.

ship-making techniques had developed and the newer boats could carry more goods.

Yu Wenkai (555-612), the Minister of Works, was appointed to design a new river to the east of the new capital near Wei and the Yellow River in 584. He had rich engineering knowledge and had led several large-scale state projects, making him an obvious choice. Yu assigned people to conduct a survey of the site, and made a plan together with two other officials, Su Xiaoci and Yuanshou, who also had considerable engineering knowledge.[197] The new waterway, named *Guang Tong Qu* 广通渠, and later also known as *Yong Tong Qu* 永通渠, was designed to follow an old watercourse built during the Han Dynasty (202 BC-220). This waterway had also been excavated to transport food. The new waterway was made by deepening and widening this old course in order to accommodate the new larger Sui barges. Many labourers were forced to work on this project, and the construction of this 300 li long waterway was completed in three months.[198]

In imperial China adult men usually had to serve for public construction work for a certain number of days each year, and building the canal counted as part of that labour service. The Sui court declared the following regulations for taxes and labour services in their Ordinances made in 582: land tax at the rate of three *dan* (traditional Chinese unit of weight, 1 *dan* roughly equalled 53kg) of grain per family per annum; a contribution of forty *pi* (traditional Chinese unit of measurement, 1 *pi* roughly equalled 1.2m) of silk or linen cloth of a prescribed width of 1.8 *chi* (1 chi roughly equalled 30cm) plus three *liang* (1 *liang* roughly equalled 42g) of silk floss or three *jin* (1 *jin* equalled 668g) of hempen thread; and finally labour service of twenty days per annum levied on all adult males between 17 and 60.[199]

Yong Tong Qu's course was straighter than the old waterway's and made to flow parallel to the Wei River to the south, which was the only source of its water. The new waterway

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197 Wei, Wikisource Online Library <https://zh.wikisource.org/wiki/隋書/卷24> [accessed in 30 June 2016] (para. 32).
198 Twitchett and Fairbank, *The Cambridge History of China Vol 3, Part 1,* pp. 114-115.
199 Ibid., pp. 94-95.

successfully connected Tong Guan to the capital Chang-an, and marked the beginning of the Sui's canal-making.[200]. Emperor Wen's son, Emperor Yang (604-618), took this first step much further.

After his succession to the throne in 605, Emperor Yang moved the capital from Chang'an further east to Luo Yang, which at that time was the most significant city, both politically and economically. It also had better connections than Chang'an to Shandong and the He Bei Province, both important regions for grain production. Emperor Yang paid more attention than his father to monitoring the culturally distinct southern region, realising the urgent need to build a better connection to these productive lands to consolidate his power.[201]

In the first year of Emperor Yang's reign, he ordered the construction of another waterway, *Tong Ji Qu* 通济渠, aiming to link the new capital Luoyang to Su Zhou in southern China. This waterway also followed, for the most part, earlier watercourses: the section from Luo Yang to Jun Yi (present Kai Feng, Henan Province) was mostly adapted by dredging and sometimes widening the ancient Yang Qu and Bian River as well as a number of other natural rivers. From Jun Yi, the canal was diverted further to the south-west to link to the ancient Han Gou, rather than continuing to follow the watercourse of Bian River which linked to the Si River. This was done to mitigate the risk of floods from the Si River.[202] *Tong Ji Qu* was impressively completed in the same year, believed to be due to the extremely heavy *corvée*: more than a million labourers were forced to work on the northern section of the new canal, and over a hundred thousand on the southern section. While getting the canal built was a great success, the human cost was considerable with approximately four hundred thousand labourers dying on the site due to the extremely demanding work and poor conditions.[203]

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200 Wei, Wikisource Online Library <https://zh.wikisource.org/wiki/隋書/卷 24> [accessed in 30 June 2016] (para. 32).
201 Twitchett and Fairbank, *The Cambridge History of China Vol 3, Part 1,* pp. 135-137.
202 Sima, Chinese Text Project Online Ebook, <http://ctext.org/wiki.pl?if=en&chapter=571928&remap=gb#p46> [accessed 30 June 2016] (para. 45).
203 Ibid.

There is little surviving contemporary information about the construction of this waterway, except for the large number of labourers involved; however, we can find quite a detailed account in the fictional *Kai He Ji* (A Record of Opening up of the Canal) written in the Song dynasty (1127–1276). Although this is a folk tale rather than a formal history, it is highly valued by historians and thought to reflect the reality quite accurately. In the book it is said that while preparing for the construction of the canal, 3.6 million men over 15 were recruited, and children, elders and women who were not bound to do labour service had to provide catering. Another fifty thousand strong young men were recruited to serve in a supervisory role, all working under the crucial leadership of Ma Shumou, the director of this project.[204]

Further details were given in another fictional account written in 1631.[205] It says that before construction began, every thousand men were allocated to a barrack, each of which consisted of five teams and each of those composed of two hundred men. All the men were sent to the site at the same time; starting from Luoyang, millions of men lined up over some over ten li, digging the canal with shovels and carrying the earth with baskets. It is believed that while building the Sui Canal, the emperor set the uniform length standards, by which all the sections were to be forty *bu* wide.[206] The supervisors were very strict, and men who were found to be lazy would be given a whipping. People had to work day and night to finish the work on time, it was said that the only way to stop working was to die.

Emperor Yang did not seem to care much about the misery he brought to the labourers, because he himself was very satisfied with this new canal. Once Luoyang was successfully connected to the Yangzi region, he immediately ordered the building of a series of large boats including dragon boats, phoenix vessels, red battle cruisers and multi-decked transports. Because the boats were often too big to travel through some sections, a number of ropes had to be attached to each boat for people to pull them. To maintain the luxurious style of the

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204 Unknown, *Kai He Ji (A Record of Opening up of the Canal)* (gu jin yi shi ben, 1804) Chinese Texts Project Online Ebooks, <http://ctext.org/wiki.pl?if=gb&chapter=268040&remap=gb> [accessed 30 June 2016] (para. 2).
205 Qi Ye Dong Ren, *Sui Yang Di Yan Shi* (The Merry Adventures of Emperor Yang) (Wuhan: Qun Yi Tang, 1985), p. 28.
206 Sima, Vol.5, Sui Dynasty.

vessels, the ropes were all covered with green silk.[207]

Among these, the dragon boat was the biggest. It was 200 chi (60 metres) long and 45 chi (13.5 metres) high, with four-layer decks. It also contained many rooms: on the top floor there were main, inner, east court and west court halls, with another 120 rooms on the second and third floors. The whole boat was decorated with red powder, gold, green jade and pearls, in a feast of unbelievable luxury.[208] To be able to accommodate the huge dragon boats, the *Tong Ji Qu* had to be both very wide and deep. There are no clear records about how deep it was, but the width was forty *bu* (200 chi or 60 metres).[209].

While travelling on the canal, Emperor Yang would always lead the excursion in the dragon boat, with officials following behind on smaller boats according to their grade. Local officials from the places they passed through were forced to offer provisions: those who provided a good service would be rewarded by a promotion; but those who failed to serve the emperor properly could expect punishment, of which the worst was a death penalty.[210]

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207 Twitchett and Fairbank, *The Cambridge History of China Vol 3, Part 1,* p. 137.

208 Zhang Chuanhui et al, *Zhong Guo Ji Xie Gong Cheng Fa Zhan Shi (The History of Development of Chinese Mechanical Engineering)* (Beijing: Tsinghua University Press, 2004, Second Edition), p. 254.

209 Sima, Chinese Text Project online ebook, <http://ctext.org/wiki.pl?if=en&chapter=571928&remap=gb#p46> [accessed 30 June 2016] (para. 45).

210 Wei, Wikisource Online Library <https://zh.wikisource.org/wiki/隋書/卷 24> [accessed in 30 June 2016] (para. 37).

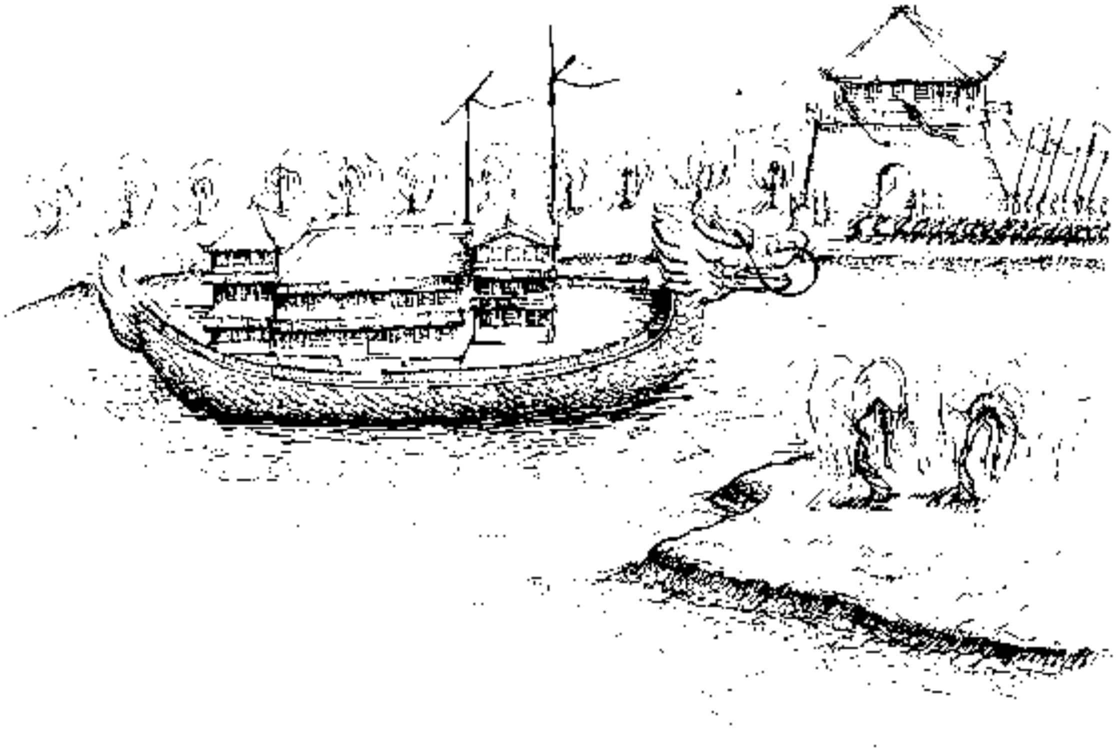

Figure 2. 10 This conjectural drawing by the author shows the dragon boat of Emperor Yang travelling on the canal. The boat was so big that its movement often had to rely on large numbers of people to pulling it. The earth banks were bordered by weeping willows, and local officials had to greet the emperor with tributes as he passed by.

The construction of *Tong Ji Qu* not only provided a safe route for grain to be shipped from the south to the capital, but also ensured the control of the rich regions of China. Emperor Yang quickly ordered another canal, *Yong Ji Qu* 永济渠, to connect Luo Yang to Beijing, to enable appropriate supplies to be provided for the armies on the northern frontier. At that time the northern regions, including Hebei and Shandong, had a quarter of the entire population of China; and land policy, the *Jun Tian Zhi* 均田制 (land-equalization system), had helped to increase agricultural production there. *Yong Ji Wu* was designed to ensure receipt of the large quantity of tax grain due from this region.[211]

The (land-equalization system) was inherited from the Northern Zhou dynasty. It stipulated

[211] Twitchett and Fairbank, *The Cambridge History of China Vol 3, Part 1,* p. 135.

that the government owned all the lands of China, but would assign a certain amount of land to individual households based on their ability to work. For example, men who were older than eighteen were classified as *ding*, who would receive 80 mu (1 hectare roughly equalled 15 mu[212]) of land, while women who were over eighteen would be assigned 40 mu.[213] Although the problem of there being insufficient agricultural land for everyone remained, this at least ensured that some land was assigned to each person.

In 608, the construction of this new canal, *Yong Ji Qu*, was carried out, again making use of old waterways. It was completed in one year and was 1900 li long. There were not only millions of male labourers involved in this project but also, for the first time, women were force to work too when the state ran out of man power for *corvée* service. This hints at the astonishing numbers that were involved and the heavy toll that the work took on those involved. Due to the vast water supply from the Qin River, even though *Yong Ji Qu* was less wide than *Tong Ji Qu*, its capacity allowed it to accommodate large ships.[214]

So by the early seventh century, with the completion of the nation-wide waterways, almost all the important rivers were connected; the journey from Jiang Du (present Yang Zhou) to Zhuo Jun (present Zhuo Zhou, He Bei) only took about fifty days by boat. The Sui Emperor had by then ensured his control over the most productive lands in China. Large amounts of tax, grain and clothes could be shipped from the fertile lands of the south to the capital and to the northern frontier.[215]

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[212] 1 mu in Sui Dynasty equals to 1.13 mu in present day

[213] Wu Tingyu, *Zhong Guo Li Dai Tu Di Zhi Du Shi Gang* (Historiography of the Land System of the Imperial China Part One) (Jilin: Jilin University Press, 1987), p. 221.

[214] Wei, Wikisource Online Library <https://zh.wikisource.org/wiki/隋書/卷 24> [accessed in 30 June 2016] (para. 36).

[215] Liu Jun, 'Da Yun He De Qian Chen Wang Shi (The past of the Grand Canal)', *Sina Finance E-news,* 19 March 2007. <http://finance.sina.com.cn/g/20070319/16463419861.shtml> [accessed 30 June 2014] (para. 11).

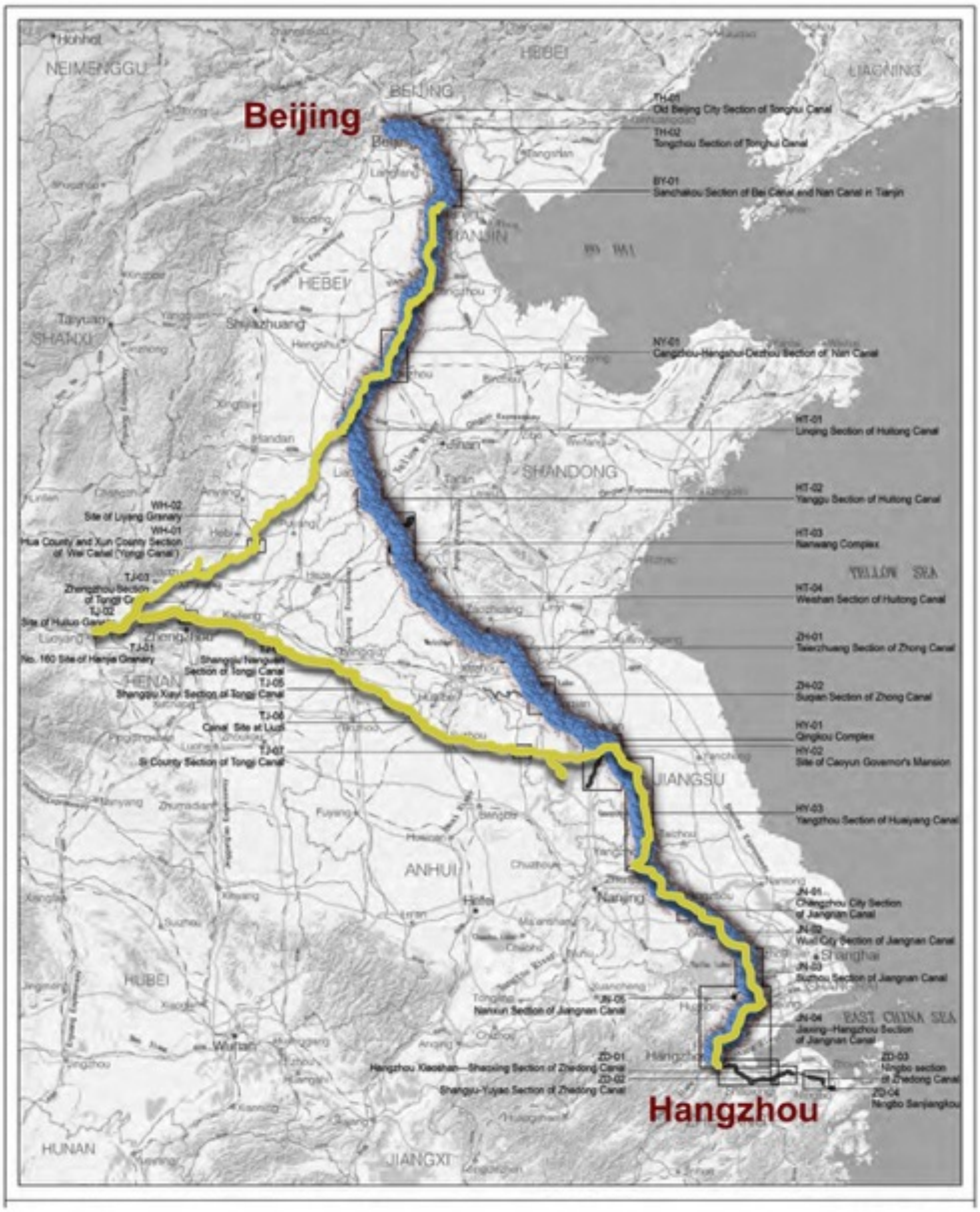

Figure 2. 11 The map shows the canal system of the Sui Dynasty (yellow), marking a different route from the current one (blue). Source: map originally from State Administration of Cultural Heritage of People's Republic of China, Normination documentation submitted to the World Heritage Convention Cultural Heritage (p.54), modified by author.

The volume of tax grain shipped to the western and northern frontiers was enormous, and this was probably the first time that sufficient grain was supplied for the capital and armies; granaries had to be established in order to store it. Six official *Da Cang* 大仓 (great granaries) with considerable capacity were built both in Luo Yang and nearby. Among them, the Luo kou Granary, also known as Xing Luo Granary, was the most significant during the

Sui period. It was built in 606 and located where the Luo and Yellow Rivers joined together, so that the grain stored there could easily be transferred to either the capital Luo Yang in the west, or the armies in the northeast, as required.[216].

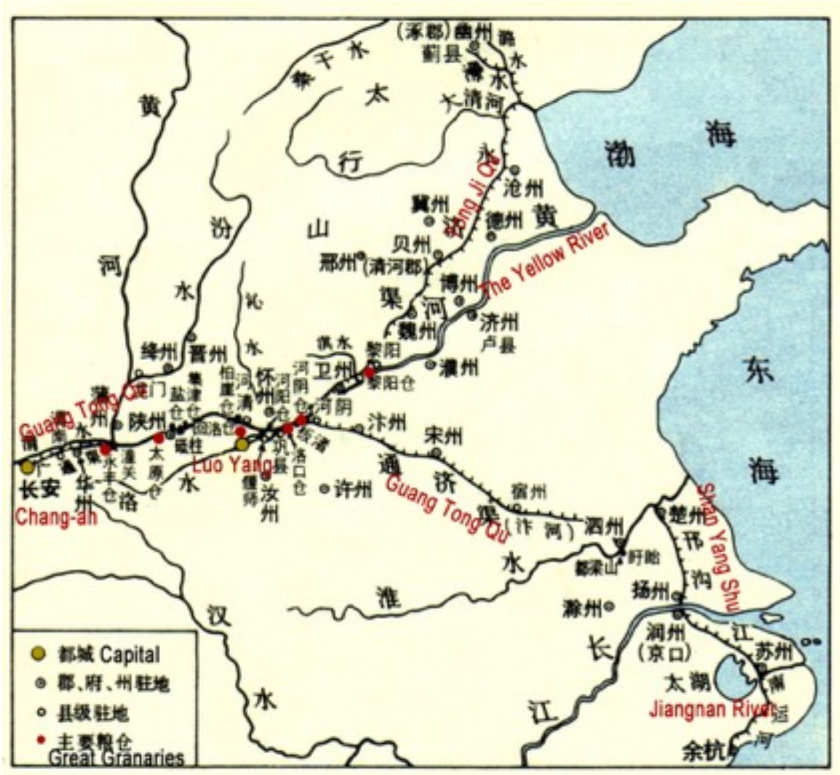

Figure 2. 12 The map shows basic information about the waterways, granaries and capitals of the Sui Dynasty. The six red dots represent the six great granaries that were established during this period, which were all located close to Chang-an and Luo Yang, to ensure sufficient food supplies for the imperial family and its armies. Source: Unknown, 'sui chao liang cang (the granaries of the Sui Dynasty)', *Official website of Wuhan Institute of Shipbuilding Technology* (2016) <http://www.wspc.edu.cn:8080/cbwh/–Articleshow.asp?id=264> [accessed 26 June 2016]. English translation is added by author.

It was recorded that the circumference of Luo Kou Granary was over twenty li long, consisting of three thousand cellars each one of which could store approximately eight thousand *dan* (424,000 kg) of grain. The whole granary could store as much as twenty-four thousand million *dan* of grain, which made it the largest and most significant of the Sui. In total a thousand soldiers and officials were stationed at the granary.[217]

[216] Yilin Zou, 'Cong Han Jia Cang De Fa Jue Tan Sui Tang Shi Qi De Cao Yun He Liang Cang (the Discussion of Tribute Grain Transport and Granaries in Sui and Tang period with the Discovery of Relics of Han Jia Granary)', *Cultural Relics*, 2(1974), 57-66 (p. 60).

[217] Sima, Chinese Text Project online ebook, <http://ctext.org/wiki.pl?if=en&chapter=571928&remap=gb#p46>

The appearance of iron tools

As discussed earlier, the canals were dug with wooden tools until the first[t] century BC, when iron became more common for making digging tools. A song written in the late first century says that while the waterway *Bai Qu*, which was only used for irrigation, was under construction in 95 BC, 'Cha are lifted up and pushed down that are just as good as clouds, and opening a canal is like bringing rain'.[218] The Chinese character for the tool mentioned here was *cha* 臿, which worked the similar way of the modern tool shovel. And the name *cha* also describing the movement of digging: *cha* also means to 'stick in something'.

Cha is believed to have evolved from *Si Lei*, mentioned earlier. During the Han Dynasty (202 BC-220), when people first used iron to make agricultural tools, it was at most only applied to the edge of the blade, to make it stronger and sharper. *Cha* is very similar to *Si Lei*, but has an extra iron edge, as well as a slightly different shape of blade. The most common blade shape was pointed at one end, straight at the other, which made it easier to dig soil. You could step on it to increase the force of insertion, like the shovels we use in modern times. People thought the blade part looked like a piece of leaf, so named it *Ye* 叶, which means 'leaves' in Chinese.

The iron part of the blade would be made with a socket so that it covered the edge of the wooden blade. The iron part came in three different shapes: one was completely straight; one had a gap in the middle; and one had a gap in a middle and was pointed at the other end (Figure 2.13). To make it stronger as well as easier to make, the entire *cha* would be made of one piece of Huaxiang wood (化香木, Black Dye Tree, *Platycarya strobilacea Siebold & Zucc*).[219]

[accessed 30 June 2016] (para. 64).

218 Ban Gu, *Han Shu (Book of Han)* (wu ying dian ben, 1680), Chapter 29. The original Chinese sentence is 举臿为云, 决渠为雨.

219 Wang, p. 192.

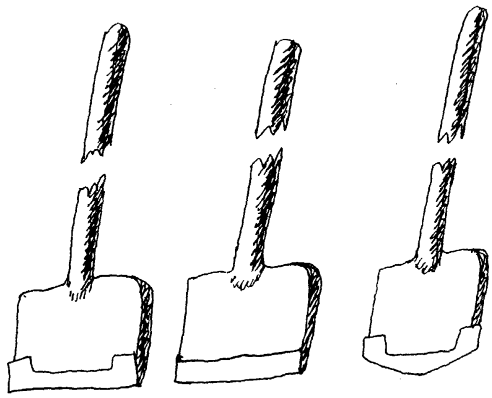

Figure 2. 13 The three different shapes of iron edges attached to the wooden blades of *cha*. Source: Wang Xiaoxi, 'Cong Ma Wang Dui Han Mu Chu Tu Wen Wu Kan Han Dai De Nong Ju- Tie Kou Cha (The study of Han agricultural tools through the relics discovered from the King Ma's Mound)', *Agricultural Archaeology*, 1 (2002), 191-194 (p. 193), Figs. 2-4.

In many texts, people tended to use 锸 rather than just 臿 to refer to *cha*: the extra component in the first character means 'metal', one of the traditional *wu xing* 五行(Five Elements). This recognises iron as one of the materials used to make *Cha*. Another tool that often appeared with *Cha* was 箕 (*Ji*) or 畚 (*Ben*), which was simply a basket made of bamboo or willow branches[220] to hold the soil that was moved by the shovel. Because the two tools were so often used together in river work, some historical records and dialects, confused the name of *Cha*, calling it *Ben Cha*, which actually means both the basket and shovel.[221]

During the Han dynasty, the iron making technique was so mature that a specific department called *Tie Guan* 铁官 (officials who were in charge of iron production; this term refers to both the position and department) was set up, with 49 branches all over China.[222] This strongly suggests that the canals built during and after this period, including the Sui Canal, must have been dug by iron-enhanced tools like *Cha*, with the records suggesting that other

[220] The material to make the basket depends on the region, usually southern people made it with bamboo, while northern Chinese used willow branches.
[221] Lin Qing and Cheng Pengju, *He Gong Qi Ju Tu Shuo* (Illustrations of Tools for River Works) (Zheng Zhou: He Nan Education Press, 1994), p. 571.
[222] Lu Dimin and Wang Daye, *Zhong Guo Gu Dai Ye Jin Yu Jin Shu Wen Wu* (The Metallurgy and Metal Cultural Relics of China) (Xi'an: Shaanxi Science and Technology Press, 1998), p. 221.

iron tools like the axe may have also have employed.

Figure 2. 14 The Stone figurine (left) discovered in Sichuan can be dated back to the Eastern Han period (25-220). He holds a *cha* (shovel) and a *ji* (basket). We can see the iron edge at the end of the shovel. The nineteenth century drawing (right) also shows a shovel and basket. The handle of the shovel has been improved to a slightly different shape, with a T-shape part added to make it easier to grasp the handle. The blade of the shovel here was entirely made of iron rather than having just an iron edge. Source: the figurine is from unknown, 'hui tao shi cha nan li yong (the pottery male figurine with gray cha)', *The China Economists* (2016) <http://treasure.chinesecio.com/article/2010-01/27/content_104913.htm> [accessed 28 June 2016]. The picture on the right is from Lin Qing (1791-1846), *Illustrations of Tools for River Works 河工器具图说*, ed. by Pengju Cheng (Zheng Zhou: He Nan Education Press, 1994), p. 571.

Planting for the Sui Canal

There is not much documented evidence of the planting along the Canal from ancient times, apart from references to the willow trees that were planted along the Shan Yang Du section of the Sui Canal. The Tang Dynasty poet Bai Juyi (772-846) described the willows along the Sui Canal in his poem *Sui Di Liu* (the willows on the embankment of the Sui Canal): 'during the reign period (569-618) of the Emperor Yang of Sui, lines of willow trees were planted with the canal placed in between. It connected the Yellow River in the west and the Huai

River in the east, like a green belt meandering for thirteen hundred li'.[223] Lu You (1125-1210) also wrote in his dairy *Ru Shu Ji* (Entering Si Chuan),when he was travelling along the southern section of the canal, that 'there are high embankments with tall willows and dense population'.[224]

This section of the canal was used to host a smaller river made by previous dynasties to link the Huai and the Yangzi Rivers. It was repaired and broadened to became a large, 300 *li* long and 40 *bu* wide canal, with the *Yu Dao* (imperial paths) bordered by rows of willow trees planted on both banks of the canal. The imperial paths were built specifically for Emperor Yang when he travelled to the south, and 40 palaces were built along the watercourse in order to serve the emperor and officials when they passed by.[225] This gave the Shanyang Du its later name, Yu Canal (the imperial canal).

It is hard to be sure when the ancient Chinese started planting willow trees along rivers, but it seems likely that willows have been preferred as canal-side plants because not only do they provide shade for people, but they also strengthen the embankment with their roots. The references to planting willow trees along the Grand Canal mostly appeared after the Ming dynasty, to be discussed in later chapters.

The Tang (618-907) and Song (1127–1276) period

The socio-political context

After the Tang Dynasty was established in 618, the emperor Gao Zu decided to relocate his capital back to Chang-an, because it had always been the political base of the Guan Long

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223 The original Chinese words are 大业年中炀天子，种柳成行夹流水。西自黄河东接淮，绿影一千三百里。大业末年春暮月，柳色如烟絮如雪.

224 Lu You, translated by Philip Watson, *Ru Shu Ji (Grand Canal, Great River, the Travel Diary of a Twelfth-century Chinese Poet)* (London: Frances Lincoln Limited, 2007), p. 135.

225 Sima, Chinese Text Project online ebook, <http://ctext.org/wiki.pl?if=en&chapter=571928&remap=gb#p46> [accessed 30 June 2016] (para. 45).

aristocracy from which he originated. However, the lack of resources and unreliable weather of Chang-an made life more of a struggle for the imperial family compared to that of the Sui Dynasty, who had always enjoyed plenty of food in their capital Luo Yang. Various attempts were made to improve the court's financial problems, but all eventually failed. The Tang emperor considered reutilising the Sui canal to ship grain from the fertile lands in the south, but the silted Yellow River and the rapids at San Men, near Chang-an, made the shipping of grain by barge from the south very difficult.

To solve the problem, grain had to be transferred between different granaries by barge, with ox-carts employed for the journey over land between Luo Yang and Chang-an. This made the grain shipment very difficult and slow, so only about two hundred thousand *dan* of grain could be shipped to Chang-an each year. Following a rapid economic recovery in the early seventh century, Chang-an grew into a metropolis with a population of over a million citizens. The small volume of grain that could be transported by canal was certainly not enough for this populous city.[226]

The financial problems in Chang-an became worse when natural disasters and a number of military campaigns occurred in the final years of the seventh century, bringing further misery. The Emperor's family and officials travelled to Luo Yang frequently to avoid the severe lack of food supplies. China's most famous female emperor, Empress Wu (reign 690-705) took the throne from her son and moved her capital to Luo Yang, but the capital was later moved back to Chang-an again and it remained the capital throughout the Tang Dynasty, after the Li Clan took the throne back from the Wu Clan.[227]

The famine problems of Chang-an remained, and caused the price of rice to rise in the Guanzhong region, so the Tang government realized that the grain shipment problem had to

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[226] Twitchett and Fairbank, *Cambridge History of China, Vol. 3, Part 1*, pp. 355-356.
[227] Ibid., p. 356.

be fixed to keep the economy stable.[228] In 733, a proposal for the reform of tribute grain transport was submitted by Pei Yaoqing (681-744), who was the chief minister of the Secretariats and Chancellery. He believed that the key to solving this problem was to avoid the difficulties and dangers of the rapids in San Men, rather than to overcoming them. This proposal was approved by Emperor Xuanzong (reign 712-756) and Pei was designated as director of this project.[229]

The key idea of Pei's reform was to revise the food shipment route in order to increase the transport's efficiency. This required building a long path of 10 li on the northern bank of San Men, and the establishment of granaries at the eastern and western ends of the path. When the grain arrived at the eastern granary, it could then be transferred to the western one by land, from where the grain was transferred to barges for shipment to the granaries near the capital. In this way the dangerous rapids of San Men could be avoided.[230] Other granaries were established along most sections of the Sui canal, so that when the grain was transferred to the next granary, it could be consigned to the barges of local boatmen from the new region instead of keeping the same boatmen, avoiding difficulties caused by the unfamiliarity of local waters. Pei also enhanced the flexibility of the new shipment scheme in relation to its water supply: when the water level was not deep enough to carry large barges, the grain would be stored in the granaries to wait for more suitable water levels. This ingenuity saved both material resources and manpower.[231]

The new scheme did not alter any of the courses of the canal, but provided a more efficient means of shipping the tribute grain. It saved the Tang government considerable costs, and made an important contribution to future transportation improvement.[232] The grain shipment

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[228] Twitchett and Fairbank, *Cambridge History of China, Vol. 3, Part 1*, pp. 357-358.
[229] Ibid., pp. 399-400.
[230] Sima, Chinese Text Project online ebook, <http://ctext.org/wiki.pl?if=en&chapter=496738&remap=gb#p7> [accessed 30 June 2016]. Line 12.
[231] Ibid., Chinese Text Project online ebook, <http://ctext.org/wiki.pl?if=en&chapter=428618&remap=gb#p112> [accessed 30 June 2016]. Line 138
[232] Lai Ruihe, *Tang Dai Zhong Ceng Wen Guan (The Middle-Level Civil Officials of the Tang Dynasty)* (Taipei: Linking Publishing Company, 2008), p. 270.

method was further developed later, when a new waterway, *Kaiyuan New River* 开元新河 was built by Li Qiwu near San Men in 741, to replace the land transport over this section.[233] Several new channels were also ordered by Wei Jian the following year, and the annual grain transported to Chang-an gradually increased to four million *da*; the highest volume during the Tang Dynasty reached seven million *dan*.[234]

Granaries

One of the lessons that the Tang learned from the Sui was never to store their grain separately: the Sui emperor had kept his grain in several different granaries, and the capital had suffered from insufficient food supplies when rebel armies occupied the granaries. So the Tang government preferred to store most of its grain in a few important granaries, of which the Hanjia Granary was the largest. It was used to store all the tax grain shipped from the south and east of China, as much as half the grain stored nationally.[235]

The Hanjia Granary had been built before the establishment of the Tang dynasty. It was built in 605, at the same time as the Eastern Palace (at Luo Yang) of the Sui Dynasty (Figure 2.15). However, there is no record of it having been used as an important granary during the Sui period, and it was certainly not one of the six official granaries. But the need to have a large granary inside Luo Yang city brought Hanjia granary great significance, and its scale was extended so that it could hold the enormous amounts of grains shipped on the canal.[236]

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233 Sima, Chinese Text Project online ebook, <http://ctext.org/wiki.pl?if=en&chapter=973389&remap=gb#p8> [accessed 30 June 2016] (Line 7).
234 Wan Guoding, *Gu Dai Jing Ji Zhuan Ti Shi Hua (Historical Narrative of the Economic Subject of the Imperial China)* (Shanghai: Zhong Hua Shu Ju, 1997), Readers 365 Online Ebook <http://www.readers365.com/gudaijingji/0043_ts010053.htm> [accessed 30 June 2016]
235 Zou, p. 61.
236 Ibid.

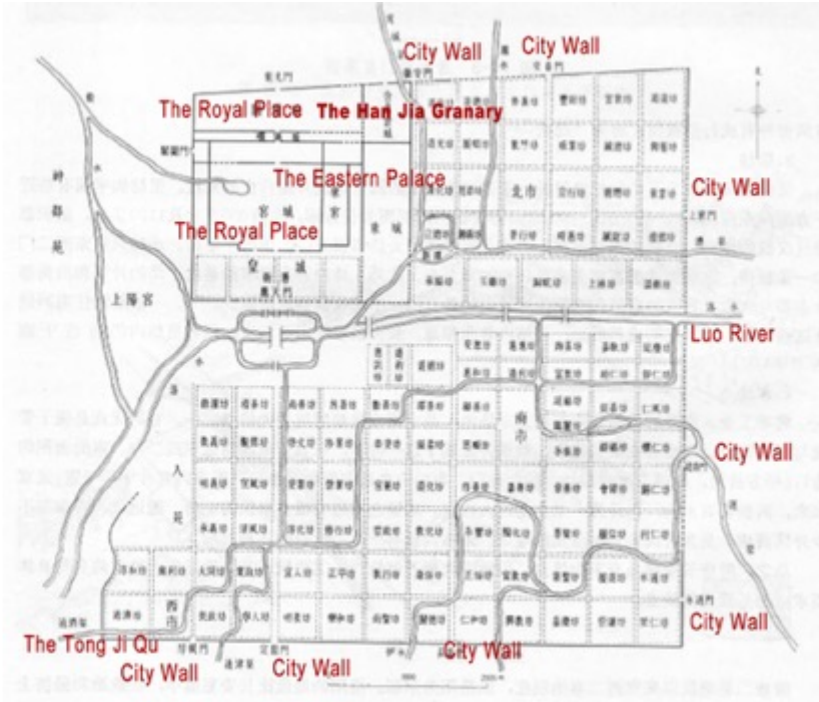

Figure 2. 15 The plan of Luo Yang during the Sui and Tang dynasty. The Hanjia Granary was located in the northeast corner of the imperial palace. It was next to the waterway linked to Tong Ji Qu, from which the tax grain could be easily transferred to the granary. Source: Dunzhen Liu, *The History of Ancient Chinese Architecture, second edition* (Beijing: China Architecture & Building Press, 1984), p. 124, Fig. 81.

As shown on this map of Luo Yang city, the Hanjia Granary was located in the northeastern corner of the imperial palace, and was built in a square shape. It had a seventeen metre thick earth-wall and was about 600 metres east-west, about 700 metres north-west. It sat next to an artificial river linked to the Sui Canal named Xie Cheng Qu, which had been built in order to directly transfer grain to the granary from canal barges.[237] Inside its walls, there were a large number of underground Jiao 窖 (cellars) positioned with an interval between them of three to five metres. Each cellar was a smooth cylinder shaped with a small bottom, and wider rim, with a depth of about six to twelve metres. When the ancient Chinese had first started storing food underground, the pits had been excavated in a different shape, with a bigger bottom and smaller rims, but the new form was stronger, and so used in Hanjia Granary.[238]

[237] Zou, p. 61.
[238] Luo Yang and He Nan Museum, 'The report of the Excavation of the Han Jia Granary built during the Sui and Tang period at Luo Yang', *Relics*, 3(1972), 49-62 (p. 53).

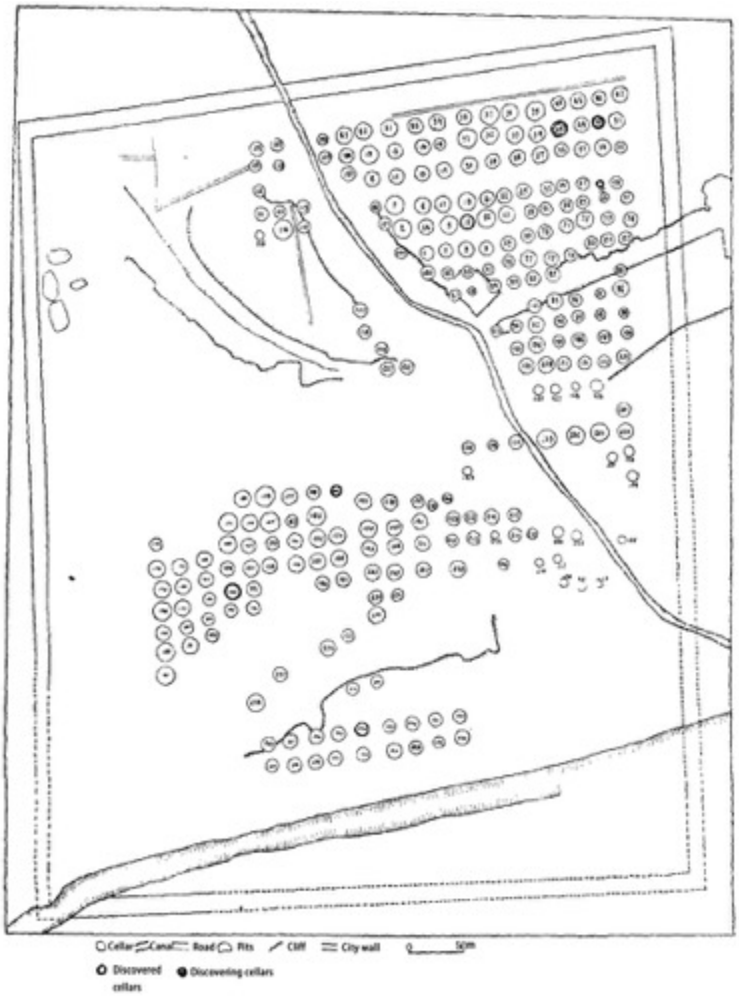

Figure 2. 16 The archeological plan of the Hanjia Granary drawn up during the investigation in 1972. The numerous pits for storing grain were still visible after a thousand years. Source: Luo Yang and He Nan Museum, 'The report of the Excavation of the Han Jia Granary built during the Sui and Tang period at Luo Yang', *Relics*, 3(1972), 49-62 (p. 50).

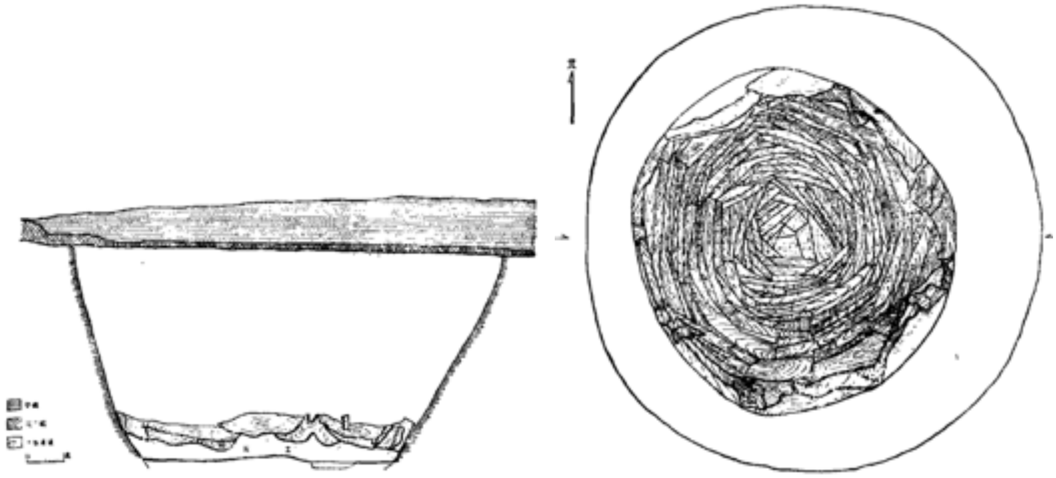

Figure 2. 17 The archaeological plan shows the plan (right) and section (left) of one of the cellars in the Hanjia granary. The diameter of the rim is 11.8 metres, 7 metres at the bottom. Its depth is 6 metres. It can be seen from the plan that the wooden planks at the bottom followed the circle line towards the centre. Source: Luo Yang and He Nan Museum, pp. 51-52.

Keeping the grain dry, a key requirement for grain storage, meant managing humidity. There were various ways to achieve this, like burning the bottom of the cellar with fire, or placing a material in it which was mixed with burned soil and ash. Wooden planks or hay would then be placed on the bottom of each cellar, reinforced with another layer of bran and straw mat, in order to separate the grain from the humid earth. To ensure it was absolutely dry inside the cellars, the inner walls would also be covered with wooden planks. In some circumstances, an extra layer of bran and mat would be placed on the bottom to avoid further humidity (Fig. 2.18).[239]

[239] Luo Yang and He Nan Museum, p. 52.

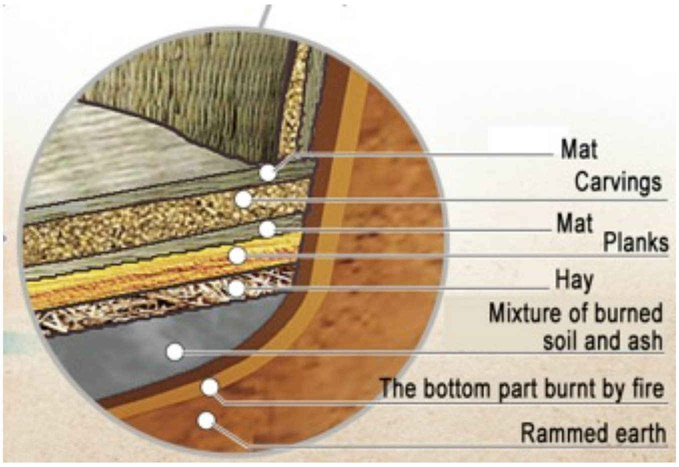

Figure 2. 18 The section plan shows the multiple layers of the bottom of each cellar of Hanjia Granary to prevent humidity. Source: Xinwei Li, 'Luo Yang Tu Shuo (Illustrations of Luoyang)', *Luoyang Evening Paper,* 10 September 2013 <http://lywb.lyd.com.cn/images/–2013-09/10/1378773266406lywb20130910A23.pdf> [accessed 30 June 2016]. Texts on the picture are translated by the author.

Finally, each cellar would be covered with a wooden lid, with a layer of hay on its surface, and a cone shaped roof made of wood and hay would be laid on top of that. To ensure it was both strong and airtight, soil would be placed on the surface of the roof.[240] It is hard to know what the roof part looked like, but the archeological evidence suggests that the top of each cellar was over ground, with a roof and door, so that people could enter and exit, as shown in the picture below.

[240] Luo Yang and He Nan Museum, p. 52.

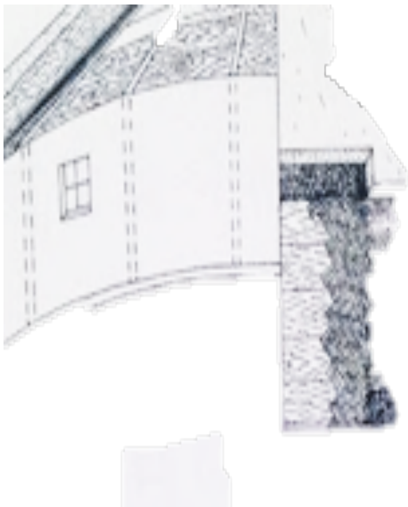

Figure 2. 19 A conjectural plan of the cellar. Source: Unknown, 'World Heritage Grand Canal: the Royal Han Jia and Hui Luo Granary', *Souhu Website* (2014) <http://roll.sohu.com/–20140722/n402577184.shtml> [accessed 30 June 2016] (Image 11).

The Tang dynasty had fostered the greatest flourishing in China yet, unrivalled by previous dynasties, but like its predecessors, it was characterised by an unstable political climate. Northern China had been continually attacked by rebels since the late eighth century, and Luo Yang was never able to recover from the civil wars. The central government decided to have the tribute grain shipped straight to Chang-an instead of it passing through Luo Yang. The Hanjia Granary and the earlier-built Hui Luo Granary were used less and lost their importance. Instead, the Heyin Granary built by Pei Yaoqing in 734 at the conjunction of Tong Ji Qu and the Yellow River became more important as it had a better connection with the southern regions, and was used to store over one million *dan* of grain from southern and eastern China.[241]

From the decline of Tang to the establishment of Song

In 755 the Tang general An Lushan claimed northern China and founded the rival Yan

[241] Zou, p. 65.

Dynasty;[242] this made the Tang government focus more on the control of tax grain from the southern region, as they would no longer receive tax from the north. Almost all the grain that was shipped to the capital on the canal was from the south, more specifically from the forty *zhou* (states) of southeastern China, putting great pressure on the people who lived there.[243] Han Yu (768-824), the Tang Scholar said that 'nine tenths of the tax revenue of Tang was paid by Jiang Nan (lower Yangzi Region)'.[244] Li Fangjing also wrote in his poem *Bian He Zhi Jin Chuan* (Travel on the Bian Canal) that this canal took all the flesh and blood from the people who lived in the forty-three states.[245]

Although the An's rebellion was defeated in seven years, the Tang government failed to recover from the decline of the central administration which had been caused by the rise in power of the regional military governors in the north. Even more pressure to meet tax requirements was exerted on the southern regions, but this did not stop the Tang court from coming to its end in 907.[246] Zhu Wen (852-912), the lieutenant of one of the rebel armies which appeared in the late Tang dynasty, took over the throne from the last Tang emperor and founded the Later Liang Dynasty (907-923), but he could not unify China and the country suffered from disunity for half a century.[247]

This period is known as *Wu Dai Shi Guo* (Five Dynasties and Ten Kingdoms, 907-960), during which the power of the *Jie Du shi* 节度使 (regional military governors) grew bigger and they announced independence from their central authority. This was a very unstable period in China's history, as every state wanted to ensure their control over the Sui Canal so

242 Yao Runeng, *An Lu Shan Shi Ji* (Story of An Lushan) (si ku quan shu ben, 1780), Wikisource Online Library, <https://zh.wikisource.org/wiki/安祿山事跡/卷下> [accessed 30 June 2016] (para. 1).

243 Chen Feng, 'Shi Lun Tang Song Shi Qi Cao Yun De Yan Ge Yu Bian Qian (The Evolution and Changes of the Tribute Grain Transport during the Tang and Song period)', *The Chinese Economic History Study*, 3(1999), 83-93 (p. 84).

244 The line is from the poem *Song Lu Qi Zhou Shi Xu 送陸歙州詩序*, the original Chinese texts are '当今赋出于天下，江南居十九'.

245 Li Jingfang, *Bian He Zhi Jin Chuan* (Travelling on boat on the Bian River), undated,oua Souyun Online Poem book, <http://sou-yun.com/PoemBookNav.aspx?b=&d=426> [accessed 30 June 2016] The original Chinese texts are 东南四十三州地，取尽脂青是此河

246 Ouyang Xiu, *Xin Tang Shu* (New History of the Tang) (wu ying dian ben, 1739), Chinese Text Project online ebook, <http://ctext.org/wiki.pl?if=gb&chapter=563401&remap=gb> [accessed 30 June 2016] (para. 23).

247 Ouyang Xiu, *Xin Wu Dai Shi* (New History of the Five Dynasties) (wu ying dian ben, 1739), Chinese Text Project online ebook, < http://ctext.org/wiki.pl?if=gb&chapter=292635&remap=gb> [accessed 30 June 2016] (para. 15).

that they had the best way to transport supplies. As a result, all five dynasties except for the Later Tang Dynasty (923-937), located their capitals in Kai Feng, which at the time was the most important junction point of the Canal, a transfer point from and to all the regions of China.[248] This fragmentary period led to an even greater cultural and economic difference between northern and southern China. The gap between north and south widened even though the five northern states controlled the transport of the canal. The continuing invasion by *Qi Dan* (an empire in East Asia which included Mongolia, the Russian Far East and northern Korea) and other natural disasters ensured that the north was left behind in terms of economic and scientific development compared to richer southern China, a situation which has never been reversed.[249]

This unstable period only lasted for a few decades until Zhao Kuangyin (927-976), later known as Emperor Taizu of Song, took the throne from the child emperor of the Later Zhou Dynasty and unified China again. The Song dynasty marked a special period for imperial China, when for the first time the emperor valued intellectual activity over military force, which greatly encouraged scientific development during this period.[250] This will be discussed later.

The capital of Song remained in Kai Feng, partly because of its convenient location on the Sui canal. Being close to this waterway was critical, as shown by what happened in the early twelfth century, when the Song government lost control of Kai Feng to northern China following an invasion by the Jin (the Wanyan clan based in northeast China). The capital was moved to Lin An (present Hang Zhou) in the south, also an important city on the bank of the Sui Canal, ensuring sufficient supplies for the emperor and his family.[251]

[248] Wang Yan and Du Wenyu, 'The Study on Water Carriage in Five Dynasties and Ten Kingdoms Period', *Journal of Chinese Historical Geography*. 23:3(2008), 125-133 (pp. 129-130).
[249] Fan Wenlan and Cai Meibiao, *Zhong Guo Tong Shi (General History of China)* (Beijing: Renmin Press, 2009). <http://gz.eywedu.com/zhongguotongshi/0018_ts011071.htm> [accessed 30 June 2016]
[250] Toqto'a and Alutu, Chinese Texts Project Online Ebook <http://ctext.org/wiki.pl?if=gb&chapter=838956&remap=gb> [accessed 30 June 2016] (para. 2).
[251] Twitchett and Fairbank, *Cambridge History of China, Vol. 3, Part 1*, p. 222.

By the time the Song Dynasty was founded, the Canal was not kept very well as none of the previous states had lasted for long, and good maintenance of the watercourse had not been a priority for rulers busy conquering other states. Even worse, the dikes of the Yellow River were often deliberately destroyed in order to flood the enemy states. This frequent flooding together with the heavy military conscription led to a decrease in the population of northern China, so grain and tax revenue for the Song Court had to rely, again, on the more productive lands of the eastern and southern regions.[252]

On a more positive note, because the Song capital moved to Kai Feng, it shortened the journey taken by the grain as Kai Feng is slightly closer to the southeast region compared to the old Tang capital of Chang-an, and also avoided the dangerous rapids in San Men.[253] Because of the different water conditions in different regions, the Song government decided to continue to apply the same grain shipment scheme that had been used by the Tang dynasty, allowing local boaters to carry grains to certain granaries at middle points rather than transporting it all the way to the capital.[254]

Despite the bad shape of the Sui canal when the Song dynasty was founded, this period was a golden time for scientific development; the development of advanced hydraulic knowledge accelerated the appearance of many more sophisticated designed locks. This affected the shipments of grain, which had to be carefully coordinated with the lock opening times. [255] Liu Yan, a Song official, suggested allowing boaters to sell a certain amount of salt on their way back home to make up for the expenditure of transporting the grain. This motivated the boaters and the volume of grain shipped to the capital increased to over 9 million *dan* annually. However, by the time of the reign of the eighth emperor, Hui Zong (1082-1135), the official Cai Jing suggested that the central government should take a monopoly over

252 Twitchett and Fairbank, *Cambridge History of China, Vol. 3, Part 1*, pp. 222-223.
253 Ibid., p. 222.
254 Chi Chaoting, *Key Economic Areas in Chinese History – As revealed in the development of public works for water-control* (New York: Kelley, 1970), pp. 116-127.
255 Chen, pp. 86-87.

earnings from selling salt, instead of the local departments. This resulted in further difficulties in canal transportation, as the diminished funding made it almost impossible to manage canal work and grain transport at its earlier level.[256]

So in the late Song dynasty, the official Zeng Xiaoguang suggested transporting grain directly to the capital instead of transferring it between different granaries on the way. As discussed above, this method had considerable disadvantages, as canal barges from all regions would have to frequently travel through the Huainan section of the canal leading to severe disruption of the management of the locks. Because of the need to open and close the gates so frequently, a large amount of water was lost, so many channels of the canal became really shallow and some almost dried out. Eventually the large scale food shipment declined after the capital city of Song moved to southern China.[257]

In summary, however, despite the poor management of the canal in the late Song dynasty, the Song government made important contributions to its development. It increased the number of canal-related departments, and produced a better cooperation system between the central and local governments. The Department of Southeast Transport was established to take charge of all the tax grain transport from the six main regions in southeastern China, which played an important role in stabilising the price of grain during floods or drought.[258]

Plants for the canal

There are slightly more records of the planting along the canal from the Tang and Song period. Apart from trees, specifically willow trees to provide shade and strengthen the embankment, there is also evidence to show that trees were planted to signal pathways. In 792, the Huzhou

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[256] Chen, p. 88.
[257] Ibid., pp. 88-89.
[258] Cheng Dachang, *Kao Gu Bian* (si ku quan shu ben, 1780), Vol. 7. Chinese Texts Project Online Ebook, <http://ctext.org/wiki.pl?if=gb&chapter=400259&remap=gb#p19> [accessed 30 June 2016]

Governor of Tang, Yu Di (? -818), ordered the rebuilding of the Wu Xing Tang Canal, and added an embankment with paths for people and carriages. To mark the road, two lines of trees were planted to signal the road boundaries.[259] There was a great deal of *Di* (荻, *Triarrhena sacchariflora [Maxim.] Nakai*) growing in this section of the canal, which is why this channel was called Di Tang Canal before it was reconstructed; this was due to native species which were growing there naturally.[260]

Some other written records of water plants in the southern section of the Canal can also be found in early imperial Chinese poetry. Qing Shaoyou, a scholar of the Song dynasty, wrote in his poem *Qiu Ri* (Autumn Sun): 'it is full of Gu (菰, *Sagittaria trifolia L. var. sinensis [Sims] Makino*) and *Pu* (蒲, *Typha latifolia*) growing in the water so I thought nothing further was in front of it, but suddenly I heard people laughing and talking'.[261] These plants were not specially planted, but just grew naturally in the vicinity of the canals.

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[259] Wang Pu, *Tang Hui Yao (Institutional History of the Tang Dynasty)* (si ku quan shu ben, 1780), Vol 80. Chinese Texts Project Online Ebook, <http://ctext.org/wiki.pl?if=gb&chapter=977376&remap=gb#p26> [accessed 30 June 2016]. Line 25 The original sentences were 則繕完隄防,疏鑿畎澮,列樹以表道

[260] Zhang Jianguang and Zou Guowei, 'Tang Wu Dai Huan Tai Hu Di Qu De Shui Li Jian She (The Water Conservancy of the Tai Lake region in the Tang Dynasty)', *Journal of Nanjing University*, 3(1999), 114-121 (p.115).

[261] Qin Shaoyou, *Qiu Ri (Autumn Sun)*, undated, Ancient Poem Online, <http://www.gushiwen.org/mingju_961.aspx> [accessed 30 June 2016]

Figure 2. 20 A drawing of 'gu 菰' from the early seventeenth century. Source: Wang Qi and Wang Siyi, *San Cai Tu Hui* (Illustrations of the Three Powers) (Shanghai: Shanghai Gu Ji Press, 1988), p. 2612.

One of the clearest documents to show the plants along the canal for this period is the painting 清明上河图 (Along the River During the Qingming Festival) from the early twelfth century. It not only presents a busy scene including the architecture, people and barges along the Kai Feng section of the Canal, but also shows about 124 trees planted along the canal, both inside the courtyard and in the fields. The trees in the painting are hard to recognize, so there have been countless arguments between historians about the type of trees planted.

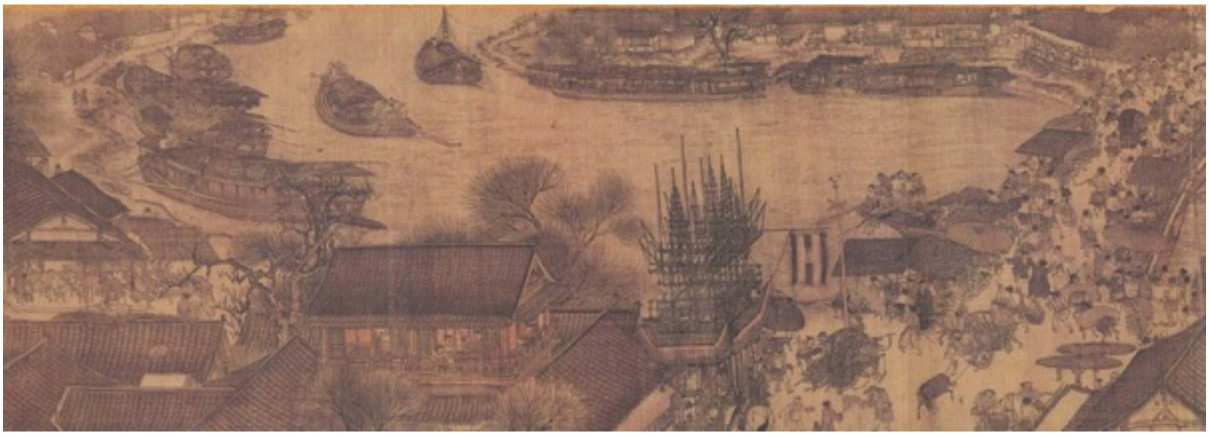

Figure 2. 21 Part of the painting *Along the River During the Qingming Festival* shows a busy scene along the Canal in Kai Feng, and the type of canal boats that were used during this period, as well as a boat being built on the bank. The earth embankment and trees can be also seen. There are arguments about the species of the trees in the painting as some are hard to recognize. Zhu and Xue believe that the two big trees in the middle might be Magnolia (left) and locust tree (right).[262] Source: Unknown, 'quan juan qing ming shang he tu (the full length Along the River During the Qingming Festival)', *China Lizhi Website* (2016) <http://www.zhlzw.com/lz/yis/793213.html> [accessed 30 June 2016]

Figure 2. 22 Another part of the painting clearly shows a group of willows trees along the river, which is the type of tree that has been recognized with the least controversy. Most of these trees are Chinese willows rather than the popular weeping willows (there is only one in the whole painting) which people usually expect near the canal. This might be because in a cold place like Kai Feng (central China) it is harder for weeping willows to survive, compared to the warmer southern region. The willow trees have clearly been cut to ensure better growth. There still remains uncertainty about the other types of trees in this painting. Zhu and Xue believe that from the characters of the branches of some trees, the painter has painted elm, magnolia and locust tree.[263] Source: Ibid.

[262] Zhu Liangliang and Xue Feng, ''Spring' in Life along the Bian River at the Qingming Festival', *Journal of National Museum of China*, 1(2015), 93-102 (p. 99).
[263] Ibid., pp. 99-100.

The big step in river engineering development

Chinese science and technology flourished during the Song Dynasty, including river engineering. By the eighth century, *Yan Dai* and *Dou Men* had been invented a long time, and the latter had come into common use. In 737, one of the Ordinances of the Department of Waterways suggested that all the water mill owners should build *Dou Men* to regulate the flow of water, but these had to be able to allow boats to pass through too. There were as many as 79 *Dou Men* in the Shan Yang section of the Sui Canal, but they all seem to have been in disrepair by the time the Song Dynasty was founded.[264] The *Dou Men* had a shortcoming: they often wasted water. In 984, Qiao Weiyue, the Assistant Commissioner of Transport for Huainan, invented the *Fu Zha* 复闸(pound lock) when he was looking for a solution to this problem on the northern section of the Grand Canal between the Yangzi and Huai Yin.

At first, he built five double slipways between An Pei and Huai Shi: 'each of them had ten lanes for the barges to go up and down'.[265] However the boats containing tribute grain were too heavy to pass over them, and *Dou Men* were not an ideal solution as using them would have resulted in the drying out of some sections of the canal. So Qiao tried to build two locks together at the third dam along the West River near Huai Yin: 'The distance between the two gates was rather more than 50 *bu* (about 75 metres), and the whole space was covered over with a great roof like a shed. The gates were *Xuan Men* 悬门 (hanging gates), and when they were closed the water accumulated like a tide until the required level was reached; when the time came it was allowed to flow out'.[266] He also built a horizontal bridge between the banks, and added dykes of earth with stone revetments. It is said that after he replaced all the double slipways, 'the previous corruption was completely eliminated, and the passage of the boats went on without the slightest impediment'.[267]

264 Toqto and Alutu, <https://zh.wikisource.org/wiki/宋史/卷 96> [accessed 30 June 2016] (para. 38).
265 Ibid., Wikisource Online Library, <https://zh.wikisource.org/wiki/宋史/卷 307> [accessed 30 June 2016] (para. 2).
266 Ibid.
267 Ibid.

This two-gate lock is believed to have been the first ever pound lock.[268] Because it was proved to work very well, a few decades later Tao Jian, the Transport Commissioner and Palace Intendant of Zhen Zhou (of Jiangsu Province), suggested that more of this type of lock should be built, both to prevent the loss of water and to save the labour of hauling the barges over. The Emperor Songren designated Fang Zhong Xun (the Director of the Ministry of Works) and Zhang Lun (the Fine Craftsmanship Bureau Commissioner) to be the Chief and Deputy Industrial Transport Commissioners respectively, to carry out the construction of this project. It began at Zhen Zhou, and soon all the double slipways at Bai Shen, Shao Bo, Long Zhou and Chu Yu were replaced by *fu zha*.[269]

Hu Su (995-1067), an official of Song, described the work in the Zhen Zhou section very poetically when he paid a visit in 1027: ‘For the outer gate they piled up good masonry for the foundations, and made a strong dyke to take the force of the water, setting horizontal baulks (across the entrance), with two pillars (the crane arms) rising (one on each side). The lock basin is deep as the home of a sleeping black dragon, and like a dragon the water rises in the pool, so that the ships come and go continually, borne on waves like the tide flowing and ebbing’.[270]

268 Needham, p. 351.
269 Ibid., p. 352.
270 Hu Su, *Wen Gong Ji* (Collection of Wengong), 1778, Chapter 35. Universallibarary Online Archive https://archive.org/details/06051102.cn [accessed 15th June 2016].

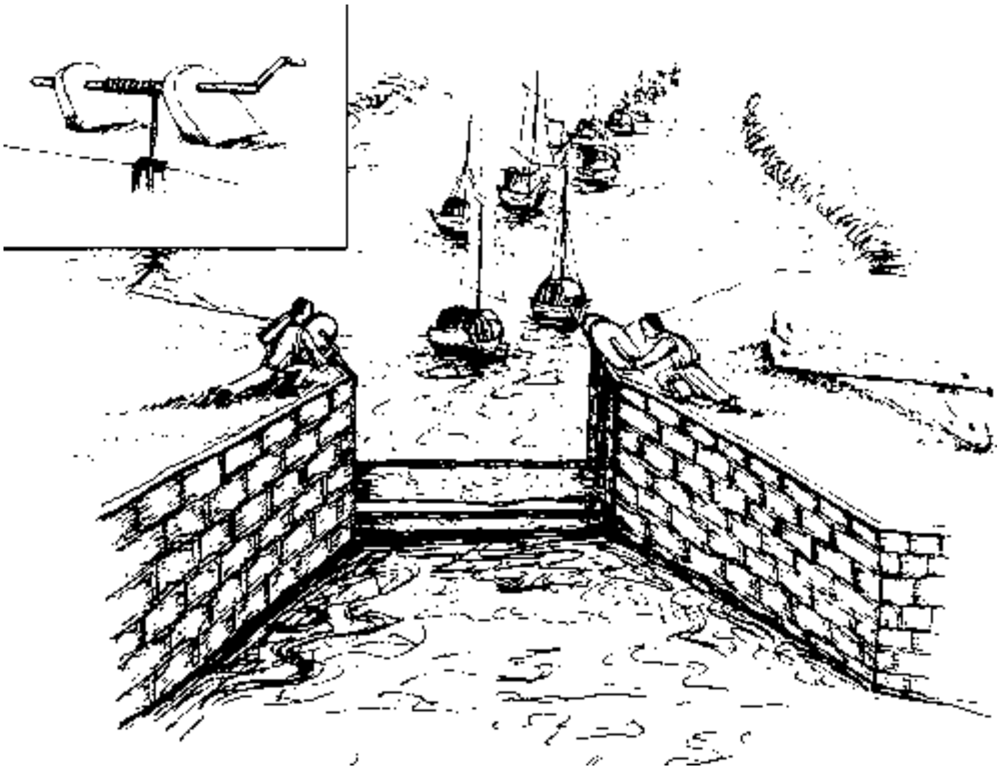

Figure 2. 23 This conjectural drawing by the author shows the type of lock that was widely used during the Ming and Qing (1644–1911) Dynasty. There is little pictorial information about how the pound lock looked when it was first invented in the Song dynasty, but based on written records it should look like this. The smaller picture (top left) of the two crane arms with a roller hoister shows how people lifted and lowered the beams (as the lock gate).

While opening the gate of *fu zha*, each wooden beam would be attached by two ropes that tied onto the roller hoist on either side; while rolling the roller hoists, the beams could be lifted one by one. The biggest advantage for the Song government of the invention of the pound lock was that it largely increased the amount of produce each boat could carry. In the past only ships with no more than 300 *dan* (21 tons) of rice could be hauled to pass over a double slipway, but after these locks were built, boats carrying 400 *dan* could easily pass, and later on this weight increased to 700 *dan*.[271] It also saved about 500 labourers 1,250,000 cash expenditure every year.

[271] Shen Kuo, *Meng Xi Bi Tan* (The Dream Pool Essays) (Beijing: Wenwu Press, 1975) Vol.1, p. 135.

Jojin the Japanese monk gave a detailed account of the operation of *Fu Zha* when he travelled northward on the Grand Canal in 1072:

[…] About the wei double hour (1 pm) the magistrate came, and we took tea at the Chang'an rest house. About the shen double hour (3 pm) two of the lock gates were opened (in succession), in order to let the boat through. When it had passed through, the stop-logs were dragged back so as to close (the middle gate), and then the stop logs of the third lock gate (were lifted out) to open it, and the boat was let through. The surface of the succeeding part of the canal was a little more than five feet lower (than the upper part). After (each) gate was opened, the (water from the) upper section fell and the water level became equal, whereupon the boat proceeded through.[272]

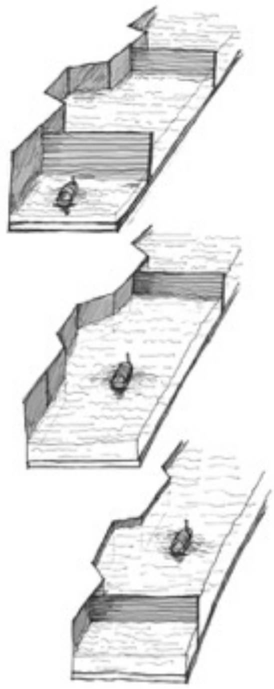

Figure 2. 24 A conjectural drawing by author to show how a *fu zha* operated when a boat was travelling upstream. When the boat entered the lock, the lower gate opened and the water level slowly equalized (top); the boat entered the space in between the lower and upper gates (middle); then the lower gate closed, the upper gate opened, the water level became equal again, and the boat exited the lock (bottom).

[272] Cheng Xun, *can tian tai wu tai shan ji* (Travelling to the Wutai Mountain), undated, Chapter 3. Chinese Texts Project Online Ebook, <http://ctext.org/wiki.pl?if=gb&chapter=509840&remap=gb> [accessed 30 June 2016]

Although the process of entering a lock was complex, it still did not entirely solve the water waste problem.[273] So the *Ao Zha* 澳闸 (a lock with chain-pimps mounted on pontoons) was put into use later to help save water. An *Ao Zha* was very similar to a Fu Zha, except that it had two extra pools for getting and returning water from or to the upper level at each passage. When ships were going to a lower level, the first gate would be opened to let ships stay in the space between the two gates. Water in this space would then be returned to the pool until the level was as low as downstream. Then the second gate was opened to let ships go through, and *vice versa*.[274] In this way, the water that was let out by the lock gate would not be lost but stored in the pool; when it was needed it would be returned to raise the water level. We do not know the exact date when the *Ao Zha* was first invented, but according to Hu Su's records, it was first built in Zhen Zhou between 1025 and 1026.[275]

In order to utilize these locks well, a carefully made system to manage the opening and closing time was very important. However, officials tended to put their own interests first and bribed watchmen to open the gate for their boats when it was not supposed to be the opening time. In addition, as mentioned earlier, food transportation strategy was changed to ship all the tribute grain direct to the capital in the early twelfth century, and it was ordered that barges carrying the tribute were allowed to pass through the locks as soon as they arrived. This badly interrupted the operation of the locks, as large amounts of water were lost if the gates opened too frequently. What was even worse, the workers also started to open the locks for private boats in exchange for money. As a result, the pound locks were poorly maintained during the twelfth and thirteenth centuries, so many had only the abutments left, or were degraded to the flash lock; sometimes the double slipways deteriorated considerably too.[276] Despite this, the *fu zha* became the basic form of locks on the Grand Canal until they fell into

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[273] Li Peihong and Wang Shaoliang, 'Some Important Technical Achievements regarding Canal Harnessing Engineering during the Northern Song Dynasty', *Wu Han Shui Li Dian Li Xue Yuan Xue Bao (Academic Journal of Institute of Water Conservancy and Electric Power of Wu Han)*, 4(1984), 101-103 (p. 102).

[274] Dong Wenhu, *History and Future of the Beijing-Hangzhou Grand Canal* (Beijing: China Social Science Academic Press, 2008), pp. 100-101.

[275] Hu, Universallibarary Online Archive https://archive.org/details/06051102.cn [accessed 15th June 2016]

[276] Li and Wang, pp. 102-103.

decline in the early twentieth century, and although the techniques for building them improved in later dynasties, their basic structure did not change.

Conclusion

This chapter reviewed the history of the Grand Canal, from when its first section was traditionally thought to be built in the fifth century BC, to the time of the Song Dynasty when the river engineering achieved rapid development.

Since the study of the history of the Grand Canal became popular from the 1990s, it seems to be a commonplace belief in these studies that the history of the canal started when the waterway *Han Gou* was built in 485 BC. However, after having reviewed a large number of historical documents, the author believes the canal's true origin is in the year 605, as this is when the Sui Canal building project commenced. This is because *Han Gou* was built for transporting war supplies during a particular period of time (770-476 BC), marked by endless internal conflicts between independent states. However, the main purpose for the Grand Canal to be built was to ship grain, which shows the irrelevance of the building of *Han Gou* in light of the overall historical purpose of the Grand Canal.

Therefore, if it is more accurate to say that the history of the Grand Canal should start from the seventh century, instead of fifth century BC, this suggests that the claim made by the state party in the statement of Outstanding Universal Values, that the Grand Canal is the 'oldest canal in the world', is rather exaggerated. It might be true that the Grand Canal is the oldest existent canal, as there were other ancient canals built before the Grand Canal, such as the Canal of the Pharaohs in what is now modern Egypt, although its physical remains are scarce.[277]

[277] Carol A. Redmount, 'The Wadi Tumilat and the Canal of the Pharaohs', *Journal of Near Eastern Studies*, 54 (1995), 127-135 (pp. 127-129).

Chapter Three. A new capital and the construction of the Shandong section (in the thirteenth century)

This chapter focuses on one of the most significant periods of the Grand Canal's history: how the route of the Sui Canal was straightened to go pass the Shandong province, instead of central China, under the order of the Yuan emperor Kublai (reign 1260-1294). This includes details of the building of two new waterways- Hui Tong River and Tong Hui River, identification of the engineering challenges, such as the scarce water sources, and the management of the embankment and watercourses due to the frequent flooding from the Yellow River. The development of sea transport during the Yuan Dynasty is also explored, as this was actually the main grain shipment route during this period, as the Grand Canal suffered from insufficient water.

In terms of historic sources, the standard history-*Yuan Shi* (History of Yuan) (1784) [278], was used as the main source to study the social and political context of the remodelling of the Grand Canal route. It also identified the design of the canal locks, especially a particular type of lock Ai Zha (Narrow boat lock) invented during this period. Another historical book-*Tong Hui He* Zhi (Biography of the Tong Hui River) (1527) [279], was used to access the details of the making of one of the new waterways-Tong Hui River.

Furthermore, factors enabling the repair of the embankment and watercourse for flood control purposes are explored: namely the methods of making *sao* (fascine bundle)- a widely used structure for repairing and reinforcing embankments, and its function. A range of historical data and sources were reviewed to achieve the above, such as the *he fang tong yi*

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278 Song Lian, *Yuan Shi (History of Yuan)* (wu ying dian ben er shi si shi, 1784), Chapter 16, He Qu (Rivers and Canals). Chinese Texts Project Online Ebook, <http://ctext.org/wiki.pl?if=gb&chapter=548553&searchu=%E4%BC%9A%E9%80%9A> Chapter 42, Shi Huo (Food and Goods). Chinese Texts Project Online Ebook, <http://ctext.org/wiki.pl?if=gb&chapter=625167#p4> [accessed 30 June 2016]

279 Wu Zhong, *Tong Hui He Zhi (Biograohy of the Tong Hui River)* (Jia Jing Liu Nian Ben 1527).

(A General Discussion of the Protection Works along the Yellow River) (1321),[280] and the *zhi zheng he fang ji (Memoir on the Repair of the Yellow River Dykes in the Zhizheng Reign-period)* (2004).[281] Two illustration of *sao* (Figures 3.16 and 3.17), from the books *Science and Civilization of China* (1971),[282] and Zheng's *he gong xue (Studies of River Engineering)* (1935)[283] respectively, provided a clearer picture of its construction.

For the barges that used to carry grains on the Grand Canal during this period, the famous Marco Polo (1254-1324) traveller's account; *The Description of the World* (1938) [284] provided a detailed record of the barges physical attributes, which supplemented the small number of Chinese documents about the appearance of canal boats in that period. It also provided written evidence of the appearance of planting along the canal, which helps further understanding of the specific tree planting policies sought in the *Statutes of the Yuan Dynasty* (2011).[285]

The final section of this chapter focuses on the introduction of the advanced sea transport during the Yuan Dynasty, the historic books *ying zao fa shi* (Treatise on Architectural Methods) (1775)[286] and *song hui yao kao* (drafts for the history of the administrative statues of the Song Dynasty) (1957)[287]. These were valuable sources revealing the traditional tools-*wang tong* (sighting tube) and *wang dou* (dipper observer), which were used for orientation by sailors while at sea. Supported further by books such as *wu bei zhi* (Treatise on Armament Technology) (1672)[288] and *jie an lao ren man* bi (An Abundance of Jottings by Old Mr. Jiean) (1606),[289] which provided detailed information of another traditional guiding method- *qian xing shu* (guiding stars method). Also, the illustration of one of the four main navigation guides (Figure 3.21) was provided from, the aforementioned, *Science*

280 Zhansi, 'Juan Sao (Fascine)' in *He Fang Tong Yi* (A General Discussion of the Protection Works along the Yellow River) (Zhi Zhi Yuan Nian Ben, 1321).
281 Ouyang Xuan, Zhi Zheng He Fang Ji (Memoir on the Repair of the Yellow River Dykes in the Zhizheng Region-period)', in *Quan Yuan Wen* (Collected Works of the Yuan Dynasty), ed. by Li Xiusheng (Nanjing: Fenghuang Press, 2004).
282 Joseph Needham. *Science and Civilisation in China, Volume 4, Part 3* (Cambridge: Cambridge University Press, 1971), p. 319, Fig. 906.
283 Zheng Zhaojing, *He Gong Xue* (Studies of River Engineering) (Shanghai: Shang Wu Yin Shu Guan, 1935).
284 Marco Polo, A.C. Moule and Paul Pelliot (ed.). *The Description of the World* (London: London G. Routledge, 1938).
285 Gao Chenhua (ed.), *Yuan Dian Zhang* (Statutes of the Yuan dynasty) (Beijing: Zhong Hua Shu Ju, 2011).
286 Li Jie, *Ying Zao Fa Shi (Treatise on Architectural Methods)* (Si Ku Quan Shu Ben, 1775).
287 Xu Song, *Song Hui Yao Kao* (Drafts for the History of the Administrative Statutes of the Song Dynasty) (Beijing: Zhong Hua Shu Ju Ying Yin Ben, 1957).
288 Mao Yuanyi (1594-1640), *Wu Bei Zhi (Treatise on Armament Technology)* (Gu Ke Ben 1672).
289 Li Yu, *Jie An Lao Ren Man Bi* (An Abundance of Jottings by Old Mr. Jiean), finished in 1606.

and Civilization of China although the image is originally from the ancient *wu bei zhi*.

In relation to modern sources, the *Cambridge History of China*[290] was consulted to gain a different perspective of the social-political context of constructing the new canal routes. Dang's article (2013)[291] provided supplementary information of planting policies during Kublai's reign (1260-1294). While several modern pieces, such as Lane's (2014)[292] and Chen's article (1984),[293] were reviewed to study the chief engineer of the Yuan time-Guo Shoujing, and his methods. Zou's book *Chun Lu Shi Di Lun Gao* (2005)[294] was also analysed to help understand the topographical difficulty of the making of the Tong Hui River, together with the section map (Figure 3.4) from the *Science and Civilization in China* to provide a direct indication of why there was a failure in finding enough water sources for this section.

Finally, Yao's book *Jing Hang Yun He Shi (the history of the Beijing-Hangzhou Grand Canal)* (1998)[295] provided supplementary information on the dimensions of the locks. This was used as a basis for the author's reconstruction of the lock (Figure 3.13) to further understanding of the structure of different parts of a typical canal lock. Furthermore, the archaeological report, *The Excavation of a Shipwreck of the Yuan Dynasty in Heze City* (2016),[296] helped to provide a specific sample of a Yuan boat, identifying its construction process, as well the goods it carried once in use.

The social and political context: a new capital

The rise of the Mongol and the establishment of the Yuan dynasty (1271–1368)

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290 Denis C. Twitchett (ed.) Herbert Franke, *The Cambridge History of China, Volume 6: Alien Regimes and Border States, 907–1368.* (Cambridge: Cambridge University Press, 1994).

291 Dang Baohai, *Hu Bi Lie De Zhi Shu Fa Ling (The Tree-planting Policy of Kubilai).* Institute of Chinese History Research at the Peking University Online E-paper, 2013 http://chuansong.me/n/2648652 [accessed 4 July 2016]

292 George Lane, 'Guo Shoujing', *Berkshire Dictionary of Chinese Biography*, 2(2014), 808-815.

293 Chen Duanping, 'Guo Shou Jing De Shui Li Si Xiang (The Water Conservancy Theories of Guo Shoujing)', *Studies in the History of Natural Sciences,* 3(1984), 340-342.

294 Zou Yilin, *Chun Lu Shi Di Lun Gao* (Tianjin: Tianjin Guji Press, 2005)

295 Yao Hanyuan, *Jing Hang Yun He Shi* (The History of the Beijing-Hangzhou Grand Canal) Beijing: Shui Li Shui Dian Chu Ban She, 1998.

296 Shandong Provincial Institute of Cultural Relics and Archaeology Commission for Preservation of Ancient Monuments, Heze City, 'The Excavation of a Shipwreck of the Yuan Dynasty in Heze City, Shandong Province', *Relics,* 2(2016), 40-49.

More than half a century after the Song dynasty (960-1279) was established, China was facing disunion once more when the Song court had to retreat south to the Yangzi region, after it was defeated by the Jin Dynasty (1115-1234), and lost its control of northern China. In the meantime, the Mongols had risen rapidly and become one of the strongest powers in the north. The name 'Mongols' was first mentioned in the Tang dynastic histories as 蒙兀 Meng Wu, considered a branch of the larger ethnic group-室韦 Shi Wei.[297]

The Meng Wu, later also known as Khamag Mongol, began to slowly migrate westward toward the Argun River, and eventually settled down in eastern Mongolia in the eleventh century. The Khamag Mongol soon became a significant tribal power in the Mongolian steppe, alongside the other four tribes, Keraites, Naiman, Mergid, and Tatar, all of which were subjects of the Liao Dynasty (907-1125). Each tribe had its members from the same family, and would have one leader to rule over their business such as migration routes, distributed pasturelands and organized hunts. One distinctive feature of their way of life was that they were nomadic: each single extended family would live in their own tents and with their own herds. When in need of protection or cooperative labour, the tents could be easily moved to form a temporary protective circle.[298]

In 1125, the Liao dynasty was defeated and lost its control over the Mongolian area after the Jin conducted a series of military campaigns in almost all the lands of northern China. The entire Mongolian area was then ruled by the Jin dynasty. This situation did not last once Genghis Khan (1162 –1227), later also known as the Great Khan of the Mongol Empire, ascended to power and was elected to be the khan (a title for 'ruler' widely used by medieval nomadic Mongolic tribes) of the Mongols.[299] Though the tribes in the Mongolian steppe continued to be politically disunited, Genghis Khan spent the next twenty years subduing the various other challenges to his powers, and for the first time the Mongols became a unified confederation, with the word 'Mongol' no longer only referring to the steppe, but to the whole

[297] Liu Xu, *Jiu Tang Shu (Old Book of Tang)*, (wu ying dian ben er shi si shi, 1784), Chapter 212. Chinese Texts Project Online Library, <http://ctext.org/wiki.pl?if=gb&chapter=215201&remap=gb#p47> [accessed 04 July 2016] (Line 46).
[298] Denis C. Twitchett and Herbert Franke, *The Cambridge History of China, Volume 6: Alien Regimes and Border States, 907–1368* (Cambridge: Cambridge University Press, 1994), p. 325.
[299] Twitchett and Franke, *The Cambridge History of China, Volume 6*, p. 336.

Mongol Empire (1206–1368).[300] Genghis Khan then conducted two more campaigns, against the domains of the Western Xia dynasty who shared its western borders, and against the territories of the Jin Dynasty who had ruled the Mongols for almost a century. By 1215, he had been successful in managing to occupy the capital of the Jin Dynasty, Zhong Du (present Beijing).[301]

Figure 3. 1 A portrait of Genghis Khan who founded the Mongol Empire. Source: Dschingis Khan und seine Erben (exhibition catalogue), *München* (2005), p. 304.

However, Genghis Khan unexpectedly died in 1227, and his son Ögedei (c. 1186 – 11 December 1241) was appointed to be his successor and the second khan of the Mongol Empire.[302] Ögedei took over his father's unfinished task and conducted several campaigns in the Middle East, Georgia, Armenia, Korea and Europe. He also defeated the Jin Dynasty in 1234, after decades of wars that had started during his father's reign. By then the Mongols had total control of the north of China.[303] After Ögedei died, Mongke was elected to be the

300 Twitchett and Franke, *The Cambridge History of China, Volume 6*, pp. 342-343.
301 Song, Chinese Texts Project Online Ebook, http://ctext.org/wiki.pl?if=en&chapter=830490&remap=gb [accessed 1 July 2016].
302 Song, http://ctext.org/wiki.pl?if=en&chapter=830490&remap=gb [accessed 1 July 2016] (Line 51).
303 Twitchett and Franke, *The Cambridge History of China, Volume 6*, p. 362.

new Khan with his mother's help.[304] He was the brother of Kubilai, who later established the Yuan dynasty in 1271.

Because his brother had became the new ruler of the Mongol empire, Khubilai began to be noticed more, and he joined the inner circle of decision makers at court. He was trusted by his brother who often assigned important military tasks to him, including an attack on the Southern Song dynasty based in southern China.[305] From the influence of his mother's control of his upbringing, Khubilai understood that the Mongols had to have sufficient knowledge of Chinese culture and literature if they wanted to rule China. She recruited not only Mongolian teachers but also Chinese advisers to teach Khubilai Chinese ways. She also persuaded Ogodei Khan to grant jurisdiction over Xingzhou (a region in Hei Bei) to Khubilai in 1236; at the time it had a population of ten thousand households. Khubilai himself gathered a number of advisors to work for him, most of whom were Chinese Confucians, who helped him to improve agricultural production and religious toleration in his lands.[306]

In 1259, Mongke Khan died in the middle of the Mongol invasion of southern China. The succession was not clear, resulting in civil wars inside the Tolui clan, mainly between the third prince Khubilai and the fourth prince Arigh Boke. Khubilai was fascinated by the civilizations which had developed in the Chinese lands, while Arigh Boke attached greater importance to traditional Mongolian ways and values, two different world views which were echoed within the Mongolian elite.[307]

Khubilai was supported in his quest to be the new ruler of the Mongol Empire by most of the powers in northern China and Manchuria, although few members of the imperial family were on his side. In 1260, he managed to make the Kurultai (Mongol great council) proclaim him as the new Khan, and this resulted in the three tribes in northwest Mongolia, Ogedei, Khanate, Golden Horde, declaring their independence and pursuing their own separate interests and objects: Khubilai only remained in control of part of Mongol.[308]

[304] Twitchett and Franke, *The Cambridge History of China, Volume 6*, p. 414.
[305] Ibid., p. 417.
[306] Ibid., p. 415.
[307] Ibid., pp. 421-422.
[308] Ibid., p. 413.

Khubilai failed to gain approval of his authority from the other Mongol khans, so he needed more support from China, where he had always shown his respect for Confucian rituals and practices. On the advice of his Chinese adviser, Liu Pingzhong, Khubilai moved his capital from Khara Khorum to Da Du (present Beijing) in 1266, and ordered the reconstruction of the city according to a Chinese conception and style.[309] The selection of the location for the capital was unconventional, as most of the earlier Chinese capitals had been situated near the Yellow River or one of its branches: Da Du was located near the Chinese northern border. It is believed that Khublai had two reasons for this decision. Da Du had been the capital of the Liao and the later Jin Dynasty whose territory reached Mongolia, Russian Far East and North Korea, giving Khbilai access to domains beyond China; and the proximity of the new capital to Mongolia, could help him to maintain control over his homeland.[310]

[309] Twitchett and Franke, *The Cambridge History of China, Volume 6*, p. 413.
[310] Ibid., pp. 454-455.

Figure 3. 2 A drawing from fourteenth century shows the battle scene of Mongol warriors. Source: German image bank AKG-Images. <http://www.akg-images.co.uk/–C.aspx?VP3=SearchResult&VBID=2UMESQ4WPFNQU&SMLS=1&RW=1408&RH=712&POPUPPN=23&POPUPIID=2UMDHUTPKGMR> [accessed 1 July 2016]. The picture is originally from *Compendium of Chronicles* by Rashid al-Din.

Having established a regime in northern China however was not enough for Khubilai, for his Mongolian roots led him to believe that territorial expansion was an essential part of being a successful ruler. At the time southern China was still ruled by the Southern Song dynasty, whose emperor was still hoping for a chance to reunify China. Since Khubilai wished to focus on the expansion of his lands to go hand-in-hand with governance of China, the wealth and volume of food production in south China could not escape him. So a campaign against the Southern Song Dynasty was initated in 1268.[311]

It took nine years, until 1279, before the Mongol armies eventually defeated the Song armies,

[311] Twitchett and Franke, *Cambridge History of China, Vol. 6,* pp. 429 and 431.

because the Mongolian soldiers could not accustom themselves to the heat and humidity in south China. Naval warfare, which the Song navy dominated with their great ships and fragmentation bombs, was also a factor.[312] It was only then that Khubilai had control over all of China, a unification not achieved for over five hundred years.

In 1271, after Khubilai was declared the ruler of northern China and had located the capital in Da Du, he considered giving a new name to his dynasty that could symbolize China; he did not want to be seen as a non-Chinese conqueror but rather as an open-minded ruler who could successfully blend both Chinese and Mongolian cultures. On his Chinese advisor's suggestion, Khubilai selected the name '元 *Yuan*' from the book *Yi Jing* (Book of Changes). The word represents the 'origins of the universe' and 'the primal force'. The Yuan dynasty was established, and Khubilai became the Emperor Shizu of Yuan.[313]

The Remodeling of the Sui Canal bypassing Shangdong province

The making of the 会通河 Hui Tong River and the chief engineer Guo Shoujing

Having moved the capital to Da Du (present Beijing), Khubilai had to face the fact that the region did not grow grain. To solve this problem, the food needed to be regularly shipped to the capital from the fertile southern lands. At first, the food shipment relied on two pirates, Chu Qing and Chang Xuan, who had cooperated with the General Bai Yuan for shipping supplies during the war against the Southern Song dynasty, transporting the grain by sea along the eastern coast of China to Da Du in the north. It worked very well at first, making these two men the wealthiest and most influential people in southeastern China.[314] But from the mid-1280s, these food shipments failed as the result of numerous natural disasters such as typhoons, which damaged the ships many times,[315] so an alternative route for transporting the grain had to be sought quickly.

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[312] Twitchett and Franke, *Cambridge History of China, Vol. 6,* p. 430.
[313] Song, http://ctext.org/wiki.pl?if=en&chapter=283077&remap=gb#p16 [accessed 1 July 2016] (Line 15).
[314] Luo Junpang, 'The Controversy over Grain Conveyance during the Reign of Khubilai Khan, 1260-94', *Far Eastern Quarterly*, 13 (1952), 262-266 (pp. 262-265).
[315] Song, http://ctext.org/wiki.pl?if=en&chapter=625167&remap=gb [accessed 1 July 2016] (Line 61).

Acknowledging that water transportation was the easiest way to ship heavy baulk goods, Khubilai thought of the Sui canal, which had served as the main artery for grain transport in the past. However, this canal was built to cater for central China, and since the capital had moved to Beijing, there was no point in the Yuan government having the grain shipped through the central region. So in 1289, Kubilai ordered the construction of a short cut on the current canal route between Da Du and the southern region, on the suggestion of the magistrate of Shou Zhang, Han Zhonghui, and an astronomer, Shi Bianyuan.[316]

A similar idea had already arisen in 1275, when a preliminary survey had been carried out by Guo Shoujing (1231-1316), the astronomer, engineer and mathematician of the Yuan dynasty. Guo was born into a poor family. His grandfather Guo Rong, who had raised him, had thorough knowledge of the Chinese *Wu Jing* 五经 (Five Classics),[317] hydraulic engineering and mathematics, thought his grandson was very gifted and sent him to be a student of Liu Bingzhong,[318] an influential official of Kubilai who designed both the Yuan capital and its summer capital Shang Du.[319] Guo Shoujing was accepted as a pupil, studying mathematics with Liu and his other friends in the Zi Jin Mountainfrom which his understanding in hydraulics and astronomy grew[320].

When Guo Shoujing was 20, he started to work as a hydraulics engineer for the Yuan government. After decades of wars between Southern Song, Jin and Mongols, Kubilai realized the imminent need to restore the water conservation facilities that had been badly damaged during the wars, in order to recover the economy.[321] Guo Shoujing was strongly

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316 Song, http://ctext.org/wiki.pl?if=en&chapter=625167&remap=gb [accessed 1 July 2016] (Line 61).
317 五经 (The Five Classics) are five Chinese books which form part of the traditional Confucianism. The texts were first seen as a set collection during the Western Han Dynasty (206 BC – 9 AD) when Confucianism became the official ideology.
318 Ke Shaowen, *Xin Yuan Shi (The New History of Yuan)* (undated), Lie Zhuan (Biographies) 68, Guo Shoujing, pp. 676-677.
319 Nancy Shatzman Steinhardt, *Chinese Imperial City Planning* (Honolulu: University of Hawaii Press, 1999), p.153.
320 Lane, pp. 808-809.
321 Chen, p. 341.

recommended by Zhang Wenqian, his friend and fellow official. Zhang said Guo had rich knowledge in hydraulic engineering and that his ideas were always better than others. When Kubilai called Guo, he had already prepared six new water conservancy projects to present, including attempts to build a waterway connecting Da Du to the south.[322]

Figure 3. 3 The profile of Guo Shoujing, who was the chief engineer for the remodeling of the canal route during the Yuan Dynasty. Source: The 1962 stamp collection of Chinese ancient scientists <http://www.ikexue.org/archives/32132> [accessed 18 May 2016]

Kubilai was very pleased with Guo's new ideas and said 'people like this would never have meals for nothing'. In 1275, Guo was promoted to be 都水监 *Du Shui Jian* (the Director of the Department of Waterways),[323] and was designated to conduct investigations of the possibility of building shortcuts between Da Du and the south. From the result of the surveys conducted, he believed that just one new waterway in the western Shandong area would be enough, as the sections in both the north and south were already connected and could be utilized. But because sea transport was still working, this proposal had been left in limbo.[324]

When the new waterway project was officially approved in 1289, the Department of Waterways had merged with the Ministry of Works instead of being an independent

[322] Ke, p. 677.
[323] Song, http://ctext.org/wiki.pl?if=gb&chapter=46115#p28 [accessed 1 July 2016]
[324] Cai Fan, 'Guo Shou Jing', *China Water Resources,* 1(1984), 29-31 (p. 30).

department, and Guo Shoujing had been assigned another important job, the production of a new calendric system for the Yuan dynasty.[325] Shi Bianyuan and Ma Qinzhen were designated to make a final survey for the construction of the new waterway and presented Kubilai the plans and charts; Han Zhonghui was assigned to take charge of the construction on the site.[326]

The site of this new waterway, the western Shandong region, is part of the Northwestern Shandong Plain built up by the Yellow River's deposits, with its terrain higher in the southwest and lower in the northeast. All the natural rivers in this region flow from the southwest to the northeast, including the two main rivers: the Wen and the Si River, which were to be used as the main water sources for the new waterway. The area between the two rivers to the north of Jining city was built up with abandoned dykes and sand, resulting in a summit point (39 metres above sea level) where the new canal would cross.[327] (Figure 3.4) It was realised that the biggest challenge was for the Grand Canal to have a sufficient water supply at this point. This remained a difficulty in later times.

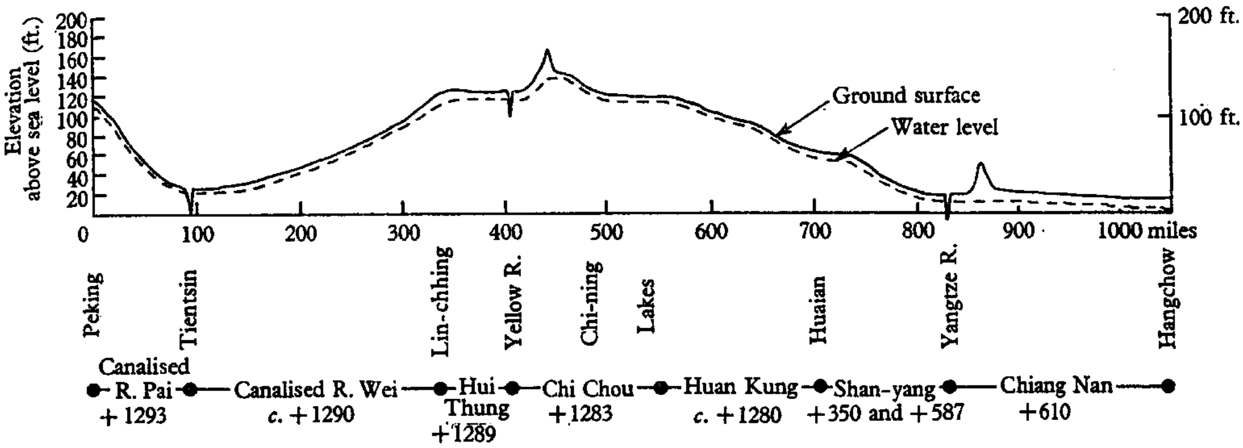

Figure 3. 4 This shows the basic typography of this section of the Grand Canal after its remodelling during the Yuan Dynasty; the hilliest part in the middle is where the new section, the Tong Hui River, was to cross. The summit point was 39 metres above sea level (170 feet on the picture, which is slightly higher than 40 metres), requiring the installation of various artificial devices such as locks. Source: Needham, p. 319, Fig. 906.

325 Cai, p. 30.
326 Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016]
327 Zou Yilin, *Chun Lu Shi Di Lun Gao* (Tianjin: Tianjin Guji Press, 2005), pp. 151-153.

The construction of this 250-li-long section, 会通河 Hui Tong River, was completed in 1291 having taken six months to build, at great cost and with three million labourers.[328] It made use of an existing waterway, 济州河 Ji Zhou River, which had been built six years previously to assist with sea transport of the tribute grain. This existing waterway, linking Ji River in the north and Si River in the south, was the work of the Mongolian military engineer, Ao Luqi, with the assistance of Guo Shoujing. The river was not artificial, but had been canalized as Ji Qing Du, built in the mid-fourth century and Huan gong Gou built slightly later. With its completion, grain could be carried by canal boats as far as the Ji River, then transferred to sea ships to travel to Tian Jin, enabling greater security for the transport than when it was totally reliant on transport by sea. However, Ji Zhou River was only in use for three years until the estuary silted up because of the inadequate water supply.[329]

By joining with the Ji Zhou River in Dong Ping, the Hui Tong River was diverted all the way north to Liao Cheng city,[330] which created a north-south inland waterway for Shandong province for the first time. However, this newly built river soon encountered problems with water sources. As mentioned earlier, the main water sources of the Hui Tong River were the Wen and Si Rivers, which both flow from southwest to northeast. They vary considerably in the amount of water they carry, depending on the time of year, due to uneven rainfall in this region. This caused difficulty because food shipments usually began in the spring, when there was little water in the rivers. During the summer months of June to September, the high rainfall could result in floods. In addition, the Wen and Si Rivers contained large amounts of soil and coarse sand, which made their branches silt up easily.[331]

To provide enough water for the Hui Tong River, more intervention had to take place. As

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328 Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016].

329 Wang Yun, *Shan Dong Yun He Wen Hua Yan Jiu* (The Study of the Culture along the Shandong section of the Grand Canal) Jinan: Qilu Shushe, 2006, p. 14.

330 Zheng Zhaojing, *Zhong Guo Shui Li Shi* (History of River Conservancy, Transport Canals and Irrigation Engineering in China) Shanghai: Shanghai Shu Dian, 1939, p. 214.

331 Zou, p. 156.

early as 1257, while the Mongols were still at war with the Southern Song dynasty, the official Fu Guobi built a *Dou Men* in the southern course of the Wen River, to divert its water to the Guang River in the south and eventually to the Si River. This was done to raise the water level of the Si River to benefit the troops nearby, and irrigate the fields of nearby cities such as Ji Ning and Yan Zhou. Fu also built a temporary earth dam in the Gang Cheng section, naming it Gang Cheng Dam. However, because it was made of earth which was very vulnerable to floods, it was frequently destroyed, which in turn slowly raised the riverbed and the silted up the river. The locals had to frequently rebuild the dam, which was a burdensome task.[332]

When the Hui Tong River was built in 1291, it relied on sufficient water from the Wen River. Ma Zhizhen, the head of the Department of Waterways, ordered the construction of a lock with a *Xuan Men* (hanging gate) east of the Gang Cheng Dam. The lock was made of stone, and was operated together with the previous lock built by Fu in 1257. As mentioned earlier, the amount of water in the Wen River would fluctuate according to the rainfall. To guarantee that enough water would be diverted to the canal, a temporary dam with wood and sand was built to stop the water flowing along the original watercourse, so that all the water could flow to the Guang River and eventually to the Grand Canal.[333]

The Yuan court also ordered an upgrade to a permanent stone dam for the earth dam on the Yan Zhou section of the Si River, and named it the Jin Kou Dam. A lock with the same name was also built on the Guang River to enhance water control. During the summer months when there was a threat of flood, the lock would be closed, allowing water from the Si River flow along its old course to the south of Ji Ning city, and eventually into the Grand Canal. This would ensure the floods were directed through a longer route, avoiding damage to the canal. During the dry season, the dam would be closed but the lock opened, and the water from the

[332] Zhang Boxing, *Ju Ji Yi De 居济一得* (Tong Zhi Ji Yi Tang Ben, 1868). Chapter 6, p. 3.
[333] Zhang, p 4.

Si River would go straight to the Guang River and the Grand Canal.[334] Because of the complex topography where the Hui Tong River crossed, a total of thirty-one locks were built to preserve the water level.

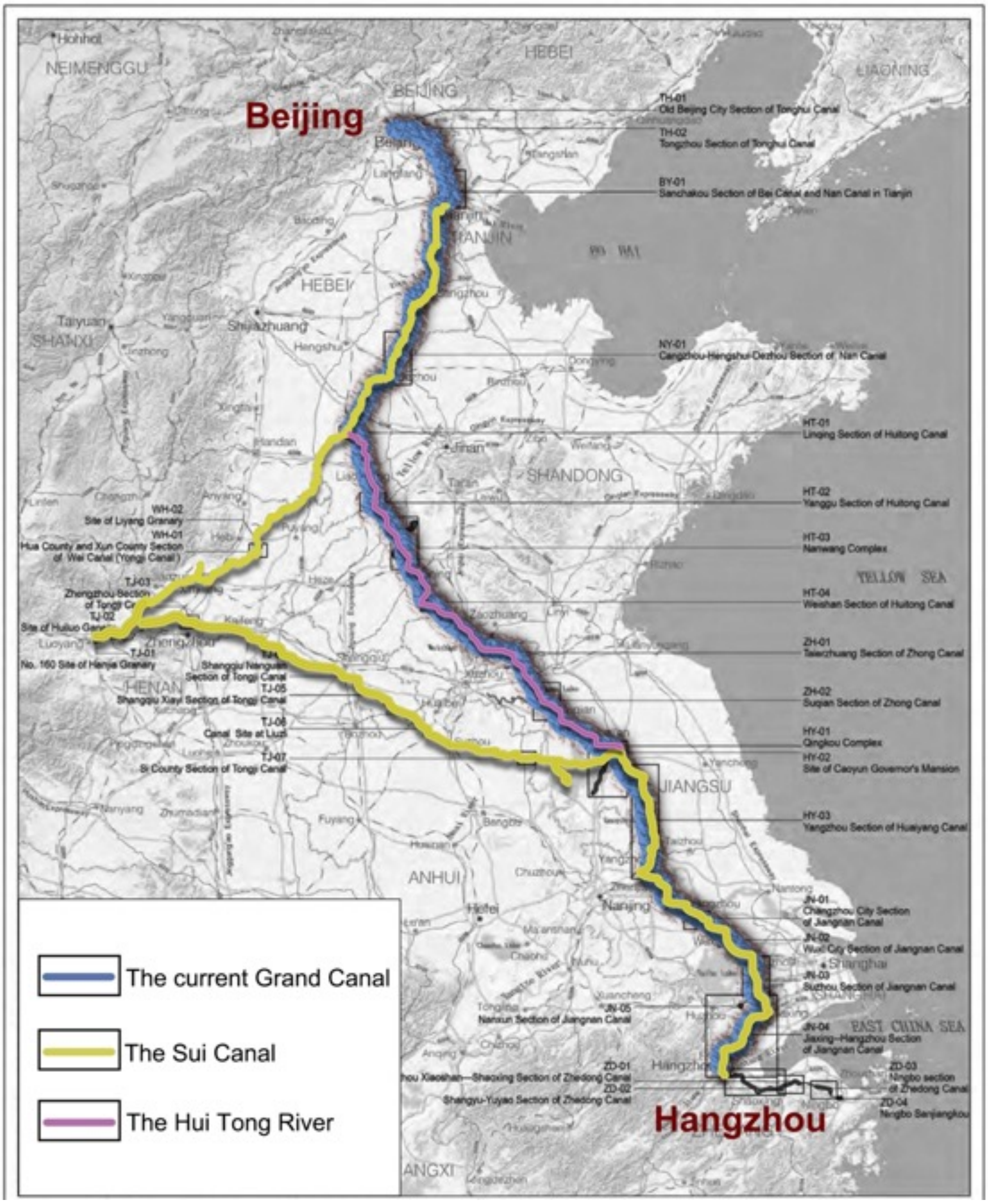

Figure 3. 5 The map shows the course of Hui Tong River (pink) passing the Shandong province, which forms part of the current Grand Canal, and was introduced to shorten the route used previously by the Sui Canal (yellow). Source: map originally from the normination documentation submitted to the World Heritage Convention Cultural Heritage (p.54), modified by author.

[334] Lu Yao, *Shan Dong Yun He Bei Lan 山东运河备览* (Qing Kang Xi Si Shi Yi Nian, 1776). Chapter 4. Seq. 225.

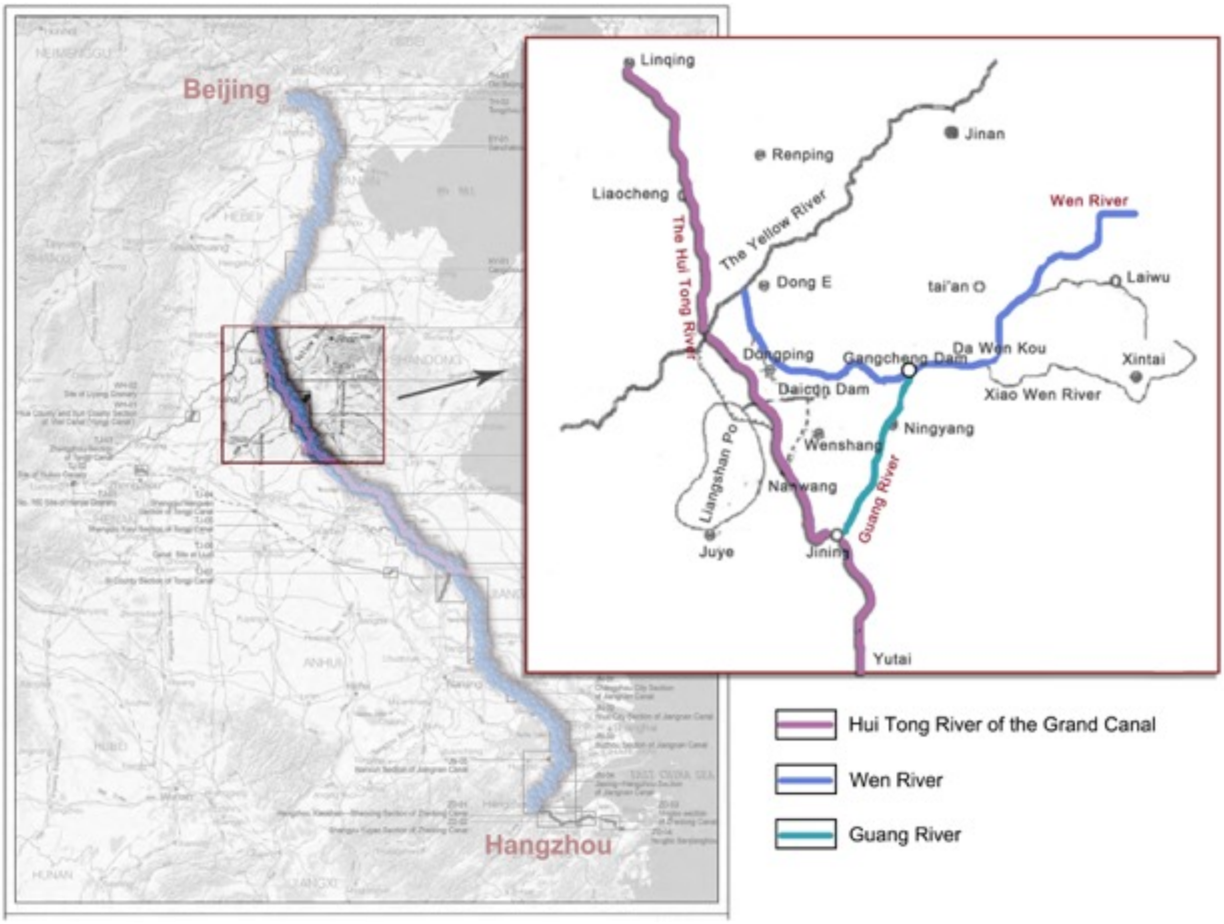

Figure 3. 6 The map shows the relationship between the various natural rivers and the Hui Tong River, and how the water from the Wen River was diverted to the Guang River by the building of various artificial obstructions, to supply the Grand Canal. Source: Wang Yuanlin and Meng Zhaofeng, 'Yuan Ming Qing Shi Qi Yin Wen Ji Yun Ji Qi Ying Xiang (The Wen River Supplying the Grand Canal and its Impact in the Yuan, Ming and Qing Dynasty)', *Yellow River*, 31: 4 (2009), 4-8 (p. 5). Modified by the author.

The making of the 通惠河 Tong Hui River linking Da Du to Tongzhou

Once the Hui Tong River was in use, it was connected to Tong Zhou through the Yu and Bai River, and the tax grain that was shipped there could be shifted to land transport to reach Beijing, about 50 *li* away. This was not an easy method, as ten million *dan* of grain had to reach the capital every year, and large numbers of labourers and donkeys who provided the transporter died of hardship and fatigue.[335] An easier means of transport was needed.

It became an urgent matter when the summer capital of Yuan, Shang Du, required a larger food supply. Shang Du was located in the Mongolian steppe (present Inner Mongolia), north of Beijing, and was the former location of the capital of Yuan. Although Kubilai decided to move to Beijing, he still stayed in Shang Du every summer and took large numbers of officials and troops with him. At the beginning of the Yuan Dynasty the detailing of officials's wages had not been included in the Yuan Ordinance until, in 1285, it was settled that each month each official was paid by silver and paper money as well as rice.

This greatly increased the amount of grain needed by both capitals at a time when an official of medium rank would be given six *dan* of rice each month, not to mention the high volume of food required for the numerous common labourers and soldiers.[336] As a result of these demands, the summer palace quickly suffered from famine, and urgently needed more food supply from the capital Beijing, so a more reliable transport artery connecting Beijing to the south was required, a waterway for shipping heavy bulk goods. As early as 1262, Guo Shoujing had suggested to Kubilai Khan that he restore an old waterway linking Tongzhou to Beijing, which had been made during the Jin dynasty (1115–1234) and had become silted up by the time the Yuan Dynasty was founded.[337]

From the little evidence in historical records, it seems that Kubilai approved Guo Shoujing's proposal and ordered the restoration of this waterway, although it in fact played a more important role in transporting material for the construction of the Yuan capital than shipping grain, because it silted up so easily that it could not serve for grain transport route over the

335 Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016] (Line 4).
336 Pan Ding and Xiang Ying, *Guo Shoujing* (Shanghai: Shanghai People Press, 1980), p. 188.
337 Lu Zhengyuan and Wang Xiong, 'The Realignment of the Tonghui River in Yuan Dynasty', *Journal of Inner Mongolia University (Humanitis and Social Sciences)*, 37: 5 (2005), 32-34 (p. 33).

long term.[338] In the last decade of the thirteenth century, the need for a reliable grain transport route which linked directly to Beijing had become more urgent, and in 1291 two proposals were presented. Kubilai sent Guo Shoujing to carry out a site investigation to see whether these plans could be successfully implemented.[339]

Guo reported to Kubilai that he did not believe the new proposals would work, but that he had a new plan himself after reflecting on the learned lessons of the previous failure. Guo was already 61 years old at that time and had become one of the most influential officials and engineers of the Yuan court. Kbubilai approved this new project, which was still to make use of the old Jin waterway, but added various springs nearby as new sources of water. Kublai ordered the restoration of the Department of Waterways to take charge of the construction of the embankment, bridges and locks of this project. Guo was assigned as director and was given the privilege of giving orders to all the officials whose ranks were lower than the Prime Minister's.[340]

The new waterway, Tong Hui River, was built in 1292. Guo Shoujing diverted the water from Bai Fu Spring northwest of Beijing to the southeast, to join the various other springs until the water flowed into the Ji Shui Tan River near Beijing. It then connected to the old waterway built in the Jin Dynasty to link Tong Zhou. In this way the water level was raised by the various springs and the problem of soil and sand contained in the old Jin waterway could also be lessened by the inflow of clear spring water.[341] A problem which Guo Shoujing did not foresee was that the many springs were also the water sources for the Yu and Ba Rivers, which also served as a grain transport route, and the Ba River was directly connected to the granaries. As their water sources were diverted to the Tong Hui River, the water level of these two rivers became very shallow. In 1293, the Department of Waterway of Grain Transport reported to Kubilai that the water level in the summer was only two *chi* deep, and the grain

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338 Lu and Wang, p. 34.
339 Wu Zhong, *Tong Hui He Zhi* (Biograohy of the Tong Hui River) (Jia Jing Liu Nian Ben 1527), Seq. 26.
340 Ibid., Seq. 25.
341 Lu and Wang, p. 35.

had to be transferred to very small barges, causing a delay in the grain transport[342]. As a result, a water channel had to be excavated linking the Tong Hui River to the Ba River to supply it with water.[343]

The new project to build the Tong Hui River, which was 164 li long, was completed in a year and a half; over 20,000 people including soldiers, labourers and prisoners were involved.[344] Kubilai even mobilized his officials to work on the site with shovels and baskets.[345] From the map below, we can see that the section northwest of Beijing city was joined by various springs to serve as water sources, and the section from Tong Zhou to Beijing served as a main tax grain transport artery. Traditionally the Tong Hui River includes both the sections of water sources and the grain transport route, which is why this waterway is so long, 164 li.[346] Because of the water level difference, a total of eleven locks were built here, details of which will be introduced later.

342 Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016] (Line 39).
343 Yao Hanyuan, *Jing Hang Yun He Shi* (The History of the Beijing-Hangzhou Grand Canal) Beijing: Shui Li Shui Dian Chu Ban She, 1998, p. 98.
344 Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016] (Line 4).
345 Wu, Seq. 25
346 Yao, pp. 87-89.

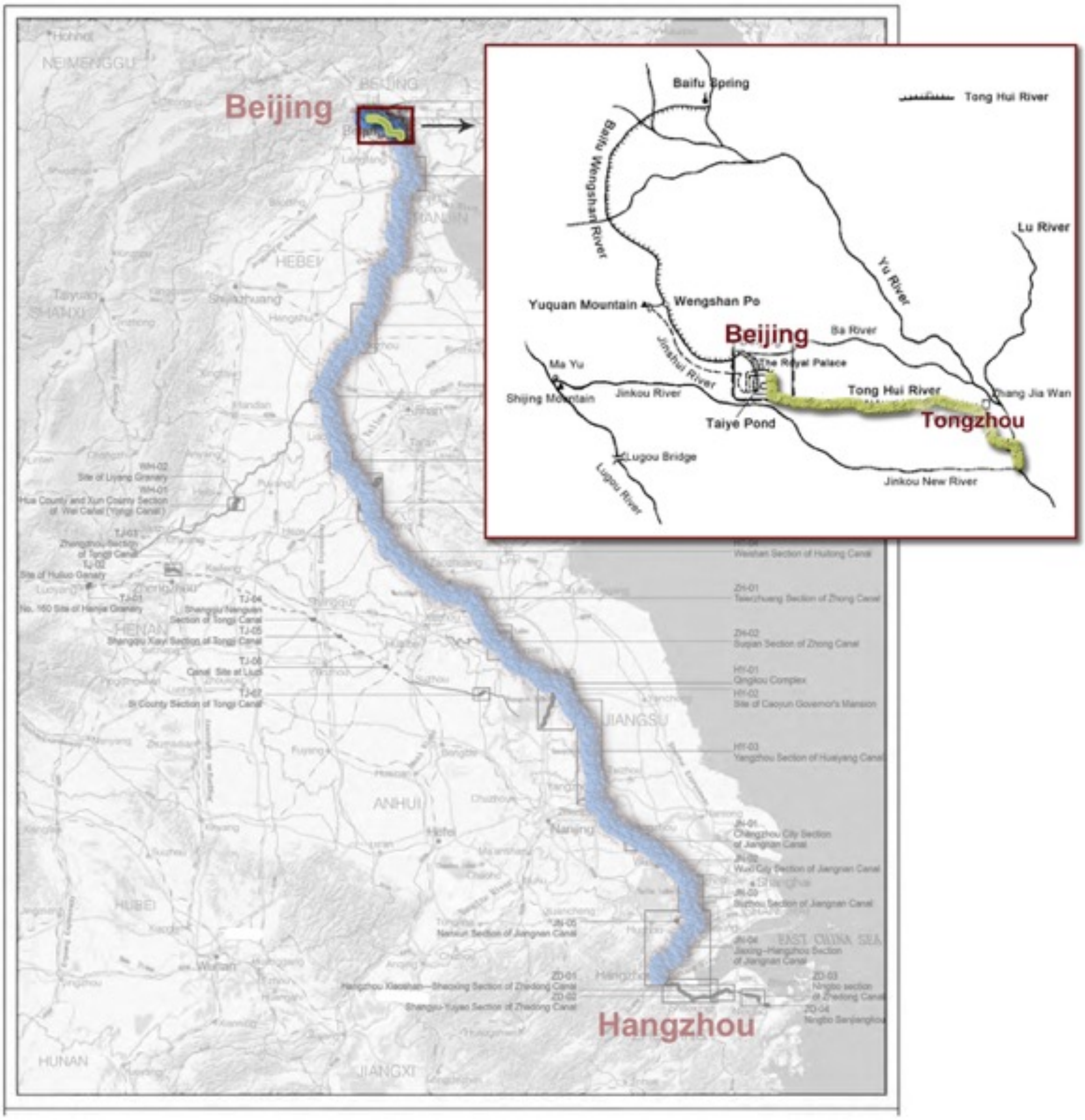

Figure 3. 7 The map shows the new section Tong Hui River (yellow) linking Tongzhou to Beijing, and the various springs and rivers which provided water for it. It needs to be noted that although the Bai Fu Wengshan River in the northwest of Beijing served as the main water source for the Tong Hui River, it was not part of its tax grain transport route, canal boats only travelled on the section between Beijing and Tong Zhou, which had been built in the Jin Dynasty. Source: key map originally from the normination documentation submitted to the World Heritage Convention Cultural Heritage (p.54), modified by author. The smaller map is from Yao, p. 88, Image 3-10-2. Modified by the author.

Figure 3. 8 This painting of the Tong Hui River shows the landscape around it, including the earth bank, bridges, houses, boats and plants. From the city gate and wall it can be inferred that this is the city section of the river, perhaps the Yuan capital Beijing. The large numbers of weeping willow trees planted along the water were used to strengthen the bank, and as weeping willows were usually thought to be precious in the north of China this increases the likelihood that this is the capital.[347]. Source: unknown, 'Tong Hui He Cao Yun Tu Juan (Scroll Painting of the Grain Transport on the Tong Hui River)' in *Tu Shuo Yuan Chao* (The Illustrated History of Yuan Dynasty) ed. by Gong Shuyi and Liu Dein (Beijing: Zhi Shu Fang Press, 2014), p. 145.

By 1293, the strengthened Grand Canal route linking Beijing directly to the south was completed, and route remains in this form today. The part of the Sui Canal which was completed in the seventh century was thus abandoned as the capital of China never moved back to central China. Marco Polo, the famous Italian merchant and traveller who stayed in China between 1275 and 1292, described this new canal route: 'the Great Khan has made very great channels, both broad and deep, from the one river to the other and from the one lake to the other; and makes the water go through the channels so that they seem a great river;

[347] This is based from various historical accounts, such as 东京梦华录 and 吴郡志, the article *Spring in Life along the Bian River at the Qingming Festival* also discusses it.

and quite large ships go there with the said grain loaded from this city of Caigiu (Gua Zhou, the town at where the Grand Canal opens into the Yangzi River) up to the city of Cambaluc (Beijing) in Cathay'.[348]

Figure 3. 9 Portrait of Marco Polo, in China between 1275 and 1292. Source: Gong Shuyi and Liu Delin, *Tu Shuo Yuan Chao* (The Illustrated History of Yuan Dynasty) Beijing: Zhi Shu Fang Press, 2014, p. 138.

The barges

As they had originally been a nomadic nation, the Mongolian it was perhaps surprising that they achieved considerable advances in ship-making techniques. The effort began during the war against the Southern Song Dynasty, with the intention of an expedition against Japan.[349] At the time the Southern Song Dynasty was based in southern China and boasted a very strong navy, which made it hard for the Mongol armies to compete. Official Liu Zheng said to Kubilai that 'if we want to take over Xiangyang,[350] the most important preparations would

348 Marco Polo, A.C. Moule and Paul Pelliot (ed.), *The Description of the World* (London: London G. Routledge, 1938), pp. 322.
349 Needham, p. 477.
350 A crucial city near the Han River, had major offensives of the Southern Song Dynasty. If the Kublai wanted to conquer the Southern Song, they had to take over Xiangyang first.

be the training of our navy and making our own battleships'.[351] Kublai put considerable effort and expenditure into building battleships in the northern Yangzi region. Five thousand battleships were constructed in 1270, and another three thousand the following year.[352]

The Song dynasty, as mentioned above, made considerable progress in terms of the development of science and technology, including advanced ship-making industry. The sources of the Yuan technology included those neighbouring countries which had been conquered by the Yuan Dynasty, increasing the communication between different cultures, an important accelerator for the rapid development of science and technology during the Yuan era.[353]

After the canal route was remodeled and put into use, the Yuan government also built large numbers of canal barges. The ship-making system remained similar to that of the Song Dynasty, as the Yuan had inherited most of their administrative systems from the Song. There were different sizes of barge, including some so large that they could carry three to eight hundred *liao* (1 liao roughly equalled 1 dan, about 53 kg).[354] The large barges were usually used in the south section of the canal, where there was a greater water supply.

While Marco Polo was traveling to Chuzhou city in southern China, he described seeing at least 15,000 ships on the Yangzi River at once: 'they are covered with only one deck and have only one mast with one sail, but they are of great tonnage, for I tell you that they carry cargo for the most part from 4,000 quintals up to 12,000 (which some of them carry) in weight'. He also talked about the tow ropes: 'all the ships have not all the tackle of ropes and hemp, except indeed that they have the masts and sails rigged with them. But I tell you that they have the hawsers, or to speak plainly, tow-lines, of nothing else but of canes, with which

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351 Song, http://ctext.org/wiki.pl?if=en&chapter=283077&remap=gb#p4 [accessed 1 July 2016] (Line 3).
352 Ibid.
353 Pang Longfei, *Zhong Guo Zao Chuan Tong Shi (The History of the Ship-making of China)* Beijing: Haiyang Press, 2013, pp. 214-216.
354 Sha Keshi, *He Fang Tong Yi* (A General Discussion of the Protection Works along the Yellow River) (Zhi Zhi Yuan Nian Ben, 1321). Chapter 2, p. 23.

the ships are towed upstream by this river…And you understand that these canes are the thick and long canes of which I have told you, which are quite 15 paces long. They take these canes and split them from one end to the other into many thin strips, and bind them the one end with the other, and make them ropes as long as they wish, twists quite 300 ells, that is paces, long, and it is much stronger than hempen rope would be, with so great care are they made'.[355]

Marco Polo's description serves to supplement the small number of Chinese documents about the appearance of the canal and the boats in that period. While these large boats were used for carrying goods and grain in southern China, the barges that travelled on the Hui Tong River in the north had to be made much smaller. As mentioned earlier, the newly remodeled Grand Canal went past its summit at Ji Ning city, a difficult point for the canal to receive sufficient water. The watercourse had to be narrowed to maintain the water level, so the barges on it had to be made narrower.[356]

A canal barge on the Hui Tong River could be no wider than 8.5 *chi* (the Yuan government inherited its metrics system from the Song dynasty, 1 chi here equals 0.31 metre[357]), once it had been found that larger boats were too hard to move and slowed traffic. To block bigger barges, a special lock, *ai zha* 隘闸, was established at both ends of the Tong Hui River, with lock gates only 9 chi apart.[358]

A flat-bottomed barge with a width of 8.5 *chi* could only carry a maximum of 200 *liao* of goods, which was thought to be too small, especially for merchants and officials who were hoping to take advantage from the shipment. As the length of a barge had not been clearly standardized, the boat suppliers started to build longer narrow boats which could be as long as one hundred chi, to bring their capacity up to 500 to 600 *liao* each.[359] Such boats looked

355 Polo, pp. 320-321.
356 Pang, p. 220.
357 Yang Kuan, *Zhong Guo Li Dai Chi Du Kao* (A Research of the Metrics in Imperial China) (Taipei: Taiwan Shangwu Shu Ju, 1868), p. 81.
358 Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016] (Line 97).
359 Ibid.

very long and narrow; in the Song Dynasty a barge with 100 *liao* tonnage had been 12 *chi* wide and 40 chi long,[360] much wider and shorter than these new ones.

Unsurprisingly, these long barges could not easily turn around once they had entered the lock, which often caused traffic problems on the Tong Hui River.[361] The Yuan government had to dictate clearer regulations on both the width and length of the canal boats, it decided that each boat could not be larger than 8.5 chi wide and 65 chi long; barges of this size could carry 200 liao of goods. Two abutments near the *ai zha* locks were also installed, exactly 65 chi apart, to measure boats entering the canal.[362] Larger boats could still travel on other wider sections of the Grand Canal, but the goods and grain on them had to be transferred to smaller barges before they entered the Hui Tong River.[363]

There are few historical records available to show how the boats were designed and built during the Yuan Dynasty, but we know that both official and private ship-making yards were established during the Song Dynasty, which were still available to the Yuan after the Song court moved to the southern China. Since most of the regulations and policies of the Jin and Yuan dynasties were inherited from the Southern Song, it seems likely that the ship-making system also remained.

The official ship-making yards were scattered across different regions of China, close to the sources of materials and water. Sometimes temporary yards would have to be built to cater for a need for extra boats, for which orders came to local government from the centre.[364] Ship-making commissions had normally been placed under the direction of the Ministry of Works since the Song era, though the actual construction would be assigned to its lower

360 Sha, p. 13.
361 Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016] (Line 97).
362 Ibid.
363 Yang Xi, 'Cheng Qian Qi Hou De Yuan Dai Chuan Bo (The Ship-making of the Yuan Dynasty that Served as an Important Link between the Previous and later Dynasties)', *Journal of Dalian Marine College*, 9(1983), 105-119 (p. 110).
364 Zhang Huanyu, 'A study of Shipbuilding Industry in Song Dynasty' (Unpublished master dissertation, Chinese Culture University, 2010), p.102.

authorities such as the Department of Waterways and the Military Commission.[365] By contrast with the business and recreational purposes of the private ship-making yards, the official ship-making yards usually served for the production of ships for military, canal and sea transport.[366] A very well organized system of ship-making production was developed: before building the boats, the materials would be purchased by a specific department, which would purchase all the wood and small components such as iron nails; then the budget of making each boat would be calculated and presented to the Ministry of Works; finally a plan of the new boat, *chuan yang* 船样 (ship model) was made which would be given to the ship-making yards as a reference for workers to produce.[367]

A *chuan yan* could be based on a previously successful model that the government wished to mass produce, or a new one whose designer would need to make a small-scale demonstration model for the artisans, since the new methods and techniques were not widely known. An example of this is that of Zhang Zhongyan, an official of the Jin dynasty, who first invented the joggle joint to use for ship-making in 1158. He made a small model fitting different parts together without any glue or lacquer, and passed it to the artisans to learn and copy the new technique.[368] The earliest pictorial evidence of *Chuan Yang* dates from the Ming Dynasty (1368–1644),[369] though a written document survives from the tenth century.

There are few historical records of the dimensions and detailing of the canal boats of the Yuan era. However, the lack of historical data can be supplemented by archeological research. In 2010, a sunken boat was discovered in He Ze city, Shandong, believed to be a boat of the Yuan Dynasty because of the relics found.[370]

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365 Toqto'a and Alutu, *Song Shi (History of Song)* (er shi si shi ben, 1644), chapter 116, Zhi Guan San (Civilian Official Part Three). Chinese Texts Project Online Library, http://ctext.org/wiki.pl?if=en&chapter=735849&remap=gb#p109 [accessed 2 July 2016] (Line 114).
366 Zhang, p. 102.
367 Xu Song, Chen Huan, eds., *Song Hui Yao Ji Gao (Song Dynasty Manuscript Compendium)* (Beijing: Zhonghua Shu Ju, 1957), Shi Huo Qi (Food and Goods Part Seven), p. 37.
368 Toqto'a, *Jin Shi (History of Jin)*, (wu ying dian ben er shi si shi, 1784), Lie Zhuan Shi Qi (Collected Biographic Part Seventeen). Chinese Texts Project Online Library, http://ctext.org/wiki.pl?if=gb&chapter=98767&remap=gb#p2 [accessed 2 July 2016]
369 Needham, pp. 408-409.
370 Shandong Provincial Institute of Cultural Relics and Archaeology Commission for Preservation of Ancient

This boat, built mostly of cedar wood, contained twelve compartments.[371] The archaeological analysis shows that the first compartment (see Figure 3.11) in the bottom of the boat was used for religious sacrifice, and the next two rooms were the boat owner's living quarters. Those in the middle were storage rooms, while the two near the head of the boat were the sailors' living quarters. The boat was a '150 liao tonnage' boat: its mast was placed close to the head of the boat, as it was believed to be easier for the trackers to pull the boat when ropes were attached. There were also two platforms called *kan tang* 瞰堂 attached to both the port and starboard with iron nails, to serve as a platform for sailors to stand on when they poled the boat.[372]

Those barges which had sails would use them whenever the wind allowed; however, they were not practical to use on inland waterways because of the numerous locks and bridges. For most of the canal-journey, it relied on the trackers and poling, which explains the presence of the *kan tang*.[373] The restoration drawings of the boat, below, give its details and dimensions: it was a rather shallow barge, only d1 metre deep. This suggests that the barges had a smaller capacity adjusted to deal the shallow water level of the Hui Tong River. The various fine artworks in china, jade and gold suggest that this boat could have been either a merchant or an official boat.[374]

Monuments, Heze City, 'The Excavation of a Shipwreck of the Yuan Dynasty in Heze City, Shandong Province', *Relics*, 2(2016), 40-49 (p.49).

371 Ibid., p. 47.

372 Pang, pp. 240-241.

373 Ibid.

374 Shandong Provincial Institute of Cultural Relics and Archaeology Commission for Preservation of Ancient Monuments, p. 48.

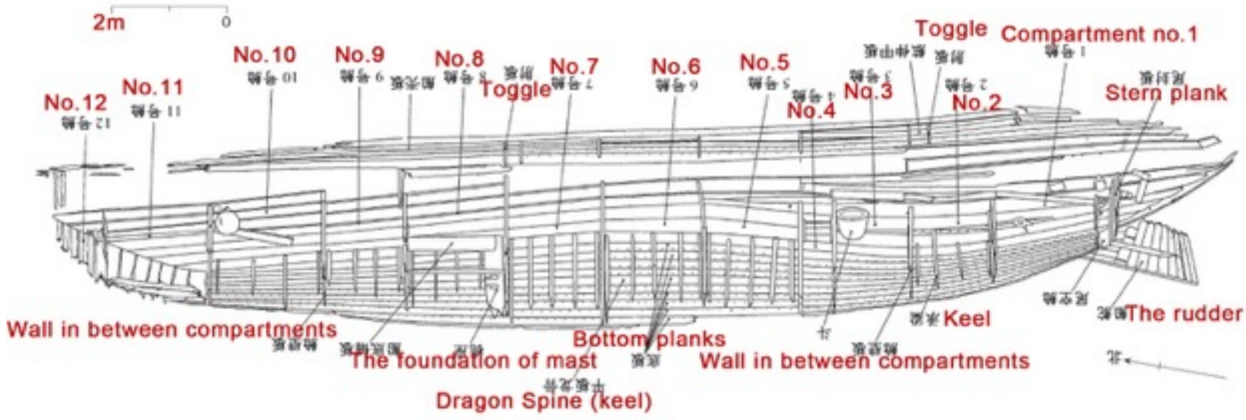

Figure 3. 10 The plan of the sunken boat discovered in He Ze city, Shandong. It is about 20 m. long and 4 m. wide, a similar size to the standardized canal barge size (65 chi long and 8.5 chi wide) of the Yuan Dynasty. The barge contains twelve compartments with different functions. Source: Shandong Provincial Institute of Cultural Relics and Archaeology Commission for Preservation of Ancient Monuments, He Ze City, p. 41, Picture 3. English translation by author.

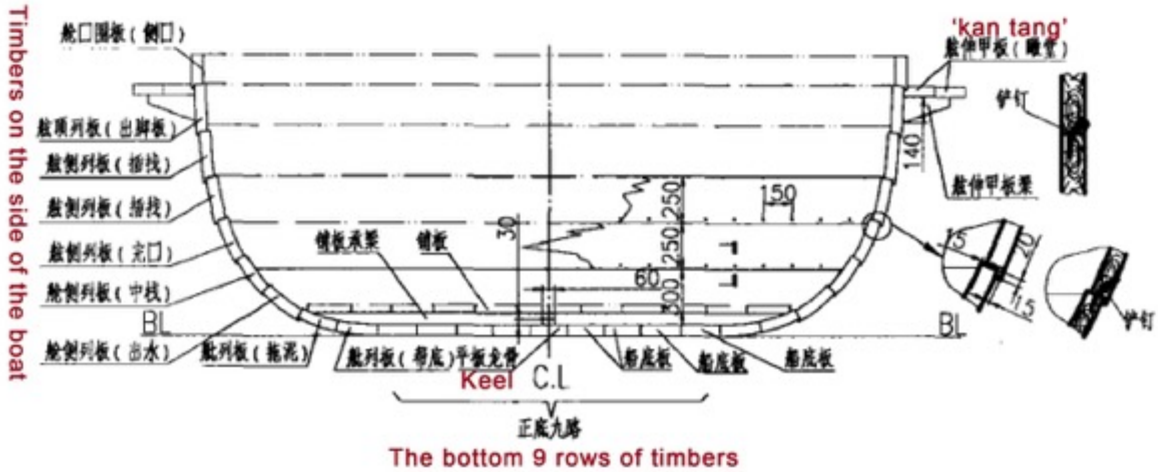

Figure 3. 11 The cross-section plan of the boat. The barge was built with 26 rows of 60mm-thick timbers, with the bottom part composed of nine rows. The width of each timber varies from 100 to 300mm. The k*an tang* on both sides of the barge, used for sailors to stand on to pole the barge, is also clearly shown; each of them is made of two pieces of timber. Source: Pang, p. 240, Picture 8-14. English translation by author.

Figure 3. 12 A china vase (left) and jade goblet (right) found on a sunken boat, examples from the 110 pieces of artwork found. This may suggest the kind of goods carried on the boats of the Grand Canal during the Yuan dynasty, though this one was likely to have been used by an official of rank or a merchant. Source: Shandong Provincial Institute of Cultural Relics and Archaeology Commission for Preservation of Ancient Monuments, He Ze City, p. 44, Fig. 10. p 45, Figure 15.

Locks and embankment

Locks

The Hui Tong River is known for its challenging topography as it crosses the hilly area of Western Shandong with a summit height of 39 metres above sea level. To make the channel navigable, dams were built to divert water from the Si and Wen River to the Grand Canal, as well as thirty-one locks on the Hui Tong River to save water. These are a particular characteristic of this waterway, which has been commonly known as *Zha He* 闸河 (River of the Locks) since the fifteenth century.

From the various historical accounts of the Yuan Dynasty, we know that although the plan to build the many locks on the Hui Tong River was made at the same time as the plan for building the watercourse, which was completed in 1289, none of the locks was actually finished until 1293, and new locks continued to be built until the early fourteenth century.[375] There are also records showing that the wooden locks were upgraded to stone locks from the second year after the Hui Tong River was built, because the heavy rainwater destroyed the bank as well as many of the wooden locks.[376] This suggests that there may only have been a very short period when wooden locks were used for the Grand Canal, as they were gradually replaced by the stone ones which became the main type during the Ming and Qing dynasties. So most of the records of locks being built on the Hui Tong River were about these upgraded stone locks.

As discussed earlier, the watercourse was deliberately made narrower to raise the water level because the water supply to the Hui Tong River was inadequate. A special type of lock, the *ai chuan zha* or *ai zha* (Narrow Boat Lock) had to be built, with a gate only 9 chi wide to prevent oversized barges entering the river. There were two *ai chuan zha* locks installed at each end of the Hui Tong River, in 1314 and 1315 respectively,[377] long after the completion of the watercourse, the building of these two locks may not have been part of the original plan, but rather found to be necessary later.

Apart from the special gate of the *ai chuan zha* lock, its width was the same as the other eleven locks on the northern section of the Hui Tong River, 80 chi. This suggests that the width of this part of the river was about 80 chi. The total length of each lock was usually 100 chi, including two 40-chi-long *zhi shen* 直身 (the two abutments of the lock) and four 30-chi-long *yan chi* 雁翅 (the four wings on both ends of *zhi shen*). The height of a lock was usually 20 chi, its gate 20 chi wide (Figure. 3.13).[378]

375 Yao, p. 109.
376 Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016] (Line 73).
377 Ibid., http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016] (Line 75- 92).
378 Ibid.

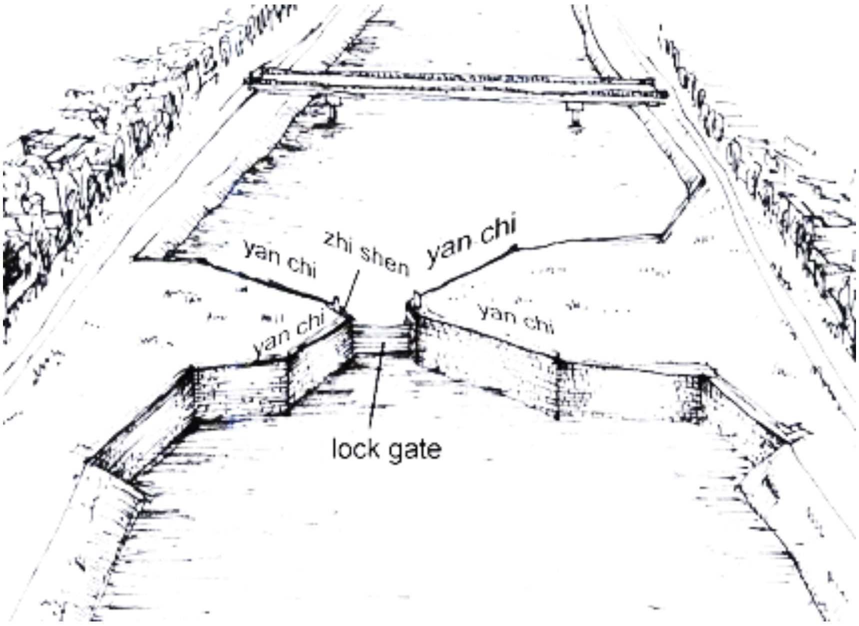

Figure 3. 13 This sketch made by the author shows the basic structure of a lock and the name of each part.

The appearance of locks of this period was very similar to the *fu zha* invented by Qiao Weiyue in the tenth century, and they were mostly made of regular shaped stone slabs. The lock gate was made of several wooden beams which could be lifted by ropes, one after the other, to open the gate. There was usually a branch channel called *yue he* 月河 (the moon-shaped river) close to each lock, which could be helpful when boats needed to turn around, or served as an alternative route when the main one was under maintenance.[379]

[379] Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016] (Line 96).

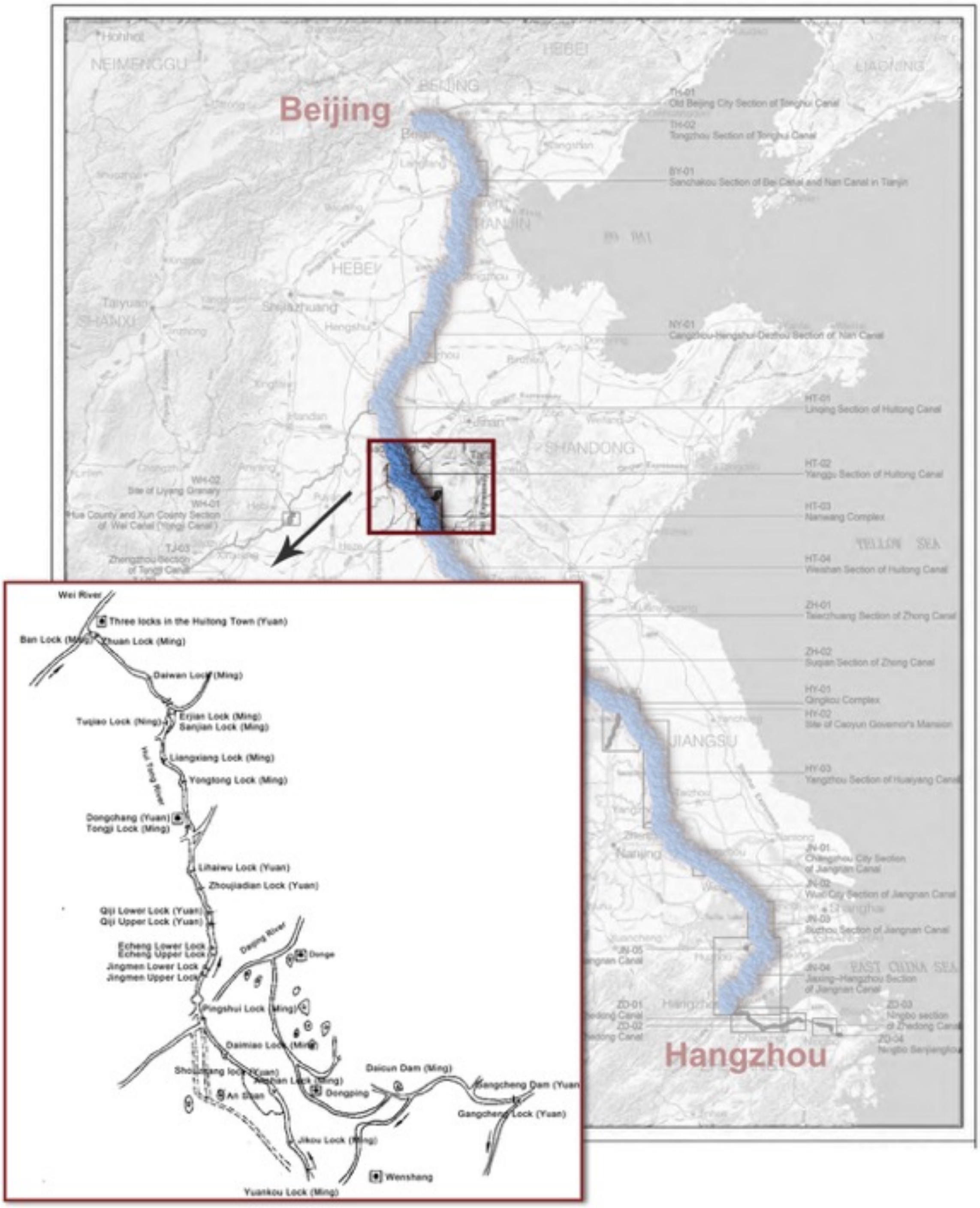

Figure 3. 14 This map of the Linqing-Dongping section of the Hui Tong River shows the locks built both in the Yuan and Ming Dynasty. There are several locks with the name ‘upper’ or ‘lower’, because when the water level varied too much, two locks would be built very close (usually about 500 m away), and would function as a pair lock. The northern one was named *Xia* (lower) Lock and the southern one *Shang* (upper) Lock. This tells us the direction of the two locks: according to *Fengshui* principles, *Shang* means south and *Yang*, and *xia* means north and *yin*. So a *Xia* Lock means the lock to the north. Source: key map originally from the normination documentation submitted to the World Heritage Convention Cultural Heritage (p.54), modified by author. Map at the left corner is from Yao, p. 88, Image 3-12-2. Modified by the author.

The dimensions of the locks on the southern part of the Hui Tong River were more varied. For example, the Hui Yuan Lock built in 1321 was 160 chi long and 50 wide, with its total height 15 chi and the lock gate 20 chi wide. The Gu Ting Lock, further south, was 80 chi long including a 27-chi long *zhi shen* and four 50-chi long *yan chi*, with a total height of 22 chi and a 22-chi wide lock gate.[380] This may be because the southern section was closer to the summit point in Ji Ning, where the width of the watercourse must have varied according to the uneven water level, which also affected the size of the locks. More information about the design details of locks is available for the Ming dynasty, which will be analysed in the next chapter.

The repair of the embankment and watercourse

The route of the Grand Canal made use of as many natural rivers and lakes as possible to save the effort and inconvenience of digging new channels, as well as to ensure sufficient water supplies. Its course between Xu Zhou and Qing Kou in northern Jiang Su Province was shared with the Yellow River, the second biggest natural river in China.[381] However, the Yellow River was not the easiest water source to cope with: because it characteristically suffered from frequent and often devastating floods with large amounts of silt, it often broke the dams and embankments of the Grand Canal and brought the silt into its water.[382]

Another river engineer of the Yuan era was Jia Lu (1297-1353), who gained his reputation when he showed great ingenuity in repairing dykes and making relief canals.[383] The flooding of the Yellow River frequently affected nearby towns and brought great tragedy to their

[380] Yao, p. 111.
[381] Tim Wright and Ma Junya, 'Sacrificing Local Interests: Water Control Policies of the Ming and Qing Governments and the Local Economy of Huaibei, 1495-1949', *Modern Asian Studies,* 47:4 (2013), 1348-1376 (p.1353).
[382] Song, http://ctext.org/wiki.pl?if=en&chapter=548553&remap=gb#p73 [accessed 1 July 2016] (Line 10).
[383] Ibid.

inhabitants. This drew greater attention from the government when, in April of 1344, the rain did not stop falling for more than twenty days. The water level of the Yellow River increased so much that it rushed into the Grand Canal and breached its dams. What made it more urgent was that the official salt yards situated nearby were also threatened by the flooding.

Jia Lu was concerned about these disasters, and he volunteered to Emperor Shun of Yuan (1320-1370) to control the flood in both the Yellow River and the Grand Canal. There are no records which explain how Jia Lu learnt the river engineering required, but when he presented his proposal with detailed charts and maps, he seemed to be already very familiar with geography and water conservancy.[384]

Jia Lu's suggestions included repairing the embankment and dredging the water of the Yellow River.[385] At the time bamboo was favoured by the Chinese as a material for making ropes, because of its remarkable tensile strength in plaited strips. It was not only used as an important material for repairing the embankments, but also for towropes. The most common structure using bamboo to block breaches was called *zhu long* 竹笼 (Bamboo Gabion), a sausage-shaped open work crate of bamboo packed with stones. It was placed where the breach of the embankment occurred, and did not need strong foundations because its porosity allowed it to absorb the shocks from surges without itself being damaged or swept away.. This breach blocking method is believed to have been available since the first century BC, and has been one of the most practical strategies for repairing embankments ever since.[386] It could also be used for temporary weirs in emergencies, as the drawing from the early fourteenth century, below, shows.[387]

384 Song, http://ctext.org/wiki.pl?if=en&chapter=505269&remap=gb#p7 [accessed 1 July 2016].
385 Ibid, (line 9).
386 Needham, pp. 339-340.
387 Ibid., p. 341.

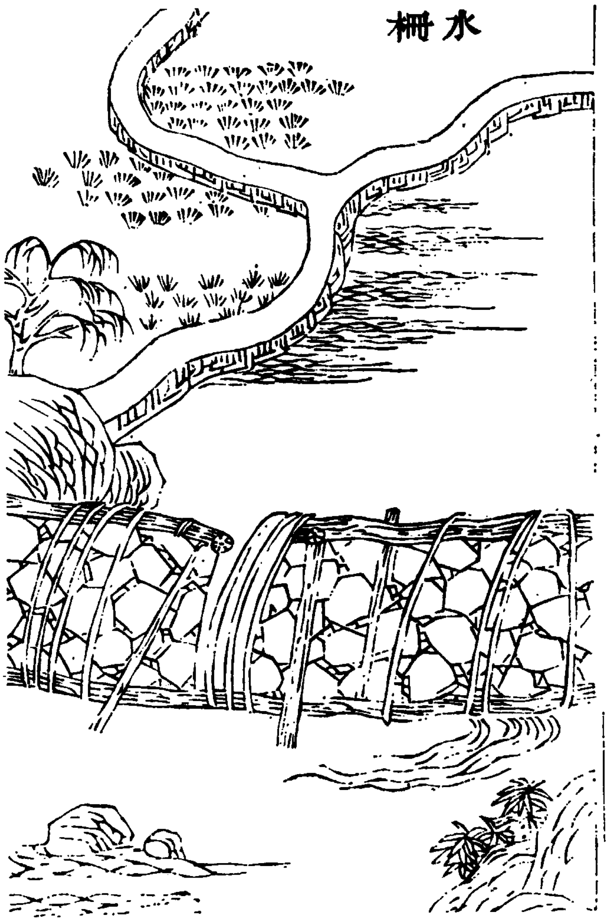

Figure 3. 15 The drawing of *zhu long* (bamboo gabion) from the book *Nong Shu* 农书 of 1313. It shows its structure, with stones bundled into a sausage shape by bamboo ropes; some wooden sticks can also be seen in the picture, helping to keep the whole bamboo gabion in place. Here the bamboo gabion is being used as a temporary weir, another of its functions; when used like this its name was sometimes changed to *shui zha* 水栅 (water palisades) as shown in the picture. Source: Needham, p. 340.

The *juan sao* 卷埽 or *sao* 埽 (fascine bundle) is another widely used structure for repairing and reinforcing embankments, often applied to flood control work by Jia Lu. This technique was developed after the bamboo gabion, and only appeared in the tenth century.[388] It quickly became so commonly used that it could be seen in all kinds of flood control projects until the early twentieth century. A *sao* is made of a massive fascine bundle of kaoliang stalks fastened with bamboo ropes, and is most suitable for water which carries a large quantity of silt, because the silt was blocked by the interstices of the mass which allowed the water to filter

[388] Zhang Zhenxu, Zhu Jingping and Wang Wei, 'The Analysis of the Methods and Techniques applied by Jia Lu in Water Control', *China Water Transport*, 15:3 (2015), 161-163 (p.162).

through, making the whole bundle compact and strong.[389]

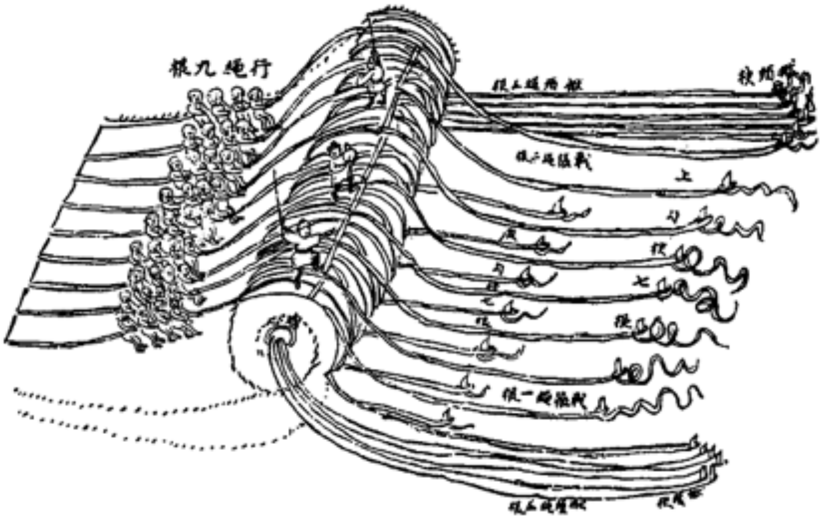

Figure 3. 16 The drawing shows a giant *sao* 埽 being made. A *sao* had to be made in an open yard. A layer of materials mixed with treetops, reeds and sometimes kaoliang stalks would be laid out evenly, a layer of earth would be placed on top, and then a layer of rubble. One or several bamboo cables would be placed in the middle, with both ends fixed to the ground to keep the whole thing in place. The layers would be rolled together into a sausage shape, and bundled with bamboo ropes. When the fascine is ready to go, the cables in the centre were slowly taken out, which in the meantime could also act as brakes. The size of *sao* varies, and a large one might need hundreds of people to work together to make it. Source: Needham, p. 342.

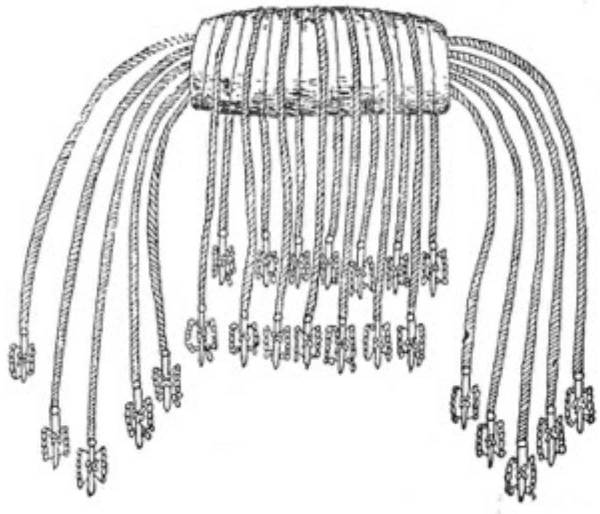

Figure 3. 17 A *sao* after construction. Source: Zheng Zhaojing, *He Gong Xue* (Studies of River Engineering) Shanghai: Shang Wu Yin Shu Guan, 1935, p. 279. Figure 181.

[389] Needham, p. 341.

Such structures were often used in the Yellow River, and at the conjunction point between the Yellow and the Grand Canal, where breaches of the embankment occurred. Before it was applied, two 8-chi-long *biao gan* (scale) would be set on either side of the breach, used to measure the distance by observing the shadows at certain hours of the day. A temporary bridge made up of barges would be prepared to let workers cross the river freely. When positioning the fascine bundles into the breach, it went from both ends towards the middle, until the breach was only 30 to 40 chi. At the pivotal moment, the fascine bundles needed to be put in place quickly, along with large numbers of bags of earth. In the meantime workers would beat the gongs and drums to keep up morale. The process of blocking the final breach was called *he long men* 合龙门 (Closing the Dragon Gate): after the 'dragon gate' was closed, puddle would be used wherever small gaps were noticed.[390]

The size of each fascine bundle differed, depending on the specific situation; however, there seems to be certain regular proportions. For example, a 20-bu-long and 10-chi-wide fascine bundle would be made of 1,100 small bundles of kaoliang stalks and 2,625 bundles of hay, because the proportion between the stalks and hay was set to be 3:7.[391] Jia Lu applied *sao* of all kinds of sizes to flood control, from 20 *chi* long down to less than one zhang (1 zhang equals 10 chi) long.[392]

Sao were also classified under different types according to their function, as well as size, and were given names based on their appearance. These included the *long wei sao* 龙尾埽 (the Dragon Tale Bundle) and *ma tou sao* 马头埽 (the Horse Head Bundle). When Jia Lu was repairing the dyke on the Huang Ling section of the Yellow River, he laid earth together with small-sized *sao* first; when it was repaired, he lined the *long wei sao* to the dyke by fastening

390 Sha, pp. 32-33.
391 Ibid., pp. 31-32.
392 Ouyang Xuan, 'Zhi Zheng He Fang Ji (Memoir on the Repair of the Yellow River Dykes in the Zhizheng Region-period)', in *Quan Yuan Wen (Collected Works of the Yuan Dynasty)*, ed. by Li Xiusheng (Nanjing: Fenghuang Press, 2004), p. 572.

it on the piles, in order to protect the dyke from damage by the stormy waves.[393]

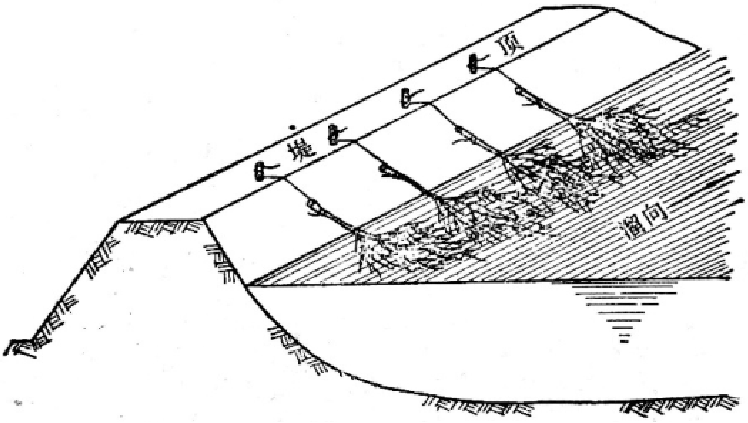

Figure 3. 18 This drawing shows another type of *sao*, The *long wei sao* is attached on the waterfront side of the dykes to protect them from damage by stormy waves. A *long wei sao* usually consisted of firewood, hay, reed stalks fastened by bamboo ropes. Source: Zhang, Zhu and Wang, p. 162.

Jia Lu also invented the *shi chuan di* 石船堤 (embankment made of stone-filled boats), which was formed by big boats carrying stones, lined up where necessary and then linked by bamboo ropes. The boats would also be kept in place by iron chains connected to the bed of the river, so that when each boat was deliberately broken, it would sink to where it needed to be to serve as a weir. Then small fascine bundles and mixture with soil and grass would be applied where there were small leaks.[394]

There are many more stories to tell about Jia Lu's project. He was said to have organized dredging a watercourse 280 li long, repaired embankments of 550 li long and blocked 107 breaches, all within only seven months. One of Jia Lu's biggest projects was to divert the Yellow River to its old watercourse, in an attempt to solve the flooding issues of the Grand Canal. This was only achieved with the heavy work of 150,000 labourers. Some historians have argued that this large-scale project contributed to the end of the Yuan Dynasty, as the first group of rebellions were initiated by river workers who decided to revolt against the heavy physical work: their team soon grew to a nation-wide scale. However, we should not

393 Ouyang, pp. 571-573.
394 Song, http://ctext.org/wiki.pl?if=en&chapter=230160&remap=gb [accessed 1 July 2016] (Line 16).

deny that Jia Lu was an idealistic scholar who was very determined. Maybe, in his hurry to solve the flooding issue, he was too confident, but failed to gain the support of the other officials because of the massive scale and expense of the project. The revolts, too, had other causes, including poor governance in the late Yuan Dynasty, which we will discuss in the next chapter.

Plants

The Mongols worshipped nature, especially trees. This can be seen in their ancient myths: it is said that one of the ancestors of the Dzungar Khanate was fed with tree juice and guarded by an owl when he was a child. The hunter who found him in the forest believed this child was meant to be a great man and brought him back home. The boy was given the name Choros, which means the 'nephew of heaven', and he became the ruler of Dzungar after he grew up.[395]

Trees were also an important element in celebrations. For example, when Hotula (uncle of Genghis Khan) was elected to be the Khan of Khamag, his people celebrated and danced around the big trees.[396] Although it is hard to know whether worshipping and being devoted to trees and nature influenced tree-planting policy during the Yuan dynasty, what is certain is that tree-planting was given a higher level of importance than before.

There were clear regulations about specific types of tree being planted and protected along the roads and the Grand Canal: in the *Yuan Dian Zhang 元典章* (Statutes of the Yuan dynasty) it says that: 'the Darughachi (originally a type of official of the Mongol Empire, who was in charge of taxes and administration in a certain province), citizen officials, military officials, currier station officials, craftsmen, hunting men, monks, Taoist priests, doctors, Confucians,

[395] Ba Dai et al, *Wei La Te De Li Shi Wen Xian* (Historical Literarure of Oirats) (Hohhot: Inner Mongolia Cultural Press, 1985), pp. 185-185.
[396] Historians of Mongol Empire, ed. by Yu Jie, *Meng Gu Mi Shi* (Secret History of Mongol Empire) (Beijing: Central Compilation&Translation Press, 2011), pp. 21-22.

Christians and Islamists, of all regions, plant elm or willow or locust trees around the cities, along the Grand Canal, near the courier stations and shops, according to local climate…the trees are to be planted at the beginning of spring, and are sure to survive. Horses are not allowed to feed from the leaves of these trees, and citizens are not allowed to cut down the trees.'[397]

The Emperor Kubilai gave clear orders on the maintenance of roads and bridges: 'on the first day of every September, the maintenance of roads needs to be carried out by local residents under the monitoring of local officials. And by the first day of November the work needs to be completed. When urgent circumstances such as a sunken surface and water blockage occur and cause a traffic problem, local workers need to repair them as soon as they can'.[398]

Planting enough trees on both sides of roads and rivers was believed to provide shade for travellers and merchants, and more importantly, to mark directions. This was described by Marco Polo: 'he (Kubilai) has arranged that by all those main roads through the province of Catai and through the neighbouring provinces, by which the messengers and the merchants and the other people go, he has had trees planted there beside the ways on either side two or three paces distant the one from the other, which are of the sort which grow large and tall. And I tell you that they are so large that they can well be seen from very far. And the great Khan has had this done so that each may see the roads, that the merchants may be able to rest there in the shade, and that they may not lose the way either by day or by night…of which I have told you, that is through all provinces and through all kingdoms which are under his rule; provided that the place is suitable to be planted; but in the sandy and desert places and in the rocky mountains where the said roads pass, and it is not possible to plant them, he has other signals put up of stones and pillars which show the way. And he has certain barons who have the duty of arranging that they may be always kept in repair'.[399]

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397 Gao Chenhua (ed.), *Yuan Dian Zhang (Statutes of the Yuan dynasty)* (Beijing: Zhong Hua Shu Ju, 2011), pp. 1979-1980. Translated by author.
398 Gao, pp. 1976-1977. Translated by author.
399 Polo, pp. 248-249.

Another interesting thing is that when discussing the reason why Kubulai paid so much attention to planting trees, Marco said it was 'because his advisers and astrologers say that he who has trees planted lives a long time'.[400] Kubilai had a number of advisors including astrologers, augurs, Shamans and lamas, and often asked for advice from them before conducting campaigns or hunting activities.[401]

More information about the planting along the roads and Grand Canal can be found in Rashīd al-Dīn Fadl Allāh's (1247–1318) *Jami al-Tawarikh*. 'The Great Khan ordered the building of a big canal…barges travel from Khanbaliq (Beijing), passing Quinsai (Hanzghou) and Zayton (Quanzhou) […] it only took forty days…Along the canal, there is a wide road connecting Khanbaliq. It is paved with stones, to prevent the livestock's feet from being trapped in the mud. On both sides of the road willow trees and other trees are planted, which covered the entire road with shade. No one, no matter military men or others, would dare to break one single branch of those trees, or feed their livestock with one single leaf.'[402]

The Grand Canal replaced by sea transport

As discussed earlier, the lack of water supply was the biggest obstacle to the management of the Grand Canal throughout the Yuan Dynasty. Although a great deal of effort was put into diverting the water from the Si and Wen River to the Hui Tong River, the challenge of the summit point in Jining city still could not be completely overcome. After the new route was completed, the annual amount of tax grain that arrived to the capital via the Grand Canal was only two to three hundred thousand *dan*,[403] far less than the three million plus *dan* of grain that used to be shipped annually by sea.[404] Kublai realized the need to reuse the sea transport

400 Polo, p. 249.
401 Dang Baohai, 'Hu Bi Lie De Zhi Shu Fa Ling (The Tree-planting Policy of Kubilai)', *Institute of Chinese History Research at the Peking University Online E-paper* (2016) <http://chuansong.me/n/2648652> [accessed 4 July 2016] (para. 2).
402 Ibid., (last paragraph). Translated by author.
403 Wang, p.15.
404 Song, http://ctext.org/wiki.pl?if=gb&chapter=625167 [accessed 1 July 2016]

again, especially as the Yuan had made considerable progress in nautical development. However, a carefully made plan was needed in order to avoid previous problems.

In 1293, after several failed attempts, Yin Ming, a former Song official who then served the Yuan court, suggested a new sea route after he himself led the fleet and tested its feasibility. The new route was to depart from Liu Jia Gang (belonging administratively to Su Zhou city), and travel east, entering Hei Shui Sea (now the Yellow Sea), arriving in Tian Jin by passing the Shandong coastline. From here the grain could be moved from the sea ships to canal boats for the final journey to the capital. This new sea route proved to be the most practical, and the whole trip only took about ten days in total if the wind helped.[405]

From the map below we can see that the new route was more direct than the other two routes developed earlier: it was further away from the coastal area compared to the other two, avoiding the possibility of ships being stranded there. This was a common problem with sea transport at that time, as big ships with heavy goods were harder to move once they were close to the coastal area. Zhou Mi (1232-1298), a scholar, explained the difficulty: 'between Zhang Jia Bang and Yan Cheng there are eighteen sandbanks. If a sea-going junk should go around, the cargo of grain must be thrown overboard to lighten her. If the ship still cannot be moved, rafts of timber should be prepared to save the lives (of the crew), for she will go to pieces and give no protection.'[406]

[405] Song, http://ctext.org/wiki.pl?if=gb&chapter=625167 [accessed 1 July 2016]
[406] Zhou Mi, *Kui Xin Za Shi (Miscellaneous Information from Kuixin Street)* (Beijing: Zhong Hua Shu Ju, 1988), Hai Qu (Ligia), p. 157. Translated by Joseph Needham, from the Science and Civilization of China, Vol. 4, p. 644.

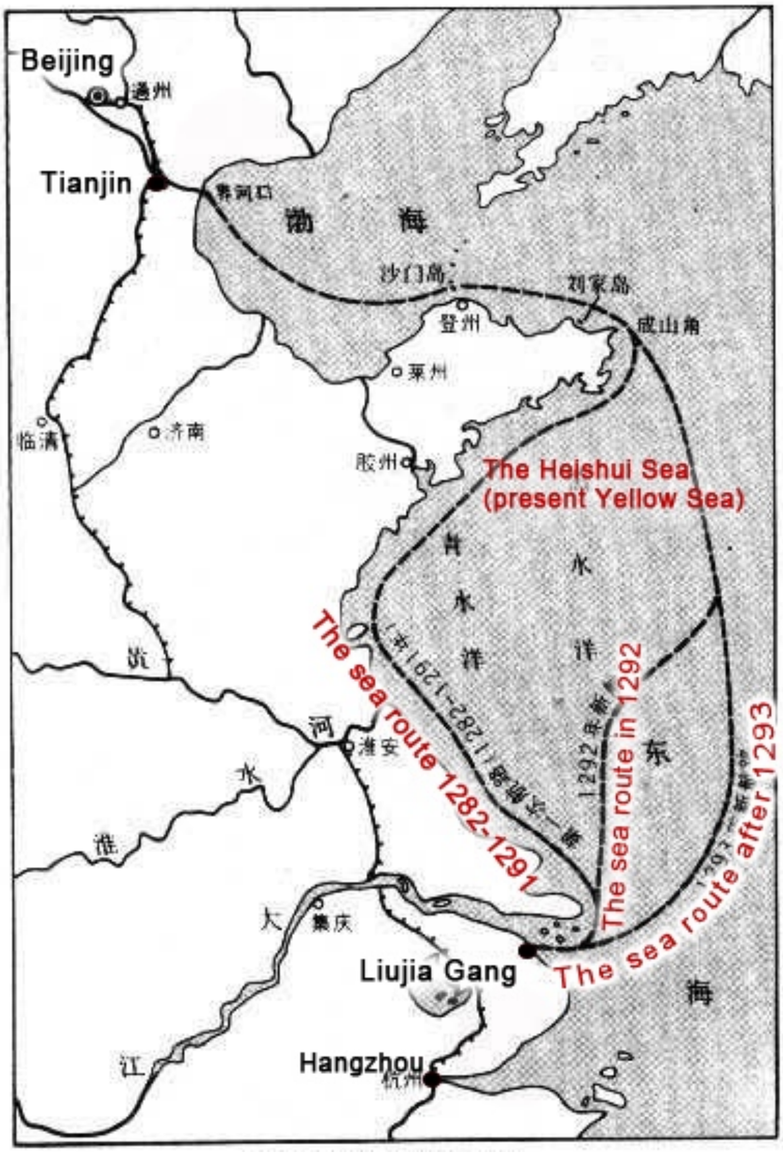

Figure 3. 19 The map shows the three different sea routes utilized in the late thirteenth century, of which the last, developed in 1293, was thought to be the most practical. It served as the main tax grain transport artery for the remainder of the Yuan dynasty. Source: unknown, 'yuan dai hai yun (Sea Transport during the Yuan Dynasty)', *China Encyclopedia* (2016) http://www.chinabaike.com/article/316/327/2007/2007022258353.html [accessed 4 July 2016], English translation by author.

This new route then served as the main tax grain transport artery for the rest of the Yuan Dynasty; although accidents caused by storms still happened almost everyday,[407] the Yuan government seemed to be very determined to develop its sea transport, which was thought to be easier to manage and need lower investment. With the improvement of sea transport of

[407] Song, http://ctext.org/wiki.pl?if=gb&chapter=625167 [accessed 1 July 2016]

tax grain, the Grand Canal became only an auxiliary method of grain transport, and the quantity of grain shipped to the capital on it only counted for one tenth of the amount shipped by sea. The Grand Canal was not been seen as a significant waterway for grain transport again until the Ming Dynasty.

Another factor that helped the sea transport replace the canal route was the astronomical knowledge that developed during the Yuan Dynasty. Because of its territorial expansion, the Yuan court had significant interaction with the Middle East; many Persian and Arabic scholars came to the East increasing the exchange of culture and knowledge, including their astronomy studies. Guo Shoujing was believed to have learned from the work of Arabic astronomers while making his *shou shi li* 授时历 (Calendar for Fixing the Seasons) for Kubilai.[408]

Chinese shipmasters had long been observing the tides, winds and weather to aid their nautical activities, and using stars and sun as landmarks in seeking direction. In 1103, a kind of Sighting Tube called *wang tong* 望筒 was recorded in the book *Ying Zao Fa Shi* (Treatise on Architectural Methods). It was used for observing the position of the true pole and the circular motion to help find directions (Figure 3.20).[409] In 1129, while Lin Zhiping the Supervising Censor was taking charge of the defences of the Yangzi River and the sea, he requested the sea ships to be equipped with *wang dou* 望斗 (Dipper Observer)'[410]. The *wang dou* is believed to be similar to *wang tong*, and both were used to study the positions and altitudes of the stars of the Great Bear in order to ensure accurate navigation.[411]

408 Lane, pp. 813-814.
409 Li Jie, *Ying Zao Fa Shi* (Treatise on Architectural Methods) (Si Ku Quan Shu Ben, 1780), Vol.3, pp. 2-3.
410 Xu Song, *Song Hui Yao Kao* (Drafts for the History of the Administrative Statutes of the Song Dynasty) (Beijing: Zhong Hua Shu Ju Ying Yin Ben, 1957), pp. 31-32.
411 Needham, pp. 575-576.

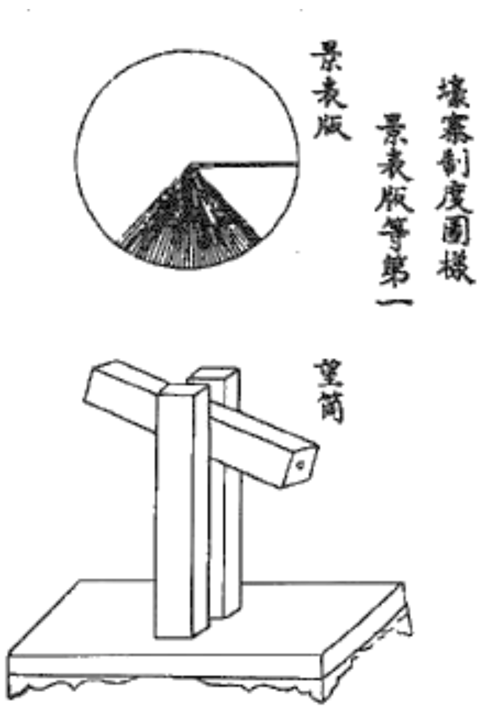

Figure 3. 20 The *wang tong* 望筒 (Sighting Tube) and quadrant from the early twelfth century. The tube was 1.8 chi long and 0.3 chi wide, with lens diameter 0.05 chi. At night, the tube to the south would be moved until the pole star could be seen; one could then attach ropes to each end of the tube, and the two points where the ropes reached the floor would provide accurate north and south directions. Source: Li, pp. 2-3.

One of the most significant inventions during this period was the *qian xing shu* 牵星术 (the guiding stars method), which was to find the latitude at sea by locating the position of the stars. The way to do this was to measure the latitudes of the pole star and other stars using units of *zhi* 指(finger-breadths) and *jiao* 角 (parts).[412] The sailors only needed to follow the instructions using their fingers as aids. For example, it was said that the *bei chen* 北辰 (Pole Star) is at one *zhi* above the horizon, the *hua gai* 华盖(Imperial baldachin star) is at eight *zhi* above the horizon, while the *zhi nv* 织女(weaving girl star) is 11 *zhi*.[413] These are only a small example of how to use the stars as guides, and a more detailed account can be seen in the illustration. This shows one of the diagrams Zheng He (1371－1433) and his fleet were

[412] Needham, pp. 566-567. It needs to be noted here that one 'jiao' equals to a quarter of one 'zhi'.
[413] Mao Yuanyi, *Wu Bei Zhi* (Treatise on Armament Technology or Records of Armaments and Military Provisions) (Gu Ke Ben 1661-1672). Texts are from the four navigational diagrams in Chapter 240.

given as a guide before their trip to visit foreign countries in the early fifteenth century.[414]

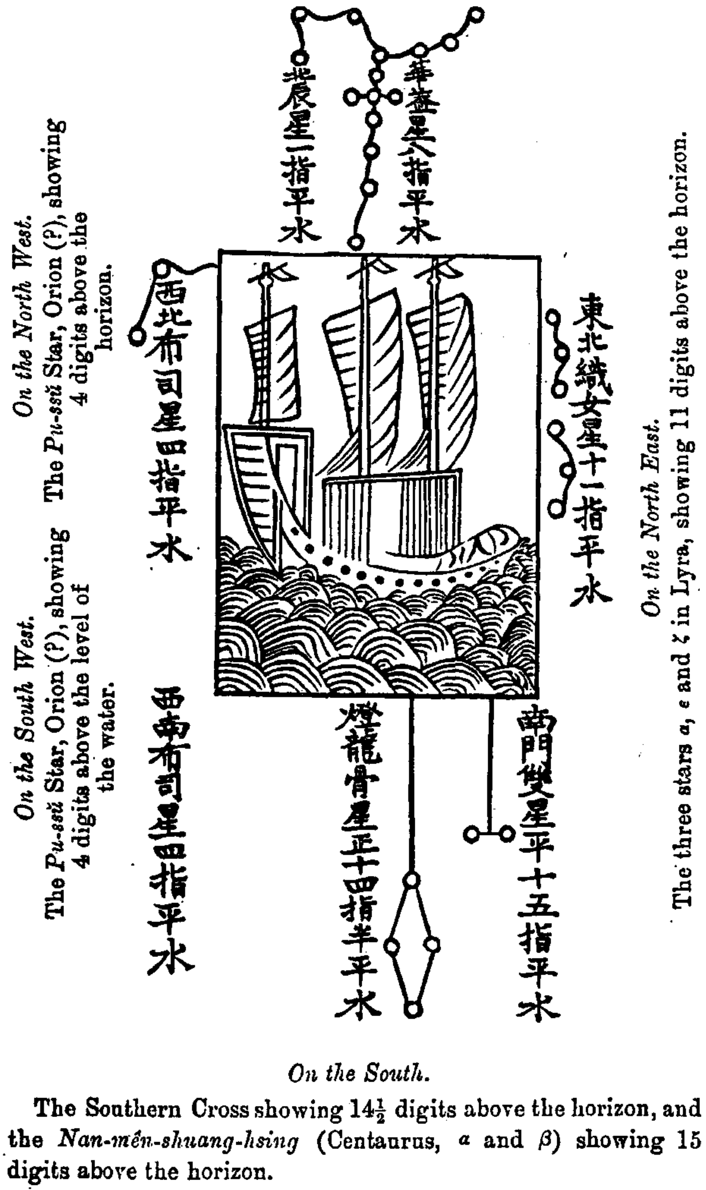

Figure 3. 21 One of the four stellar guides originally from the book *Wu Bei Zhi* 武备志 given to Zheng He and his fleet for their return from Ormus to Kozhikode in the early fifteenth century. This explained the guiding stars of the five directions (north, south, southwest, northwest and northeast). Source: Needham, p. 566. Fig. 994.

The *qian xing han* 牵星板 (guiding star stretch-boards) were invented to assist in the use of the stars as a guide. Li Yu (1505-1592), a Ming scholar, described this device as containing:

[414] Needham, p. 566. Zheng He was a mariner and diplomat of the early Ming Dynasty, who traveled to the Southeast Asia, South Asia, Western Asia and East Africa between 1405 and 1433 under the order of Emperor Chengzu of Ming.

'twelve plates in all, made of ebony, ranging gradually from small to large. The largest is more than seven *cun* (1 *cun* roughly equals 3 cm) long. They are labeled 'one zhi', 'two zhi' etc., up to 'twelve zhi', all marked in fine script upon them; and they differ regularly just as a cun is divided into fen. There is also one ivory piece, two cun long, and cut off at the corners so that it indicates half a zhi, half a jiao, one zhi and three jiao. This may be turned on one side or another facing you (in conjunction with one of the larger plates), and these lengths must be the measurements (required for right-angle triangle calculations according to the methods of the) Zhou Bei'.[415]

The earliest evidence of the utilization of the guiding star method comes from 1403. Historians have argued that since the method recorded in *Wu Bei Zhi* was very developed and detailed, it is very likely that it had been used and improved by the Yuan and even the Song dynasty.[416]

Apart from observing the stars and the sun, other methods were used by Chinese sailors to orient themselves while travelling by sea, such as the use of the device *luo pan* 罗盘 (compass). Zhu Yu, a scholar of Song, said that 'shipmasters are well acknowledged in geography, they observe the stars during the night, and observe the sun during the day, when it is cloudy they used the *zhi nan zhen* 指南针 (*luo pan*, compasss) instead'.[417]

The oldest form of compass was in a spoon shape and made of lodestone which could rotate on a bronze plate. It was found that the lodestone could be replaced by a small piece of iron or steel that was attracted to it, which could also be made to float on the surface of water in other devices. This kind of floating compass was the earliest form used for maritime travel, and by the tenth century it had evolved to a magnetized needle floating on water in a small

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415 Li Yu, *Jie An Lao Ren Man Bi* (An Abundance of Jottings by Old Mr. Jiean), finished in 1606. Translated by Joseph Needham from *The Science and Civilization of China*, Vol.4, pp. 574-575.
416 Needham, p. 575.
417 Zhu Yu, *Ping Zhou Ke Tan* (undated), Chinese Texts Project Online Library, http://ctext.org/wiki.pl?if=gb&chapter=57805#p5 [accessed 6 July 2016] (para. 4). Translated by author.

cup. As the needle was magnetized, it could move freely in water and always pointed to the earth's magnetic poles despite the movement of the ship.[418]

The floating compass became one of the most common devices used for navigation, with the assistance of compass-bearings. The compass-bearings usually had twenty-four needle positions, which were formed by eight 天干 *tian gan* (Heavenly Stem), twelve 地支 *di zhi* (Earthly Branch) and the four of the directions of 八卦 *ba gua* (Chinese eight trigrams). The mariners would carry the compass bearings for their navigation activities, and could choose to place one or two needles on it. When there were two, the direction would be taken as the centre between the two needles. In this case, the compass-bearings would be considered to have forty-eight positions rather than twenty-four.

A clear passage of the forty-eight-position compass-bearings was made by Zhou Daguan, when this Yuan official travelled to the Khmer Empire in 1296. He said that 'after departing from the Whenzhou harbour, we followed the 丁未 *Dingwei* (equivalent to 22.5 degree SW.) position, and arrived at Champa (in Vietnam) by passing various harbors in Li Min and Guang Hai… then we took the needle direction of 申昆 *Shen Kun* (52.5 degree SW) after arriving at Baria and entering the Kunlun Sea'.[419] Information about the compass of the Yuan era comes from texts rather than illustrations, though we have pictorial evidence from the two pictures, below, made in the Ming dynasty.

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418 Needham, pp. 562-563.

419 Zhou Daguan, *Zhen La Feng Tu Ji (The Customs of Cambodia)* (undated). Introduction. Wiki Source Online Library: https://zh.wikisource.org/zh-hans/真臘風土記 [accessed 10 June2016]

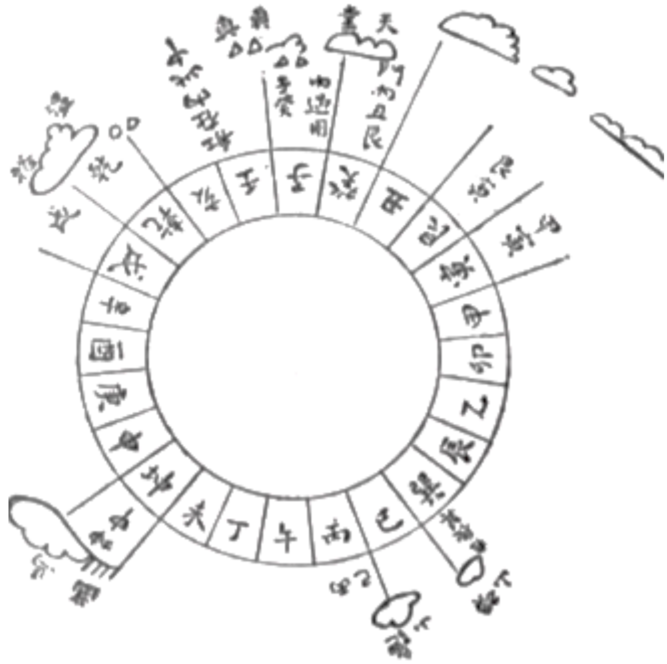

Figure 3. 22 The picture shows the twenty-four positioned compass-bearings used for navigation used during the Ming dynasty, which is believed to have been used since the late thirteenth century. Source: Han Zhaoqing, ‘Studying the History of Senkaku Island from the Chinese Maps drew by European pre-Sino-Janpanese War (Part 2)’, *Studies of Maritime History* (2016) <http://mp.weixin.qq.com/s?__biz=MzIyNzEzMDIzOA==&mid=402312883&idx=1&sn=e7934b4d81b4ee039b11d94ac95ed6c4&scene=4#wechat_redirect> [accessed 10 June 2016]

There is also evidence to show that a kind of dry compass was invented in the thirteenth century, which inserted the lodestone into a piece of wood with pointed ends. It was attached to the top of a standing pin until it floated or balanced. It does not seem to have been widely produced or indeed used.[420]

[420] Needham, p. 563.

Conclusion

This chapter critically reviews how the Grand Canal route was slowly straightened from the previous Sui Canal, to its current alignment. Although the Grand Canal was being modified extensively, it in fact did not serve as the main grain transport artery during the Yuan Dynasty, due to a lack of water supply. The main route for shipping royal grain at the time was by sea.

However, this fact about the Grand Canal's history does not seem to be mentioned in most contemporary Chinese studies, which instead focus on the significance of the canal, and ignore the fact the Grand Canal was not considered to be an important transport artery until the sixteenth century. This omission might be purposely misleading, especially when the Grand Canal has been claimed to be 'the greatest masterpiece of hydraulic engineering in the history of mankind', according to its nomination statements.

In addition, through the examination of the making of the Sui Canal, as well as the two new channels- Hui Tong River and Tong Hui River which were completed during the Yuan era, a conclusion can be drawn that the Grand Canal is not entirely an artificial waterway. Most of the channels were, in fact, natural rivers which were often regularised, for example, the Hui Tong River made use of the existing Ji Zhou River, and the Tong Hui River was connected with an old waterway built in the Jin Dynasty. This suggests that the statement that 'the Grand Canal is the longest canal in the world', made by the state party, is inaccurate, as the number of artificial channels of the Grand Canal are actually few.

Chapter Four. The Grand Canal as the lifeline of Imperial China (sixteenth to eighteenth centuries)

This chapter focuses on the heyday of the development of the Grand Canal from the sixteenth century to the eighteenth century. Particular attention will be paid to the study of the rapidly developing river work during this period, especially on how the Grand Canal eventually overcame the topological challenge and started to serve as the main route for grain shipment.

In terms of the historic sources used in this chapter, the official historic records of the Ming and Qing Dynasty - *Ming Shi* (History of Ming) (1784)[421] and *Qing Shi Gao* (Draft History of Qing) (1927)[422] were the main documents used to explore the social and political context of the reopening of the Grand Canal. There are many more sources available for the study of the river work of this period compared to earlier chapters, due to the fact that many original texts have been preserved. The work of Pan Jixun and Jin Fu was closely examined, resulting in the realisation that they were the most significant river engineers of their time due to their advancement of the knowledge base of traditional river work. Pan's own book *he fang yi lan* (General View of Water Control) (1780)[423] provided a first-hand source to study his water control methods and was furthered by Jin Fu's subsequent contribution, entitled *he fang zou ji shu* (Book of the Achievement of Water Conservancy) (1784).[424] In addition, the book *wen shang xian zhi* (Gazetteer of Wenshang County) (1717)[425] provided understanding of the engineering methods used for the Nanwang water division project, which overcame the water supply challenges of that section.

Additionally, the invention of *qian chuan* (shallow-drought canal barge) in the late fourteenth century, which was thereafter used as the main type of grain shipping barge on the Grand Canal to adjust to its shallow water level, was studied mainly through the historic book *tian*

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421 Zhang Tingyu, *Ming Shi* (History of Ming) (ying wu dian ben er shi si shi, 1784), Chinese Texts Project Online Ebook, http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb [accessed 1 July 2016]
422 Zhao Erxun, *Qing Shi Gao* (Draft History of Qing), 1927, Chinese Texts Project Online Ebook, http://ctext.org/wiki.pl?if=gb&chapter=844552&remap=gb#p18 [accessed 30 June 2016]
423 Pan Jixun, *he fang yi lan* (General View of Water Control) (Qin Ding Si Ku Quan Shu Ben, 1780).
424 Jin Fu, *he fang zou ji shu* (Book of the Achievement of Water Conservancy), Yingyin Wenyuange Si Ku Quan Shu Ben, 1784. Vol.4.
425 Li Keshi, *shang xian zhi* (Gazetteer of Wenshang County) (Kangxi 56 Nian (1717) Ke Ben). Chapter 6 Personage 12.

gong kai wu (The Exploitation of the Works of Nature) (1771).[426] This source gifted the author details of the structure and dimensions of this type of boat. Furthermore, the relationship between the canal and the surrounding environment, including the canal-side settlements, were explored through the travel accounts *An Authentic Account of an Embassy from the King of Great Britain to the Emperor of China* (1797),[427] which provided a detailed description of the appearance of canal-side reclaimed lands.

In relation to historic maps, the historical book *huang yun he kou gu jin tu shuo* (An Illustrated Essay on the Yellow River-Grand Canal Confluence from Former Times to the Present) (1841)[428] provided a number of maps showing how the routes of the Yellow River and Grand Canal changed over time. Illustrations from the book *he gong qi ju tu shuo* (Illustrations of Tools for River Works) (1994),[429] helped to explain the range of traditional tools used to build locks (Figure 4.19). Two maps from 1703 provided pictorial evidence of the large numbers of willow trees planted along the northern section of the Grand Canal, which were obtained from the book *the Collection of the Qing Dynasty Maps at the Tianjin Library* (2007).[430] These sources also further support the hypothesis that the type of willow trees planted along the canal's northern section was primarily Chinese willows instead of the weeping willows, as already discussed in Chapter Two.

In reference to modern literature, The *Cambridge History of China* (1988)[431] was an important source to examine this part of the canal history from a Western perspective, in order to obtain a more balanced viewpoint in combination with Chinese writings. Lu and Liu's article (2015)[432] explained the engineering techniques used for the Nanwang water division project through the lens of contemporary understanding. While in regards to the design of the embankment and dredging of the canal, as well as the aforementioned *Ming Shi*,

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426 Song Yingxing, *tian gong kai wu (the exploitation of the works of nature).* Tokyo: Lang Hua Shu Lin, 1771, Vol.2.
427 George Staunton, *An Authentic Account of an Embassy from the King of Great Britain to the Emperor of China* (London: printed by W. Bulmer and Co. for G. Nicol, 1797).
428 Lin Qing, *huang yun he kou gu jin tu shuo (an illustrated essay on the Yellow River-Grand Canal confluence from former times to the present)* (dao guang er shi nian ben, 1841).
429 Lin Qing, (ed.) Pengju Cheng, *he gong qi ju tu shuo (illustrations of tools for river works)* (Zhengzhou: He Nan Education Press, 1994).
430 *Shui Dao Xun Wang- Tianjin Tu Shu Guan Cang Qing Dai Yu Tu Xuan (The Collection of the Qing Dynasty Maps at the Tianjin Library)* (Beijing: Renmin University Press, 2007)
431 Denis C. Twitchett (ed.), *The Cambridge History of China, Volume 7, Part 1, The Ming Dynasty, 1368–1644.* (Cambridge: Cambridge University Press, 1988).
432 Lu Yong and Liu Qizhen, 'Hydraulic Engineering techniques for Nanwang Water-Division Hydro-Junction of the Grand Canal in Early Ming Dynasty', *Anhui History Studies,* 2(2015), 57-59.

the book *Science and Civilisation of China* (1971)[433] supplied useful information about the evolution of dredging tools used for the Grand Canal.

In addition, Qian's article (2012)[434] provided an overview of Pan Jixun's contribution to river engineering development during the Ming dynasty and Wang's article *Qing Dynasty for the Designing of the Locks and Culverts* (1935)[435] provided a very detailed account of the different type of traditional techniques to build a canal lock, such as *zhuang gong* (piling), *shi gong* (stonework), *zhuan gong* (brickwork) and *tu gong* (earthwork).

For the planting along the Grand Canal, willow-planting is the focus of this chapter, as it was not only used to improve the canal-side landscape, but most importantly to strengthen the embankment. Li's doctoral thesis *Engineering, Environment, Society: the River Work and its Impact along the Yellow River and the Grand Canal during the Ming and Qing Dynasty* (2008),[436] provided valuable information of the central government's willow planting policies at the time. Also, the different techniques to plant willow trees were explored through Jia's article (2002)[437], as well as Pan's book *he fang yi lan*.

Lastly, the position of the Grand Canal within the local environment is considered carefully; this includes its relationship with the Yellow River, and the surrounding landscape. For the Yellow River aspect, Wright and Ma's article (2013),[438] revealed the state's policy aim to protect the grain shipment on the canal at all costs, which resulted in flood threats shifting to local residents and land. Information from Li and Wang's book *Shandong Yunhe Wenhua Yanjiu* (Studies of the Canal Culture of the Shandong section) (2006)[439], together with the author's interviews with local people, helped to rebuild the history of how the canal-side towns used to be much better developed than at present times, due to their convenient access

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433 Joseph Needham. *Science and Civilisation in China. Volume 4, Part 3* (Cambridge: Cambridge University Press, 1971).

434 Qian Hanjiang, 'Pan Jixun-Ming Dai He Gong Di Yi Ren (Pan Jixun- the Best River Work Engineer in the Ming Dynasty)', *Chinese Natural Disaster Reduction*. 185(2012), 48-50.

435 Wang Biwen, 'Qing Dynasty for the Designing of the Locks and Culverts', *BSRCA*, 6(1935), 51-72.

436 Li Denan, *'Gong Cheng, Huan Jing, She Hui: Ming Qing Huang Yun Di Qu De He Gong Ji Qi Ying Xiang (Engineering, Environment, Society: the River Work and its Impact along the Yellow River and the Grand Canal during the Ming and Qing Dynasty)'* (published doctoral thesis, Fudan University, 2008).

437 Jia Naiqian, 'Ming Dai Ming Chen Liu Tian He De Zhi Liu Liu Fa (The 'Six Method of Planting Willows by Liu Tian He the Ming Official)', *Agriculture Archaeology*, 3(2002), 215-218.

438 Tim Wright and Ma Junya, 'Sacrificing Local Interests: Water Control Policies of the Ming and Qing Governments and the Local Economy of Huaibei, 1495-1949', *Modern Asian Studies,* 47(2013), 1348-1376.

439 Li Quan and Wang Yun, *Shandong Yunhe Wenhua Yanjiu (Studies of the Canal Culture of the Shandong section)* (Jinan: Qilu Shushe, 2006).

to the canal transport.

Even though more written evidence is available to study the traditional river engineering for this period, including both historic and modern literature, most of these sources fail to provide clear pictorial information, which is key explaining changes and techniques. Therefore, to fill this gap, a number of illustrations, based on written descriptions, have been created by the author, to help interpret the traditional river work in a clearer way. These drawings include Pan Jixun's embankment building methods (Figure 4.7 and 4.8), the construction and techniques of canal locks (Figure 4.11, 4.15-4.18), and the traditional willow planting techniques (Figure 4.21). This makes a contribution to the study of traditional hydraulic engineering by increasing the access and understanding of these techniques to a wider audience.

The socio-political context

From the end of Yuan rule to the rise of the Ming Dynasty (1368-1644)

The first foreign dynasty to rule China, the Mongol Yuan dynasty (1271–1368), made a large contribution to Chinese territorial expansion, though the Yuan era was rather short: it began to decline less than a century after it was founded. A series of projects were carried out, including printing a new issue of paper currency and redirecting the watercourse of the Yellow River. This allowed it to flow back into the sea by the Shangdong peninsula, with the aim of increasing revenue and controlling flooding.[440] However, the extremely heavy river work put another burden on peoples' shoulders, and the river workers started to revolt.[441] The scale of this unrest increased when one of the rebel powers, White Lotus, tried to gain support by saying, 'whoever challenges the Yellow River will be toppled by people',[442]

[440] Twitchett and Franke, *The Cambridge History of China, Volume 6,* pp. 575-576.
[441] Ibid., p. 576.
[442] Feng Xianzhi, *Zhong Guo Li Dai Zhong Da Zhan Zheng Xiang Jie: Yuan Dai Zhan Zheng Shi (A Detailed Account of the Important Wars of Imperial China: the Warfare History of the Yuan Dynasty)* (Changchun: Jilin Wen Shi Chu Ban She,

which encouraged more river workers to join the uprisings.

From the second half of the fourteenth century, the rebels led by Zhu Yuanzhang (1328-1398), who later founded the Ming Dynasty, quickly grew stronger in southern China, from their base in Nanjing.[443] Yuanzhang created a government at Nanjing in 1356, and renamed his capital 应天 *Ying Tian* (in response to Heaven), implying that his leadership was legitimized by a mandate from Heaven.[444] In 1363, Zhu Yuanzhang managed to beat his last enemy, Chen Youliang in a massive naval battle on Poyang Lake, ensuring his control over southern China.[445] He sent troops towards Beijing in 1368, and declared that he was in control of all of China after the Yuan emperor fled to the summer capital Shang Du in the same year.[446] Yuanzhang established the Ming Dynasty (1368–1644), and kept his capital in Nanjing, where he had his military base and his primary resources.[447]

It is worth noting that even after years of internal conflict between the Yuan army and various regional powers, the south had maintained the growth of its economy, in contrast with northern China where people were starving and angry.[448]

Moving the capital back to Beijing and the reopening of the Grand Canal

Once the Ming dynasty was established, the capital Nanjing received more than enough food from the productive land nearby, but supplying the troops on the northern frontier remained a problem. The Grand Canal of the Yuan dynasty was almost abandoned, with many sections

2014). http://www.dsryd.com/chapter/715377 [accessed 6 July 2016]

443 Twitchett and Franke, *The Cambridge History of China, Volume 6,* p. 581.

444 Ibid., p. 47.

445 Zhang Tingyu, *Ming Shi (History of Ming Dynasty)* (ying wu dian ben er shi si shi, 1784), Chapter 1, Taizu Yi (Zhu Yuanzhang Part One). Chinese Texts Project Online Ebook, http://ctext.org/wiki.pl?if=gb&chapter=883013&remap=gb#p13 [accessed 1 July 2016] (Line 17).

446 Ibid., http://ctext.org/wiki.pl?if=gb&chapter=390514&remap=gb#p2 [accessed 1 July 2016] (Line 1).

447 Ibid.

448 Ibid.

silted up, so the canal could not be utilized to ship supplies.[449] There were two attempts to increase the grain supply to the northern frontier.

The first was the development of *jun tun* 军屯 (Military Farms) to allow the army to support themselves. They were intended to reduce the need for grain shipments, but there was difficulty in balancing manpower between military activity and farming duties. The second attempt relied on *kai zhong fa* 开中法 (the Middlemen Method), selling salt trading certificates to merchants. In exchange for shipping a fixed amount of grain to the border garrisons, merchants were allowed to collect a certain amount of salt to sell in designated markets. This strategy was foiled by bureaucrats who tried to obtain benefits for themselves, selling salt certificates to merchants privately, which gradually reduced imperial revenue.[450]

The idea of moving the capital back to Bei Ping (the name for Beijing during the Ming era) from Nanjing formed slowly during the early fifteenth century. Zhu Yuanzhang decided that his grandson Zhu Yunwen (1377-1402), rather than his son Zhu Di (1360-1424), should be his successor,[451] because he considered Zhu Di to have an ambitious and arrogant personality.[452] When Zhu Yunwen became the second emperor of Ming, Zhu Di was given the title of the Prince of Yan and territory of Bei Ping as well as his own armies after he started displaying military acumen.[453]

In 1399, Zhu Di initiated civil war against Zhu Yunwen, which ended when the young emperor, together with his family, were burnt to death inside the royal palace in Nanjing. Zhu Di assumed the throne as the Emperor Yongle (1402-1424) in 1402.[454] Following this, the administrative centre moved to the north, which the Emperor Yongle saw as his own power

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449 Denis C. Twitchett (ed.), *The Cambridge History of China Volume 7, Part 1, The Ming Dynasty, 1368–1644* (Cambridge: Cambridge University Press, 1988), pp. 249-250.
450 Li Longhua, 'Ming Dai De Kai Zhong Fa', *Journal of the Institute of Chinese Studies of the Chines University of Hong Kong,* 4:2 (1971), 371-393 (pp. 380-381).
451 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=127966&remap=gb [accessed 6 July 2016]
452 Twitchett (ed.). *The Cambridge History of China, Volume 7,* pp. 193-194.
453 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=569966&searchu=%E5%8C%97%E5%B9%B3&remap=gb [accessed 6 July 2016]
454 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=127966&remap=gb [accessed 6 July 2016]

base He had been responsible for the administration of this region for so many years, and Nanjing was considered too far from the northern frontiers[455]. In 1420, after dealing with complicated institutional arrangements as well as the reconstruction of the new palace, Beijing became the Ming capital.[456]

One important fact which was taken into account when the capital was moved to Beijing was the old problem, that the new capital would need to rely on the regular shipment of grain from the fertile lands in the southeastern region. At this time the main grain transport route was the sea route, and the remodeled Grand Canal only a secondary artery. By the time the Ming capital moved back to Beijing, one third of the Hui Tong River had been badly silted up because of the poor maintenance in the late Yuan dynasty.[457]

The Ming Emperor did not really consider utilizing the sea transport as he thought it too dangerous: it contained too much unpredictable elements.[458] A reliable inland waterway would be ideal, and his thoughts turned to the Grand Canal. In 1411, the Assistant Administrator of Ji Ning, Pan Shuzheng, suggested the reconstruction of the Hui Tong River. His proposal was approved after the emperor sent the officials Song Li and Zhou Chang to conduct a site survey.[459]

The reconstruction of the Hui Tong River officially began in the February of the same year, under the watch of the Minister of the Ministry of Work, Song Li (1358-1422). 165,000 men from the canal side towns in Shandong were mobilized, and large numbers of troops worked as monitors.[460] The Ming government seemed to be very aware of the welfare of the labourers, having learnt lessons from the Yuan dynasty: they promised the workers that they

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455 Wu Han, Ming Dai Jing Nan Zhi Yi Yu Guo Du Bei Qian (The Jingnan War and the Capital Moving Northwards), *Tsinghua University Journal*, 20:4 (1935), pp. 919-923 (p. 920).

456 Twitchett (ed.), *The Cambridge History of China, Volume 7,* p. 238.

457 Gu Yingtai, *Ming Shi Ji Shi Ben Mo* (The History of the Ming Dynasty Topically Arranged) (Taipei: Taiwan World Press, 1985), Chapter 24, He Cao Zhuan Yun (River and Canal Transport) Chinese Texts Project Online Library, http://ctext.org/wiki.pl?if=gb&chapter=814879&remap=gb [accessed in 7 July 2016]

458 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb#p3 [accessed 6 July 2016]

459 Li and Wang, p. 16.

460 Ibid.

would be rewarded by both cash and grain, and excused the taxes they would normally have to pay. The whole project was completed in only 100 days.[461]

Most of the work involved was the dredging of the old course of the Hui Tong River, built in the Yuan Dynasty, with some widening and deepening wherever it was needed. The main section requiring digging was the 130-li-long (1 li roughly equals 550 metres) length between Yuan Kou and Zhang Qiu, 20 li east of the old watercourse. This modification was made in order to avoid the floods threats from the Yellow River, as the original course was closer to that river and the embankment could easily be destroyed when there was flooding. Anshan Lake, situated between the Yellow River and the new channel, could relieve part of the flooding entering the Grand Canal, though this has led to Anshan Lake silting up completely.[462]

Even after the Hui Tong River was renovated, there was insufficient water because of the hilly topography of Ji Ning. This had been the reason for the abandonment of the Grand Canal during the Yuan era. Song Li, the director of this project, understood that this difficulty had to be overcome completely to enable the canal to function, and he achieved it with help from a local country man, Baiying.[463]

There are several different accounts of Baiying's background. The most convincing one is that Baiying was the local community head of Wen Shang County, with a good knowledge of local geography and hydrology. There are also various stories about how an official of high rank met this old man: the most popular was that Song Li went to visit Baiying after he heard of him from locals while he was conducting fieldwork in Nan Wang.[464]

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461 Twitchett (ed.), *Cambridge History of China, Vol. 7,* p. 252.
462 Li and Wang, p. 17.
463 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb#p10 [accessed in 7 July 2016]
464 Li Keshi, *Wen Shang Xian Zhi* (Gazetteer of Wenshang County) (Kangxi 56 Nian (1717) Ke Ben). Chapter 6 (Personage 12).

Baiying suggested that the main water source of Hui Tong River, the Wen River, should be diverted to near Nan Wang town in place of the Guang River. It would supply the Hui Tong River; this was the method used during the Yuan dynasty. Bai's reason for this modification was that Nan Wang sits at the summit point, 8 metres higher than the previous point at which the Guang River joined the canal. If water was diverted to Nan Wang, it was more certain that water could then flow to the Hui Tong River.[465]

Song Li agreed with Baiying and quickly ordered the building of a dam on the Wen River, further west than the old dam. This was then used to divert water from the Wen River to the Guang River. With the establishment of the new *Dai Cun* Dam, the old one was abandoned: the water could flow further to the west until it was stopped by the new dam and diverted southeastward.[466]

The Xiao Wen River, one of the branches of the Wen River, was also reconstructed and used as a channel to convey water to the Hui Tong River. Considering the rapid current that would rush into the canal through this river, because the Wen sits 13 metres higher than Nan Wang town, its course was deliberately made very curved to slow down the current.[467] The Guang River still received water direct from the Wen River, supplying it to the Grand Canal; later it silted up and all the water was diverted to the Canal through the new channel.[468]

Water from over a hundred springs was also diverted to the canal through this channel (Fig. 4.4), which was why the Hui Tong River was sometimes called *Quan He* 泉河 (Canal of spring). And four *shui gui* 水柜 (which literally means water box, but means water reservoir in this context) were also built on the west side of the canal on Song Li's order, both store water supply and to release the pressure of flooding in the Grand Canal.[469]

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465 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb#p10 [accessed in 7 July 2016]

466 Lu Yong and Liu Qizhen, 'Hydraulic Engineering Techniques for Nanwang Water-Diversion Hydro-Junction of the Grand Canal in Early Ming Dynasty', *Anhui History Studies*, 2 (2015), 56-58 (p. 57).

467 *Wen Shang Xian Zhi (Annals of the Wenshang County)* [Qing Kang Xi Wu Shi Liu Nian Ke Ben (The carving copy of the fifty-sixth year (1717) of the Kangxi Reign)]. Vol. 1, Fang Yu (Region)

468 Lu and Liu, p. 58.

469 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb#p10 [accessed in 7 July 2016]

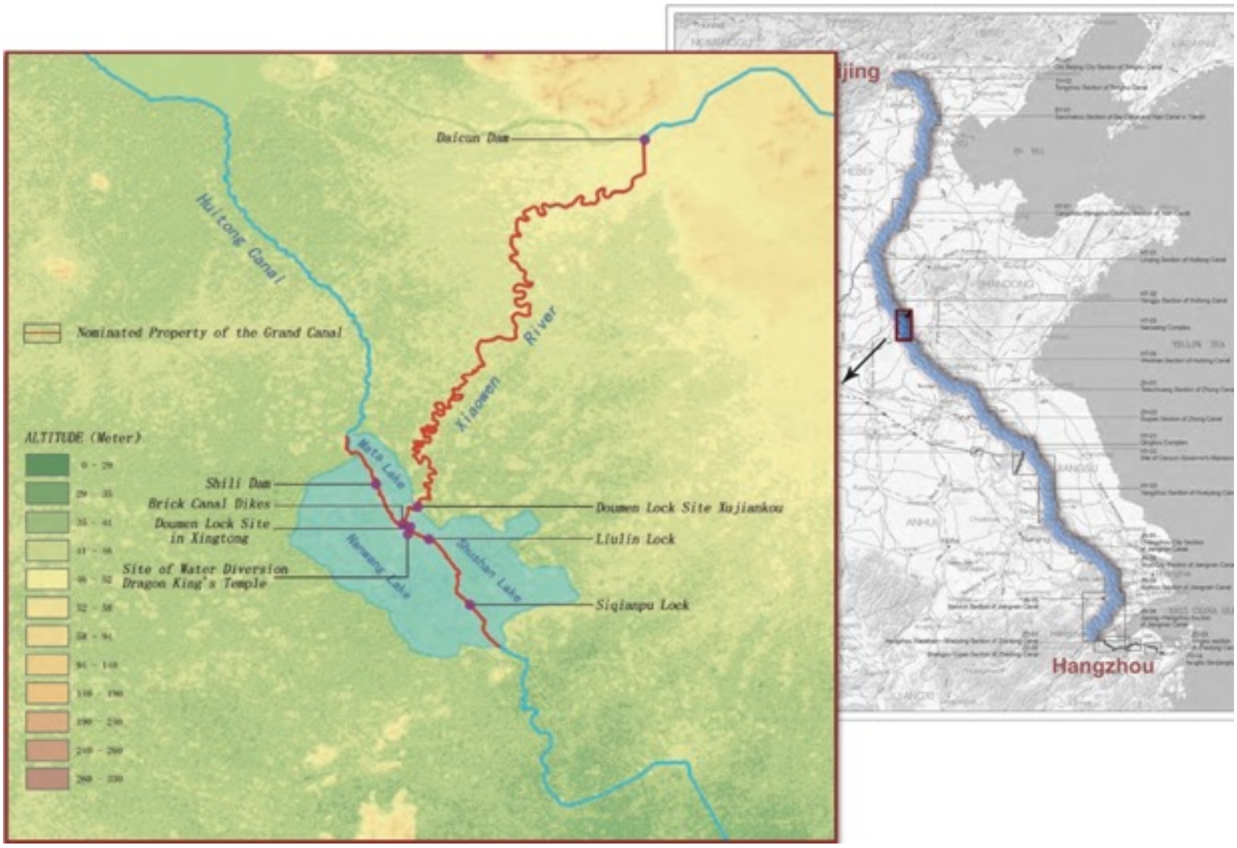

Figure 4. 1 The map shows the basic operating mechanism of the Nanwang water division project: the water of the Wen River was partly stopped by the Daicun Dam which is located at a higher altitude than the Nan Wang section (see the altitude table on the left); the water was sent to the canal through the water channel formed by the Xiaowen River. When the water arrived at the canal, it was directed into either the north or south section depending on the situation, by the operation of a pointed stone implement situated on the bank facing the Xiaowen River. Four *shui gui* (reservoirs called Nan Wang, Shu Shan, Si Qian and Mata Lake on the map) were constructed around the junction area between the Xiao Wen River and the canal, to discharge water during the flooding season and to supply the canal as necessary during the dry season. Willow trees were planted around the lake boundary in 1541 to prevent the land from being cultivated by local people.[470] Source: State Administration of Cultural Heritage of People's Republic of China, p. 293.

[470] State Administration of Cultural Heritage of People's Republic of China. Nomination documentation submitted to the World Heritage Convention Cultural Heritage, p. 293.

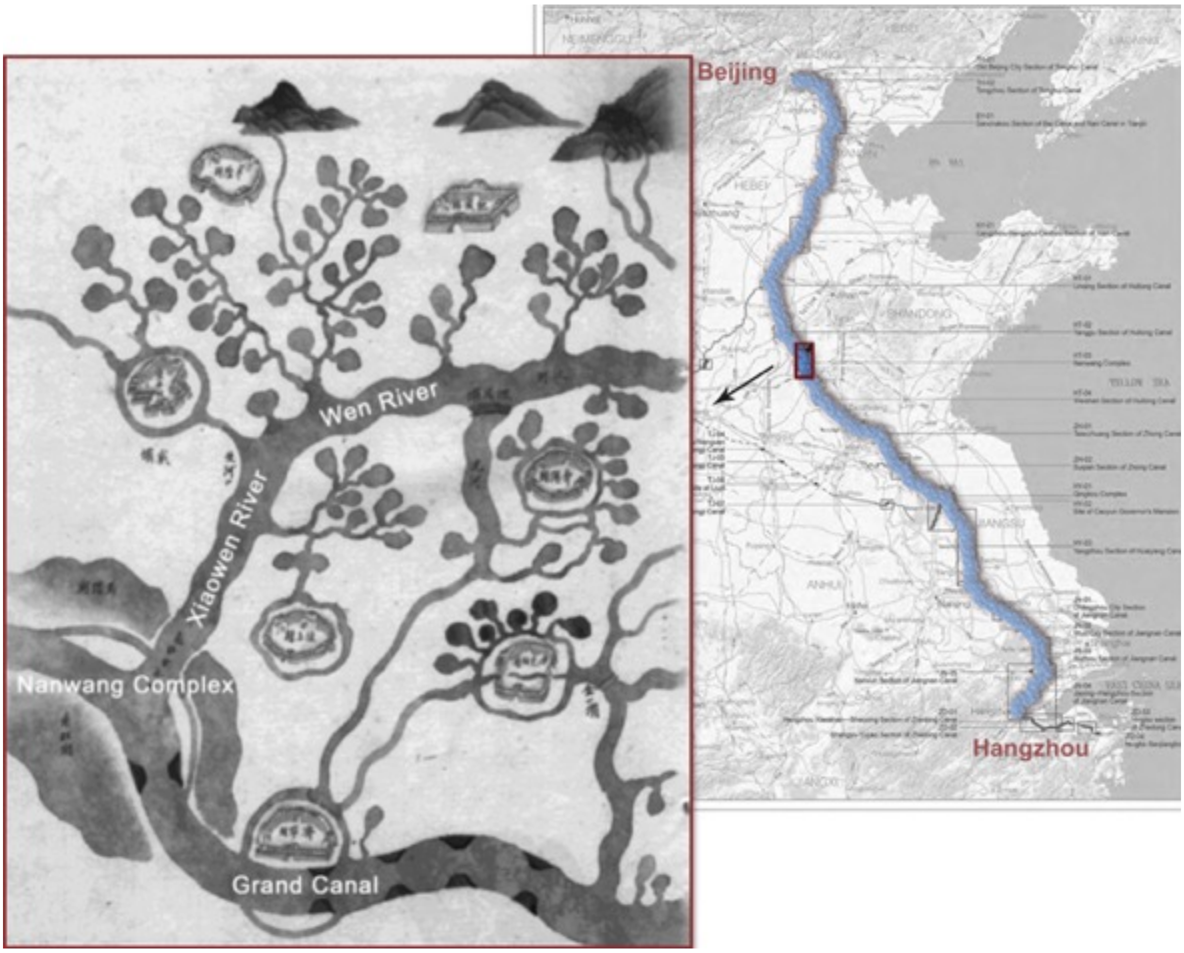

Figure 4. 2 Part of the painting *Wu Shui Ji Yun Tu* (Five Waterways Supplying the Grand Canal) of 1703 shows how the Nanwang complex was supplied by water from various rivers, lakes and springs. Source: The kep map on the right is originally from the normination documentation submitted to the World Heritage Convention Cultural Heritage (p.54), the painting is from *Shui Dao Xun Wang- Tianjin Tu Shu Guan Cang Qing Dai Yu Tu Xuan* (The Collection of the Qing Dynasty Maps at the Tianjin Library) Beijing: Renmin University Press, 2007, p. 70.

In order to prevent the rapid current from rushing into the Hui Tong River, destroying its embankment, a 4-metre-high and 220-metre-long stone embankment was built on the side facing the Xiao Wen River. At the base of this embankment, there was a pointed stone structure which could control the share of water flow going to the north and south. Because the northern section had a lower level of supply, more water from the Xiao Wen River was directed to the north than to the south, usually at a ratio of 6:4.[471]

[471] Lu and Liu, p. 58.

Diverting the water to Nan Wang town instead of Jining solved the water supply problem, and the Hui Tong River once again served for the grain transport.[472] Its watercourse was made to a uniform standard, 13 chi deep and 32 chi wide.[473] The Ming government also attempted to bring the Tong Hui River, which had not been well kept, back to life. Part of the river ran inside Beijing's newly built city wall, but it was never repaired or restored.[474] More effort was put into the section connecting Beijing to Tong Zhou, but this was only to repair its dams and locks, and the water level was hardly deeper than 2 *chi*. When grain was shipped there by barge, it had to be transferred to smaller barges to ship into the capital, and sometimes land transport would also be used.[475]

This does not seem to have been a big issue for the transport, and after the Grand Canal was reopened, the amount of grain shipped to the capital rose dramatically. In 1422, 5 million *dan* of grain arrived in Beijing, when 6 years before it had been only 2.8 million.[476] The amount of grain shipped to Beijing each year has not dropped below 5 million *dan* since then.[477] By that time the Grand Canal served as the main artery for grain transport for Beijing, Nan Jing, and for the troops on the northern frontier.[478] Matteo Ricci, an Italian Jesuit priest who came to China in the late sixteenth Century said, 'although Beijing does not produce anything, it lacks nothing'.[479]

To manage the remarkable amount of grain that was shipped to Beijing every year, large numbers of workers were recruited to work on its transportation. The grain transport was

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472 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb#p10 [accessed in 7 July 2016]
473 Fu Zehong, *Xing Shui Jin Jian* (Golden Mirror of the Flowing Waters) (si ku quan shu ben, 1773-1782), Vol. 106, Ming Tai Zong Shi Lu. Online library: Chinese Text Project. http://ctext.org/library.pl?if=en&res=5171 [accessed 13 July 2016]
474 Ying Lian, *Ri Xia Jiu Wen Kao (A Study of What is Old in Beijing)* [Qing Qian Long Wu Shi San Nian (1788) Wu Ying Dian Ke Ben]. Chapter 53, p. 16.
475 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=978226&remap=gb#p22 [accessed in 7 July 2016]
476 Twitchett (ed.), *The Cambridge History of China, Volume 7,* p. 255.
477 Wang Qiong, *Cao He Tu Zhi* (An Illustrated Account of the Grand Canal) (hong zhi jiu nian ben, 1496), Vol. 8.
478 Twitchett (ed.), *The Cambridge History of China, Volume 7*, p. 254.
479 Research Centre of the Ming Dynasty History at the Chinese Academy of Social Science (ed.), 'Li Ma Dou Ri Ji Xuan Lu (Selections from the Diary of Matteo Ricci)', in *Ming Shi Zi Liao Cong Kan (Historical Materials on the Ming Dynasty)*, 2 (1982), p.170.

mainly operated by troops, and about 120,000 permanent military men worked on it, with 11770 canal barges used.[480] Some 8000 boats were travelling on the Hui Tong River alone.[481]

Many *shui ci cang* 水次仓 (water-side granary)[482] were established along the canal to store grain collected from other areas before shipping to Beijing. The Ji Ning Granary, built in 1414, was one of the two state granaries. Three thousand barges carried the grain from the Huai An Granary in the south to this granary, from which it was later distributed to granaries near the capital, using another two thousand barges .[483]

In 1432, De Zhou Granary and Lin Qing Granary were built along Hui Tong River.[484] Located close to Beijing, these housed the grain from the south before its transfer to Beijing. This brought attention to these granaries, and the cities and towns where they were sited. More people came work there, so scale of these cities, including Lin Qing and Ji Ning increased rapidly.[485] The canal sides become a main artery for trade after the sixteenth century, and this north-south axis developed strongly in comparison to other areas in China.

The founding of the last imperial dynasty of China-The Qing Dynasty (1644-1912)

In the late Ming dynasty, the power of eunuch-officials increased, and there were problems including devastating floods on the Yellow River and other natural disasters which contributed to an economic breakdown. To protect the grain shipments on the Grand Canal from being threated by the flooding of the Yellow River, the river's was directed further south

480 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=780491&remap=gb [accessed in 7 July 2016]
481 Ran Yisan, Zhu Xiaoming and Wang Jiaobo, 'Walking along the Great Canal- an Investigation of the Heritage of the Historical Towns from Jiangsu through Shandong', *Tongji University Journal Social Science Section*, 18 (2007), 38-42 (p. 38).
482 *Shui ci* means the docks that were for loading the tribute grain. And *shui ci cang* means the granaries that were built along the Grand Canal for storing the tribute grain, first appeared in the book *Wei Shu (Book of Wei)*, written by Wei Shou (505－572).
483 Denis Twitchentt and Frederick W. Mote (ed.), *The Cambridge History of China* (Cambridge: Cambridge University Press, 1998), Vol 8, Part 2, p. 600.
484 Li and Wang, pp. 42-43.
485 Ibid., p. 82.

to the Huai River. This shifted the flood threat to the Huai Bei area (the area between the Huai and the Yellow River), causing terrible difficulty for the people who lived there.[486]

North of the border, Nurhaci (1559-1626) of the Jurchen Aisin Gioro clan in Manchuria (the area of present Ji Lin and Hei Long Jiang Provinces) reunited the Jurchen clans and founded the Jin dynasty (1616–1636).[487] They soon started to conduct military campaigns against China, and when Nurhaci's son, Huang Taiji (1592-1643) took over as leader, he succeeded in a series of battles against Ming and Li Zicheng's rebel armies at the beginning of the 1640s.[488] This led to the collapse of the Ming Dynasty, and the Qing Dynasty was established in 1644. Huang Taiji did not live long enough to enjoy his new position, as he died suddenly in 1643; his five-year-old son, Fulin (1638-1661), succeeded the next year and was known as the Emperor Shunzhi.[489]

The Qing dynasty retained Beijing as their capital. It had been very rare for a new dynasty to remain in their predecessor's capital, and this decision was made for a number of reasons. As with the Mongol Yuan dynasty, the Manchu Qing dynasty wanted their capital to be close to their homeland north east of Chinese border When the new dynasty was first established, they had not ensure their control of the southeastern region; and locating the capital close to the Mongolian steppe would help enhance the close collaboration between the Manchu and Mongols.[490]

As Beijing remained the centre of government, the Qing government directly adopted the grain transport system from the Ming dynasty: Beijing and the northern frontier still depended on this regular food supply from the fertile southern lands.[491] The canal route and

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486 Wright and Ma, p. 1356-1357.
487 Zhao Erxun, *Qing Shi Gao (Draft History of Qing)*, 1927, Ben Ji Yi (Basic Sketches of Emperors Part One). Chinese Texts Project Online Libarary, http://ctext.org/wiki.pl?if=gb&chapter=35726&remap=gb [accessed 10 July 2016]
488 Zhao, http://ctext.org/wiki.pl?if=gb&chapter=565474&remap=gb#p11. And Ben Ji Wu (Basic Sketches of Emperors Part Five) http://ctext.org/wiki.pl?if=gb&chapter=699620&remap=gb#p4 [accessed 10 July 2016]
489 Zhao, http://ctext.org/wiki.pl?if=gb&chapter=699620&remap=gb#p4 [accessed 10 July 2016]
490 Gong Shuze and Liu Delin, *Tu Shuo Qing Chao (Illustrated History of the Qing Dynasty)* (Taipei: Knowledge House Press, 2007), p. 23.
491 Lillian M. Li and Alison Dray-Novey, 'Guarding Beijing's Food Security in the Qing Dynasty: State, Market, and

management policy also remained very similar, except that extra attention was given to the southern section of the canal, where there was an increasing flood threat from the Yellow River after its redirection to Jiangsu Province, bypassing Xu Zhou and Pei Xian.[492] Various new branches of the Yellow River were constructed, some of which introduced innovative flood control methods created by Jin Fu (1633-1692), the most influential river conservancy engineer of the Qing Dynasty.[493] More information about him and his water control achievements will be introduced later.

As it had been throughout the Ming era, the Grand Canal was seen as the lifeline of the Qing dynasty, and the shipments of grain to the capital were even higher during this period due to the higher taxes levied by the state.[494] To secure the safety of the transport, the most important concern of the state, water control policies had the Grand Canal as their priority[495] until it fell into decline in the nineteenth century.[496]

The designing and detailing of the Grand Canal Embankment, and dredging

The Grand Canal was frequently affected by the flooding of the Yellow River, which contained large amounts of silt. The canal needed to be dredged regularly to avoid the silt from accumulating on the riverbed.[497] It is hard to know when specific tools for dredging were developed, as clear records are only found after the tenth century.[498] All the tools shared a common purpose: to move the accumulated silt to prevent the riverbed from being raised. The first tool recorded was called *jun chuan pa* 浚船耙 (River-dredging Harrow), an 8-chi-long beam fitted with 1-chi-long iron spikes at its end. The tool would be attached to two windlasses, each of them placed on a boat with the tool suspended between them. The *jun*

Police', *The Journal of Asian Studie,* 58: 4 (1999), 992-1032 (pp. 996-997).
492 Yao, p. 430.
493 Zhao, http://ctext.org/wiki.pl?if=gb&chapter=209480&remap=gb#p2 [accessed 10 July 2016]
494 Li and Wang, p. 57.
495 Zhang Penghe, *Zhi He Quan Shu (Complete Account of Water Regulation)* (Hand copied book, 1703), Chapter 1.
496 Zhang Zhaodong, 'Qing Dai Cao Yun Yu Nan Bei Wu Zi Jiao Liu (The Tribute Grand Transport in the Qing Dynasty and the North-South Trade)', *Studies of the Qing History*, 3 (1992), 67-73 (pp. 67-70).
497 Yao, p. 445.
498 Needham, p. 335.

chuan pa was carried along by the boats, moving the silt accumulated on the canal bed. These tools were in common use from the eleventh century, when Huang Huaixin, a leading eunuch of the Song Dynasty, organized its production.[499]

Two new dredging tools were invented during the Ming era, by Chen Bangke, who besides serving as the Imperial Censor put great effort into keeping the Grand Canal clear. He invented the *pa li* (bed-barrowing ploughs), which worked like the *jun chuan pa* discussed above, but was easier to operate. A *Ba Li* could be simply pulled along by ropes attached to flat-bottomed boats. Itt could scrape the bottom of the river as it went, to prevent the sand from sinking and settling.[500] This tool later evolved into a more complicated structure, a cylinder fitted with iron spikes. It could be towed by boats and rolled in the water under the force of current to keep the silt moving. It was given the name *hun jiang long* 混江龙 (river rolling dragon) to suggest the flexibility of a water dragon swimming.[501] This tool and the towing ploughs were widely used during the Qing dynasty.[502]

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499 Zhu Xi, *Tong Jian Gang Mu* [Short View of the Comprehensive Mirror (of History) for Aid in Government] (undated), Chapter 7, pp. 13b.
500 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=806633&remap=gb#p34 [accessed in 7 July 2016] (Para. 33).
501 Needham, pp. 337-338.
502 Ibid., p. 337.

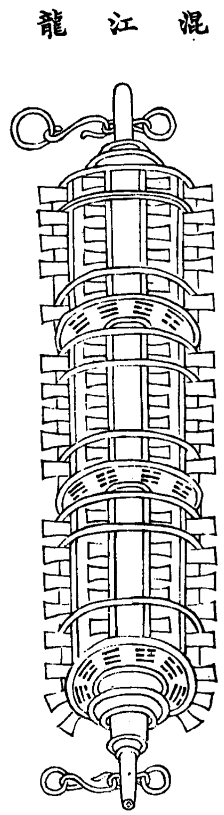

Figure 4.3 An illustration from the early nineteenth century shows the structure of a dredging tool, *hun jiang long*. Its spikes were made of iron and it was about 1 chi long. The hooks at each end were used to hang the towropes. Source: Needham, p. 337, Figure 911. The drawing was originally made by Linqing, *He Gong Qi Ju Tu Shuo* (Illustrations of Tools for River Works).

Chen Bangke designed another dredging tool in imitation of a hydraulic mill: he built a paddle-wheel vessel with bottom-agitating rakes dragged behind it, which rolled or vibrated with the current of the water, stirring up the sand.[503] This tool is hard to visualize, as there is very little information about its construction and utilization during the Ming and later dynasties.

Apart from using tools, another method used for dredging the canal water during the Ming and Qing dynasties was to let the water scour itself without the aid of tools. This was called *Shu Shui Gong Sha* 束水攻沙 (restrict the current to attack the silt) and was invented by

[503] Zhang, http://ctext.org/wiki.pl?if=gb&chapter=806633&remap=gb#p34 [accessed in 7 July 2016] (Para. 33).

one of the most influential Chinese hydraulic engineers, Pan Jixun (1521-1595).[504] Pan was born in a rather ordinary family but started to serve for the Ming court after he succeeded in the Imperial Examination in 1550. He was designated as the Governor of Water-Control four times, his main task the management of the Yellow River and the Grand Canal.[505]

Figure 4.4 A portrait of Pan Jixun, the leading river engineering of the Ming Dynasty. Source: Pan Xihui, 'ming xing gong san shang shu pan ji xun yi xiang (portrait of Pan Jixun the Minister of Ministry of Works)', *Pan Clan Official Website* (2005) <http://www.pans.cn/Info/–2005-3/13/0531319433053126.htm [accessed 10 July 2016]

The established idea of how to control the flooding of the Yellow River was to build as many branches as possible, to release the pressure of the current on the embankments and dams. Pan Jixun came up with a completely different concept: he believed that the focus of controlling the floods of the Yellow River and Grand Canal should be on the silt it contained, because it would quickly raise the riverbed and result in a higher water level, making the

504 Qian Hanjiang, 'Pan Jixun-Ming Dai He Gong Di Yi Ren (Pan Jixun- the Leading River Engineer in the Ming Dynasty)', *Chinese Natural Disaster Reduction*, 185(2012), 48-49 (p. 49).
505 Pan Jixun, *He Fang Yi Lan* (Imperial Collection of Four: General View of Water Control) (Qin Ding Si Ku Quan Shu Ben, 1780), Summary, p. 1.

floods more likely to happen. In his view, clearing out the silt in the Yellow River was the key to reducing the chance of floods. His method of clearing the silt was to restrain the current within a watercourse to enhance its force, so that the water would scour the silt all the way to the sea.[506] This concept was believed to have come from an idea dating back to the fifth century BC: 'every canal should be made so as to take account of the characteristic forces of water; every embankment should take account of the characteristic strengths of earth. A good canal is scoured by its own water.'[507]

To execute his plan, Pan Jixun ordered the building of thick and high embankments (yao di 遥堤) outside with lower and thinner embankments (*lv di 缕堤*) inside. The former was to prevent the current from running over the bank, which was similar with the modern winter dyke; and the latter was to narrow down the course so that the speed of the current would be increased, which worked the similar way with summer dyke. If the current was still not fast enough to scour silt away, a number of planks could be stuck in the bottom to enhance the force of the current.[508] This method proved to be a success, preventing the silt in the water from sinking to the bottom, so that the riverbed could be kept at a reasonable level to reduce the chance of floods.[509]

It is worth clarifying that this self-scouring method was more suitable for the sections of the canal which had a rapid current, usually the in area by the Yellow River. In the other sections, it was still more practical to use the dredging tools described above.[510]

506 Pan, p.1.
507 Du Mu (ed.), *Kao Gong Ji (Record of Examination of Craftsman)* (Xi'an: Shanxi Tong Zhi Guan, 1934), Vol 2, p. 15.
508 Pan, Chapter 4.
509 Qian, pp. 48-49.
510 Ibid., p. 48.

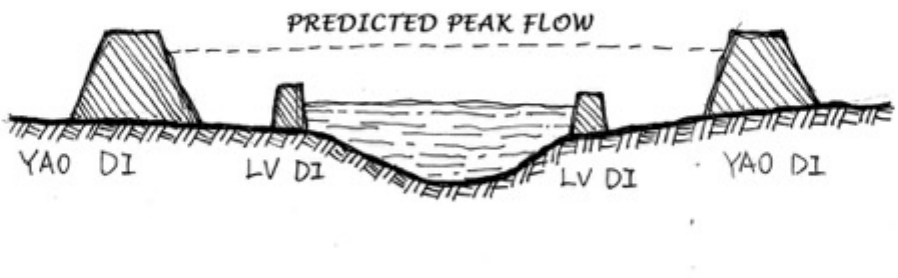

Figure 4.5 This section plan by author shows the two types of embankment, *yao di* (outside) and *lv di* (inside), that Pan Jixun had built to execute his *Shu Shui Gong Sha* method.

In Pan's profound work *He Fang Yi Lan* (General View of Water Control), he also introduced how to build specific types of dams for the Grand Canal to deal with different types of current, in order to protect the embankment. For example, when the current was right in the middle, a *ding ba* 丁坝 (dam made vertical to the bank) could be made to protect the bank from being damaged. While the current was more on the side, a *shun ba* 顺坝 (dam made parallel or with an acute angle to the bank) was more suitable[511].

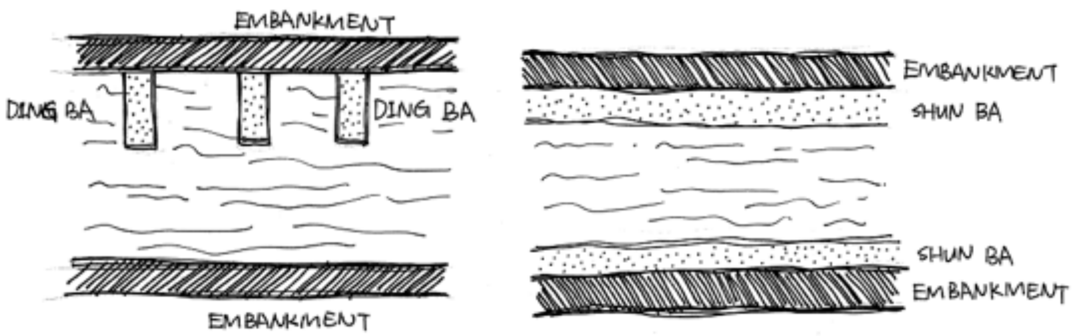

Figure 4.6 These plans by the author show the two types of dams which appeared in Pan Jixun's work: the *ding ba* (left) would be built when the rapid current was to the middle of the course, while *shun baa* (right) were built when the current was on the side. The dam was named 丁坝 (*ding ba*) was because the plan of the dam and bank looks like the Chinese character 丁.

Pan Jixun suggested that the Grand Canal should be dredged regularly, and that the

[511] Pan, Chapter 4.

management scheme of the watercourse created by Chen Xuan (1365-1433) in the early fifteenth century should be strictly followed, though by the sixteenth century the scheme only survived in part. Pan often emphasized the importance of dredging, because he believed that it was key for the Grand Canal to have clean water to keep functioning for the transport. Compared to the muddy Yellow River, the Grand Canal was much easier to keep clean by regular dredging.[512]

Pan Jixun's method of letting the river self-scour was still followed during the Qing dynasty, but with some further development. One person that must be mentioned here is Jin Fu, who was briefly introduced above. He was the Director of the river conservancy projects of the Grand Canal and the Yellow River between 1677 and 1688, and made great contributions to river engineering in late imperial China.[513]

Following Pan Jixun's *Shu Sui Gong Sha* concept, Jin Fu made some further improvements while building embankments. For example, while building *yao di* together with *lv di*, Jin Fu diverted water to the gap between the two embankments. In time the gap would be filled with the silt, making the embankments stronger and thicker.[514]

Jin Fu also invented an more practical and economical way of building embankments, called *jiu shui zhu di* 就水筑堤 (build the embankment in the water). The traditional way had been to transport earth from far away. The new method was firstly to build a bounding wall in the water on the position of the embankment or levee. The bounding wall needed to be 2 *chi* higher than the water level, 300 *chi* in width and 50 *chi* in length. This was strengthened by adding some hay after it was built. The earth for the bounding wall could be carried from somewhere far away. After this the water inside the bounding wall should be totally dried out by the waterwheels. Then workers would start moving earth from nearby to the space inside

512 Ibid., Chapter 13.
513 Zhao, http://ctext.org/wiki.pl?if=gb&chapter=209480&remap=gb#p2 [accessed 10 July 2016]
514 Ji Fu, *He Fang Zou Ji Shu* (Book of the Achievment of Water Conservancy), Yingyin Wenyuange Si ku Quan Shu Ben, 1784. Vol. 4.

the bounding wall, creating the first stage of an embankment. This served as the base of the embankment, which could be extended to 16 *chi* tall, 20 *chi* wide at the top and 10 *zhang* wide at the foundation. For each *zhang* of the embankment, it required approximately 96 *fang* (1 *fang* roughly equals 100 cubic feet) earth. This new method was said to have saved half of the amount this construction work had cost in the past.[515]

The *cao fang* 漕舫(grain-carrying ship)

The inadequate water supply was the biggest issue for the northern section of the Grand Canal, as its shallow water level could not support barges with a large tonnage. A type of *qian chuan* (shallow-drought canal barge) was invented by Chen Xuan (1365-1433), the lord of Pingjiang, to cope with the specific conditions of the Grand Canal. This was then widely produced and became the basic form of the 漕舫 *cang fang* (grain-carrying ships) used for grain transport thereafter.[516]

Figure 4.7 Portrait of Chen Xuan (1365-1433), a Ming supreme commander of the Grand Canal who invented

[515] Ji, Vol. 4.
[516] Needham, pp. 409-410.

qian chuan. He also rehabilitated the southern section of the Grand Canal and founded the army-operated waterway system. Source: Wang Qi and Wang Siyi, *San Cai Tu Hui* (Illustrations of the Three Powers), Shanghai: Shanghai Gu Ji Press, 1988, p. 702.

The name of these canal barges, shallow-drought, indicates that their size was smaller than normal inland navigation ships, 9.5 *chi* in width, 52 *chi* in length and 4 *chi* in height.[517] At this size, the locks on the Grand Canal were able to accommodate at least two barges going through the gate at the same time.

These are the detailed dimensions and materials used for the barge. It consisted of a 0.2-ch-thick 底 *di* (bottom of stout planking), usually made of nanmu (楠木, *Phoebe zhennan*), sometimes chestnut as a second choice. The 伏狮 *fu shi* (the beam, literally means the lion tamer) at the fore-mast tabernacle was 8 chi wide, with the main-mast tabernacle 7 chi wide. This was usually made of nanmu, camphorwood (樟木, *Cinnamomum camphora*), elm (榆木, *Ulmus*), Japanese emperor oak (栎树, *Quercus dentate*) or pagoda tree (槐树, *Styphnolobium japonicum*).[518]

There were fourteen 梁头 *liang tou* (bulkheads) built across each boat. The one closest to the head of boat was called 龙口梁 *long kou liang* ('dragon's mouth' bulkhead) and was 10 chi long and 4 chi high. The bulkhead next to the main mast was called 使风梁 *shi feng liang* ('wind-using' bulkhead), and was 14 chi long and 3.8 chi high. That closest to the stern was given the name 断水梁 *duan shui liang* ('cut-water' bulkhead) and was 9.5 chi long and 4.5 chi high. The materials to make bulkheads were similar to those used for beams. And the rudders were usually made of elm and Japanese emperor oak, while the oars were made of Chinese fir and Formosan Cypress (桧树, *Chamaecyparis pisifera*).[519]

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517 Song Yingxing, *Tian Gong Kai Wu* (The Exploitation of the Works of Nature). Tokyo: Lang Hua Shu Lin, 1771. Vol.2, pp. 31-32.
518 Ibid., pp. 30-31.
519 Ibid.

A canal barge like this would be equipped with two granaries 7.6 chi wide, allowing a maximum tonnage for each boat of 2000 *dan* of grain. Only 500 *dan*[520] of grain had to be carried, and the extra capacity was designed to encourage boaters to transport grain by allowing them make extra income by carrying private goods too. It was the boaters themselves, not the Ming government, who paid for the cost of transportation.[521] The water level remained rather shallow, to prevent the boaters from carrying too many private goods which would make the barges too difficult to move. The depth of water under the barges on the Grand Canal was not allowed to be more than 6 *na* (1 *na* equals the distance between the thumb and index fingers, 6 na was about 3 chi long).[522]

Despite this policy, many barges were secretly built with an extra 20 x 2 chi space, increasing their tonnage to 3000 *dan*. These barges were able to carry more private goods without sinking into the water. As this encouraged people carry the grain, and barges of this size were just slim enough to go through the lock gates, the government chose to acquiesce in the deceit.[523] These extended shallow-drought canal barges were about the same size as the officials' boats which travelled on the Grand Canal, although these were built with wider windows, doors and passageways, and were more beautifully painted and decorated.[524]

520 Song, *Tian Gong Kai Wu,* pp. 30-31.
521 Dong Wenhu, *History and Future of the Beijing-Hangzhou Grand Canal* (Beijing: China Social Science Academic Press, 2008), pp. 111-112.
522 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb [accessed 1 July 2016].
523 Song, *Tian Gong Kai Wu*, p. 31.
524 Ibid.

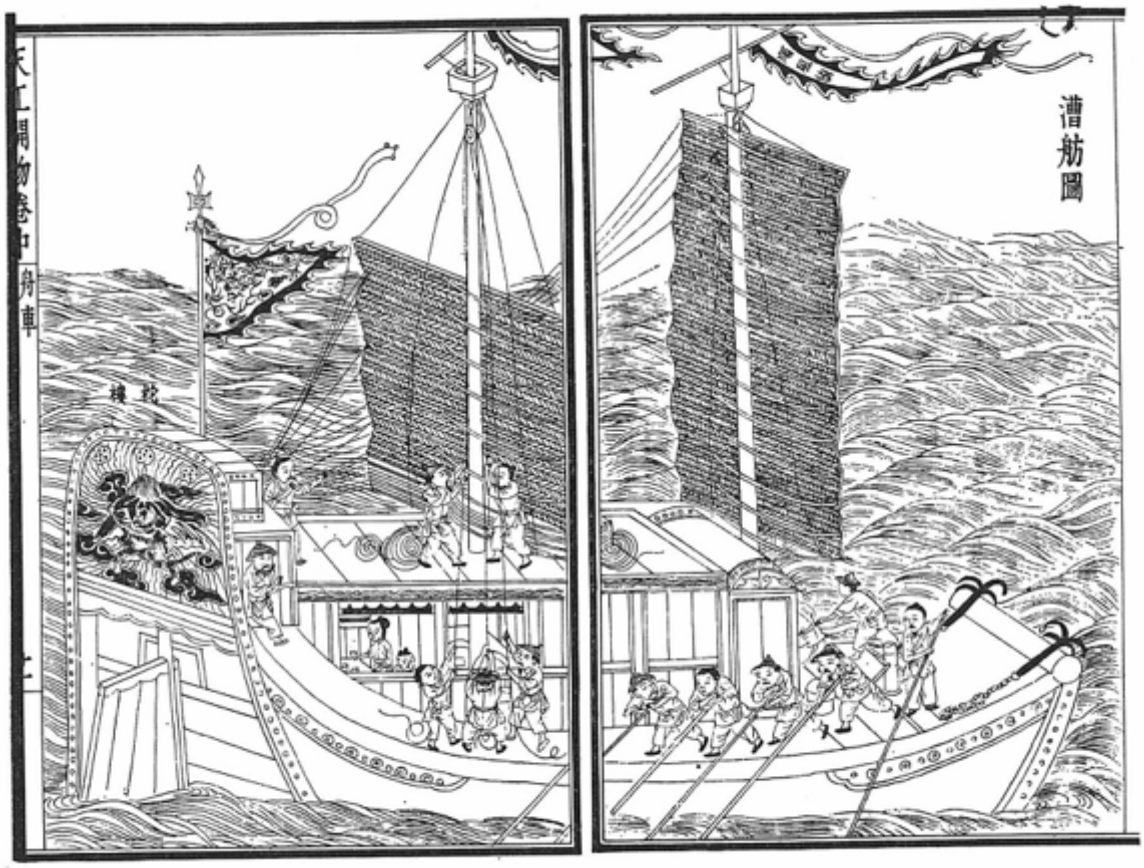

Figure 4.8 A painting from 1637 shows the *cao fang* (grain-carrying ship) used for tax grain transport on the Grand Canal at the beginning of the Ming dynasty. The painter, Song Yingxing, used a very interesting way to describe its structure, seeing it as a house: 'a bottom (底 *di*) (of stout planking) serves as the foundation, there are (thwart and fore-and-aft) timbers (枋 *fang*) like the walls of a building, and there is bamboo tiling (阴阳竹 *yin yang zhu*) (to cover the hold) as if it were a roof. (The compartments) forward of the mast framework (伏狮 *fu shi,* that is, its tabernacle and associated structures) are like the main gates, and (the compartments) aft of it are like the sleeping quarters. The mast (桅 *wei)* is like (the stock of) a crossbow, and the halyards (弦 *xian*) and sails (蓬 *peng*) are like wings. Oars (橹 *lu*) (may also be motive power) as the horse is to the cart; hauling cables (纤绳 *qian sheng*) are as the shoe is to the walker. The cordage (缆索 *lan suo*) adds strength like the bones and sinews of a hawk. The bow-sweep (招 *zhao*) goes before like a spearhead, the rudder (舵 *duo*) (at the stern guides the direction of the vessel) like a commander, and the anchors (锚 *mao*) call a halt like an army encamping for the night'.[525] Source: Needham, p. 410, Figure 943. Originally from *Tian Gong Kai Wu*.

[525] Needham, p. 411.

The *zha* (locks)

By the Ming era, *zha* (locks) were already very common, widely used on the Grand Canal. As discussed in the previous chapter, the challenging typography of the Hui Tong River required thirty-one locks which had been built in the Yuan dynasty to save water. When the canal route was reopened in the early fifteenth century, the number of locks increased to thirty-eight, and later fourty-seven.[526]

Pan Jixun described the engineering details required to build a lock: in preparation, a solid foundation was needed, and any water should be removed by waterwheel. Then piles would be hammered into the soil and a layer of wooden planks placed on top, with all the gaps filled with wood oil and lime. After a layer of stone slabs were laid, the main body of the lock was ready to be built, consisting of strong masonry (*you shen*) and two wings (*yan chi*) on each side of the watercourse. Usually the *you shen* was 27 *chi* long, and each *yan chi* was 50 chi long; this would use about 3,100 *zhang* of stone. The other parts of the lock, including the bottom, top and surface stones would consume about 900 *zhang*. The final step was to place the four stone crane arms and the beams which served as the lock gate in position.[527]

Although Pan did not mention the width of the lock gate, we know from other sources that the locks on the Grand Canal were made with gates that were 12-chi-wide.[528] More engineering details about *zha* appeared in the Qing Dynasty, in various water conservancy textbooks like *An Lan Ji Yao* (Summary of Flood Control).

The canal locks were made to a uniform standard in the Qing dynasty, although sometimes

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[526] Yang Shiqi, 'Ping Jiang Bo Zhui Feng Ping Jiang Hou Yi Gong Xiang Cheng Gong Xuan Shen Dao Bei Ming (Inscription of Chen Xuan being awarded as the Lard of Pingjiang)', in *Guo Chao Xian Zheng Lu (Evident Worthies of Our Dynasty)* (undated), ed. By (Ming) Jiao Hong, Chapter 9. Wikisource, https://zh.wikisource.org/zh-hans/國朝獻徵錄/卷之九 [accessed 15th June 2016]
[527] Pan, Chapter 4.
[528] Song, *Tian Gong Kai Wu,* p. 31.

small modifications would be needed in a specific situation. The official standard was: a *jin men* 金门 (a space between the two *you shen*) was 22 *chi* long and 30 *chi* high; the width was decided by the width of the lock gate. For the four *yan chi*, the two shorter ones (*shang ying shui yan chi)* on the upstream side of the canal were 64 chi wide and 30 chi high, with the two ends (*shang guo tou)* 20 chi wide and 30 chi high; the two longer ones (*xia fen shui yan chi)* on the downstream side were 136 chi wide and 30 chi high with their two ends (*xia guo tou*) the same size as the upstream ones. The grooves to keep the lock gate in place were cut into the two walls of *you shen*, and were 0.4 to 0.5 chi deep and of varied width.[529]

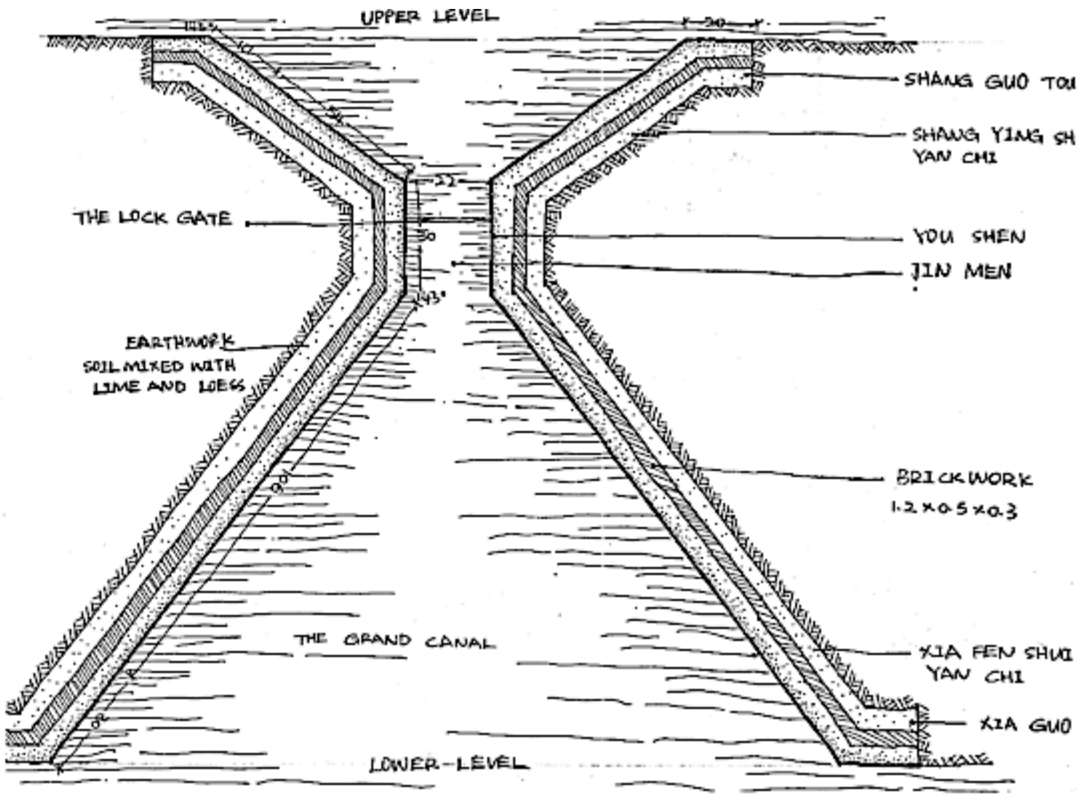

Figure 4.9 Conjectural drawing of the plan of a lock by the author. The angle between *you shen* and *yan chi* was 36 degrees.

[529] Wang Biwen, 'Qing Dynasty for the Designing of the Locks and Culverts', *BSRCA*, 6:2 (1935), 51-72 (pp. 58-61).

Figure 4.10 The Qingfeng Lock on the Tong Hui River. It is a typical canal lock which shows their basic structure. Some materials, such as stone slabs and beams, can also be seen. There is a bridge over the lock gate, a movable one which could be removed when barges were going through the lock. The surrounding landscape including earth bank, residential houses, a two-store pavilion and willow trees are also shown. Source: Liao Cheng Canal Museum. The sketch was originally from Linqing’s *Hong Xue Yin Yuan Tu Ji* (llustrated Traces of a Life) from the early nineteenth century.

Figure 4.11 This painting from the late eighteenth century shows a scene of the barges of a British embassy passing through a lock on the Grand Canal. We could see the groove on the lock, designed to keep the lock gate's wooden beams in place; here they have already been lifted up. There are also many other elements in the picture, including the earth bank, plants, the lock keeper's cottage (right) on the side of the lock, and the more majestic tower behind the threshold (left) which was a *wei suo* (guard post) for the troops stationed along the canal. The people sitting on the bank might be trackers waiting for business. Source: Yale University Library, Beinecke Rare Book and Manuscript Library, originally from *An Authentic Account of an Embassy from the King of Great Britain to the Emperor of China*.

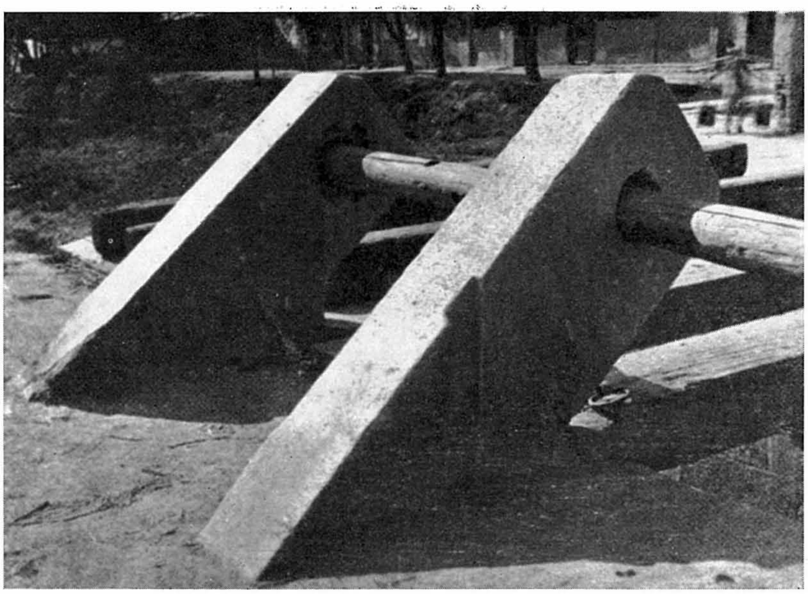

Figure 4.12 One of the pair of *jiao guan shi* (stone crane arms) of the Qingfeng lock on the Tong Hui River. The wooden roller hoists were used for lifting and lowering the lock gate. Source: Needham, Plate 386. Figure 921.

Here is a more detailed record about different types of work involved to build a lock, from the Qing dynasty.

Zhuang gong 桩工 (Piling). The piling is the foundation of the lock construction, thought to be the principal work to ensure that the whole lock was properly supported. In traditional piling technology it usually constructed of used timber with a circumference varying from 1.3 to 1.5 *chi*, length from 16 to 18 *chi*. The wood was most often China fir, Korean pine and weeping cypress trees, with elm less often, as it does not last as well as other types of wood. Each pile needs to be pointed at the end so that it can be stuck into the soil; sometimes it would be given an iron tip if the earth was hard. The top of each timber pile also had iron protection to prevent it from breaking under the pressure of the hammer. There were various patterns of piles: the three most common were *mei hua zhuang* 梅花桩(plum blossom piling), *ma ya zhuang* 马牙桩(horse teeth piling) and *pai zhuang* 排桩(line-up piling).[530]

[530] Wang, pp. 56-57.

Figure 4.13 This drawing by the author shows the three basic patterns of piling: the *mei hua* (top), *ma ya* (middle) and *pai* (line-up) (bottom).

Shi Gong (Stonework). The stonework is the key to building a lock, and involves complicated steps and elaborate techniques. Stone was the main material for a lock, and two sizes of stone slabs were used for building the locks on the Grand Canal. One was thinner, 1.2 chi wide, 1.2 chi long and 0.6 chi thick, the other thicker, their width and thickness both 1.2 chi, and length varying from 2.4 chi to more than 3 chi depending on their function.

Stonework was applied to the surface of the entire lock, as well as to the *wan nian fang* 万年枋 (the support underneath the lock gate) and the bottom part of the lock. 1.2 x 1.2 x 2.4 thick stone slabs were used to cover the surface, built up in a pattern of *shun qie* 顺切 (stretcher bonded stonework) (Figure. 4.16), a total 26 courses. *Shun qie* was the most common pattern in traditional stone laying techniques: simply laying the stone slabs in successive courses, each staggered by half a stretcher. The slabs would be cemented together with mortar, and in every 10 *chi* one small stone would be mixed with other stretchers to enhance the strength of the stone masonry. In order to make the stone surface even stronger, two stone slabs would be bound together with iron nail. The interior part of a lock also required stonework using the same technique, but less need for a uniform size (Figure. 4.17).[531]

[531] Wang, pp. 52-53.

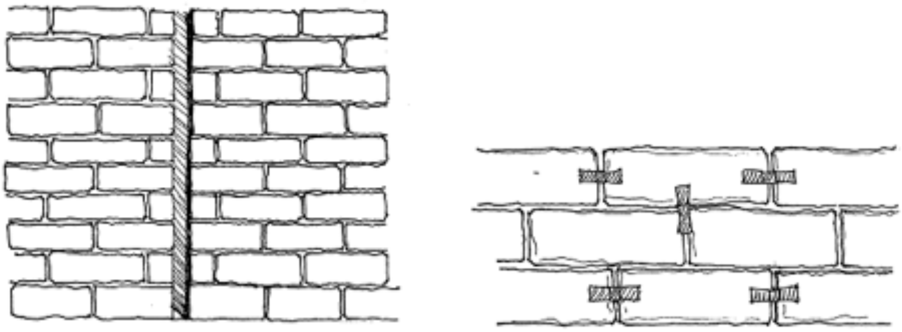

Figure 4.14 These drawings by the author show the basic pattern of stonework of a canal lock. That on the left shows the *shun qie* technique, particularly how the stones were laid beside the groove in the middle, where the lock gates were kept. The drawing on the right shows the iron nail used to help bond the stones together.

The *wan nian fan* was the big stone slab that was placed under the lock gate. It had the same width as the beams of the gate. It required a specific type of stone, which had to be one entire slab with a length of over 20 *chi* rather than several smaller ones put together.[532] Under the *wan nian fang* there was another layer of stone slabs, built underneath the entire lock using 1.2 x 1.2 x 2.4 size slabs to strengthen the lock when there was a rapid current.[533]

Zhuan gong (Brickwork). Brickwork was only applied to the interior part of the two solid abutments of the lock. The specific type of brick used for building the canal lock was called *he zhuan* 河砖 (river brick), which was larger than normal bricks. The standard size was 1.2 *chi* long, 0.5 *chi* wide and 0.3 *chi* thick. There were also larger river bricks with a thickness of 0.4 *chi* but these were less commonly used for canal locks.

Unlike the stonework, brickwork used the technique called *ding yi bian er* 丁一扁二 (Flemish bond) (Figure. 4.17), which had courses of mixed stretchers and headers. One stretcher was placed between headers, with the headers in the centre of the stretchers in the course underneath, with mortar applied between them. This pattern was considered to be

[532] Sometimes it could also be two stone slabs placed together, but according to the *Da Qing Hui Dian* (Collected Statues of the Great Qing Dynasty), the official standards for building locks in Shandong section were more restricted that it required one entire slab.
[533] Wang, pp. 52-53.

rather stable in a way that could help enhance the strength of the lock.[534]

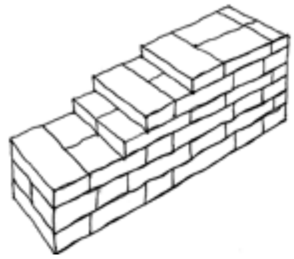

Figure 4.15 This drawing by the author shows the brickwork 丁一扁二 *ding yi bian er* used for inside the canal lock.

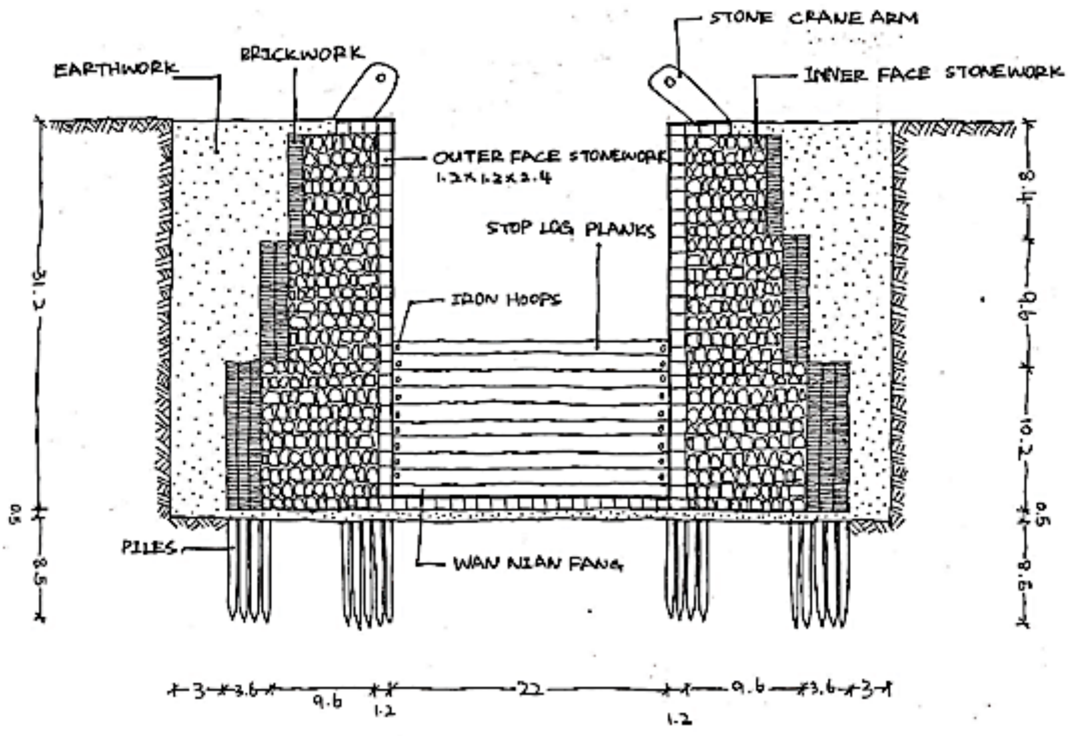

Figure 4.16 Conjectural drawing of the cross-section plan of a lock by the author. There were usually 25 courses of brick, the same number as the courses of stone inside the lock. Of these 25 courses of brick, the bottom ten would be repeated three times, the middle eight courses twice, and the upper seven courses only once, as shown in the picture above. The locks built on the Shandong section had a slightly different standard for brickwork, with only two vertical bars of 16-course brick.

Tu gong (Earthworks). Apart from stone and bricks, earth was another important material in building a canal lock. It was applied mainly in the construction of the two solid abutments

[534] Wang, p. 56.

and the foundation of the lock (Figure 4.18), with the type of soil of either *su tu* 素土(natural soil) or *san he tu* 三合土(soil mixed with lime and loess). While building up the earth, it would be rammed by flappers, each of which needed eight to ten people to work together. There were different requirements as to what degree the earth needed to be compacted, depending on usage. For example, to build the foundation of the lock, every 0.75 *chi* of soil was required to be compacted to 0.5 *chi*. This technique of ramming is called *xiao hang* 小夯 (little ramming). For building the main body of the lock, every 1 *chi* of soil was to be compacted to 0.7 *chi* high, or every 0.7 *chi* lime-loess compacted to 0.5 *chi*. This technique is called *da hang* 大夯 (big ramming). It was important to make the earthwork as solid as possible, and the rammed earth had to be both very dense and strong. To test its quality, a pointed iron stick like that shown in the picture below would be used after the earthwork was completed.[535]

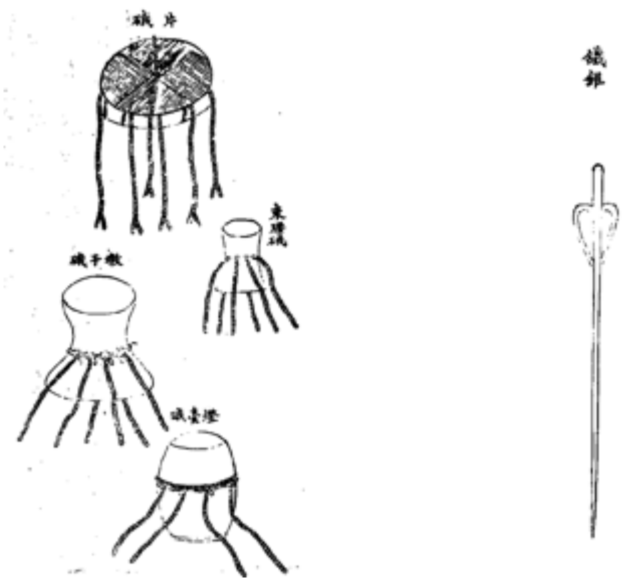

Figure 4.17 These pictures from the nineteenth century shows the *wo* (flappers) that were used in traditional river work for compacting the earth (left), and the *tie zhui* 铁锥 (pointed iron stick) to test the strength of the earthwork (right). To do the test, the iron stick would be hammered into the earth and taken out, then some amount of water would be poured into the hole; the earthwork would be proved to be of good quality if the water did not permeate. Source: (Qing) Lin Qing, (ed.) Pengju Cheng, *He Gong Qi Ju Tu Shuo* (Illustrations of Tools for River Works), Zheng Zhou: He Nan Education Press, 1994, pp 572-573.

[535] Wang, pp. 54-56.

Figure 4.18 This photograph was taken in the 1930s and shows that the same way of compacting earth was still used in the early twentieth century. Source: Liaocheng Canal Museum. Photograph taken by William Smith.

Plants for the Grand Canal

The canal-side plants had many functions, including providing shade for trackers and peddlers, strengthening the embankment while providing wood and vegetal materials for maintenance work, and of course, improving the canal-side landscape. One plant that could meet all these criteria is weeping willow. Its canopies could provide shade, its roots could strengthen the embankment, its branches could be used for river work, and not to mention its beautiful appearance.[536]

So it became a commonplace that the weeping willow tree was the best choice to plant along the Grand Canal, and records since the seventh century show its appearance along the canal. This dominance was even clearer in the Ming and Qing period. From the fourteenth century

[536] Jin, Vol. 4.

there were many specific policies covering the planting of willow trees along the Yellow River and the Grand Canal, at first on the advice of Chen Xuan.[537] At that time almost all the river work required willow as an important material, especially the *sao*, the technique commonly used to block breaches discussed in the previous chapter; the Ming government needed to make sure there were enough supplies of willows for large scale river maintenance.[538]

The government's focus on planting willow trees encouraged many local officials to put great effort into the work. For example, Tao Xie, the Vice Commissioner of Henan province, ordered the building of many cottages along the river to accommodate the workers who were taking care of the willow and peach trees. In this way the workers could stay on the site and prevent the trees from being chopped down by thieves or eaten by animals.[539] This strategy was encouraged by the central government and soon copied by other regions.[540]

The Ming official Liu Tianhe put together the 'Six Methods of Planting Willows' (*zhi liu liu fa* 植柳六法): *wo liu* (willow-laying method), *di liu* (delay planting method), *bian liu* (willow-knitting method), *shen liu* (further-to-water willow planting), *man liu* (willow-in-water method) and *gao liu* (strengthen bank by willow roots).[541] This includes all the possible ways of planting willows on the embankments, and was further developed by Pan Jixun.[542] Many of these methods are still in use in modern river work.

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537 Li Denan, 'Gong Cheng, Huan Jing, She Hui: Ming Qing Huang Yun Di Qu De He Gong Ji Qi Ying Xiang (Engineering, Environment, Society: the River Work and its Impact along the Yellow River and the Grand Canal during the Ming and Qing Dynasty)' (published doctoral thesis, Fudan University, 2008), p. 56.

538 Ibid.

539 Tao Xie, *Tao Zhuang Min Gong Wen Ji (The Collected Work of Mr Tao)* (Ming Tian Qi Si Nian Ke ben 1624). Vol. 4.

540 Zhang, http://ctext.org/wiki.pl?if=gb&chapter=506506&remap=gb#p2 [accessed 1 July 2016].

541 Jia Naiqian, 'Ming Dai Ming Chen Liu Tian He De Zhi Liu Liu Fa (The 'Six Method of Planting Willows by Liu Tian He the Ming Official)', *Agriculture Archaeology,* 3 (2002), pp. 215-218 (pp. 215-216). The details of the first and third method-*wo liu* and *bian liu* have been introduced in Figure 4.21. The second method- *di liu* was to plant willow branches after the embankment was made, with the same method of *wo liu*. The fourth one- *shen liu* was to plant willow trees a little further from the bank with a distance of 5 chi in between, and each tree needed to be 20 chi in the soil and 2-3 chi above it; this was to let their root strengthen the bank. The fifth method- *man liu* was taken place at where the water often damages the embankment; and a layer of branches were to plant densely on the bank; this could soon serve as strong embankment after the dense willow trees grow taller. And the last method-*gao liu* was to plant lines of big thick willow trees on the bank, to both strengthen the bank and provide shades.

542 See his work: *He Fang Yi Lan (General View of Water Control*) Vol. 4. Xiu Shou Shi Yi (Matters relating to Repairs and Maintenance)

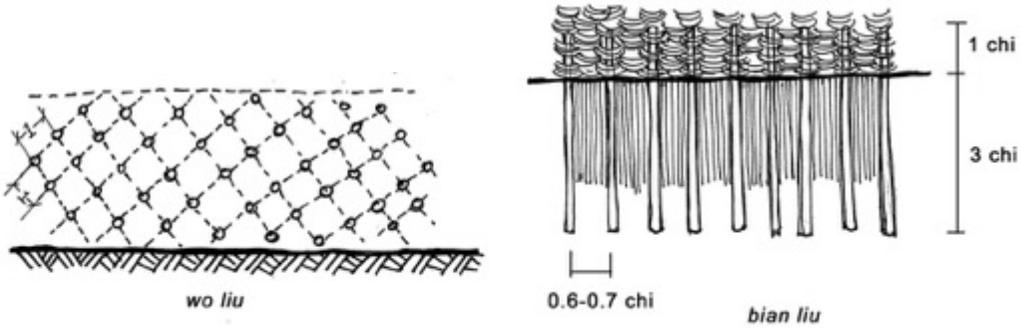

Figure 4.19 The two drawings by the author show two of the willow planting methods summarized by Liu Tianhe: *wo liu* (left) and *bian liu* (right). The first was to plant willow branches at the same time as the construction of the embankment: with each layer of soil added, the branches were planted evenly over the entire bank at an interval of 1 chi; each branch needed to be 2 chi in the soil and 0.2 chi above it. *Bian liu* planted 4 chi high willow trees at an interval of 0.6-0.7chi on the waterside of the embankment, then planted branches in between them, to knit them together with the trees to 0.5 chi higher; then soil was added. This process was repeated until it reached the required height of the embankment.

During the Qing dynasty, the demand for willow supplies became even higher, and almost all the related staff from high rank officials to normal river workers and even soldiers were given orders to plant certain numbers of willow trees. For example, the river administrators and lock keepers of the Yan Zhou and Dong E counties had to plant 20 willow trees each person each year, 18 for canal workers. The Kangxi emperor (1654-1722) also gave rewards to officials who were able to successfully plant over ten thousand willows along the canal each year.[543] A similar policy was made for the canal-side troops: the Qianlong emperor (1711-1799) ordered that for each troop along the canal, each soldier had to plant 100 willows each year and ensure that they would survive. Punishment would be handed down to those who did not take this order seriously or if less than half of their trees survived.[544]

The demand for willow trees become so high during the Qing dynasty that willow groves were planted from the mid-seventeenth century, in order to provide enough willow when it

[543] Yan Yanmo, *Bei He Xu Ji* (Summary of Flood Control) (Record of the Northern River) (Hainan: Hainan Press. 2000), Vol. 4.
[544] Xu Duan, An Lan Ji Yao (qing dao guang er shi er nian 1842), Vol. 2.

was needed. The groves were located mostly on wild lands or on riverside cultivated fields, especially those close to where the Grand Canal joined the Yellow River, where flooding was more likely.[545] Weeping willows survived more easily in southern China than in the north, so the Chinese willow mentioned in chapter two became more common in northern China, due to its tolerance of the dry and cold climate there.[546] Other plants such as peach, pear and apricot trees, and reed, were used to replace the willows when emergency situation occurred.[547]

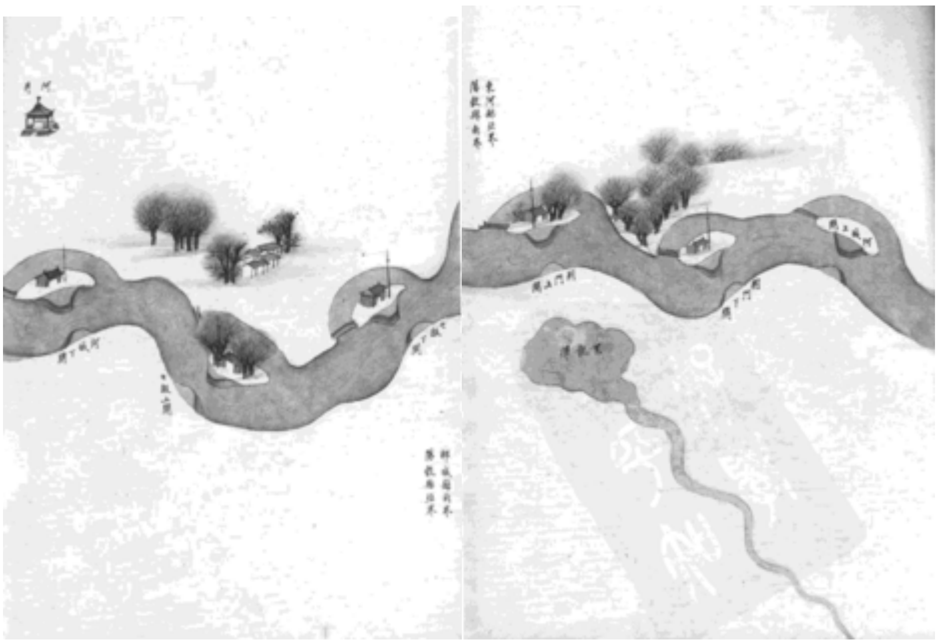

Figure 4.20 Two sections of a map from 1703 show the northern section, Liao Cheng (left) and Dong E (right) section of the Grand Canal. It can be observed that the willow trees here were not the weeping willow, but the Chinese willow, better able to survive in northern China. Source: *Shui Dao Xun Wang- Tianjin Tu Shu Guan Cang Qing Dai Yu Tu Xuan* (The Collection of the Qing Dynasty Maps at the Tian Jin Library), Beijing: Renmin University Press, 2007, p 21.

545 Fu Ze Hong, *Xing Shui Jin Jian (Golden Mirror of the Flowing Waters)* (si ku quan shu ben, 1780), Vol. 46, p.12.
546 Zhu and Xue, p. 99.
547 Li, pp. 60-61.

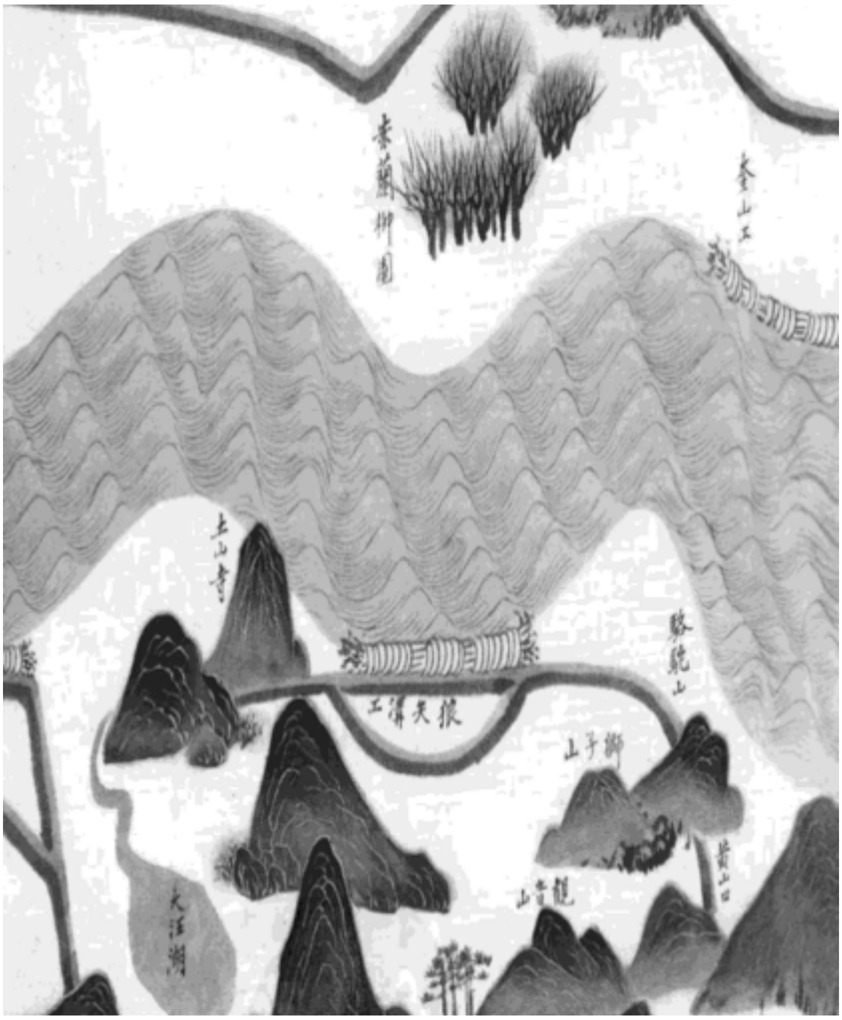

Figure 4.21 Another map from 1703 shows the San Shan Tou section of the Yellow River. On the northern bank of the river there is a *chi lan liu yuan* (the Chilan Willow Grove), an example of the groves created near the Grand Canal and the Yellow River during the Qing dynasty. There are also several *sao* shown in the picture, for which willow was the main material, so this may be illustrating a section which required willows for frequent repair and maintenance. These are Chinese willow rather than weeping willows. Source: *Shui Dao Xun Wang-Tianjin Tu Shu Guan Cang Qing Dai Yu Tu Xuan* (The Collection of the Qing Dynasty Maps at the Tian Jin Library), p. 150.

The canal-side plants were mainly looked after by the *qian fu* 浅夫 (dredging man), who was one type of river worker carrying out maintenance of the Grand Canal, at the lowest level of the canal's management administration. Their duties included taking care of the boats to prevent them stranding on the bank, maintaining and dredging the waterway, watching for thieves, and also planting a certain number of trees and looking after them.[548] *Qian fu* were organized based on the unit of *qian pu* 浅铺 (dredging station), which served as their base and were stationed along the entire course of the Grand Canal. There were in total 532 *qian pu* located along the Grand Canal in 1576, about 10 *qian fu* in each.[549] Another type of river worker, *bao fu,* were responsible for looking after the willow trees too, specifically the groves. *Bao fu* had similar duties but carried out river work for a longer time than *qian fu*.[550]

Apart from the willows, grass was also considered to be useful to plant on the embankment, as it could help reduce the force of the current and protect the embankment from being eroded or damaged. Jin Fu mentioned a specific species of grass, *jiao cao* 茭草 (*zizania caduciflora*). He also recommended planting it together with reed and willow trees, to strengthen the embankment.[551]

The position of the Grand Canal within the local environment

The relationship with the Yellow River

As discussed above, the study of the Grand Canal cannot be comprehensive without mentioning the Yellow River. When the canal route was straightened, the central government and river engineers tended to see the Yellow River as one of the largest water sources for supplying the canal, and attempted to make the canal join the Yellow River to utilize both its water and course. This strategy was called *jie huang xing yun* 借黄行运(assist the Grand Canal by borrowing the course of the Yellow River) or *yin huang ji yun* 引黄济运 (supply the Grand Canal by receiving the water from the Yellow River).[552]

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548 Wang Qiong, *Cao He Tu Zhi (Illustrated Account of the Grand Canal)* (hong zhi jiu nian ben 1496), Vol 3.
549 Ibid.
550 Jin Shican, 'Ming Qing He Gong Bao Fu Wen Ti Yan Jiu (Research on the Baofu System of the River Consevancy in the Ming and Qing Dynaty)', *Journal of North China Institute of Water Conservancy and Hydroelectric Power (Social Science)*, 28:1 (2012), 17-20 (pp. 17-19).
551 Jin, Vol. 4.
552 Hu Mengfei and Song Shixiang, 'Ming Qing Shi Qi Yun He Xu Zhou Duan He Dao Bian Qian Ji Qi She Hui Ying Xiang (The Change of the Watercourse of the Xuzhou section and its Impact during the Ming and Qing Dynasty)', *Huaihai Review*, 2 (2010), 30-36 (p. 30).

Before the early twelfth century the Yellow River was running along the Shandong peninsula, until in 1128 the flow breached its banks and the channel broke into two: one stream went into the Huai River further south. The Yuan government was going to construct the Hui Tong River passing by Shandong province, letting it share its course with the Yellow River between Xu Zhou and Qing Kou. The same policy was followed when the Ming government reopened the canal route. However, the sharing of watercourses brought the devastating floods from the Yellow River to the canal.[553]

In the early fifteenth century, there were several floods from the Yellow River that left the Hui Tong River silted up, interrupting the grain shipment near the Zhang Qiu city.[554] As the safety of grain transport on the Grand Canal had slowly become one of the priorities for the Ming court,[555] the Ming government decided to reduce the flood threat on Hui Tong River by directing the Yellow River to the Huai River further south. A 360 li long embankment called *Taihang di* was constructed on the northern bank of the Yellow River in 1495 by Liu Daxia, the leading river management official of the Ming,[556] through which Huai River took almost the entire flow from the Yellow River.

This canal-focused decision apparently did not take the large area of agricultural lands in Huaibei area (the area between the Huai and the Yellow River) into account. The flooding of the Yellow River frequently affected the farmland nearby with serious effects on local people. What was even worse, to secure the grain transportation during peak time (June to October) on the Grand Canal, the locks were usually kept closed to save water. This resulted in a lack of water for irrigation in the fields, while in flood season the locks were frequently opened to reduce the pressure of the current. This resulted in the water going onto nearby farmland and turning it into lake.[557]

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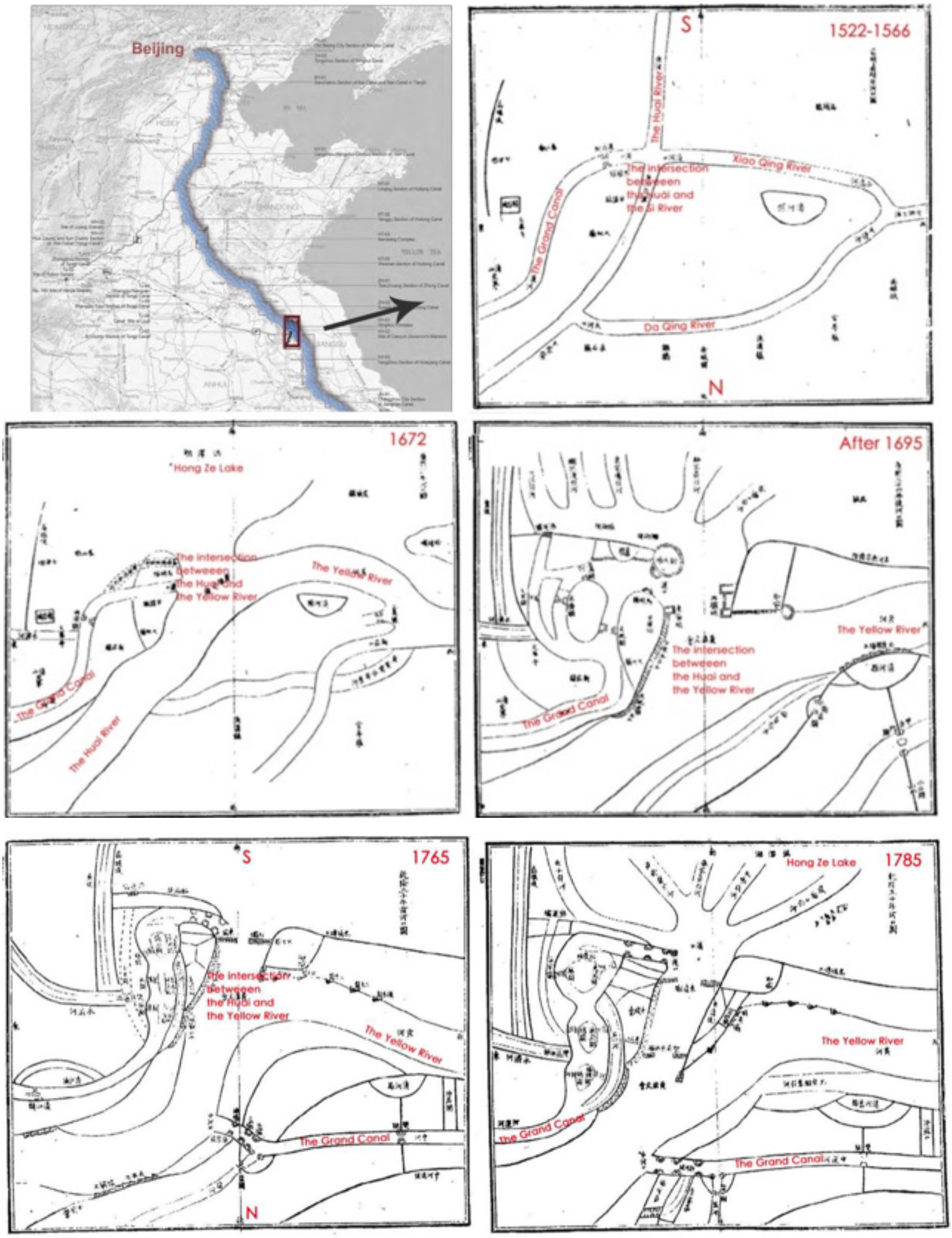
553 Zhang, Vol. 83, He Qu Er (Rivers and Canal Part Two)
554 Ibid.
555 Wright and Ma, pp. 1353-1357.
556 Gu Zuyu, Du Shi Fang Yu Ji Yao (Essence of Historical Geography) (Undated), Chapter 126, Chuan Du San (Rivers and Canals Part Three). Chinese Texts Projects Online Library, http://ctext.org/wiki.pl?if=gb&chapter=927719&remap=gb#p3 [accessed 13 July 2016]
557 Wright and Ma, pp. 1354-1357.

To ensure the transport, the proposal to build a new section of the canal connecting Sha River and Liu Cheng city (in Pei Xian) was made after the floods in 1528 and 1565 caused over 100 li of the Grand Canal to silt up.[558] The new channel, Nan Yang, was completed in 1567 and is 15 kilometres east of the old waterway (which shared its course with the Yellow River). It joined back to the Grand Canal in Pei Xian and avoided the Pei Xian section of the Yellow River.[559] Another waterway called Jia River was also built in 1604 connects Xia Town (in Wei Shan County) and Li Jia Kou (in Pi Zhou) to avoid the Xu Zhou section of the Yellow River.[560]

[558] Zhang, Chapter 83, He Qu Yi (Rivers and Canal Part One).
[559] Lu Honghai, Chen Shiyue and Zhang Chongyang, 'Relationship between Changes of the Canal and Diversion of the Yellow River', *Journal of Shandong Normal University (Natural Science)*, 25:2 (2010), 82-84 (p. 83).
[560] Yao, p. 261.



Beijing
1522-1566
S
The Huai River
Xiao Qing River
The intersection betweeen the Huai and the Si River
The Grand Canal
Da Qing River
N
1672
Hong Ze Lake
The intersection betweeen the Huai and the Yellow River
The Yellow River
The Grand Canal
The Huai River
After 1695
The Yellow River
The intersection betweeen the Huai and the Yellow River
The Grand Canal
1765
S
The intersection betweeen the Huai and the Yellow River
The Yellow River
The Grand Canal
N
1785
Hong Ze Lake
The Yellow River
The Grand Canal

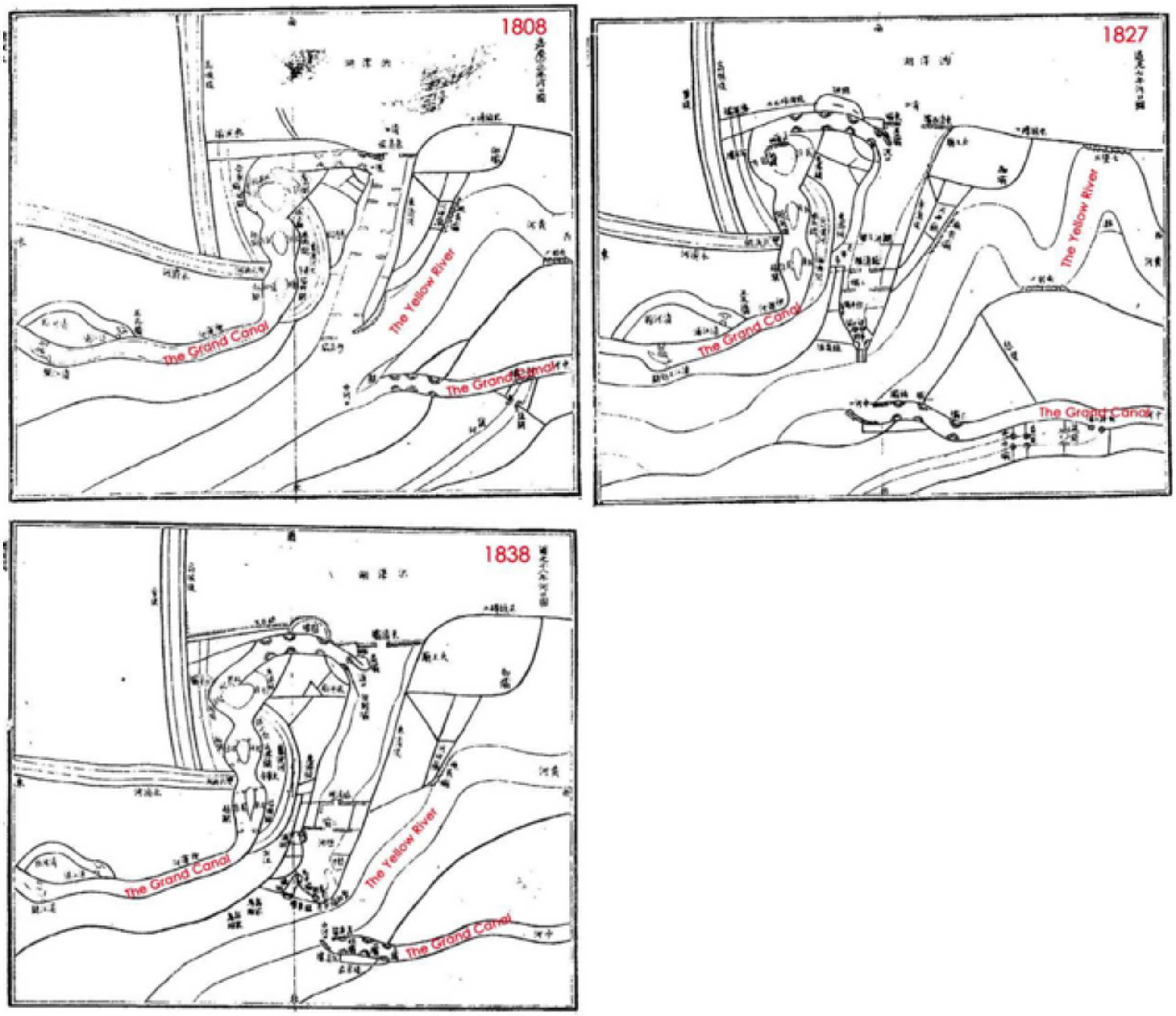


Figure 4.22 The nine maps show *qing kou*, the conjunction point between the Grand Canal, the Yellow and the Huai Rivers, and how it changed between 1522 and 1838. It shows how the Yellow River became joined the Huai River, resulting in the much larger size of the Hong Ze Lake. After 1694, a new section of the canal was built to the north of the Yellow River, which means that apart from the intersection area where the Canal joint the Yellow and the Huai River, the Canal was totally running separately from the Yellow River. The key map on the right corner shows the position of *qing kou* complex. Source: Lin Qing, *Huang Yun He Kou Gu Jin Tu Shuo* (An Illustrated Essay on the Yellow River-Grand Canal Confluence from Former Times to the Present) (dao guang er shi nian ben, 1841). Translation by the author.

The relationship with surrounding environment: the appearance of the reclaimed land

As mentioned earlier, four reservoirs were made for the Hui Tong River in the area between Shandong and Jiang Su Province. To ensure a sufficient water supply, the Qing government forbade local people from using water from these reservoirs for irrigation. In dry seasons water from the various springs would also be sent to the canal, leaving even less water for nearby fields.[561]

There were also restrictive policies forbidding people from cultivating the land near the bank of these reservoirs throughout the Ming and Qing dynasties, and willow trees were planted around the water's boundary to ensure the protection of the land inside.[562] However, as the lack of cultivated lands had pushed farmers to try everything to make their livelihoods, the policies only worked for a short time. During the seventeenth and eighteenth centuries some of the reservoirs made for the Grand Canal slowly dried up, and were turned into cultivated land by farmers, which led to the appearance of reclaimed lands along the canal.[563] After the eighteenth century the Qing government opened up some lakeside lands for people to cultivate, and a large area of reclaimed lands has appeared since then.[564]

We can understand how these lands looked from the travel account of a British Embassy to China who travelled through the Grand Canal in 1793. Sir George Staunton said that: '[…] through which the canal passes, that a vast proportion of it had consisted of lakes and morasses, several parts of which appear to have been since reclaimed, and are now, as well as the upper surface of the embankment, regularly cultivated.'[565] In the account he said that the fields were subdivided into small enclosures by narrow ridges of clay. There was a ditch by each ridge to convey water into wills for every allotment.[566]

561 Wei Yuan, *Wei Yuan Ji (Collected Works of Wei Yuan)* (Beijing: Zhong Hua Shu Ju, 2003), book 1, p. 408.
562 State Administration of Cultural Heritage of People's Republic of China, p. 293.
563 Zhang Boxing, *Ju Ji Yi De 居济一得* (Tong Zhi Ji Yi Tang Ben, 1868), Vol. 1, pp. 23-24.
564 Li Fengrong, 'Ken Hu Yu Jin Hu: Yun He Shui Gui Nan Wang Hu De Li Shi Kao Cha (Historical Study of the Nanwang Lake-the Reservoir of the Grand Canal)', *Journal of the Liaocheng University,* 307-308 (p. 308).
565 George Staunton, *An Authentic Account of an Embassy from the King of Great Britain to the Emperor of China* (London: printed by W. Bulmer and Co. for G. Nicol, 1797), p. 390.
566 Ibid., p. 394.

The prosperity of the canal-side towns

The focus on the Grand Canal might have caused a lot of change and harm to the surrounding water system and lands, but we cannot deny the opportunities it has brought to the canal side cities and towns. As mentioned, the Ming government did not pay for the cost of the transportation of tax grain, but instead allowed boatmen to carry a certain amount of private goods to trade on the way to make up for the cost of the journey.[567] Private commerce developed rapidly, bringing the state considerable profits through a tax on commerce.[568]

The central government realised that the benefits from private commerce and the amount of goods that was permitted to be carried were increasing. At first (the early sixteenth century) people were not allowed to carry more than 10 *dan* of private goods, which was later increased to 40 *dan* and then 60 *dan* in the late sixteenth century and early seventeenth century. In fact the real number was far more than that: in the late eighteenth century, the official record of the annual amount of the private goods being carried by the canal barges was 4200,000 dan, which did not include the extra goods many barges carried. It is said that there were even more private goods than the tribute grain being shipped on the Grand Canal each year.[569] The Grand Canal was already as much a route for private commerce as for the official grain transportation.

Goods such as silk and tea from the south were very popular for trading on the way to the capital, and cotton and fruit from the north were always in great demand in the southern region. Commerce also developed in the canal side cities and towns, and the area near the wharfs and docks became the best trading centres. This made the canal-side areas, especially along the northern section, a unique place as the traditional idea of lifelihood in the north was *zhong nong yi shang* 重农抑商(agriculture rather than trading), and doing business was

567 Twitchett (ed.) *The Cambridge History of China, Volume 8,* p. 602.
568 Li and Wang, p. 97.
569 Zhang, p. 69.

regarded as *min zhu mo li* 民逐末利 (chase after commercial benefits).[570]

Figure 4.23 The photograph shows the scene of a busy market in Dong Chang Fu (present Liao Cheng), one of the cities on the canal bank. Source: Gao Wenxiu, 'Old Yanggu Photographs from the Canadian missionary William Smith between 1934 and 1937', *Sina Blog* (2011) <http://blog.sina.com.cn/s/blog_4c3ea8090102dt8z.html> [accessed 21 July 2016]

Figure 4.24 Another photograph taken by William Smith shows the market in Yang Gu town along the Grand Canal. Source: Ibid.

570 Li and Wang, p. 72.

The convenient traffic and working opportunities also attracted more people to come to work and live along the Grand Canal. For example, there were about 14,000 full-time workers working on the maintenance of the Shandong section of the canal during the Ming dynasty, many of whom were said to have eventually settled down in villages along the canal.[571] There were also stories about ferry men who came to make money by carrying river workers cross the river, but stayed along the canal for longer to be able to keep their ferries safe at night, which resulted in many of them choosing to settle down along the canal. People who came to work also included peddlers who sold daily supplies or cups of tea to boatmen who came to the bank to have a rest while waiting to go through the lock: it took a long time to open the lock gates in order to save water.[572] Many settlements appeared after the Grand Canal was built, usually located close to locks and wharfs,[573] suggesting that the canal might have been a factor in their appearance. More details of canal-side towns will be discussed in chapter six, in the case study of the Shandong section of the canal.

571 Li and Wang, p. 63.
572 From the informal interview with villagers in Jining. Although it is hard to find out whether this information is accurate or not, it gives us an idea of how people were attracted to work and live along the canal at that time.
573 Li Chen, 'Analysis of the Disciplines of the Settlements' Distribution along the Jing-Hang Grand Canal', *Architectural History*, 26 (2007), 163-166 (p. 166).

Figure 4.25 the painting shows a peddler standing along the Grand Canal near Hang Zhou, holding a basket of birds' nests for sale. This was a very expensive food favoured by upper class Chinese people. Source: Alexander William, 'Front View of a Boat, Passing over an Inclined Plane or Glacis', in The *Costume Of China: Illustrated In Forty-eight Coloured Engravings* (London: William Miller, 1805).

Conclusion

This chapter reviewed a key section of the Grand Canal history, from when it was reopened in the early fifteenth century, after the water source problem was solved, to when it became the lifeline of imperial China, not only as the main artery for grain transport, but also as a vessel for private merchandise.

Traditional river engineering developed rapidly during this period, for example with an increased understanding of the different techniques of building canal locks, as well as the various methods of making use of willow trees for flood control. Many of these techniques were specifically adapted to the canal's characteristics, such as the invention of the *qian chuan* to adapt to the shallower water level in the northern section. These show how different methodologies were adopted to solve difficulties for canal transport. The related river works should be seen as a significant part of the development of the Grand Canal, contributing greatly to its historic value.

Unfortunately, most of the physical features of these traditional techniques were removed during the second half of the twentieth century. Although the government conducted large numbers of projects to repair and reconstruct these structures for the World Heritage nomination, due to the lack of historical research and limited scientific standards, numerous mistakes were made in the repairs. Through the extensive material covered in this chapter, the author intended to increase the limited historic research of the canal's river engineering, in the hope that this may help correct mistakes made in the reconstruction of canal features.

Furthermore, although the author has no doubt about the significant values of the traditional river work for the Grand Canal, knowing that most of the work has disappeared during the process of modernization, it is questionable how much historical authenticity, and hence value, is embodied in the canal.

Chapter Five. From the twentieth century onwards:
From dereliction to World Heritage Site

This chapter focuses on the Grand Canal's history, from the end of the *cao yun* (tribute grain shipment) system in 1912 to when the southern section was transformed as a coal transport route during the late twentieth century. It covers a range of aspects, including the decline of the canal transport since the late nineteenth century, flood control with the aid of western experts during the early twentieth century, and the extensive modification on the canal waterways after the communist government was established in 1949.

For the study of the social and political context of the decline of the Grand Canal, the books *Cambridge History of China* (1988)[574] and Li and Wang's *shan dong yun he wen hua yan jiu* (2006)[575] were consulted, focusing on canal management corruption during the late Qing Dynasty (1644-1912). Wu and Wang's (2010)[576] and Zhang's articles (1992)[577] also provided valuable information of how the canal transport was once again replaced by sea transport and eventually stopped completely in 1912.

With respect to the consultation of American engineers during the early twentieth century, a number of western sources were available, which were primarily published by the engineers who came to China to aid flood relief efforts in the Yellow River. For instance, in Jameson's *River, Lake and Land Conservancy in Portions of the Provinces of Anhui and Kiangsu, North of the Yangtze River* (2015),[578] the poor-quality maintenance by the central government at the time was documented and a valuable record of a traditional canal lock provided (Figure 5.1). Todd also provided in his article (1937)[579] a very detailed account of a water control project taken place in the Shandong Province in 1935, which he had witnessed, and he observed that although modern techniques had begun to be introduced in China, the

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574 Frederick W. Mote and Denis Twichett (ed.) *The Cambridge History of China* (Cambridge: Cambridge University Press, 1988). Vol.10: Late Qing 1800-1911. Part 1.
575 Li Quan and Wang Yun, *Shandong Yunhe Wenhua Yanjiu (Studies of the Canal Culture of the Shandong section)* (Jinan: Qilu Shushe, 2006).
576 Wu Cui and Wang Min, 'Shi Xi Jing Hang Yun He Shan Dong Duan Zai Jin Dai De Shuai Luo Yuan Yin (The Decline of Shandong Section of Grand Canal in Modern History)', *Journal of Baicheng Normal College,* 24:1(2010), pp. 70-73.
577 Zhang Zhaodong, 'Qing Dai Cao Yun Yu Nan Bei Wu Zi Jiao Liu (The Tribute Grand Transport in the Qing Dynasty and the North-South Trade)'. *Studies of the Qing History*, 3(1992), 67-73.
578 Charles Davis Jameson, *River, Lake and Land Conservancy in Portions of the Provinces of Anhui and Kiangsu, North of the Yangtze River* (London: Forgotten Books, 2015).
579 Oliver J. Todd, 'China's Ol's Man River', *Scientific American*, 1937, 5-9.

traditional techniques and mass labour were still the defining features for most of the projects during this period. He also provided a number of valuable photographs showing different types of river work undertaken, and the main tools that were used.

Apart from western sources, Chinese literature such as Wu's book *the American Large Enterprises and Internationalization of the Modern China* (2012),[580] Qian's (2006)[581] and Wang's (2006)[582] articles, were also reviewed, to identify the complex situation of the cooperation between the Chinese government and international organizations such as the American Red Cross at that time.

In addition, for the development of the Grand Canal during the Mao era (1949-1976), several propaganda publications were reviewed to help understand its social-political context. Three books: *Water Conservancy in New China* (1956),[583] *Ten Great Years* (1960)[584] and *China's Big Leap in Water Conservancy* (1958),[585] which were published with the Western media in mind, intended to show the big achievements that had been made in water conservancy development under the new government's lead. Chi's article (1965),[586] however, critically examined the new government's water conservancy goals, and revealed the fact that most of these goals were rather unrealistic and bold, and the achievements reported by local government were also exaggerated. Moreover, articles such as Ray's (1970),[587] together with the information obtained from the author's interviews with local elderly people, helped reveal how large numbers of Grand Canal properties were deliberately destroyed during the campaign of *po si jiu* (the destruction of the Four Olds) led by the central government.

For the Grand Canal's development during this period, it was the government's intention to 'upgrade' it to a standardized modern waterway as part of the modernization transformation of the state. The *di fang zhi* (annals of local cities/provinces) were consulted to identify the

580 Wu Lingjun, *Mei Guo Da Qi Ye Yu Jin Dai Zhong Guo De Guo Ji Hua (The American Large Enterprises and Internationalization of the modern China)* (Taipei: Lianjing Press Ltd, 2012).
581 Qian Jian, 'Harnessing the Huai River Planned by Zhang Jian And the American Red Cross', *The paper of the 4th International Conference of Studies about Zhang Jian*, 2006, pp. 13-16.
582 Wang Xingcheng, 'Min Guo Shi Qi Hua Yang Yi Zhen Hui Huai He Liu Yu Zai Hai Jiu Zhi Lun Shu (Discussion of the Disaster Reliving from the China International Famine Relief Commission for the Huai Valley)', *Archive of Republic of China*, 4(2006), 126-132.
583 *Water Conservancy in New China* (Peking: The Ministry of Water Conservancy, 1956).
584 State Statistical Bureau, *Ten Great Years* (Beijing: Foreign Language Press, 1960).
585 Gu Lei, *China's Big Leap in Water Conservancy* (Beijing: Foreign Language Press, 1958).
586 Chi Wenshun, 'Water Conservancy in Communist China', *The China Quarterly*, 23(1965), 37-54.
587 Dennis Ray, ''Red and Expert' and the China's Cultural Revolution', *Pacific Affairs*, 43:1(1970), 22-33.

design detailing of the canal waterways, these include *zao zhuang shi zhi (Annals of Zao Zhuang)* (1993),[588] *Jining shi zhi (Annals of Jining)* (2002)[589] and *jiang su sheng zhi (Annals of Jiangsu Province)* (2000).[590] Several governmental reports, such as '*the Migration Plan of the Hanzhuang and Tai'er Zhuang Section*' (1963),[591] and '*the Areas of Lands Occupied by the Reconstruction of the Grand Canal*' (1960),[592] which were obtained from the Shandong Archive, were also reviewed, to gain knowledge of how local residents' houses and land were sacrificed under the massive modification of canal waterways.

In addition to the aforementioned *zao zhuang shi zhi*, Xu el al's book *jing hang yun he zhi (Annals of the Grand Canal)* (1998),[593] and Gao's book *Shandong yun he min su (The Customs of the Shandong Section of the Grand Canal)* (2006)[594] were also reviewed with the aim to review the development of barges and transport, and specifically to explore the evolution of the canal barges in terms of their material, tonnage and dimensions.

Finally, for the development of the Grand Canal after 1978, the government made further plans to adapt the canal route to serve as the main inland waterway for coal transport,[595] as well as part of the route for the South-North Water Transport project.[596] To achieve these goals in 1980s, extensive modification took place on the southern section of the canal waterway. Xu's *jing hang yun he zhi* was consulted once more for details of the massive

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588 The compilation Committee of Annals of Zaozhuang. *Zaozhuang Shi Zhi (Annals of Zao Zhuang)* (Beijing: Zhong Hua Shu Ju, 1993). < http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=378&run=13> [accessed 17 May 2016]

589 The compilation Committee of Annals of Jining. *Jining Shi Zhi (Annals of Jining)* (Beijing: Zhong Hua Shu Ju, 2002). <http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=378&run=13> [accessed 17 May 2016]

590 The compilation Committee of Annals of Jiangsu Province. *Jiang Su Sheng Zhi (Annals of Jiangsu Province)* (Nanjing: Jiangsu Renmin press, 2000). <http://www.jssdfz.com/book/zhjjz/D12/D2J.HTM > [accessed 18 May 2016]

591 *The Migration Plan of the Hanzhuang and Tai'er Zhuang section* 枣庄市运河韩庄台儿庄段新移民工作计划. 关于韩庄运河工程枣庄地区移民迁占安置计划的批复 Reply to the Resettling Plan of the Migrants of the Hanzhuang Canal Reconstruction project. Department of Shandong Water Conservancy, 10 June 1963. From the Shandong Archive.

592 运河占用土地情况 *The Areas of Lands Occupied by the Reconstruction of the Grand Canal*. 24 October 1960. From the Shandong Archive.

593 Xu Congfa, Li Baohua and Han yunchen, *jing hang yun he zhi (Annals of the Grand Canal)* (Shanghai: Shanghai Social Science Press, 1998)

594 Gao Jianjun, *Shandong yun he min su (The Customs of the Shandong Section of the Grand Canal)* (Jinan: Jinan Press, 2006)

595 Han, Qiang, 'Guo Wai Deng Xiao Ping Yan Jiu Bu Duan Tuo Zhan (The Extending Oversea Research about De Xiaoping)', *Central Compliation and Translation Burea* (2014) <http://www.cctb.net/llyj/lldt/hwzg/201408/t20140805_311354.htm> [29 May 2016]

596 Water Conservancy Committee of the Huai River, 南水北调东线工程规划(2001 年修订)简介 *Brief Introduction of the Project Planning (2001 Revision) of the Eastern Route of the South-North Water Diversion* (Beijing: Official Website of the South-North Water Diversion, 2003) <http://www.nsbd.gov.cn/zx/gcgh/200308/t20030825_195172.html >[accessed 21 May 2016]

widening and dredging undertakings in this project; an illustration from the *Science and Civilization of China*[597] is also included to show the detail of a widely-used dredger at the time-*jiao ni chuan* (Figure 5.24). Moreover, for the design of canal locks, Huang and He's article (1996)[598] provided an example of how the traditional canal locks were replaced by modern materials like concrete and steel, which resulted in the removal of original fabric.

Due to the pervasive propaganda environment created by the central government, the Grand Canal's extreme modifications during the second half of the twentieth century, especially during the Mao era, are not discussed enough in modern Chinese studies. However, this period plays a key role in the development of the canal, as it was when most of the original features were removed due to the government's aim to build a modern China. The author critically examined these water conservancy policies and projects, and for the first time provided a critical account of how the canal gradually lost its historic values under a misguided development plan.

From the end of the Qing Dynasty (1644-1912) to the founding of the Republic of China (1912-1949)

The socio-political context

The end of the *cao yun* (tribute grain shipment) system

As explained in the previous chapter, the tax grain transport on the Grand Canal was a focus of the Qing Dynasty's policy, along with flood control of the Yellow River, which frequently threated the functioning of the canal.[599] Because of their significance, corruption became a serious problem in the early nineteenth century. An example of this was the overstaffing of the grain shipment: not only were there large numbers of hereditary boatmen who had served in that role since the Ming era, but also a dramatically increasing number of *shui shou* 水手

597 Needham, p. 338.
598 Huang Weijin and He Weigang, 'Tai'er Zhuang Er Xian Chuan Zha She Ji Jian Jie (The Introduction of the Design of the Tai'er Zhuang Twin Lock)', *Hydraulic Engineering,* 1(1996), 30-34.
599 Frederick W. Mote and Denis Twichett (ed.), *The Cambridge History of China, Vol. 10: Late Qing 1800-1911, Part 1* (Cambridge: Cambridge University Press, 1988), p. 119.

(sailors), whose role had been created in the Qing.[600] The posts in the grain transport stations became so important that there were often more than one or two officials holding each position.[601] The Qing government tried to make up for the rising salaries by increasing the tax on each barge, which contributed to decreasing amounts of grain being transported to Beijing.[602]

There was a similar situation in relation to the Yellow River conservancy. The aim of water conservancy administration from the nineteenth century was no longer to control the floods as before; instead, this became a way for officials to procure a steady flow of funds from central government. Six million silver *liang* were allocated to support the water conservancy every year, but only ten percent of them would be spent legitimately. This was part of the reason why the floods of the Yellow River in this period were much worse than before.[603]

The neglected flood control of the Yellow River badly interrupted the tax grain transports: after the devastating floods in 1824, only a quarter of the barges could survive their journey to Beijing, crossing the Yellow River in *qing kou*. Facing the risk that the capital might suffer a food shortage, the Qing government started to reconsider the sea route that had been developed during the Yuan Dynasty.[604]

This proposal was opposed by many officials, partly because the grain shipments on the Grand Canal had benefited them in many ways. At that time, the sea route only served for private trading and there had been no governmental administration since the late seventeenth century, so important opportunities for earning fees would be lost if the transports transferred from the canal to the sea. However, because of the food shortages, the Daoguang Emperor (reign 1820 – 1850) had to combine the sea route with the canal route, though he promised

600 Li and Wang, pp. 63-64.
601 Mote and Twichett, *Cambridge History of China, Vol. 10*, p. 121.
602 Ibid.
603 Jiang Duwu, 'The Yellow River Administration in the Qing Dynasty', *FEQ*, 14:4 (1955), 505-513 (pp. 507-510).
604 Mote and Twichett, *Cambridge History of China, Vol. 10*, pp. 120-122.

that the Grand Canal would remain the main means of grain transport once it was fully repaired and reconstructed.[605] But the Grand Canal was never to return to its heyday because of the Tai Ping rebellions, continuing flooding from the Yellow River and the two Opium Wars with the Great Britain, and the sea transport became more and more important.[606]

In 1825, the Maritime Transport Bureau was established in Shanghai, and the Exchange Department was established at Tianjin. Grain from the main producing areas in the southeast (Su Zhou, Song Jiang, Chang Zhou, Zhen Jiang and Tai Zang) could be transported to Tian Jin on the Huang Pu River and then the Bo Hai Sea: the sea route remained the longer part of the journey.[607]

After the 1840s, the Qing government suffered dramatic dynastic issues which made it almost impossible to recover the inland waterway transport. In 1872, Li Hongzhang (1823-1901), the leading official of the Qing government, founded the Ship Business Soliciting Bureau in Shanghai as part of the Self-Strengthen Movement (1861-1895).[608] This gradually took over grain transport on the sea route, making the restoration of the canal even less necessary.[609] Li predicted that 'no reasons would be found to reopen the canal transport within a hundred years'.[610] In 1902, the grain transport on the Grand Canal ceased, and two years later, the position of grain transport Governor was also removed.[611] In 1912, the *cao yun* system was officially stopped, ending the practice of 2000 years.[612]

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605 Mote and Twichett, *Cambridge History of China, Vol. 10*, pp. 124-125.
606 Ibid., p. 125.
607 Dong Wenhu, *History and Future of the Beijing-Hangzhou Grand Canal* (Beijing: China Social Science Academic Press, 2008), p. 271.
608 The 洋务运动 Self-Strengthening Movement was a period of institutional reforms in the late Qing dynasty between 1861 and 1895. The two main concepts for these reforms were 师夷之长技以自强 (adopt the western technology to grow our own power) and 师夷之长技以求富(adopt the western technology to develop economy)
609 Wu and Wang, p. 71.
610 Li Hongzhang. 'Fu Liu Zhong Liang Fang Bo, Tongzhi Shi Er Nian Shi Yi Yue Shi San Ri (Reply to Liu Zhongliang. 13 November, 1873)', in *Li Hong Zhang Quan Ji (Collected Work of Li Hongzhang)*, ed. By Chinese Qing History Compilation Committee (An Hui: An Hui Education Press, 2008), p. 615.
611 Zhang, pp. 67-73.
612 Dong, p. 272.

The Republic of China (1912 – 1949): cooperation with American engineers and the emergence of modern means of transportation

The Republic of China was founded in Beijing in 1 January 1912 after the success of the Xin Hai Revolution against the Qing Dynasty. During this period water conservancy focused on the Grand Canal, the Yellow and Huai Rivers, which were all having great difficulties. The northern section of the Grand Canal was badly silted because its maintenance had been neglected, and in the dry season the water level was only one or two metres. The bank of the canal from Lin Qing to the junction with the Yellow River had mostly been cultivated by people who lived in nearby villages.[613] Because of the raised canal bed the flood happened often, frequently affecting the surrounding area. The region between the Yellow and Huai Rivers also suffered severe floods issues and famine.[614]

We know a little more about the condition of the canal from the 1913 account of Charles Davis Jameson (1855-1927). He had been the architectural consultant for the late Qing dynasty since 1895, and later served as the director of the Huai River Water Conservancy Project led by the American Red Cross (ARC). The river was 183 to 366 *chi* (the original texts used 'feet' as the unit) wide and 9 to 11 *chi* deep, and had not been maintained until serious breaks occurred in the dykes; and even when they were repaired, it was done in a 'weak, cheap, temporary manner at a tremendous cost'. When he tried to control the flooding, Charles complained that instead of lowering the canal bed, the government put all its effort into increasing the height of the dykes.[615]

613 Zhang Ziqing, *Lin Qing Xian Zhi* (The Annals of the Linqing County) (Ming Guo 23 [1934] Qian Ben). Vol. 6.
614 Li and Wang, p. 36.
615 Charles Davis Jameson, *River, Lake and Land Conservancy in Portions of the Provinces of Anhui and Kiangsu, North of the Yangtze River* (London: Forgotten Books, 2015), pp. 12-13.

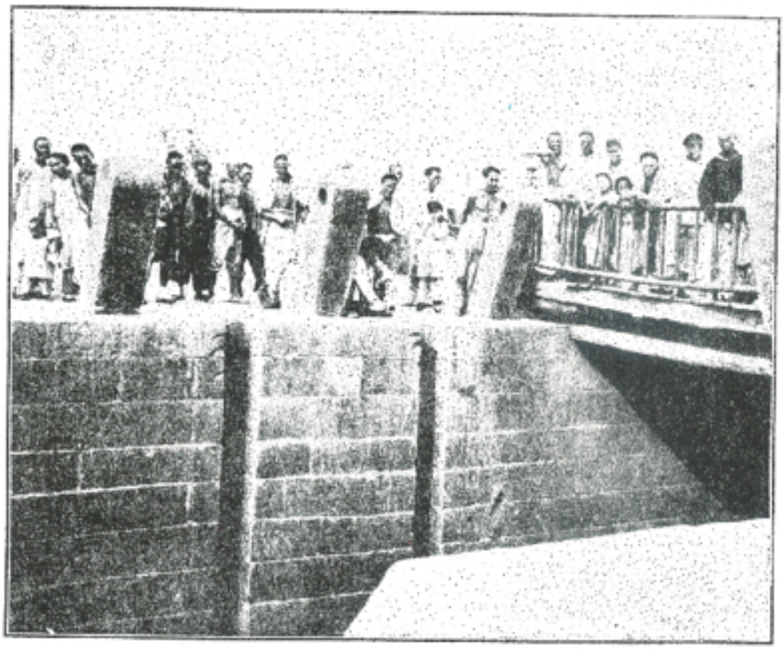

Figure 5.1. A photograph taken by Charles D. Jameson shows part of a traditional lock on the Grand Canal in the 1910s. The grooves for inserting the wooden beams, the *jiao guan shi* (stone crane arms) and the bridge can be seen. There are three pieces of jiao guan shi shown in the picture, rather than the usual number, two, and the hole on each was for positioning a wooden stick to attach ropes to lift and lower the lock gates. Source: Charles Davis Jameson, *River, Lake and Land Conservancy in Portions of the Provinces of Anhui and Kiangsu, North of the Yangtze River* (London: Forgotten Books, 2015), p. 29.

At the time the most influential water conservancy engineer and industrialist was Zhang Jian (1853-1926). He had studied all the works of Pan Jixun and Jin Fu in his youth, then later the modern western techniques. He began serving in his water conservancy post in the late Qing Dynasty, and realized the importance of collecting hydraulic data for water control projects after he was sent to carry out a site survey for the Yellow River in 1887. In 1906, as a local governor, he founded the Huai River Bureau to take charge of the water conservancy for the entire river valley. A year later he established the Jianghuai (Yangzi and Huai River) Water Conservancy Company and its Survey Department. He also started receiving students, training them in modern surveying techniques. Nine of the forty-three students were selected to work in his newly founded Civil Engineering Department in 1908, gathering valuable data on the hydraulic conditions of the Huai valley.[616]

Figure 5.2 Zhang Jian (1853-1926) was a leading hydraulic engineer and industrialist. Source: A.R. Burt, J.B. Powell and Carl Crow, eds., *Biographies of Prominent Chinese* (Shanghai: Biographical Publishing Company Inc., 1925), p. 12.

While Zhang Jian was very keen to improve the local environment conditions of the Yellow and Huai valleys, his project was beyond the resources of the new government,[617] who decided to ask for help from the United States with whom they had a closer relationship at that time. They appointed Zhang Jian to communicate with them as the expert on the Chinese side. The successful opening of the Panama Canal in 1914 had been widely reported and praised by the Chinese media, and the Americans' modern hydraulic technology was thought to be exactly what was needed to deal with the flooding in China.[618] Fortunately, the American Red Cross had been involved in flood relief for people living in the Huai River Alley since 1906, and helped bring several American engineers to China in attempts to tackle the problem. They also helped put the Chinese government in touch with the American International Corporation (AIC), who might be able to provide aid, both financial and

616 David A. Pietz, *Engineering the State: the Huai River and Reconstruction in Nationalist China, 1927-1937* (New York: Routledge, 2002), p. 29.
617 Ibid., p. 28.
618 Wu Lingjun, *Mei Guo Da Qi Ye Yu Jin Dai Zhong Guo De Guo Ji Hua (The American Large Enterprises and Internationalization of the modern China)* (Taipei: Lianjing Press Ltd, 2012), pp. 179-180.

technical.[619]

Unfortunately the interaction between Zhang Jian and the American experts did not go very well. As early as 1911, Zhang Jian and Charles were arguing. After Charles conducted his survey of the Huai valley, he thought the Huai River's flooding could be reduced by directing it to the sea through the old course of the Yellow River, or through the Yangzi River, through the lakes to the east of Hongze Lake.[620] Zhang Jian did not agree with Charles' proposal, but thought that rivers and sea should not be linked.[621]

A similar situation arose between Zhan Jian and the other two American engineers, William Luther Sibert and John Ripley Freeman, who came to China slightly later. Zhang did not agree with either of their plans. Sibert suggested diverting the entire Huai River to the Yangzi,[622] while Freeman believed it should be diverted to the sea.[623] In fact between 1914 and 1928, about seven proposals for the Huai River conservancy were presented by both Chinese and foreign experts, but none of them was agreed by both sides.[624]

This was not the only obstacle to cooperation between China and AIC: discussion of the loan agreement was interrupted by the local governments of Shandong and Jiangsu provinces,[625] while the Japanese government claimed that the water conservancy projects would affect their administration in Shandong province: the loan agreement between China and America could not be made without the consent of the Japanese government.[626]

619 Pietz, p. 30.
620 Ibid.
621 Wu, p. 208.
622 George Burleigh Baird, 'Famine Relief and Prevention in China' (unpublished M.A dissertation, Chicago University, 1915), p. 50.
623 Vannevar Bush, 'Biographic Memoir of John Ripley Freeman, 1855-1932', *National Academy of Sciences of the United States of America Biographical Memoirs Volume XVII-Eighth Memoir,* p. 185.
624 Qian Jian, 'Harnessing the Huai River Plannedby Zhang Jian And the American Red Cross', The paper of the 4th International Conference of Studies about Zhang Jian, 2006, p. 14.
625 Wu, p. 190.
626 Report of Interview, 23 February 1917, between Roy Anderson, Warren R. Austin and Pan Fu, China File, *Austin Papers*, Carton 5, Folder 6.

In the meantime, floods continued to affect the Yellow and Huai River region and caused severe famine; between 1914 and 15 it took the lives of hundreds of thousands of peasants.[627] In this pressing situation, Zhang Jian made a new plan in 1919, to divert seven tenths of the water from the Huai to the Yangzi River and the rest to the sea, and to reconstruct the northern embankment of the Grand Canal. However, China was suffering both civil war and external threats at the time, and financial difficulties made it impossible to carry out his plan.[628]

In 1921, the China International Famine Relief Commission was established, focused on natural disaster relief nationwide.[629] Oliver J. Todd, an American engineer, was employed by this organization as consulting engineer for the Shandong Government and the Yellow River Commission in 1923.[630] He made a great contribution to the Chinese water conservancy industry by successfully repairing numbers of dykes on the Yellow River and the Grand Canal, as well constructing the highway in Shandong province; he was named the 'River Tamer' by the American media.[631] More detail about his work will be introduced later.

Figure 5.3 Photograph of Oliver J. Todd. Todd first came to China to work on the site investigation for the Grand Canal Improvement Board in 1919, and stayed there for 19 years. He made a significant contribution to the flood control of the Yellow River and the canal. Source: Alumni News. *The Michigan Technic*, Vol. 67-68. 1948, p.12.

627 Qian, p. 13.
628 Ibid., p. 14.
629 Wang, p. 126.
630 'Alumni News', *The Michigan Technic*, 67-68 (1948), p. 12.
631 Ibid.

While progress on flood control was not great, railway and road transport developed rapidly in China. In 1912, Beijing was connected to Shanghai by rail for the first time.[632] In 1929, the Chinese government issued a *National Highway Planning Guideline* to develop the highway system. In Shandong province alone there were a total of 65 new highways constructed between 1927 and 1937.[633] Modern means of transport slowly replaced the transport on the Grand Canal, though it still served as an important route for coal shipping between the north and the south.[634]

The combination of modern and traditional techniques

Traditional river engineering began to be studied at the beginning of the twentieth century from the perspective of modern science, by scientists and engineers such as Zheng Zhaojing (1894-1989) and Li Yizhi (1882－1938), as well as Zhang Jian who was introduced above. Most of these pioneers had studied hydraulic engineering in Europe or the United States, and carried out research on traditional river engineering as well as introducing modern methods after they came home.[635] Various important works were published during this period, including Zheng Zhaojing's *He Gong Xue* (Studies of River Engineering) published in 1933. Many of them have since been used as textbooks.[636]

While bringing in modern methods and technology, these pioneers did not only advocate modern science but also combined its advantages with traditional technologies. This was

632 Dong, p. 275.
633 Edit Committee of Transportation History of Shandong Province. *Shandong Gonglu Yunshu Shi (Highway Transportation History of Shandong Provicne)* (Jinan: Shandong Science and Technological Press, 1992), Part 1, Xianqin ZhiQing Daolu Yunshu (Road Transport from the Qin to Qing Dynasty)
634 The compilation Committee of Annals of Jining. *Jining Shi Zhi (Annals of Jining)* (Beijing: Zhong Hua Shu Ju, 2002). < http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=378&run=13> [accessed 17 May 2016]. More details of coal transportation on the Grand Canal will be discussed in later paragraphs.
635 For example, Zheng Zhaojing received the Master Degree on hydraulic and municipal engineering from the Dresden University of Technology in the early 1920s. Li Yizhi studied at the Technical University of Berlin in 1909 and Gdańsk University of Technology in 1913, but did not receive degrees.
636 *Zhong Guo Shui Li Zhi Fu-Zheng Zhaojing* (Zheng Zhaojing the Father of Chinese Hydraulic Engineering) (Shanghai: Tongji University Alumni Association, 2007) http://tongjiren.org/cms/xyxy_xyfc/131188.html [accessed 27 July 2016]

important in wartime China, which could not afford to import large amounts of modern materials or invest in training for all the river workers,[637] so this combination method was very practical.

A good example of this kind of combination method was the water conservancy project on the Yellow River in 1935, under the consultancy of the American engineer, Oliver J. Todd. As discussed above, Todd had been involved in water conservancy projects and modern highway construction in China since 1919, and kept accounts of his work in terms of the methods and materials that were used in great detail. The 1935 project was carried out in cooperation with the Shandong Government and the Chinese Yellow River Commission, after two severe floods in 1933 and 1934 broke almost all the dykes east to He Nan province. This created a serious threat to Tian Jin city which might have been submerged if another flood of this severity occurred.[638]

The main objective of the project was to force the flow of the Yellow River back to its old course, from where the flood emerged from breaches in western He Nan and then southwards. This would be achieved through the reconstruction of the dykes. At first Todd was going to use the western breach-block method he had used for both the Colorado River in the United States and the Yellow River in Shandong. This used a wooden trestle as the core of the dam, which was then filled with large numbers of rocks which were then waterproofed. However, as the project was executed during the winter (beginning in November 1935 and completed the following March), it would have been dangerous to drive piles for the trestles because of the running ice. So he combined modern and traditional Chinese methods, calling it a 'contraction method'.[639]

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637 Zheng Zhaojing, *He Gong Xue (Studies of River Engineering)* (Shanghai: Shang Wu Yin Shu Guan, 1935), p. 2.
638 Todd, p. 6.
639 Ibid.

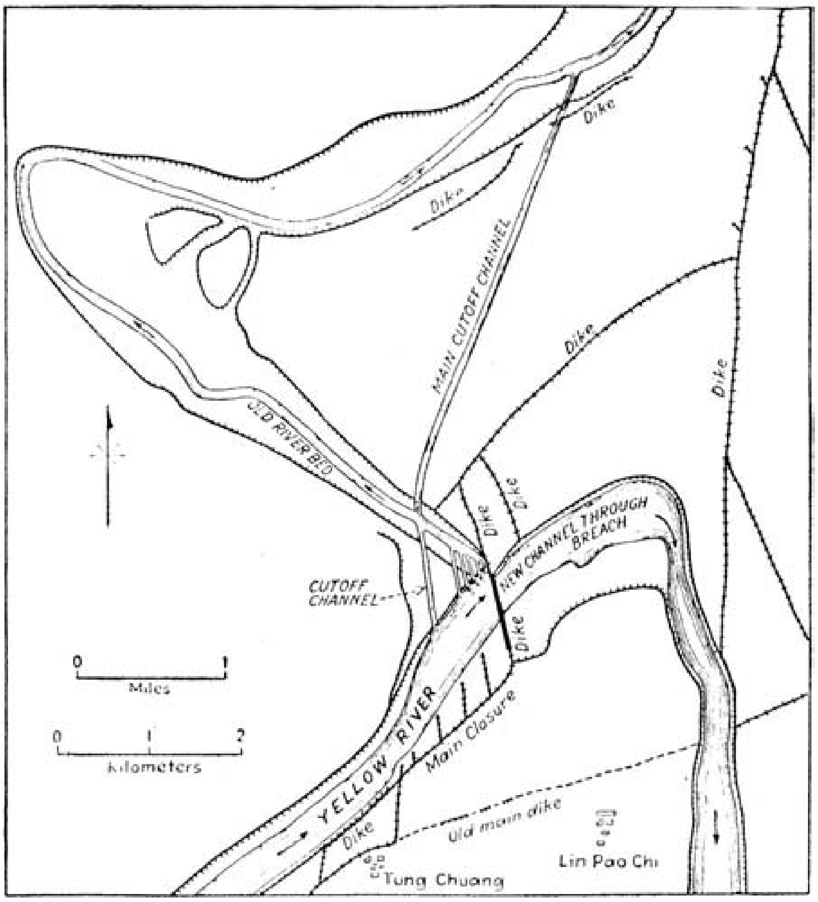

Figure 5.4 Todd's plan shows the Yellow River in 1935: the water had broken the dykes in western He Nan province and south to Lin Pao Chi village. His project aimed to raise and widen the earth dykes along the old river course and repair the broken ones to force the water to flow back along its old course. A new cut-off channel was made to relieve the flooding. Source: Todd, p. 5.

The work of repairing the dykes started from both ends and went towards the middle, until a breach of just 130 chi was left. The method and materials used to make the core of the dike kept to the traditional Chinese method, using kaoliang stalks. Layers of dry kaoliang stalks were laid parallel to the running water, carefully tied together with hemp ropes to compress them to about 3 chi in depth; then a layer of 1 to 1.5 chi of thick earth was placed on them, depending on the weight required when it was pushed out into the water. While placing these kaoliang cores into the water, their ropes would be tied to the horizontal spar on the large boat parked in front of the position of the dykes. Hundreds of men needed to work quickly to place the kaoliang works into the water and slowly detach the ropes wound on the spar.

The ropes were then moved to tie the bundles to the willow stakes on the bank.[640]

Figure 5.5 photo shows how the kaoliang stalks structure were lowered into a dyke breach. The spar used to attach the ropes of the structure can be seen on the large boat. Source: Needham, PLATE 383.

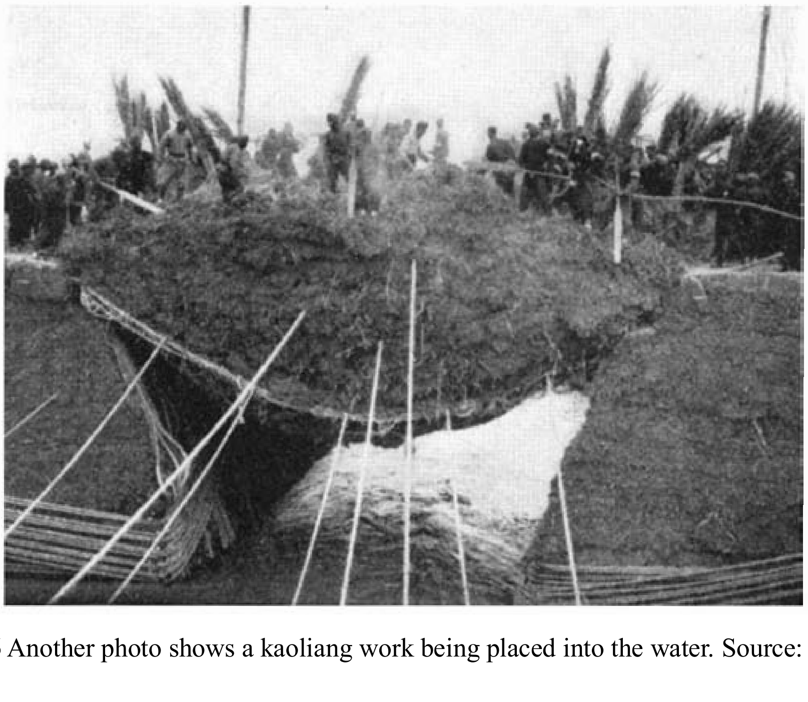

Figure 5.6 Another photo shows a kaoliang work being placed into the water. Source: Todd, p. 9.

640 Todd, pp. 7-8.

The key part of the dyke's construction came when there was a gap of only about 130 feet wide gap left to close.[641] As the water speed would be very high, stronger structures were needed. A new method was applied here: large stones were bound by a number of 50 chi long willow fascines to form a 'stone sausage'. This was formed by tying willow branches together with galvanized iron wires which were imported from America, to a roll of about six inches diameter, which were then laid on the ground with large stones placed on top of them. A heavy strong cable had to be be placed with these stones so that it could be handled later. More willow fascines would then be added to make the top and sides until the stones were totally cased. At last all of these materials would be tied together with ropes at every 3 chi of its length.[642]

To block the final gap, about 1000 of these 'sausages' were required. When they were placed in the water, the current was so rapid that a large number of wire cables had to be used to attach them to the bank. Then willow branches and earth bags were placed on top of the 'sausages' to strengthen the dike. With this step, the construction of the dyke was completed.[643] This 'stone sausage' technique was quite similar to the traditional Chinese *sao* and *zhu long* technique that we discussed in Chapter Three, also used for closing the gap.

641 This last step was also called *he long men* (close the dragon gate). For more details see section of 'the relationship with the Yellow River, and the repair of the embankment/watercourse' in Chapter three.
642 Todd, pp. 7–8.
643 Ibid., pp. 7–9.

Figure 5.7 The photo shows men making the willow fascines on an open yard, to use in the 'stone sausage' structure. Source: Todd, p. 7.

Figure 5.8 photo shows one giant 'stone sausage' being moved to a boat, where the men are preparing to place it into the water. Source: Todd, p. 8.

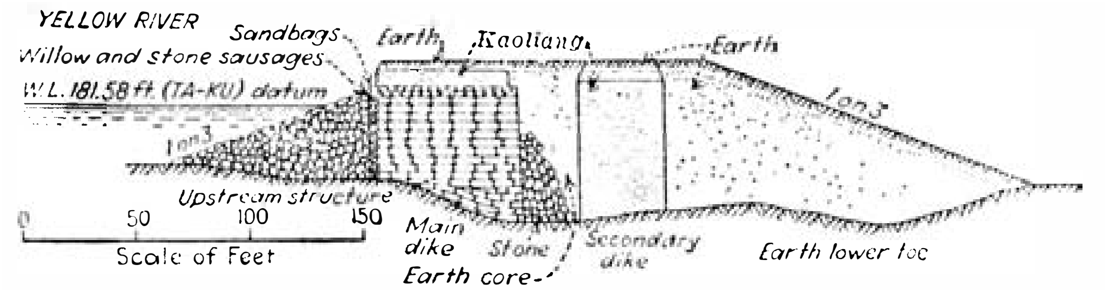

Figure 5. 9 The section plan made by Todd shows the construction details of the main dyke: the kaoliang stalks were placed on top of the brickwork (it could also be stonework, as it does not state what material it is), and was covered with earth to make it watertight; the 'willow and stone sausages' were laid in the upstream side; here it might be to strengthen the dyke, rather than to closing the final gap as discussed. Earth bags were thrown on top of them. We can also see stones laid on the toes of the dykes to protect them from being eroding by the water. Source: Todd, p. 5.

Apart from the new method, some modern equipment was also utilized for this project, like the two pumps used to remove water while digging the new channel, and a hundred dump cars with track for bringing earth bags to the closure point. Despite the use of more mechanical tools, most of the jobs were still done by manpower, like the new channel which was dug entirely by shovels and picks.[644] This was characteristic of Chinese water conservancy, and has only changed very recently.

The materials used in this project were the common river work materials, mostly from the nearby countryside and transported by either carts or wheelbarrows. These included kaoliang stalks and hemp used for making ropes (Figure 5.10). Earth was carried in *bian dan* (one carrying pole with two flat baskets suspended at its ends; a man put the pole across his shoulders to balance the weight while walking) for short distances and wheelbarrows for longer ones.[645] The only material that was not acquired locally was stone. This had to be shipped by rail from the quarries about 100 miles away to the nearest station, then transferred about 6 miles on ox-carts and light railway push cars. There it was transferred to 600 river

644 Todd, p. 9.
645 Ibid., p. 7.

junks and shipped 70 miles before it finally arrived at the site.[646]

Figure 5.10 The photos present the traditional method of twisting hemp into ropes. Another popular material for making ropes was bamboo, but this was less common in northern China. Source: Todd, p. 6.

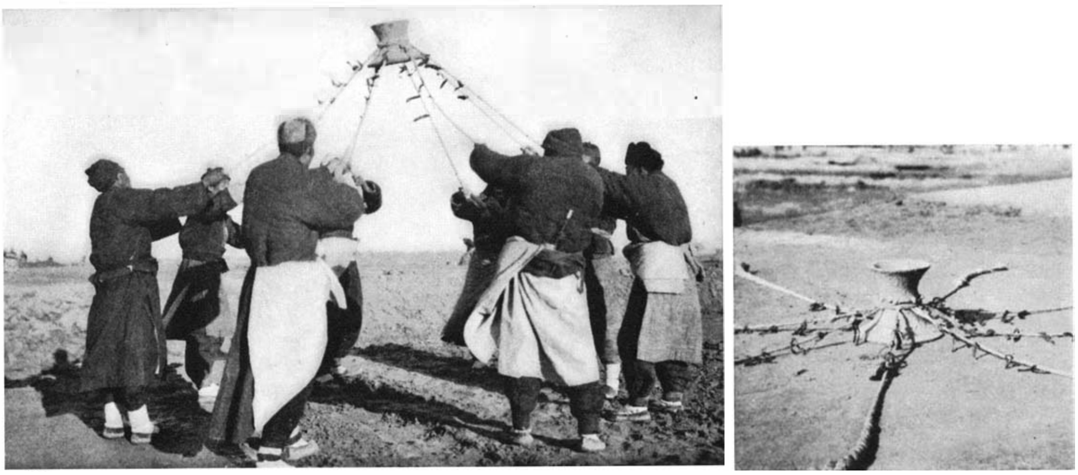

Figure 5.11 The two photos show the traditional way of compacting soil using stone flappers. This was introduced in the last chapter; the technique was still in use in the early twentieth century. Source: Todd, p. 7.

All the work was carried out under the watch of the strict ‘river police’, which was the traditional way of managing the river workers. Although in the past these supervisors were military men or low ranked officials who would hardly have any hydraulic engineering knowledge, on this project the ‘river police’ were more often people who were properly trained with river engineering knowledge and attached to governmental offices.[647]

646 Todd, p. 7.
647 Ibid., p. 8.

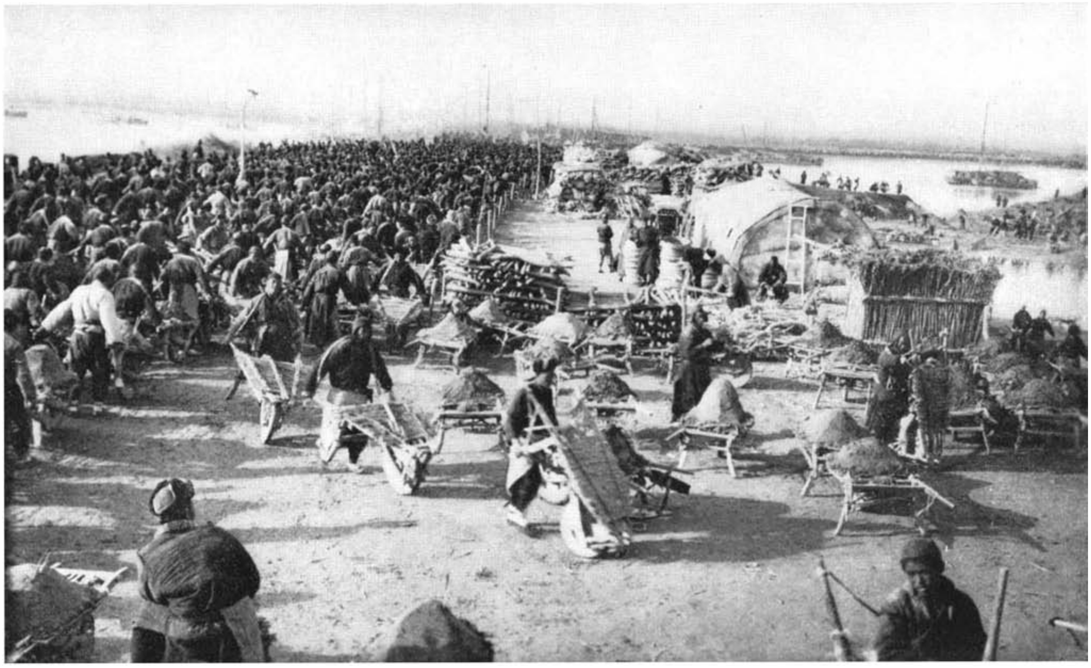

Figure 5.12 The photo by Todd shows the busy scene of the site half a mile away from the working point: numerous men are carrying supplies using wheelbarrows on the left, and on the water side we can see some tied kaoliang stalks. This photo shows a typical scene of a water control project in which most of the work was relied on manpower. This project involved about 25,000 men working at the same time, in winter, of which the hardship can be imagined. Source: Todd, p. 5.

The Mao era: from the establishment of the People's Republic of China to the Chinese Cultural Revolution (1949-1976)

The socio-political context

After winning the civil war against the Kuomintang, the Communist Party gained control over almost the entire mainland of China and founded their government on 1 October 1949 in Beijing, with Mao Zedong elected as chairman.[648] Mao's regime paid great attention to the water conservancy development to ensure agricultural production, partly to ensure popularity among the peasants, to whom it was vital to prove that the new party, who had

[648] Zhao Juan, *The Founding Ceremony of the People's Republic of China at 1st October 1949* (Beijing: News of the Communist Party of China) http://cpc.people.com.cn/GB/64162/64165/70486/70487/4792020.html [accessed 29 July 2016]

blamed all the poverty caused by natural disasters on to imperialism, feudalism and bureaucratic capitalism, was right.[649]

The focus of water conservancy construction in this period was still on the Huai and Yellow River, which was the main area suffering from floods and drought. The restoration of the Grand Canal was also part of the general water conservancy plan, The aim was to upgrade it to a modern inland waterway with uniform standards. The government hoped that by eliminating threats of natural disaster and creating a better irrigation system, agricultural production could be significantly increased.[650] This strategy was called *nong tian shui li jian she* 农田水利建设 (farm and water conservancy construction).[651] Pretty ambitious plans were made: the goals of the First Five-year Plan between 1953 and 1957 included 'permanent control of the Huai River', 'start the work of permanent control and unified development of the Yellow River, and 'build farm irrigation projects and improve irrigation facilities'.[652]

Figure 5. 13 This propaganda painting shows chairman Mao standing in front with the background full of fruitful land and well-developed water conservancy facilities. Source: The Ministry of Water Conservancy, preface picture.

649 Chi, p. 37.
650 The Ministry of Water Conservancy, *Water Conservancy in New China* (Shanghai: The People's Art Publishing House, 1956), Preface.
651 The original Chinese texts is 农田水利建设.
652 *The Fiver Year Plan for the Development of National Economy*, 1953-1957 (Beijing: Renmin Press. 1955), p. 161.

However, by 1958, the plan to carry out massive-scale projects changed to small and medium size projects instead; large-scale construction would only be approved when it was necessary and feasible.[653] This was partly because the work itself encountered greater difficulties than expected, including inefficient work practices and the disturbance to the existing drainage system. But the main reason for this change was financial, because the biggest investment at the time went into the development of the nuclear bomb programme, and other projects were left with insufficient funds, including water conservancy.[654]

In 1960, because of a series of conflicts between China and Russia, the Soviet Union recalled all their experts in China and withdrew all the aid they had promised to provide. With severely deficient funding and an absence of technical support, the main principle of the second Five-year Plan became more practical: to achieve better outcomes by spending less. The targets for the water conservancy projects, whose main slogan was *han lao bao shou, gao chan wen chan* (to ensure harvests independent of drought and floods, to ensure stable harvest and further high yielding harvest)[655] in 1964 were only to improve management work and the *pei tao* (fittings) construction of irrigation projects.[656] Many projects were praised by the government for not spending a cent of the state's money (Figure 5.15), as they were completed relying on local supplies and the work of the peasants.[657]

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653 *Ren Min Ri Bao (People's Daily)*, 25 September, 1957.
654 Chi, pp. 39-41.
655 *Ren Min Ri Bao (People's Daily),* 5 August, 1964.
656 Ibid., 30 November, 1963.
657 Gu Lei, *China's Big Leap in Water Conservancy* (Beijing: Foreign Language Press, 1958), pp. 122-124.

Figure 5.14 A propaganda poster from the 1950s shows enthusiastic people of all classes; the slogan reads: ‘*duo kuai hao sheng de jian she she hui zhu yi* (go ahead with all efforts and build socialism with more outcome, higher speed, better quality and less cost)’. Source: unknown, ‘Those posters during the Big Leap period’, *Gongzhonghao Website* (2016), http://m.gzhphb.com/article/26/268594.html [accessed 18 June 2016]

Figure 5.15 A propaganda photograph; its caption says: ‘not a cent was spent on the construction of this 10-li-long canal’. It shows the landscape along the canal, and several trees on the earth bank. Source: Gu, second photo after p. 122.

The severe financial difficulties meant that all the peasants were mobilized to participate in water conservancy projects. The Communist government achieved this by continuously encouraging them to fight for control of their own fate, instead of relying on Heaven (Figure 5.16).[658] The labouring masses were also encouraged to master high professional skills in science and technology. From media reports of the period we know peasants and workers were trained in engineering knowledge and skills, and participated in almost all the stages of water conservancy projects, from hydraulic surveys to making construction plans.[659] The achievements of this period seemed to be remarkable. For example, an official report says that eighteen new reservoirs were built between May 1954 and July 1958, and over twelve large locks were built by 1960; most of the river embankments were successfully repaired, and permanent control of floods of the Huai River had been achieved; and various locks and highway bridges were constructed on the Grand Canal.[660]

Figure 5.16 Two propaganda posters show the slogans used to mobilize peasants to participate in water conservancy projects. That on the left presents a man wiping off his sweat after hard work, and in the background there are many men working hard, digging a river with shovels and axe; the slogan here is '*ren ding sheng tian* (man's determination can subdue Heaven)'. The poster on the right shows another slogan: *rang da zi ran ting wo men bai bu* (let Nature listen to us), illustrated with a picture of a worker appearing to move the various buildings as though they were chess pieces. Source: unknown, 'Collection of Chinese Posters', *China Sina blogs* (2014) <http://blog.sina.com.cn/s/blog_a7f34fb50101imt4.html> [accessed 18 June 2016]

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658 Tan Chenlin, 'Struggle for the Advanced Realisation of the Agricultural Development Programme', *People's Daily*, 7 April, 1960.
659 Gu, p. 114.
660 State Statistical Bureau, *Ten Great Years* (Beijing: Foreign Language Press, 1960), pp. 50-51.

Figure 5.17 Photo shows numerous workers working on the river work; the caption says: 'Man conquers nature'. Source: Gu, first picture after p. 116.

Figure 5.18 A photo shows the peasants doing a survey with equipment they have made themselves. Source: Gu, third photo after p. 122.

The reality is that natural disasters such as floods and droughts during this period were extremely severe, and the areas and number of people affected by them increased every year. This period included the three years of the Great Chinese Famine, 1959 to 1961, and the areas affected by natural disasters increased from 220 millions of mu in 1957 to 900 millions of mu in 1961. This could have been partly caused by the significantly increased population and land cultivation in this period, but it is more likely that the real reason for the statistical shift lies in the exaggeration of the achievements of water conservancy construction, that it had not been as effective and fruitful as it had been reported to be.[661] This exaggeration was a major characteristic in this period of communist China, when local government tended to exaggerate the effectiveness of their work in order to match the pressures on them from the centre. This makes it very hard to be sure of the facts about water conservancy achievements in this period.

Although the achievements of this period were not as great as hoped, we can not deny that various water conservancy facilities were completed. Sadly, most of them were neglected with the coming of the ten years' Cultural Revolution between 1966 and 1976, when Mao Zedong decided to conduct campaigns to clear remaining capitalist and traditional elements in order to consolidate his power as the absolute leader of China.[662] This was a tragic time for the development of science and technology in China.

These campaigns caused conflicts between party leaders, scientists and engineers, which have been described as problems between 'expert' and 'red'.[663] Scientists and professional organizations that were close to professional peer groups rather than the administrative authorities would be labeled as bourgeois or rightists. They were forced to spend the time they should have spent on scientific work on attending political meetings or working on projects of immediate interest to the state.[664]

This period was an anti-intellectual time, when scientists and engineers were seen as having opposite interests to those of the peasants and workers, and were suspected as counter revolutionaries. As a result, large numbers of scientists and scholars were sent to the countryside for months and even years, to be reeducated with political virtue through labouring work with peasants. Most scientific research ceased, and scientific institutions and

661 Chi, pp. 45-49.
662 Mo Yu and Ding Li, 'Zhong Guo Wen Hua Da Ge Ming Da Shi Ji Ji Hui Gu (The Events and Review of the Chinese Cultural Revolution)', *Voice of America Online News*, 19 June 2016. http://www.voachinese.com/a/china-cultural-revolution-timeline-20160516/3333434.html [accessed 10 June 2016]
663 Dennis Ray, ''Red and Expert' and the China's Cultural Revolution', *Pacific Affairs*, 43:1 (1970), pp. 22-33 (p. 23).
664 Robert L. Worden, Andrea Matles Savada and Ronald E. Dolan, *China: a Country Study* (Washington D.C.: Library of Congress. Federal Research Division), p. 416.

laboratories were closed. Universities and schools became a place for political and manual labour training instead of real education. Virtually no new scientists or engineers were trained during this period.[665]

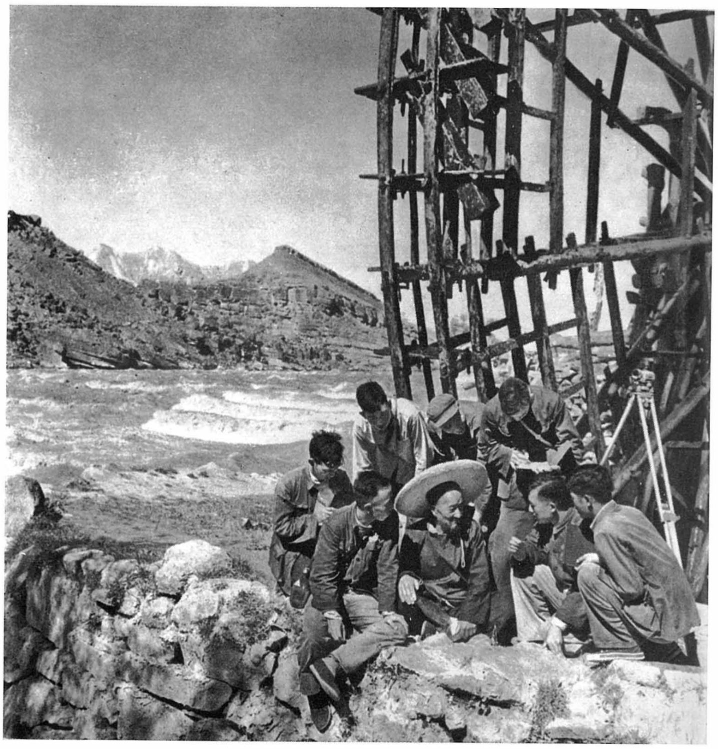

Figure 5.19 A photograph from the 1960s shows engineering students of Tsinghua University learning water conservancy skills from a local countryman. Source: Needham, PLATE 380.

What was even worse was that Mao also conducted a campaign to *po si jiu* 破四旧 (the destruction of the Four Olds), which aimed to destroy old customs, cultural, habits and ideas.[666] During this campaign, a huge quantity of valuable heritage and literature on the Grand Canal, and relating to all aspects of Chinese culture and history, were destroyed or burned, including the various water god temples and historical books and accounts. This was a great loss of the precious materials for studying Chinese culture in general and the Grand Canal in particular, and have caused many difficulties in its conservation since.

665 Worden, Savada and Dolan, p. 416.
666 Mo and Ding, http://www.voachinese.com/a/china-cultural-revolution-timeline-20160516/3333434.html [accessed 10 June 2016]

The Grand Canal as a standardized modern inland waterway

Watercourse

Although the status of the Grand Canal was not as high in the second half of the twentieth century as it had been when it served as the grain transport route of Imperial China, it was still an important inland waterway for coal shipping between the south and north. Zao Zhuang had its first coal company, the Zhongxing Coal Mining Corporation, as early as 1878,[667] and the northern cities like Zao zhuang and Ji ning produced large amounts of coal every year. These massive quantities needed to be shipped to the south, and although road and railway systems had developed, the inland waterway was still a cheaper option for transporting such bulky goods.

As part of the modern transition, the government wanted to improve the Grand Canal, the only north-south route, as a standardized modern waterway. In 1963, the Chinese Planning Commission issued the *Tentative Standard of Inland Waterway Navigation*, which included design details of different levels of watercourse, as well as their associated facilities. Before this was issued, construction work had taken the Soviet standard as its reference.[668]

The Ji Ning and Zao Zhuang sections in Shandong province were the focus of the reconstruction plan for the northern section of the Grand Canal, because of their need for coal transportation. By the 1950s the only part of the Jining section that was still able to carry boats with a tonnage below 30 ton lay between Anshan and the southern four lakes[669]: the rest was just a dry course. A new 88 kilometre-long waterway, Liang Ji Canal was made linking the Yellow River to Nan Yang Lake between 1958 and 1959.[670]

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667 The compilation Committee of Annals of Zaozhuang. *Zaozhuang Shi Zhi (Annals of Zao Zhuang)* (Beijing: Zhong Hua Shu Ju, 1993) < http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=378&run=13> [accessed 17 May 2016]

668 Wang Zhaosheng, 'Guo Biao Nei He Tong Hang Biao Zhun Jian Jie (Introduction of the Standard of Inland Waterway Navigation)', *Communications Standardization*' 2 (1991), 20-22 (p. 20).

669 The southern four lakes (*nan si hu*) was a lake group of Weishan, Zhaoyang, Dushan and Nanyang Lake. It was named after its geographical characteristic-it sits in the southern Shandong province. And the four lakes have been merged together between the late sixteenth and early seventeenth century because of the raising riverbed.

670 The compilation Committee of Annals of Jining. *Jining Shi Zhi (Annals of Jining)* (Beijing: Zhong Hua Shu Ju,

The aim was to construct all the inland waterways to the same standard. The Liang Ji Canal was designed to have the same dimensions as the southern section of the Grand Canal, 60 metres wide with a minimum water level of no less than 3.2 metres. But this bold plan was unrealistic. The inadequate water supply and the raised riverbed caused by mud from the Yellow River would not permit this waterway to be made this size. What was even worse was that although the new waterway made use of several existing rivers, the funds and supplies for the project ran out at a very early stage.[671] In 1967, to solve the problem of supplying water to the canal, a new proposal was presented, to use water from Dong Ping Lake. This version of the plan set a new, lower target size, to standardize it as a Level VI navigation waterway ,no less than 15 metres wide and 1.0 to 1.2 metre deep, which would be able to hold boats with a 100 ton tonnage. Maintenance work was scheduled for every few years to prevent it silting up.[672]

The reconstruction plan for the Zao Zhuang section on the Shandong border also took account of the large quantity of coal it would be transporting to the south. In 1967 the Ministry of Coal Industry set up a target to transport 750,000 tons of coal from the the Chaili Coal Mine[673] to southern China every year.[674]

A series of reconstructions have been carryied out since 1956. Between 1956 and 1957, the Yi Jia River linking the Wei Shan Lake to Huang Lin Village was widened and straightened to a 50-metre-wide and 2.5-metre-deep course. In 1968, headquarters for the reconstruction of the Yi Jia River were established, and by 1972, a modern style lock had been built to Level

2002) < http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=378&run=13> [accessed 17 May 2016]

671 *Jining Shi Zhi (Annals of Jining)* <http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=378&run=13> [accessed 17 May 2016]

672 Yu Kongjian, *The Grand Canal Heritage and Ecological Corridor of China* (Beijing: Peking University Press, 2012), p. 215.

673 The Chaili Mine was one of the most productive mines of the Zaozhuang Coal Mining Corporation founded in 1964.

674 The Headquarter of the Shandong Revolutionary Committee,关于报批韩庄运河复航工程台儿庄梯级布置方案并请安排第二期工程的投资报告 *The Investment Report of the Level Planning for the Tai'er Zhuang Section of the Hanzhuang Canal Reconstruction Project and the plan for the Second Phase*, No. 278, 1968. From the Shandong Archive.

V standard,[675] with a three-gate regulation lock. This helped the water level to reach a maximum of 20 metres, allowing it to carry boats with more than 100 tons tonnage. Similar modifications were carried out on the section crossing the Tai'er Zhuang town of Zao Zhuang city, which included a Level V lock and ten-gate regulation lock, which made the water level high enough to hold 100 tonnage boats.[676]

The southern section from Xu Zhou to Hang Zhou, which has always been navigable, was also standardized. Between 1958 and 1960, it was reconstructed to Level II standard, 70 metres wide with a level of no less than 4-metres. This allows it to hold large ships with a tonnage of 2000 tons. Seven modern locks and four regulation locks were also built, helping to turn the entire Grand Canal into a modern inland waterway.[677] Although attempts have been made since the 1970s, the only really navigable section lies between Ji Ning and Hang Zhou, as the section north to Jining is either silted up or only serves for discharging waste and irrigation.[678]

The large-scale reconstruction of the Grand Canal has removed large numbers of villages which were originally located along its course. For example, for the reconstruction of the Han Zhuang section in 1963, 39 canal-side villages including 1395 households of 5580 people were relocated, along with the 108 tombs of their clans. The compensation fee was only 5 Chinese *yuan* per person for moving house, and 7 yuan for moving their tomb, which made it very hard to restart a living elsewhere.[679] Many villages in this area today were formed from the old villages or households which had originally been located on the old

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675 The standard of level here is the standard of navigation waterway, a Level V waterway is 23 metres wide and 2.0-2.5 metres deep.

676 *Zaozhuang Shi Zhi (Annals of Zao Zhuang)* (Beijing: Zhong Hua Shu Ju, 1993) <http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=695&run=13> [accessed 18 May 2016]

677 The compilation Committee of Annals of Jiangsu Province, *Jiang Su Sheng Zhi* (Annals of Jiangsu Province) (Nanjing: Jiangsu Renmin press, 2000) < http://www.jssdfz.com/book/zhjjz/D12/D2J.HTM > [accessed 18 May 2016]

678 State Administration of Cultural Heritage of People's Republic of China, Nomination documentation submitted to the World Heritage Convention Cultural Heritage, pp. 82-83.

679 枣庄市运河韩庄台儿庄段新移民工作计划 *The Migration Plan of the Hanzhuang and Tai'er Zhuang section*, 关于韩庄运河工程枣庄地区移民迁占安置计划的批复 Reply to the Resettling Plan of the Migrants of the Hanzhuang Canal Reconstruction project, Department of Shandong Water Conservancy, 10 June 1963. From the Shandong Archive

embankment of the Grand Canal before it was widened.[680]

Large areas of cultivated land were occupied or submerged because of the construction work. For example, the project to modify the bridge on the Jining section of the canal in 1960 occupied 157.227 mu of cultivated land.[681] By 1960, the reconstruction of the Grand Canal had occupied in total 42104 mu of land.[682]

Even with their houses or land under threat of being removed, the local peasants were expected to take part in the construction work and were provided with supplies such as tools and wheelbarrows. They were paid very little, but worked very hard: they were encouraged to be selfless socialists and make a contribution to the new China and their own compatriots. They were praised as *mo fan* 模范 (model worker) and their stories appeared in the official media.

One typical example is the story of Zhu Yongzhen, who was praised for his enthusiasm for river work, transporting remarkable amounts of earth every day. It was said that he made a giant wheelbarrow with the wheel of his brand new bicycle, a very precious thing in China at that time. By using this big wheelbarrow he was able to transport nearly 1000 jin (1 jin roughly equals 500 g) of earth a distance of 3 li 24 times a day.[683] Another similar story was about a worker who took care of all his tools and carts, and made more himself if any were missing, so that progress would not be slowed.[684] People like these were chosen as 'first-class model workers', and their stories would be reported on the media time after time to motivate other workers.

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680 This argument is made based on the various interviews with local residents along the Canal.
681 山东省济宁专员公署交通局为补送 济宁运河大桥桥头改线工程土地青苗赔偿费单据清核拨尾款的报告 *The Report of Compensation of Cultivated Lands Occupied by the Project of the Modification of the Jining Grand Canal Bridge,* the Department of Transportation, Jining, Shandong. (60) zhuan jiao lu zi No. 070. 7th October 1960. From the Shandong Archive.
682 运河占用土地情况 *The Areas of Lands Occupied by the Reconstruction of the Grand Canal*, 24 October 1960. From the Shandong Archive.
683 Gu, p. 115.
684 Ibid., p. 116.

Figure 5.20 The photo shows large numbers of wheelbarrows being used to carry earth. The wheelbarrows here might have been 'upgraded' with the installation of bicycle wheels, as the wheels look larger than usual. Source: Gu, second picture after p. 116.

Locks

In accordance with the central government's general principle to adopt a modern style of construction, the watercourse and associated facilities of the Grand Canal were modifed, and the traditional stone locks were replaced by concrete ones. The traditional piling method was abandoned in building the foundation of the locks, and instead, the earth was replaced with earth and sand which was regarded as more suitable for the purpose. For example, while building the Funing Lock on the Su Bei section of the canal, the original muddy earth was removed and it was filled with a 3.9-metre-thick coarse sand. The top 2.2 metres of sand had to be compacted to a density of over 0.67, and the rest was vibrated to a density of 0.8.[685]

Materials such as reinforced steel began to be used, and the lock gates were made of either wood bordered with steel, or concrete and steel,[686] instead of the traditional timber beams. These gates could be controlled by machines instead of manual labour. They consisted of a

685 The compilation Committee of Annals of Jiangsu Province, *Jiang Su Sheng Zhi (Annals of the Jiangsu Province)* (Nanjing: Jiangsu Renmin press, 2000) <http://www.jssdfz.com/book/slz/D12/D3J2.HTM> [accessed 18 May 2016]
686 The compilation Committee of Annals of Jiangsu Province, <http://www.jssdfz.com/book/slz/D11/D2J2.HTM> [accessed 17 May 2016]

screw and gear, imported from European countries at first; after 1958, industries were established in Chinese cities like Shanghai to produce this kind of machine. The main body of the locks was built with concrete instead of stone. In the concrete mixture, the proportions of cement, sand and crushed stone were 1:3:6 for thick structures and 1:2:4 for thin structures. Later, the proportion of water to cement mixture was also standardized at 0.57-0.60. Although modern materials were adopted, the actual construction work still mostly relied on the labouring masses: the concrete was vibrated entirely by manpower, and the material was still mainly transported by carts and wheelbarrows.[687]

Barges and transportation

After the tribute grain shipments stopped in 1902, the Grand Canal was only used for private merchandize. From then until the 1950s the most common users were the wooden barges which were used to transporting private goods like coal from the north and tea from the south. These barges were flat-bottomed, with a very similar structure to the shallow-drought boats discussed in the previous chapter which had been in use since the fifteenth century. There were several different types of these barges which varied slightly in size and shape, but they all shared one common feature: they were all rather small and could not carry goods of more than 80 tons.[688]

Among these barges, the *hua zi* 划子 was the most commonly used. Its general shape is quite wide and shallow, which made it very stable in the water. It is usually 9 to 11 metres long and 2.5 to 3.2 metres wide, with a tonnage of about 20 to 30 tons. A larger *hua zi* could be 15 metres long, 3.8 metres wide and 1 metre deep, but it could still not carry more than 50-tons. There were usually two or three masts on a barge: the one at the head was usually made of cedar wood, and was used to tie the towropes for trackers to pull; the other masts in the

687 Ibid.
688 Xu Congfa, Li Baohua and Han Yunchen, *Jiang Hang Yun He Zhi (Annals of the Grand Canal)* (Shanghai: Shanghai Social Science Press, 1998), p. 495.

middle, one or two, were used for setting sails.[689]

Figure 5.21 The typical private wooden barges travelled on the southern section of the Grand Canal in 1932. Source: 'The Old Suzhou City', *Sohu Blog* (2009) <http://–nbchfrr.blog.sohu.com/113709420.html> [accessed 20 May 2016].

Figure 5.22 This photo shows another type of wooden barge with no masts, carrying a large quantity of goods on the Grand Canal. Trees and a stone dock can also be seen in the background. Source: Liao Cheng Grand Canal Museum.

689 Gao Jianjun, *Shandong Yun He Min Su (The Customs of the Shandong Section of the Grand Canal)* (Jinan: Jinan Press, 2006), pp. 34-36.

During the transitional time between the end of the tribute grain shipments and early industrialization, many newly founded companies organized their own teams of barges and boatmen to ship the goods they produced. A good example of this is the earliest of the coal mining companies founded in Yi Xian (present Zao Zhuang), the Zhong Xing Coal Mining Corporation. By 1906, the company already owned 72 wooden barges, with tonnage varying from 30 to 80 tons, to take coal to the southern cities on the Grand Canal. The railway laid at Tai'er Zhuang in 1935 impacted on the canal transports, and as a result the company's barges mostly ended up sold, or were left damaged.[690]

Many boatmen's labour unions were founded in various regions during the early twentieth century. They allocated goods and organized transportation for the boatmen, who could become members after paying membership and salvage fees.[691] Various nongovernmental *chuan bang* 船帮 (boatmen gangs) have appeared since the nineteenth century, which formed when boatmen needed backing to protect themselves from being bullied by others; people from one gang would support each other and join their fellows in taking action against other gangs. In 1914 there were about 30 different gangs on the Jiang Su section of the canal alone, with each gang having 300 to 2000 barges.[692]

Once communist China was established, a nation-wide rural cooperation movement was set up, starting from the 1950s, which led to a transition from individual management to collective ownership. Many barge transportation cooperatives were established during this time, as well as a Shipping Bureau.[693] The government planned to standardize the size of the barges used for shipping on the Grand Canal, removing those with a tonnage of less than 20 tons. In 1962 the Shandong Shipping Bureau declared a uniform size for the barges to be used on the Shandong section, 18 metres long, 5 metres wide and 1 metre deep, with tonnage

690 *Zaozhuang Shi Zhi (Annals of Zao Zhuang)*
<http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=378&run=13> [accessed 19 May 2016]
691 Ibid.
692 Xu, Li and Han, pp. 497-499.
693 *Zaozhuang Shi Zhi (Annals of Zao Zhuang)*
<http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=378&run=13> [accessed 19 May 2016]

varying from 50 to 100 tons. A fleet's total length could not be more than 94 metres.[694]

In the 1970s, concrete barges began to be used on the Grand Canal. Their general shape was similar to the wooden ones, but they had a deeper hull, 1.2 to 2 metres. They were self-propelled instead of being towed or sailed, and the largest could carry about 120 tons. By the late twentieth century the self-propelled barges had replaced the wooden ones and became the most commonly used type.[695]

Figure 5.23 These self-propelled barges started to appear on the Grand Canal from the 1970s. Source: Liaocheng Grand Canal Museum.

694 山东省航运管理局（Shandong Shipping），关于京杭大运河山东段航道现状和规划运河航道现状调查报告 *(Report of the Current and Planned Condition of the Course of the Shandong Section of the Grand Canal)*, A087, 01, 008, 1962. From the Shandong Archive.

695 Gao, p. 36.

From the 'Reform and Opening up' onwards (1978 to the present)

Economic reform and the Grand Canal as a coal transport route

China's economy was severely disrupted by the 10-year Cultural Revolution, and people, especially peasants, had a very low standard of living. In 1976, Mao Zedong died and the Gang of Four[696] were arrested, bringing the Cultural Revolution to an end. Later that year, Deng Xiaoping was elected to become the new leader of the Communist party and conducted a series of economic reforms, most of which were opposite to the policies of the Mao era.[697] Deng's reform policies focused on rural areas, changing People's Communes to a household-responsibility system, in order to increase agricultural production. Private business and foreign trade were permitted, which gradually brought the economy back to life. In 1982, Deng emphasized the importance of developing transportation and energy.[698] He said that the Grand Canal should be utilized as the important transport route for shipping coal from the north to the south, which could also reduce the pressure on the railway transportation.[699]

Although the Grand Canal was reconstructed and standardized as a modern inland waterway, much of the construction work was either not done properly or left unfinished, and many sections were still not navigable because of the inadequate water supply. In 1981, the Planning Institute of Water Transport under the Department of Transportation conducted a survey of the current condition of the Canal and presented a report on the feasibility of continuation the project to rebuild the Jining to Hangzhou section. The state council approved the plan the next year; the section was to be reconstructed to Level II standard to increase its

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696 The 四人帮 *Gang of Four* was formed Jiang Qing, Zhao Chunqiao, Yao Wenyuan and Wang Hongwen. They raised their power during the Cultural Revolution and were officially blamed by the Chinese government for leading the worst society chaos after they were arrested.
697 Han Qiang, *Guo Wai Deng Xiao Ping Yan Jiu Bu Duan Tuo Zhan (The Extending Oversea Research about De Xiaoping)*. Beijing: Central Compliation and Translation Bureau, 2014 <http://www.cctb.net/llyj/lldt/hwzg/201408/t20140805_311354.htm> [29 May 2016]
698 Xue Zezhou and Liu Xuejun, *Deng Xiao Ping Yu Zhong Guo Xian Dai Hua (Deng Xiaoping and the Modernization in China)* (Fuzhou: Fujian Education Press, 2001), pp. 103-104.
699 Xu, Li and Han, pp. 127-128.

coal shipment capacity by ten million tons.[700]

This continuation project included the reconstruction of the Hai Yin-Si Yang and Huai An-Jie Shou section of the Bu Lao River, and the dredging of the various silted courses. The Bu Lao River and Huai An-Jie Shou section were built to Level II standard, the rest to Level III. Eight 230 x 23 x 5 metre locks and three docks were built on the southern section. This project was completed in 1988 when it was reported that six hundred thousand workers had been mobilized to participate in the construction:[701] river work in the 1980s still largely relied on hand labour. Unfortunately this project did not improve the situation of the section north to Ji Ning very much, and it remains unviable today.

The Grand Canal as the eastern route of the *Nan Shui Bei Diao* (South-North Water Transfer Project)

The *Nan Shui Bei Diao* (South-North Water Transport Project) was a massive project whose scale and level of difficulty can be compared with the building of the Grand Canal itself. This project aims to transfer water from the Yangzi River to northern China to supply industrial production and for daily use; the annual amount of water sent to the north is set to be 44.8 billion cubic metres. The idea was first proposed by Mao Zedong in 1952 when he said 'there is plenty of water in the south, not much water in the north; if at all possible, borrowing some water would be good',[702] and the project is expected to be achieved by 2020.[703]

Three routes have been developed to transfer the water from the Yangzi River to the north.

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700 Xu, Li and Han, p. 128.
701 Ibid., pp. 128-129.
702 Jin Huaichun, 'Mao Ze Dong De Nan Shui Bei Diao (Mao Zedong and the South-to-North Water Diversion Project)', *Official Website of South-to-North Water Division* (undated) <http://www.nsbd.gov.cn/zx/zxdt/201212/t20121213_251786.html> [accessed 21 May 2016] (para. 9 of Part 1) The original texts is '南方水多，北方水少，如有可能，借一点也是可以的'.
703 Water Conservancy Committee of the Huai River, '*Brief Introduction of the Project Planning (2001 Revision) of the Eastern Route of the South-North Water Diversio*', *Official Website of the South-North Water Diversion* (2003) <http://www.nsbd.gov.cn/zx/gcgh/200308/t20030825_195172.html > [accessed 21 May 2016] (para. 2.2)

The eastern route will make use of the course of the Grand Canal, supplying water for Jiang Su, An Hui, Shandong, He Bei Province and Tian Jin city. The water from the Yangzi River will be diverted from the Yang Zhou section of the canal and conveyed north through Hongze Lake and the southern four lakes, which will serve as reservoirs to regulate the flow of water. When the water arrives in Dong Ping Lake, it will be separated into two different routes, one to Tian Jin by the Yellow River, another to the east to supply the costal area of the Shandong peninsula.[704]

To enable the water to reach a higher altitude, 13 pumping stations have been built between the Yangzi River and Dong Ping Lake, with a hydraulic head of 65 metres. Since the route from the south to Tian Jin needs to made use of almost the entire course of the Grand Canal, the nonviable section at Lin Qing must be reconstructed, and two natural rivers in northern Shandong province, Qi Yi and Liu Wu River, will be utilized.[705] Now the Grand Canal can not only serve as an inland waterway for coal transport, but also provides an important route for water to move from the south to the north.

Because of the scale of this project and the massive undertaking in terms of widening the watercourse and making new reservoirs, large areas of lands have been occupied large numbers of people relocated. For just Phase 1 of the eastern route project, 10,600 hectares were permanently taken, and 2,670 hectare temporarily; and over a million square metres of residential buildings were removed, with over 20,000 people moving away. Phase 1 of the project was completed in 2013.[706]

704 Water Conservancy Committee of the Huai River, (para. 2.3).
705 Ibid. (para. 1 of 2.3).
706 *Brief Introduction of the Project Planning (2001 Revision) of the Eastern Route of the South-North Water Diversion* <http://www.nsbd.gov.cn/zx/gcgh/200308/t20030825_195172.html > [accessed 21 May 2016]

The designing and detailing

Watercourse

The reconstruction of the Grand Canal carried out in the 1980s focused on the section south to Ji Ning city, the Bu Lao River, Hai Yin-Si Yang and Huai An-Jie Shou section. The construction work included widening the watercourse and dredging the water. The two main reconstruction projects are introduced below.

The Bu Lao River-

This 72-kilometre-long section had been reconstructed between the 1950s and the 1960s to Level II standard, but because of poor maintenance, the earth embankment eroded and the water silted up. When the new project was carried out in 1983, several temporary dams were built on the course to stop water flowing onto the construction site, and over 200,000 workers from nearby villages and towns were recruited. Tractors were used to carry earth, rather than relying on it being carried by people.

The course was again reconstructed to Level II standard: 60 metres wide and 4 metres deep, with the top of the embankment no less than 8 metres wide, and planted with trees. On the slope where it was 5.5 to 9 metres higher than the water level, protection made of stone blocks with cement mortar was applied, and grass was planted on the earthen part. In order to lower the level of underground water to ensure it would not affect the construction work, 75 temporary pumping stations were established employing 166 pumps. The whole project was completed the following February.[707]

Huai- Si section-

[707] Xu, Li and Han, pp. 139-141.

This section linking Si Yang to Huai Yin is 32 kilometres long. When the last reconstruction was completed in 1962, the dredging was left unfinished because of the lack of funds, creating different levels on the riverbed. In 1984, the project to bring the watercourse up to Level II standard was carried out, including widening and deepening the course and rebuilding the embankment. Large numbers of workers were recruited from nearby areas for all the digging jobs, as the original plan to dig the course using motorboats was thought to be too expensive. The construction work occupied large areas of land on the banks, as well as over 4000 residential houses, which led to the relocation of large numbers of residents.[708]

Dredging was a very important part of this reconstruction project, as excessive silt was the main issue affecting the functioning of this section. In 1988 two dredgers, from the Anhui Hydraulic Dredging Company and the Lock Administrative Office of Jiangsu Canal respectively, were used to carry out the work. Before the mid-twentieth century, the most common way to dredge the canal was to use the *jiao ni chuan* 绞泥船 (dredger) shown in Figure 5.24.[709] In the 1980s more mechanical aids were available, and small-size Cutter-suction dredgers were used to clear up the mud from the canal. These were particularly effective where a hard surface needed to be removed, as they could loosen the silt on the riverbed using their cutting mechanism, transferring the silt to the suction mouth to be discharged to a barge. These Cutter-suction dredgers were usually owned by jointly operated companies, set up between individuals and the state,or governmental departments; their numbers were rather limited.[710]

708 Xu, Li and Han, pp. 138-140.
709 Needham, p. 338.
710 Xu, Li and Han, pp. 134-135.

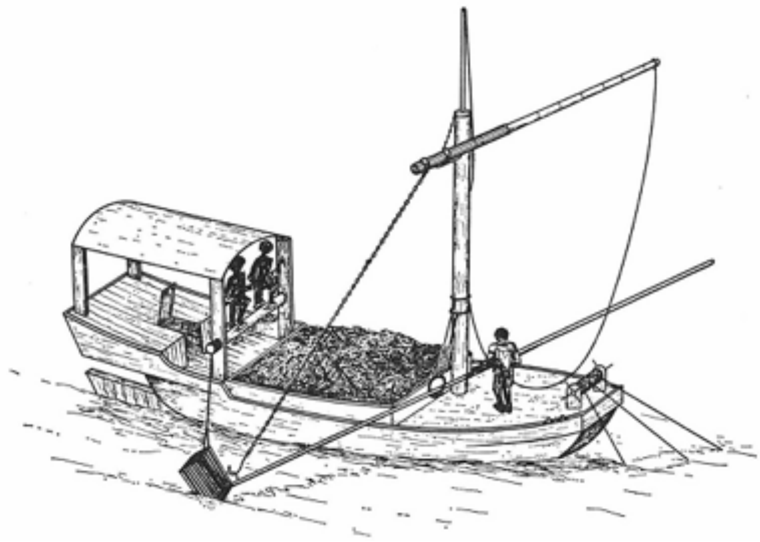

Figure 5.24 A traditional type of dredger, *jiao ni chuan*, which was still in general use in the 1960s. The silt was cleared by a rectangular bucket on the end of a long stick loosely attached to the mast of barge by a line and loop. The bucket was also attached to a pedal-operated windlass at the other end of the barge, and a swape-like lever set on the top of the mast. When the bucket was full, it would be brought to board by the windlass, and its contents could then be emptied to the hold in the middle of the barge when the extremity of the lever unattached to the bucket was hauled down. Source: Needham, p. 338.

Locks

In 1987, the Department of Transportation issued the *Code for Master Design of Shiplocks*, and between the 1980s and the 1990s, a number of locks were built on the Grand Canal south to Jining, with a uniform standard and appearance. We can take the development of the Tai'er Zhuang lock as an example, to explore how the locks on the Grand Canal evolved in the late twentieth century.

Because of the quantity of coal produced in Zao Zhuang and the need for it to be transported to the south, this section of the Grand Canal has always been a focus for the canal's development in modern times. By 1972 all the eight original locks on this section had long been demolished, so a modern style lock, Tai'er Zhuang, was built as part of the reconstruction project. In 1995, a new lock was built south of the old one, and the 1972 lock gradually fell from use. Later it was replaced by the pumping station built for the South-north

Water Transfer project.[711]

Figure 5.25 The photos show the Tai'er Zhuang Lock built in 1972. It can be seen that although it has been built in a very modern style, the walls of the lock chamber are still built with bricks, the traditional material. This is rarely seen later on. Source: Yang Yongquan, 'The old Tai'er Zhuang Lock Thirty Years Ago', *Tian Xia Kan Tai E-paper* (2014) <http://dzb.zzxxg.com/dzb-1501.html> [accessed 24th May 2015]

The main three types of barge which travelled on the Grand Canal were 1000-2000, 300 and less than 200 ton self-propelled barges. In order to accommodate all these types of barges at the same time, the 1995 lock was built so that the width of the corridor before entering the lock gate would be 70 metres, allowing two 1000 ton barges, two 1500 ton barges, three 300 ton barges, three 200 ton barge fleets and four 100 ton barge fleets to enter the lock at the same time. The lock chamber is 234 metres long and 23 metres wide.

The lock is like all the others built in this period, made with modern materials like concrete and steel. The walls on both sides as well as the bottom of the lock chamber were made of reinforced steel concrete boards, 2.5 metres thick. All the lock gates are made of steel, and

711 Huang Weijin and He Weigang, 'Tai'er Zhuang Er Xian Chuan Zha She Ji Jian Jie (The Introduction of the Design of the Tai'er Zhuang Twin Lock)', *Hydraulic Engineering*, 1 (1996), 30-34 (p. 30).

are controlled by manual, centralized interlocking or programmes. As a rule it only uses the interlocking method through the control centre located on the second floor of the downstream lock. A control room was built in the middle of the lock chamber, to conduct the registration and collect fees while the barges wait in the chamber.[712]

Figure 5. 26 An arial view of the Tai'er Zhuang lock, which shows the upgraded modern embankment and lock. Source: 'Arial Photographs of the Tai'er Zhuang Lock', *Ni-pic Web* (2012) <http://www.nipic.com/show/–1/49/6210068ka9faf9fd.html> [accessed 23rd May 2016]

Conclusion

To conclude this chapter covered the section of the Grand Canal's history after the royal grain transport system officially ended, at the end of Imperial China. It can be observed that the canal waterways faced great changes and have done so since then, from the devastating floods of the Yellow River in the early twentieth century that challenged its survival, to being transformed to a modern waterway under a series of water conservancy plans made by the new government from the 1950s onwards.

712 Huang and He, pp. 31-32.

Although it has not been highlighted by the majority of other Grand Canal studies, due to the propaganda environment, it is clear that most of the Grand Canal's historic features, especially the physical ones such as the traditional materials and techniques, were lost in the process of pursuing modernization and economic advancement. Having managed to avoid criticism thus far, there is little doubt that it was the government's inappropriate plans that resulted in the profanation of the valuable historic features of the canal.

Interestingly, it is within this context- knowing that not much of the canal's original fabric was left, that the Chinese government decided to nominate the Grand Canal as a World Heritage Site. This point will be further discussed in the next chapter.

Chapter Six. Case study: the Shandong section

This chapter takes the Shandong section of the Grand Canal as a case study, as an example of the issues facing the conservation of the Grand Canal. It focuses on the characteristics that make it unique compared to other sections, such as the traditional river engineering, the marketplace culture and the multicultural environment that surrounded it. More importantly, this chapter aims to use the Shandong section as an example to examine the current conservation approaches taken for the canal. A critical assessment will be provided at the end of the chapter, discussing the various issues that arise from the canal management.

In terms of historic sources used in this chapter, the 1840 version of the *Annals of Jining*,[713] together with Li's poetry collection *tan yan ji* (1986),[714] were reviewed to rebuild the social context of the rapid development of the local marketplace culture. In addition, two historic books: *qin ding xu wen xian tong gao (Comprehensive investigations based on literary and documentary sources)* (1789),[715] and *de zhou zhi (Annals of Dezhou)* (1788),[716] were reviewed to identify the diverse gods and beliefs in the local area, as part of the exploration of the multicultural environment along the Shandong canal.

As for modern sources, Wang's article '*Qing Dynasty for the Designing of the Locks and Culverts'* is reviewed again, to identify the difference between the design of the canal locks along the Shandong section and other sections. The Tu Qiao Lock, is taken as an example, to explore engineering detail, such as the stonework and structure of the lock gate. Most of its information is obtained from its archaeological report (2014).[717] More data of this lock was collected by the author during her fieldwork in Liaocheng city, including two drawings showing a more detailed dimension not covered in the report (Figure 6.3), and the changes of the lock's surrounding environment in preparation for World Heritage nomination (Figure 6.4).

713 Hu Delin and Lan Yinggui, *Ji Ning Zhi Li Zhou Zhi (Annals of Jining)* (Daoguang er shi nian ben, 1840)
714 Li Liufang, *Tan Yan Ji-Zha He Zhou Zhong Xi Xiao Chang Qing Ti* (Taipei: Taiwang shang wu yi shu guan, 1986)
715 Qu Huaifu (ed.), *Qing Ding Xu Wen Xian Tong kao (Comprehensive investigations based on literary and documentary sources).* Si Ku Quan Shu Ben (1789).
716 Wang Daoheng, *De Zhou Zhi (Annals of Dezhou).* Kang Xi Wu Shi San Nian Ben (1788)
717 Liaocheng Institute of Cultural Relic Archeology, Liaocheng Cultural Relic Bureau and Administration Office of Cultural Relic, Dongchang District, Liao Cheng, 'Shan Dong Liao Cheng Tu Qiao Zha Diao Cha Fa Jue Jian Bao (Brief Report of the Discovering and Investigation of the Tuqiao Lock, Liaocheng, Shandong)', *Cultural Relic*, 1(2014), 37-44.

For details of the water division project at the Nanwang complex and its current status, Lu and Liu's article (2015)[718] is consulted, to explore its engineering details. The nomination documentation of the Grand Canal (2014)[719] is examined, to review the official statement on this heritage property. This is done in the context of the current situation of the site gained through the author's fieldwork,[720] which clearly highlights the difference from the official statement.

Additionally, to depict the flourish of marketplace culture during the heyday of the Grand Canal, apart from Li and Wang's book *Studies of the Canal Culture of the Shandong Section*, a large amount of information presented in this section is collected from the author's fieldwork, such as the design of the traditional courtyard *qian dian hou zhai* (shops in the front yard and residential area in the backyard), which was specifically adapted to business needs.[721] The study of local *shang bang* (merchant group) and *hui guan* (provincial guild hall) were also covered, mainly by combining Li and Wang's book with the author's fieldwork (conducted in February 2014).[722] Two photographs (Figure 6.14) were included in the chapter to show the mosque in Tai'er Zhuang town, exhibiting the influence of Hui culture. These photographs were obtained from the Committee of the Exhibition Hall at the Tai'er Zhuang Ancient Town.

For the conservation framework of the Shandong section, the Nomination Report is used as the main source to examine the conservation approaches that were, and are currently, taken by the state party. These include the details of the nominated boundaries and buffer zones of the Shandong section, the statements of the Outstanding Universal Values, the management plan, as well as a review of relevant laws, regulations, national and international

718 Lu Yong and Liu Qizhen, 'Hydraulic Engineering Techniques for Nanwang Water-Diversion Hydro-Junction of the Grand Canal in Early Ming Dynasty', *Anhui History Studies*, 2(2015), 56-58.

719 State Administration of Cultural Heritage of People's Republic of China, Nomination Report of the Grand Canal for the World Heritage Site, 2014.

720 Author conducted fieldwork at Nanwang town in February 2014. This fieldwork also included informal interviews with local residents.

721 One photograph (Figure 6.11) of the canal-side street at the Qiji town is included to show the facade of the *qian dian hou zhai* living style, together with an author's original drawing (Figure 6.12) of an example of this type of courtyard owned by the Zhai family. These were both produced during author's fieldwork at Qiji town in February 2013.

722 Two photographs (Figure 6.13) of a local *shan shan hui guan* (Shanxi and Shaanxi Provincial Guild Halls) at Liaocheng city, are presented to show its architectural details. These were taken by author during her visit to Liaocheng in February 2014.

guidelines.[723]

Finally, for the critical assessment of the conservation approaches taken for the Shandong section, the author's own research leads the way and is supported by feedback provided by ICOMOS.

For the former, the author's own observations during her fieldwork at the local areas, raise the conservation issues of pollution, the over-developed heritage tourism, the lack of professional knowledge and historical research, and the ineffective monitoring of the canal condition or modifications made to it. Evidence (mainly in the form of photographs) collected from the fieldwork are presented: such as the local heritage tourism project- Tai'er Zhuang Replica Town, where large amounts of re-created properties were constructed and erroneously claimed to be part of the canal heritage.

For the latter, the ICOMOS' feedback is carefully examined. This was obtained through reviewing the evaluation documents of the Grand Canal (2014),[724] which include ICOMOS' concerns about the inadequate buffer zones and the excessive numbers of archaeological excavations.

Through the critical assessment of the Shandong section conservation, the author for the first time reveals the various issues relating to the canal's current condition, mainly resulting from the government's inappropriate conservation approaches. These issues have been avoided in other modern studies of the Grand Canal, due to the difficulty of voicing criticism in a highly charged political environment.

What makes the Shandong section unique?

The Shandong section of the Grand Canal consists of three independent waterways: part of the Nan Canal (Tian Jin to Lin Qing), the entire Hui Tong River (Lin Qing to Ji Ning) and

723 The international guidelines that was consulted here is mainly the ICOMOS Charters, such as the Venice Charter and the Washington Charter.
724 Evaluations of Nominations of Cultural and Mixed Properties, ICOMOS report for the World Heritage Committee, 38th Ordinary Session, Doha, June 2014.

part of the Zhong Canal (Ji Ning to Tai'er Zhuang).[725] Because of its convenient location between Beijing and the south, and its challenging topography, requiring a high level of hydraulic engineering, the Shandong section embodies unique characteristics.

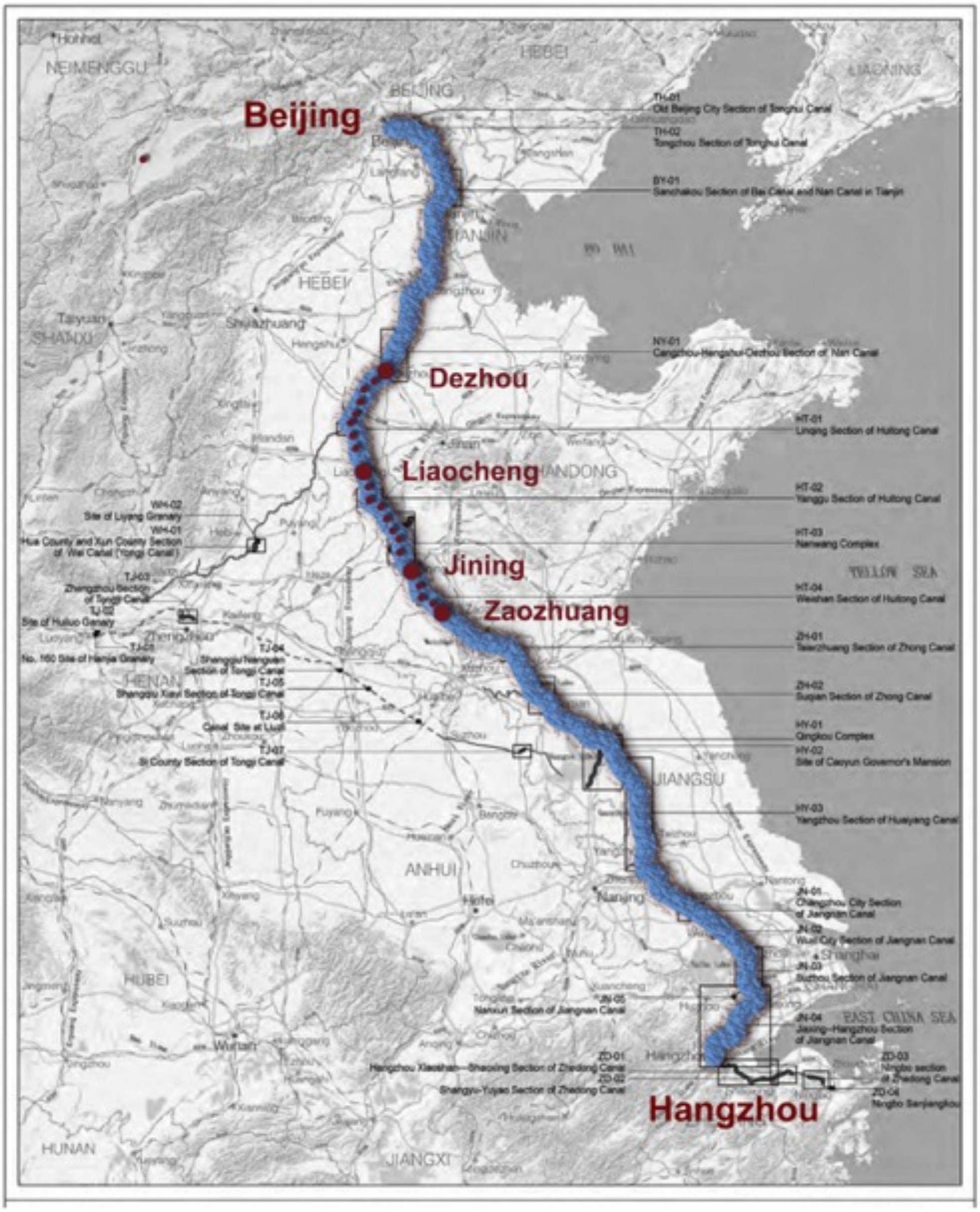

Figure 6.1 The map shows the Shandon section (red) of the Grand Canal. It covers the Hui Tong River linking Lin Qing (Liaocheng city) to Jining, part of the Nan Canal on the northern border and Zhong Canal on the southern border of the province. Source: map originally from the normination documentation submitted to the World Heritage Convention Cultural Heritage (p.54), modified by author.

[725] Zhang, http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb#p3 [accessed 1 July 2016].

The traditional river engineering

Zha He (Canal of Locks)

The challenging topography of the Shandong section has posed a challenge for the maintenance of the Grand Canal since the it was straightened to go through the Shandong peninsula instead of central China in the late thirteenth century. This is because of the height of the summit point in Ji Ning (Figure 3.3), which mad it difficult to supply sufficient water. To solve this problem, a large number of locks were built on the Hui Tong River to regulate the water level, thirty-one locks at first and increasing to forty-seven by the eighteenth century.[726] With the locks on De Zhou (of Nan Canal) and Tai'er Zhuang section (of Zhong Canal), the number of locks was over 50.[727] The Shandong section has the greatest number of locks, hence it's name, *zha he* (Canal of Locks).

Most of the locks on the Grand Canal were built with uniform standards and techniques, but those on the Shandong section were slightly different. For example, the stonework for the lock surfaces on the southern section was twenty-eight slabs wide, while for the Shandong section it was only seventeen. The width of the stonework inside the lock was one width less than that on the surface. The locks on the Shandong section had their bottom six widths built with four courses, the middle six of three courses, and the top four two courses. For comparison, the locks of the southern section had a seven course bottom width, five courses in the middle nine widths and three courses for the top eight.[728] So the locks on the Shandong section were shorter than the southern ones, perhaps because of the shallower water level and accordingly required locks.

The fewer layers of stonework resulted in fewer layers of brickwork: there were only sixteen

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[726] Yang, https://zh.wikisource.org/zh-hans/國朝獻徵錄/卷之九 [accessed 15th June 2016]

[727] Cui Jianli, 'Shan Dong Yun He Zhi Zui (The 'Number One' of the Shandong Canal)', *The Grand Canal Research Institute of Liaocheng University* (2014) <http://yh.lcu.edu.cn/content/1476.html> [accessed 29 July 2016]

[728] Wang, p. 59.

widths of two courses of brickwork inside the lock, which was much smaller scale than the twenty-seven width brickwork of the southern locks. The bottom layer of stonework required iron nails with four iron-ingots, where three were sufficient for the Shandong locks. Only one *wan nian fang* (large stone slab under the lock gate) was required for the Shandong locks, while two were sometimes necessary on the southern section; this means there could be two layers of lock gate for the southern lock, but only one for the Shandong locks.[729] Again, these differences seem likely to be due to the shallower water level in Shandong.

A good example of the locks on Shandong section is the Tu Qiao Lock on the Liao Cheng section. It was a typical stone lock built in 1471 and repaired in 1737 and 1758. It had been in use until the 1960s, when this section of the canal had so little water that it dried up. Its construction details were as follows: it was 7.5 metres high, and had a 6.2 metre wide lock gate and 6.8 metres long walls on both sides. The *shang ying shui yan chi* were 21.7 metres long on the eastern bank, 18.2 metres on the western; the *xia fen shui yan chi* were 31.1 metres long on the east and 28.7 metres on the west.[730]

[729] Wang, p. 59.
[730] Liaocheng Institute of Cultural Relic Archeology, Liaocheng Cultural Relic Bureau and Administration Office of Cultural Relic, Dongchang District, Liao Cheng, 'Shan Dong Liao Cheng Tu Qiao Zha Diao Cha Fa Jue Jian Bao (Brief Report of the Discovering and Investigation of the Tuqiao Lock, Liaocheng, Shandong)', *Cultural Relic,* 1(2014), 37-44 (pp. 38-39). Please see Chapter Four for the meaning of Chinese terms of a lock.

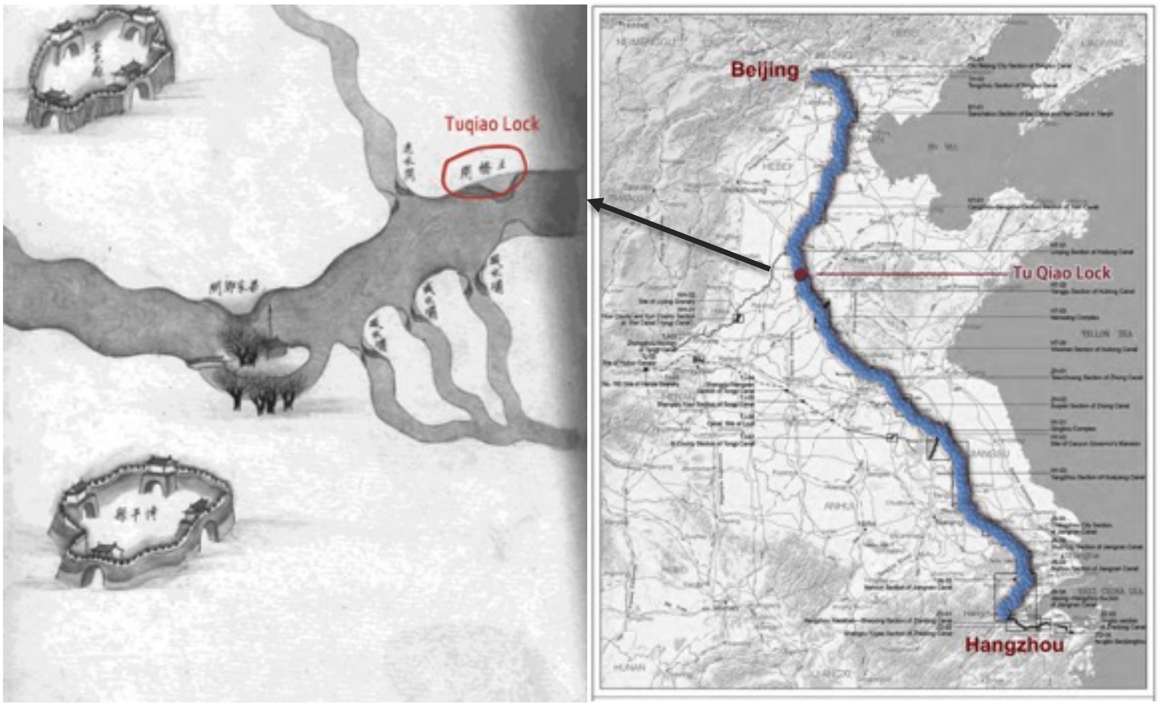

Figure 6. 2 The Tuqiao Lock is circled on the map (dated 1703) on the left, while on the right the key map shows where it is located along the Grand Canal. Source: the key map is originally from the normination documentation submitted to the World Heritage Convention Cultural Heritage (p.54), modified by author. The historic map is from Tianjin Library, p. 18.

The Tuqiao lock was built with eighteen widths of stonework, with each stone varying in size from 0.4 x 0.4 x 0.38 to 1.05 x0.4 x 0.5 metres. The structure of the lock was exactly the same as the standard locks of the period, except for the lock gate foundation. Instead of being built with a single stone slab as foundation, the Tu Qiao lock's foundation was formed of five stones, 0.5 metre thick and of varied length.[731] This might be due to conditions at the time of construction, or it might be a consequence of later repairs.

[731] Liaocheng Institute of Cultural Relic Archeology, Liaocheng Cultural Relic Bureau and Administration Office of Cultural Relic, Dongchang District, Liao Cheng, pp. 38-39.

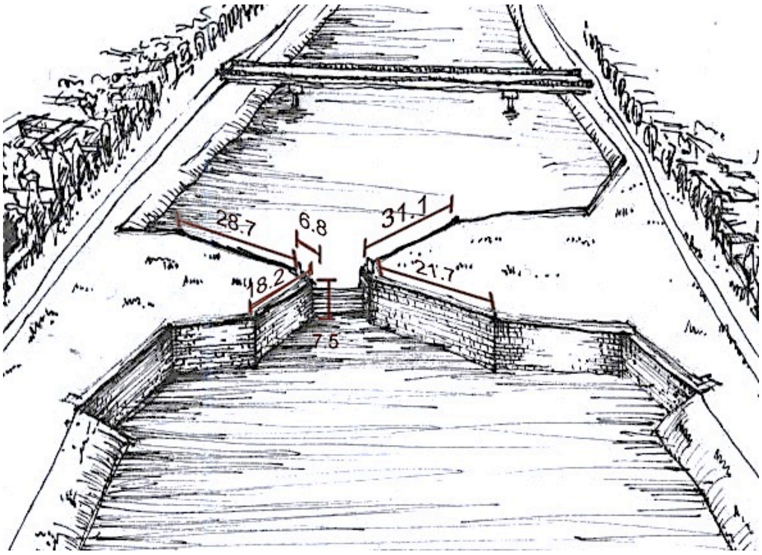

Figure 6.3 The detailed dimensions of the Tuqiao lock made by the author. The angle between the walls of the lock gate and the wings is 155°.

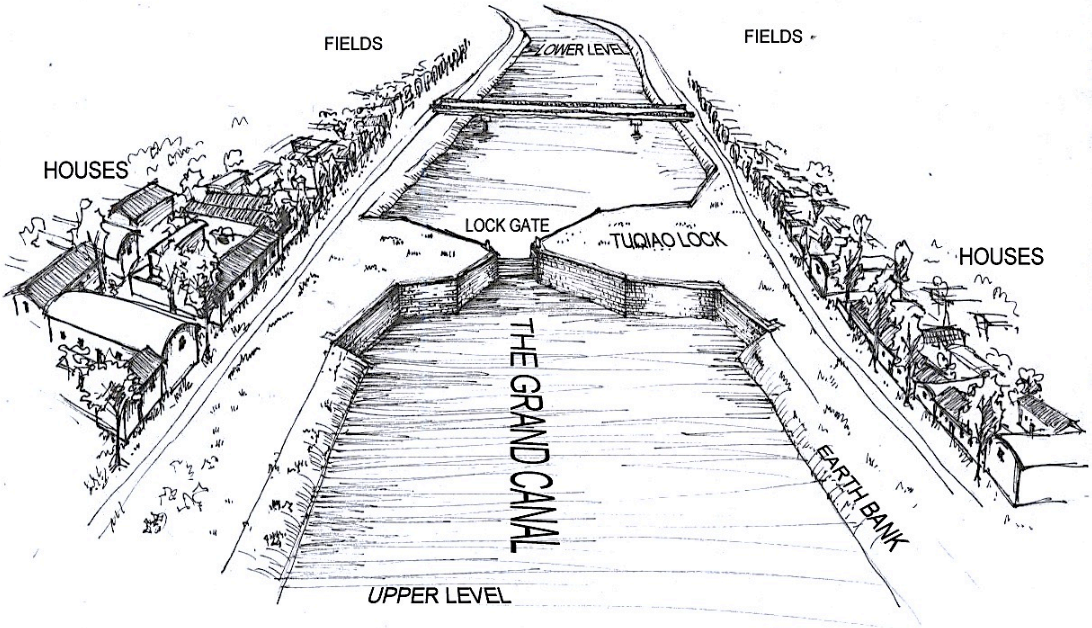

Figure 6.4 A sketch by the author to show the relationship between the Tuqiao lock and its surrounding landscapes. The housing area has been extended to be nearer to the locks. The houses further along the towpath were removed during the reconstruction of this lock in preparation for the WHS nomination.

Figure 6.5 The southern side of the Tu Qiao lock when it was discovered in 2010 during the investigation of the south-north water transfer project. The layer of stonework under the lock gate can be seen, as well as the general structure of the lock. Because of the disused waterway and lock, the residential houses have expanded to the bank. Source: Liao Cheng Institute of Cultural Relic Archeology, Liao Cheng Cultural Relic Bureau and Administration Office of Cultural Relic, Dong Chang District, Liao Cheng, p. 40.

Figure 6.6 Another photo of the Tu Qiao Lock when it was discovered. The timber beams of the lock gate have gone, but the groove can be seen: 0.25-0.3m wide and 0.2-0.25m thick, and the detail of the stonework beside it. Source: Liao Cheng Institute of Cultural Relic Archeology, Liao Cheng Cultural Relic Bureau and Administration Office of Cultural Relic, Dong Chang District, Liao Cheng, p. 40.

 

Figure 6.7 The iron nails (left) found on the lock which bound the stones together, and one of the *zhen shui shou* 镇水兽 (water-taming beast) (right) to protect boats from the impact of big waves. There were usually two beasts placed on each side of a lock, with their heads pointing in the direction of the water. Source: Liao Cheng Institute of Cultural Relic Archeology, Liao Cheng Cultural Relic Bureau and Administration Office of Cultural Relic, Dong Chang District, Liao Cheng, pp. 42-43.

Water division project at the Nan Wang complex

As discussed in chapter four, the inadequate water supply caused by the challenging topography was solved when Song Li decided to direct water from the Wen River to the canal through the Xiao Wen River at Nanwang, instead of the Guang River. This strategy had been designed in the Yuan Dynasty and did not work.[732]

The Dai Cun Dam was built on the Wen River northeast of Nan Wang, to regulate and divert water from the Wen River into the canal. The original dam was a 125 *zhang* long and 5-7 *chi* high earth dam;[733] it was replaced by Song Li with a stone dam in 1411. The new Dai Cun Dam had three parts, the Main Stone Dam, Tai Huang dyke and the *san he tu* (concrete earth) Dam.

The Main Stone Dame served for discharging flood water and preventing overflow while

[732] Zhang, http://ctext.org/wiki.pl?if=gb&chapter=171823&remap=gb#p10 [accessed in 7 July 2016]
[733] Lu and Liu, p. 57.

ensuring sufficient water supply for the Grand Canal. It was 443 metres long including a permeable rock-fill, an irregular stone and an overflow dam from north to south, with the northern part lowest and the central part highest.[734] The three parts of the main stone dam were built in an arc, with the back facing upstream to strengthen the pre-tension of the dam and a buffer threshold on the downstream side to protect the dam base. The stones used to build the dam were huge, weighing from one to six tons; the whole was strengthened by iron nails to prevent the dam from being damaged by floods.[735]

The Tai Huang Dike in the centre of the Dai Cun Dam was made of both earth and stone and mainly served to stop water from flowing further west, directing it southward instead to flow into the Xiao Wen River. The northern part is the concrete earth dam, only built in the seveteenth century to discharge floods when the other two parts of the dam were overrun. It was named after its main material, concrete earth, and is over 260 metres long.[736]

To commemorate the completion of this project, a *Long Wang* 龙王 (Dragon King) Temple was built at the water division point between 1403 and 1424. It consisted not only of a Hall of the Dragon King, but also an opera tower, a bell tower and a drum tower. Ancestral Halls of the Song Li, Bai Ying and Pan Jixun families were built later, in 1512, to praise the canals' water management experts.[737] The scale was further extended when more temples were added through the Ming and Qing dynasties, as the religions of the people living nearby diversified as a result of the multicultural environment brought by the canal trade. None of these buildings survive today, as all were demolished during the Cultural Revolution.[738]

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[734] State Administration of Cultural Heritage of People's Republic of China, Nomination Report of the Grand Canal for the World Heritage Site, p. 298.
[735] Ibid., pp. 298-299.
[736] State Administration of Cultural Heritage of People's Republic of China, pp. 297-299.
[737] Ibid., p. 302.
[738] According to the fieldwork at Nanwang and interviews with local residents in winter 2014.

Figure 6.8 The current condition of the Dragon King Temple: none of the buildings survive today. Source: State Administration of Cultural Heritage of People’s Republic of China, p. 302.

Marketplace culture

During the heyday of the Grand Canal, trading was established as one of the main means of livelihood in the towns along the Shandong section, which achieved a level of economic integration unmatched elsewhere in northern China. Unlike in southern China, where there had been a long history of commerce, the traditional idea of livelihood in the north was still *Zhong Nong Yi Shang* (agriculture rather than trading). Doing business was regarded as chasing after commercial benefits, which was contrary to Confucian values,[739] so it is an exceptional occurance for a marketplace culture to have developed so well in the canal areas of Shandong province.

The Shandong section lies in the middle of the course of the Grand Canal, so it was a must-pass section for canal boats from the south going to the capital Beijing, and it become a trading centre as boatmen from different regions offered their private goods to the inhabitants while they were waiting to go through the lock gate. Waiting to pass each of the single locks

[739] Hu and Lan, p.161.

at a time could take days, as the lock keepers needed to wait for enough barges (which could be as many as two hundred in special circumstances) before they opened the lock gate, in order to save water. The large numbers of locks on this section also slowed the passage of the barges and their traders.[740] The Ming poet Li Liufang (1575-1629) said in his poetry that 'Ji River (Shandong canal) has fifty locks, the water in between wouldn't swallow the boats; every ten li there is a lock, and water is raised as precious as it is; it takes one day to pass one lock, waiting for it feels as horrible as waiting for a ghost'.[741]

The boatmen used this time to sell goods like silk and tea from the south to local people, and private merchants started to trade along the canal as they were gradually permitted to use the route by the Ming government. Some of these goods were very rare for northern towns and villages. Of the canal-side towns, Lin Qing slowly became an important silk market for northern China. Local merchants traded the silk they bought from boatmen to neighbouring regions like Shanxi and Shaanxi.[742]

Figure 6.9 Women selling clothing along the Liao Cheng section of the canal in the 1930s. Source: Liao Cheng Grand Canal Museum.

[740] Li and Wang, p. 73.
[741] Li Liufang, *Tan Yuan Ji-Zha He Zhou Zhong Xi Xiao Chang Qing Ti* (Taipei: Taiwan Shang Wu Yin Shu Guan, 1986).
[742] Li and Wang, pp. 75-76

Figure 6.10 The scene of a busy market along the Liao Cheng section in the 1930s. The board sign of the shop, on the top left corner of the photograph, suggests that the shop was selling goods from Beijing. Source: Gao Wenxiu, 'The Old Photographs of Dong Chang Fu from the Canadian Missionary William Smith', *Sina Blog* (2011) <http://blog.sina.com.cn/s/blog_4c3ea8090102dt8w.html> [accessed 12 June 2016].

The canal stimulated the commercial development of towns along the route through Shandong province, and large numbers of local people started running their own businesses. A great many shops were opened towns whose streets were often named after their main business. Many of the canal-side towns had *zhu gan xiang* 竹竿巷 (bamboo lane), named for their bamboo trading business; there were also *mi shi jie* 米市街 (rice market street) and *tang shi jie* 糖市街 (sugar market street).[743] Sadly these unique names were changed to more patriotic ones after the establishment of the communist government.

This commercial development fostered a special type of living space in many towns in this area, called '*qian dian hou zhai* 前店后宅 (shops in the front yard and residential area in

743 According to the fieldwork at canal-side towns in Shandong and interviews with local residents in winter 2014.

the backyard)'. This was a response to the large numbers of people running businesses who used the part of their house facing the street as a shop, and the buildings to the back as living areas and workshops. This kind of courtyard was very common between the eighteenth and eighteenth centuries, and some can still be seen in canal-side towns such as Qi Ji, although most of them have been abandoned and are about to be removed.[744]

Figure 6.11 The picture shows one of the streets of Qi Ji, laying perpendicularly to the Grand Canal. It was the first street that people came to from the bank of Qi Ji Dock, which used to be an extremely busy place, designed specifically for transferring tribute grain between granaries. According to the local elderly, the busy street used to be full of people, and all kinds of goods were available in the shops; there were also restaurants, tea houses and hairdressers. This is a typical canal side street and it shows vernacular architectural features, with brick structured houses and flat roofs. The eaves are longer than normal northern structures to prevent the goods displayed outside the shops from sunlight and rain. Behind each shop there is a residential area, forming the local *qian dian hou zhai* living style. Sadly, the street is now almost abandoned due to the construction of a new town area. Source: photographs taken by the author in winter 2013.

744 According to the fieldwork at Qiji Town in winter 2013.

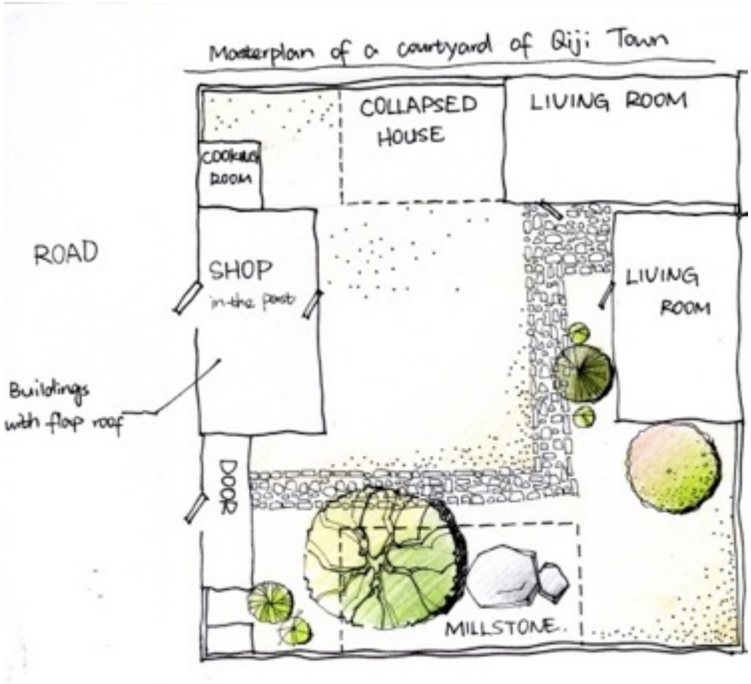

Figure 6.12 A typical *qian dian hou zhai* courtyard in Qi Ji, Liao Cheng. The shop, which used to be a tea house, is facing the road, and other buildings in the same courtyard form the living area. The courtyard was owned by the Zhai family and only two houses are now in use. Source: sketch made by author.

The development of local commerce improved people's living standards. These canal towns prospered so long as the route was in use. People were introduced to a luxury lifestyle which they had not experienced before the canal was built: 'No matter whether ordinary or literati, they were all wearing silk shoes, women were wearing silk clothes and jewellery made of jade, gems and gold. However they still tried to make even more money if they could, which would never have happened fifty years ago.'[745]

Not only did more local merchants appear, but also people from other regions went looking for business opportunities. Many of them chose to settle down in Shandong, forming a number of *shang bang* 商帮(merchant group) based on their regions of origin, and later the construction of their own *hui guan* 会馆 (provincial guild hall). Although these merchants

[745] Hu Yufan, *Teng Xian Zhi (Annals of Teng County)* (Qing Guang Xu San Shi Si Nian Qian Yin Ben, 1908), Chapter 3, Feng Su (Custom).

chose to move away from their hometown, the pride and emotion they had for it never disappeared, so they needed somewhere that could represent where they came from and at which they could organize gatherings with their fellows. There were more than 40 provincial guild halls along the Shandong canal representing a variety of regions including Shan Xi, An Hui and Zhe Jiang.[746]

At first most of the provincial guild halls were not called *hui guan.* Instead, they were named after the local gods who were worshipped there. For example, Shanxi provincial guilds were often called *Guan Di* 关帝(the god of war) Temple, while Fu Jian's guilds used the name *Tian Hou* 天后(The Heavenly Mother) Temple for most of their buildings[747]. A provincial guild hall was usually composed of several buildings which incorporated meeting rooms, temples and stages; their size often represented the scale (both in influence and numbers) of the particular merchant group.[748]

746 Li and Wang, p. 196, table of the provincial guild halls along the Shandong canal during Ming and Qing period.
747 Ibid., p. 198.
748 Ibid., pp. 198-199.

Figure 6. 13 These two photographs of *Shan Shan Hui Guan* (Shanxi and Shaanxi Provincial Guild Halls) in Liao Cheng city show the threshold and the performing stage in the eastern corner of the courtyard. The roof of the threshold is of the hip-and-gable roof style, with the words *Shan Shan Hui Guan* written on the top of the main gate. There are also the words *lv zhong* and *dao he* on top of the side gates, which represent the business faith of the native merchants.[749] In 1743, when merchants from Shanxi and Shaanxi started raising money to build a base for themselves to 'worship their god (guan di) and remember their homeland', the guild hall was built on the western bank of the Liao Cheng section of the canal.[750] According to the inscriptional records, the material and craftsmen were both transported from their region of origin in order to fully represent native architectural characteristics. Source: photographs taken by author in winter 2014.

[749] The Chinese texts are 履中 and 蹈和, the first one is to remind the merchants to be righteous, and the second is to expect them to be kind and amicable.

[750] The original Chinese texts are 祀神明而联桑梓, 桑梓 literally means mulberry and catalpa trees, which in the past were very common plants for people to plant in their courtyard. So 桑梓 usually also means a person's hometown.

Multicultural

The busy traffic on the Grand Canal also enriched the diversity of local religions. Before the Grand Canal was built across Shandong, people's beliefs were relatively simple, and most of them worshipped *Cheng Huang* 城隍 (the Town God) and *Tu Di* 土地 (the Earth God).[751] This changed after merchants from different regions came to Shandong to do business and introduced their beliefs: worshipping their old gods for blessings on their business was very common. As a result, various beliefs not originally from Shandong were slowly accepted by people who lived there.

A good example of this is the belief in the goddess *Tian Hou*, one of the mainstream beliefs of the Fu Jian region. This goddess was not worshipped in northern China until her temple appeared in De Zhou in the fifteenth century. The Min (Fu Jian) merchants travelled thousands of miles along the canal to Shandong to trade products like sugar, fruit and paper, and some of them stayed in Shandong and settled down. The people there enjoyed their goods, and began to be introduced to their culture.[752]

Through contact with the Min merchants, belief in *Tian Hou* became 'normal' for ordinary people in Shandong. They became used to worshipping her, praying for a safe trip on the Grand Canal.[753] There is evidence that *Tian Hou* was regarded as a significant god by the government. Hong Zhi (reign 1488-1505) Emperor ordered the building of a *Tian Hou* temple in An Ping town (present Zhang Qiu) to commemorate the floods of 1494. A statue of *Tian Hou* was worshipped inside the temple, together with other water gods from local tradition, such as the *Long Wang* (the Dragon King) and *Zhen Wu Da Di* 真武大帝 (the Mysterious Supreme Emperor of Heaven).[754] A seventeenth century fiction tells a story about the Minister of Work, Zhu Heng (1512-1584), who chose the *Tian Hou* temple in Lin Qing to

[751] Li and Wang, p. 258.
[752] Li and Wang, p. 278.
[753] Ibid.
[754] Qu Huaifu(ed.), *Qing Ding Xu Wen Xian Tong kao* (Comprehensive investigations based on literary and documentary sources), Si Ku Quan Shu Ben (1789), p. 20.

host officials and watch Chinese opera.[755]

Another important god was *Guan Di*. Although he was more commonly supported by Shandong people compared to *Tian Hou*, belief in *Guan Di* wasn't orginally from this region. *Guan Di* was also known as Guan Yu (?－220), a high-ranking military official from Shangxi. Unlike *Tian Hou*, *Guan Di* had been a real human being who lived in the period of the Three Kingdoms, but was later officially designated as a god by the emperors to symbolise the values of bravery and patriotism. Belief in *Guan Di* started in Shandong in the fourteenth century, when the government deliberately moved large numbers of people from Shanxi to western Shandong, because of a decline in population caused by war and natural disasters. More Shanxi merchants came to the canal region later to do business, and believed *Guan Di* could protect them by blessing their business, so they built Guan Di temples in their provincial guild halls.[756]

Soon *Guan Di* was not only worshiped by Shanxi merchants, but also by local people. They started putting statues of *Guan Di* in their shops, just like the Shanxi merchants, to pray for good business. The statues can still be seen in some local shops nowadays. Because *Guan Di* became so revered, temples in his honour were established in almost every city and town in Shandong after the fifteenth century. There were eleven new *Guan Di* temples built in De Zhou city in the late eighteenth century.[757] Temples of other religions including mosques can also be found near the Shandong section of the canal, (Figure 6.13), most of them demolished during the Cultural Revolution. Some have been rebuilt for tourists.

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[755] Unknown, *Tao Wu Xian Ping* (Informal Discussion of the Villains) (undated) Chapter 2, Kan Kan Ba Online Library, http://www.sbkk8.cn/mingzhu/gudaicn/_woxianping/224020.html [accessed 20 July 2016]
[756] Li and Wang, pp. 287-291.
[757] Wang Daoheng, *De Zhou Zhi (Annals of Dezhou)*, Kang Xi Wu Shi San Nian Ben (1788), Chapter 11, Temples.

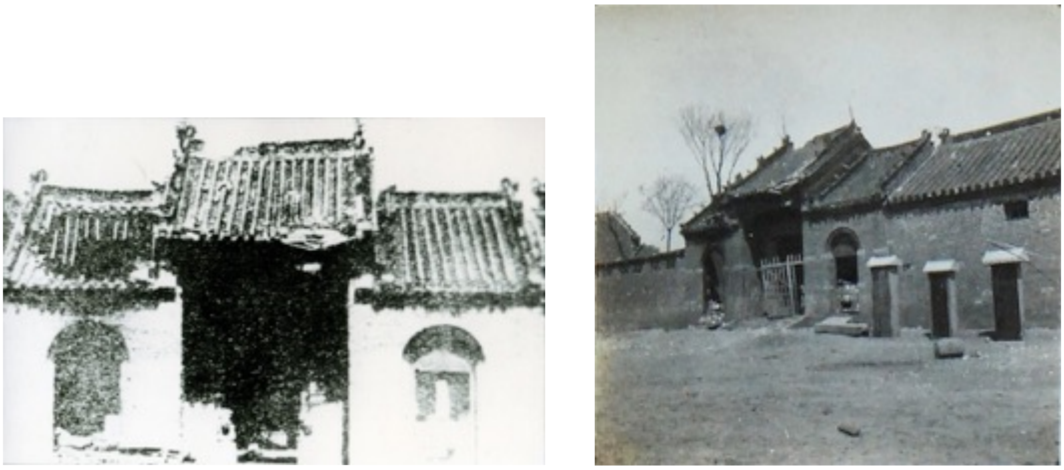

Figure 6.14 These two photographs show the Mosque in Tai'er Zhuang, which was built in 1742 by the Hui people living in this area. It was used as an office by the communist army during the war against Japan in 1938. Source: from the Committee of the Exhibition Hall at the Tai'er Zhuang Ancient Town.

The multicultural environment along the Shandong Canal was not only manifested in the multiple faiths present, but also by multiple clans. Traditionally speaking, most Chinese villages are formed by one or two clans: most people living in the same village came from one clan and share one and the same family name. For many Chinese villages this is also the village's name.[758] For example, a village formed by people from the Wang clan would be called Wang Village, and one of the Li Clan would be called Li Village.

However this rule does not apply to many villages along the canal. Many of the villages along the Shandong section tend to have more than one clan, mainly because this region used attract numerous migrants. During the heyday of the Grand Canal, there were not only merchants but also workers who had better work and living prospects because of the transport possibilities and the economic power of the canal. There were also the migrants from Shanxi migrants who came by order of central government. So instead of being named after the clan, many of the villages along the canal were named after their geographical relationship to the Grand Canal. For example, a few villages were named *He Shang/Xia* (above/below the canal)

[758] Li Wanpeng and Jiangbo, *Qi Lu Min Ju (Vernacular Dwellings of the Shandong Province)* (Jinan: Shandong Art Press, 2004), p. 47.

Village, suggesting that these villages were either to the south or north of the canal.[759] In most cases it was the locks which were taken as the basis for naming a village, so there are *Shang/Xia Zha* villages and *Nan/Bei Zha* (south/north of the lock) villages in almost every canal-side city. It seems very likely that these villages appeared after the canal was built.

The conservation of the Shandong section

Awareness of the value of heritage conservation was not raised in China until 1985, when the country became a signee of the *Convention Concerning of the Protection of the World Cultural and Natural Heritage*[760] The state government quickly nominated 28 heritage sites for inscription, including the Tai Mountain, and the Great Wall.[761] The Grand Canal was not considered valuable heritage at that time, partly because most of its original fabric had been destroyed when it was upgraded to a modern waterway.[762]

Since the 1990s, studies of the Grand Canal as a valuable heritage site have been carried out by various institutes.[763] For example, Liaocheng University conducted various research projects on environmental change and history of the Canal, and the Research Institute of Grand Canal Culture was established in 2008.[764] In 2004, research on the conservation of the Grand Canal heritage corridor funded by China's State Administration of Cultural Heritage (CSACH) was carried out by Peking University. This included investigation of the current condition of the canal, covering issues like pollution and discussing how it could be protected as a whole.[765] This research established the significance of the canal in terms of

759 See chapter three: according to *Fengshui* principles, *Shang* means south and *Yang*, and *xia* means north and *yin*.
760 *Convention Concerning the Protection of the World Cultural and Natural Heritage.* (UNESCO Official Website) <http://www.unesco.org/eri/la/convention.asp?KO=13055&language=E> [accessed 17 June 2016]
761 Yu Kongjian, *The Grand Canal Heritage and Ecological Corridor of China* (Beijing: Peking University Press, 2012), p. 51.
762 Ibid.
763 Ibid.
764 Unknown, 'Brief Introduction of the Grand Canal Institute', *Grand Canal Research Institute of Liaocheng University* (2014) <http://yh.lcu.edu.cn/content/1202.html> [accessed 10 July 2016]
765 Yu, p. 51.

culture and history, which drew attention in a way which allowed the canal to gradually be seen as a potential World Heritage Site.

In May 2006, a conference about the WHS nomination of the Grand Canal was held in Hang Zhou. It closed with a *Declaration of the Protection of the Grand Canal and the Nomination for World Heritage Site*. In the same year the canal was added to the national list of heritage sites and the reserve list for WHS nomination. In 2009, the local governments of all the eight provinces along the canal formed the Grand Canal WHS nomination committee.[766] And in 2011, it was officially announced that the entire course of the Grand Canal, including the canals of the Sui and Tang dynasties, the Grand Canal (Beijing-Hangzhou section), the hydraulic remains of the Zhedong Canal, all associated historical relics, historic blocks and towns and villages, as well as the associated environmental landscape and things of this type, would be included in the nominated boundary.[767]

The nominated area of the Shandong section covers the De Zhou section of the Nan Canal, the Lin Qing, Yang Qu, Nan Qang complex and the Wei Shan section of the Hui Tong Canal, and the Tai'er Zhuang section of the Zhong Canal.[768] A more detailed description of the boundaries of the nominated area is shown in the table below.

766 Ibid., pp. 52-53.
767 Evaluations of Nominations of Cultural and Mixed Properties, ICOMOS report for the World Heritage Committee, 38th Ordinary Session, Doha, June 2014, p. 111.
768 State Administration of Cultural Heritage of People's Republic of China. p 4.

Table 6. 1 The nominated boundaries and buffer zones of the Shandong section. Source: State Administration of Cultural Heritage of People's Republic of China, pp. 10-11.

Name	Boundary of nominated component part	Boundary of buffer zone
De Zhou section of Nan Canal	The boundary runs from Xie Jia Dam of Lian Zhen in the north to the road on the northern margin of Si Nv Temple Complex Delta in the south. Boundaries on both sides are expanded by five meters from the bay line of Nan Canal. If embankment is met, toe line of outer embankment is designated as the boundary.	The east and west boundaries have been formed by expanding 30 and 80 metres from the nominated property, by 30 meters in Wu Qiao County and Dezhou city section, and by 80 metres in other sections.
Lin Qing section of Hui Tong River	The west boundary reaches the intersection of Lin Qing canal of the Yuan Dynasty, Ling Qing Xiao and Wei Canal, and the east boundary meets Qiutun Complex. Boundaries on both sides are expanded by five metres from the Lin Qing and Xiao Canal from north to south. If embankment is met, the toe line of outer embankment is designated as the boundary.	The boundary extends 30 metres from the nominated property. In Lin Qing Customs Post west of Xiao Canal, the boundary runs along neighbouring main roads.
Yang Gu section of Hui Tong Canal	The boundary runds from 1 km north from Lower E Cheng lock in the north to Jin Di River in the south. Boundaries on both sides are expanded by 5 metres from the bay line of Hui Tong Canal from east to west. If embankment is met, tow line of outer embankment is designated as the boundary.	The east and west boundaries have been formed by expanding 80 metres form the nominated property on both sides, in Zhang Qiu Town the adjacent road has been taken as the boundary.
Nan Wang complex	The boundary reaches Kai He Dong Village north of Nanwang lake site in the north, Chang Gong Village south of Nan Wang lake site in the south, and the east and west boundaries in principle extends by 30 metres to the east and west from the central line of the waterway of Hui Tong Canal. The north boundaries of Xiao Wen Canal runs along the south bank of Hui Canal and the north bank of Da Qing Canal in the north of Dai Cun Dam, the south boundary goes to the junction of Xiao Wen and Hui Tong Canal site, and extends by 4 metres to the east and west from the toe lines of the dike.	The boundary of Nan Wang complex extends by 25 metres from the outer range of Nan Wang lake site comfirmed by archeological excavation. The north boundary of Xiao Wen Canal runs along the east-west summit lines of Long Mountain and Dong Hui Canal of Huang Xu Zhuang Village, the south boundary reaches the buffer zone boundary of Nan Wang lake site, the east and west boundaries extend by 80 or 300 metres from the nominated property.
Wei Shan section of	The boundary runs between Nan Yang Town and Li Jian Lock. In sections with obvious bay lines it extends by 5 metres from the bay	The boundary extends by 30 metres from the nominated property

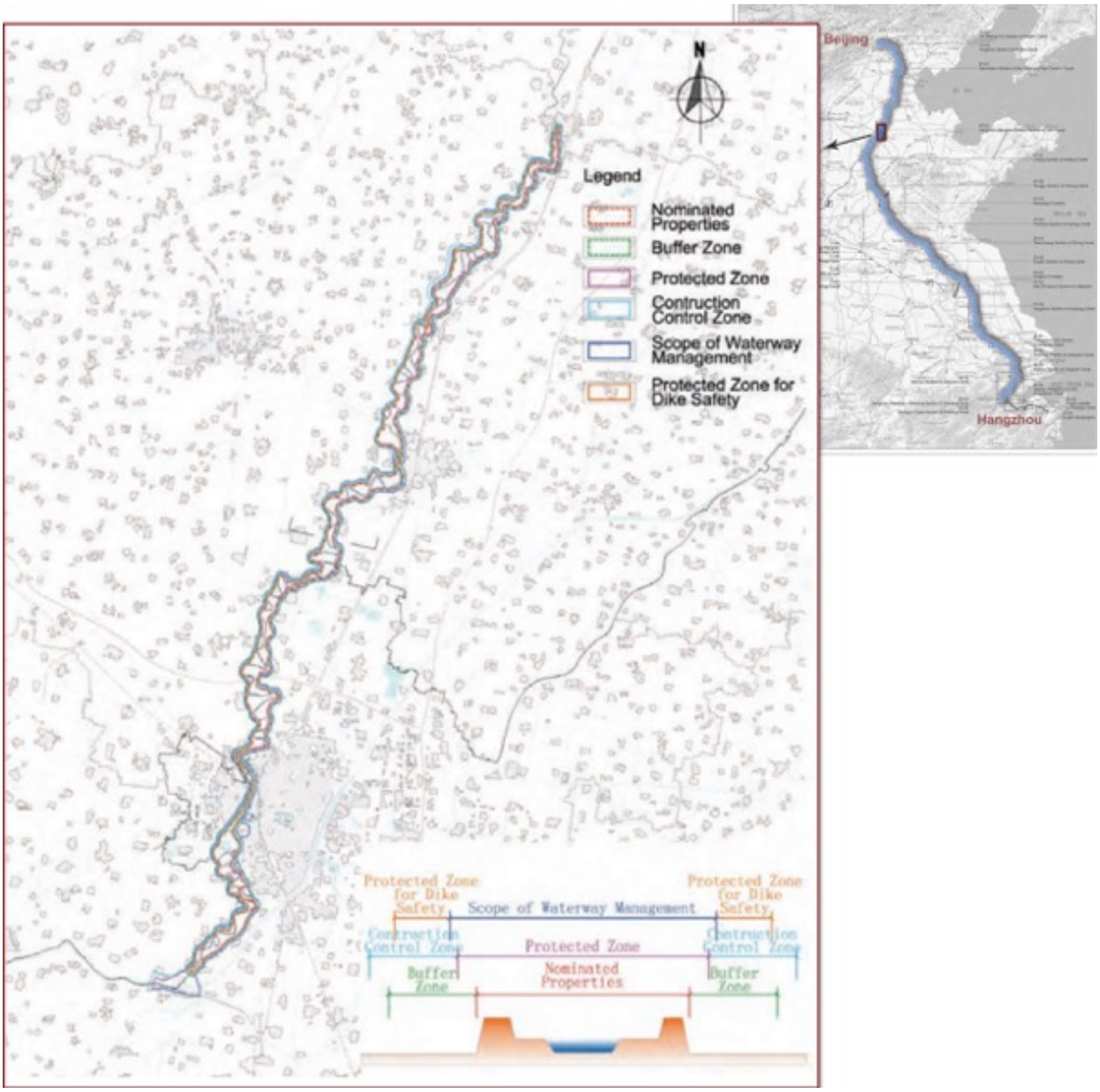

Figure 6.15 The boundary of the nominated area and buffer zone of the De Zhou section of Nan Canal.

Source: State Administration of Cultural Heritage of People's Republic of China, p. 655.

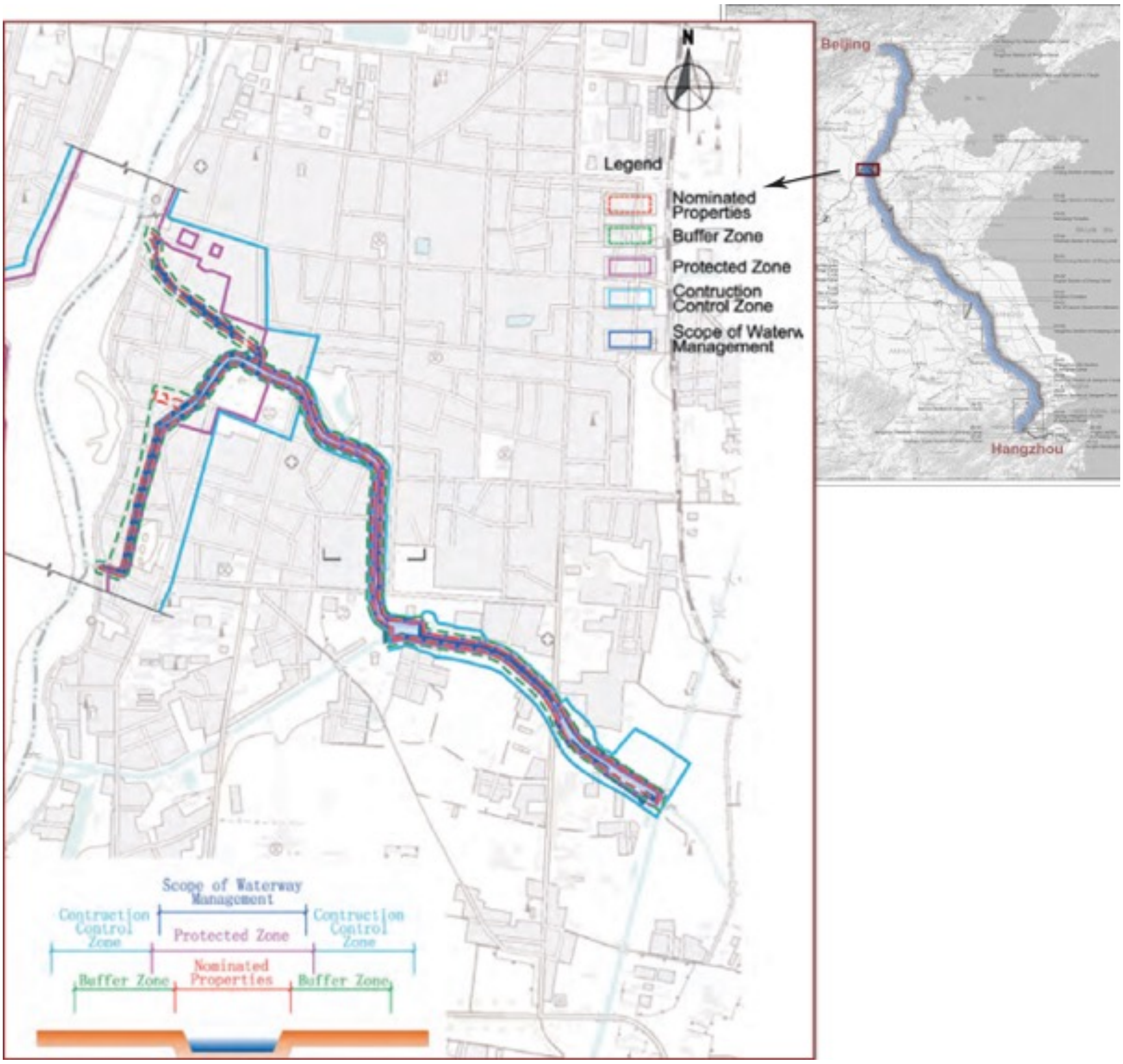

Figure 6.16 The boundary of the nominated area and buffer zone (green dashed line) of the Lin Qing section of Hui Tong Canal. The buffer zone was later extended (see Figure 6.17 below) following ICOMOS's advice. Source: State Administration of Cultural Heritage of People's Republic of China, p. 656.

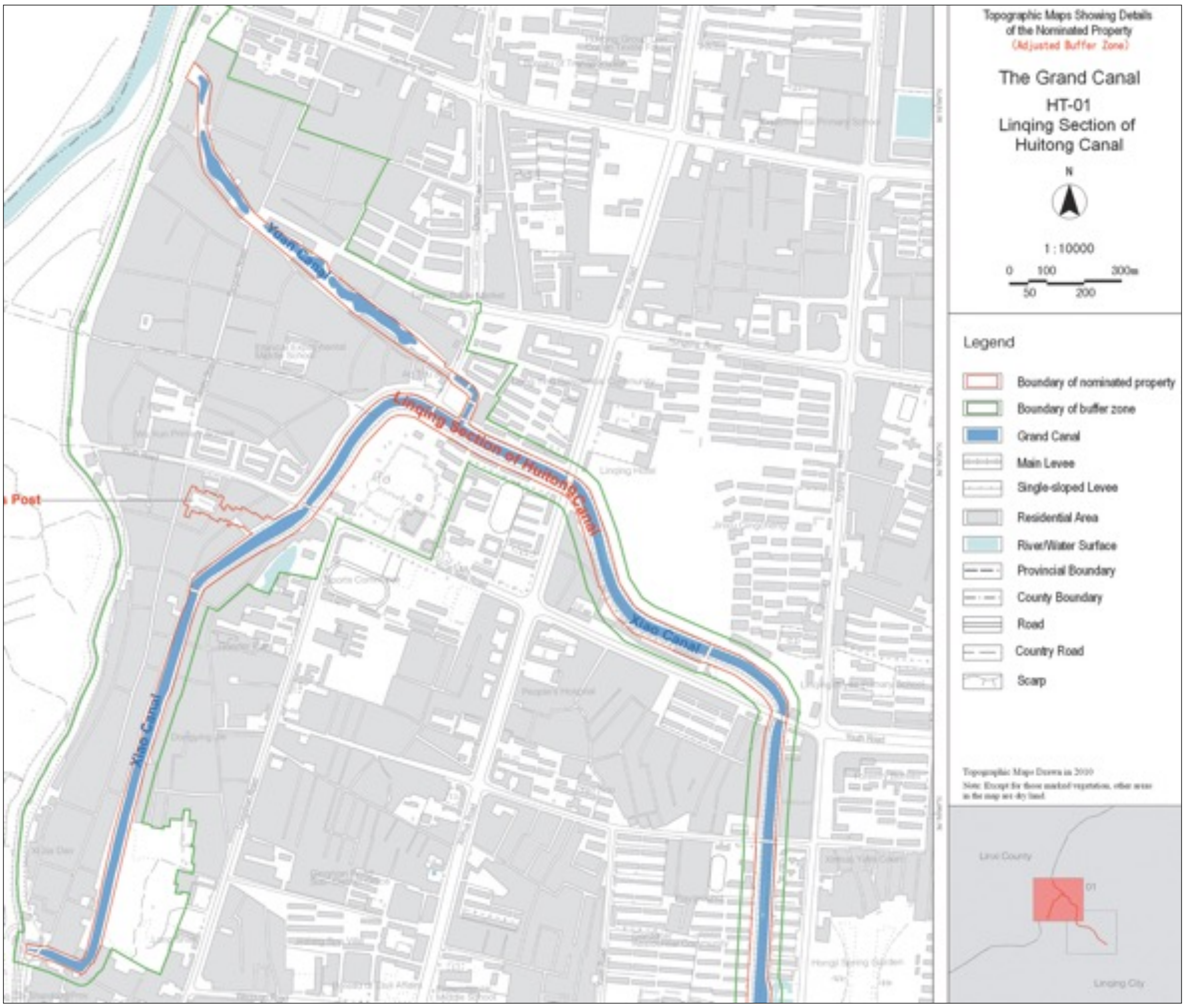

Figure 6.17 The new buffer zone (green line) after adjustment of the Lin Qing section in Shandong. Source: State Administration of Cultural Heritage of People's Republic of China. Additional Information II, p. 42.

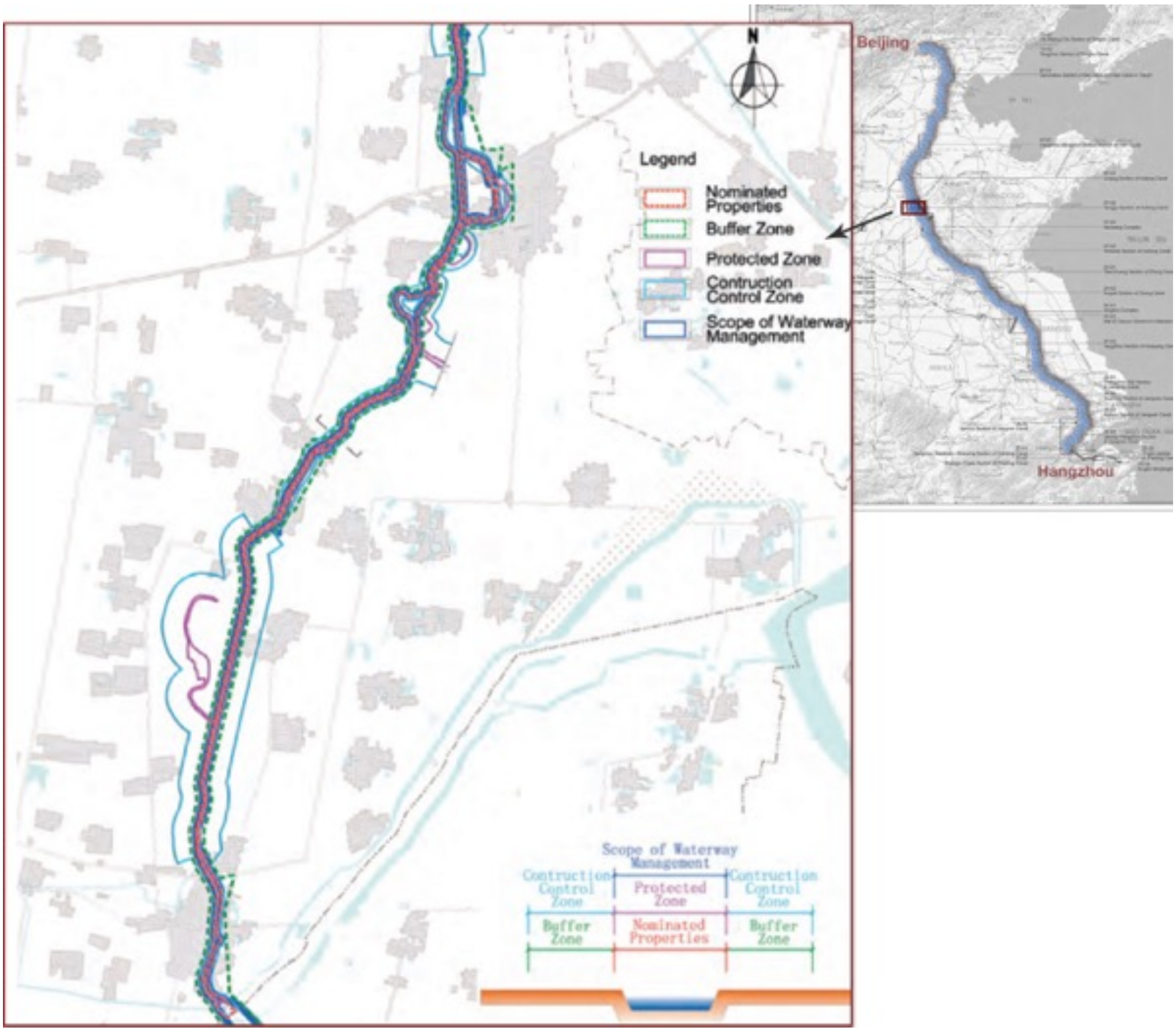

Figure 6.18 The boundary of nominated area and buffer zone of the Yang Gu section. Source: State Administration of Cultural Heritage of People's Republic of China, p. 657.

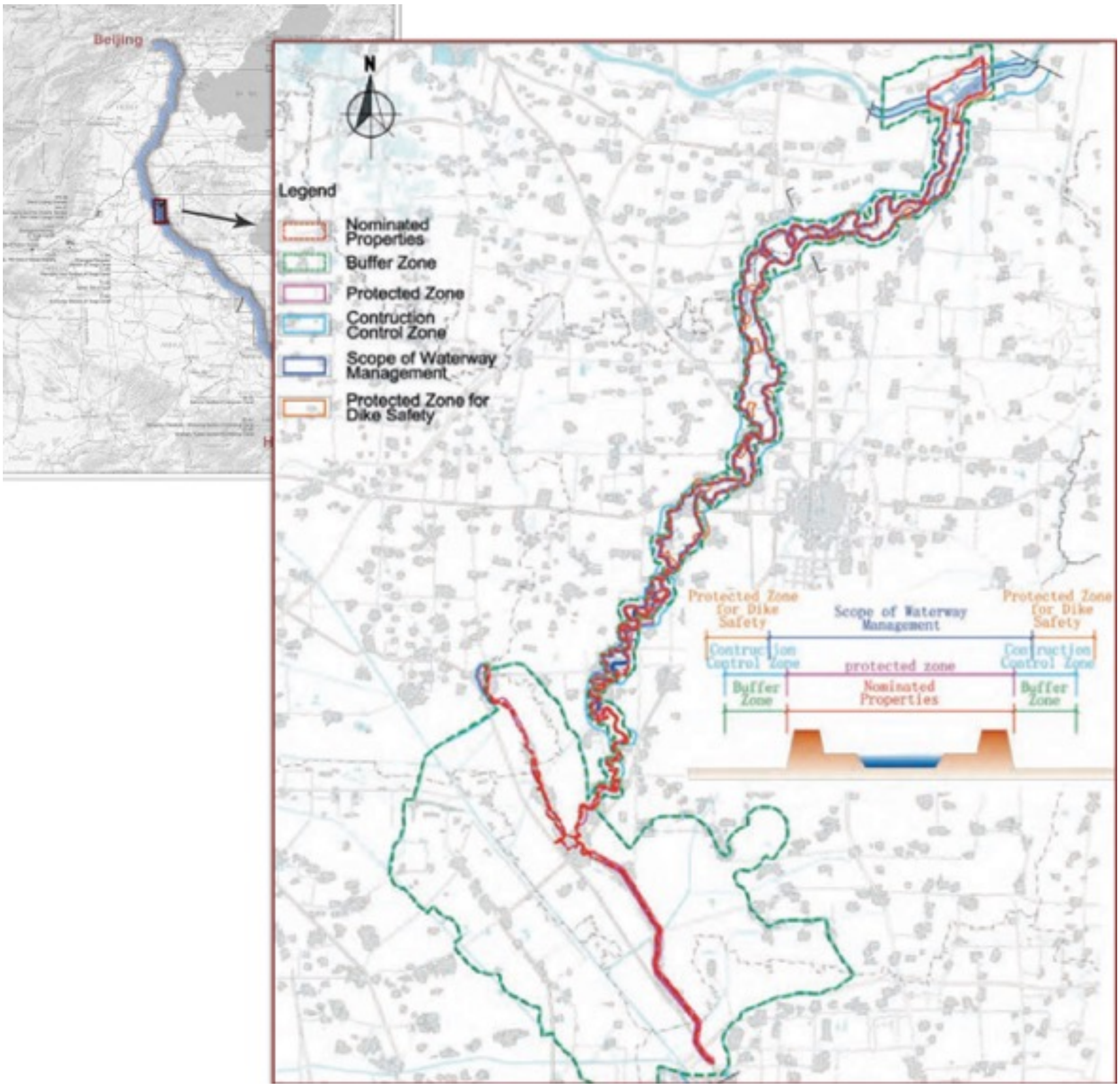

Figure 6.19 The boundary of the nominated area and buffer zone of the Nanwang complex. Source: State Administration of Cultural Heritage of People's Republic of China, p. 658.

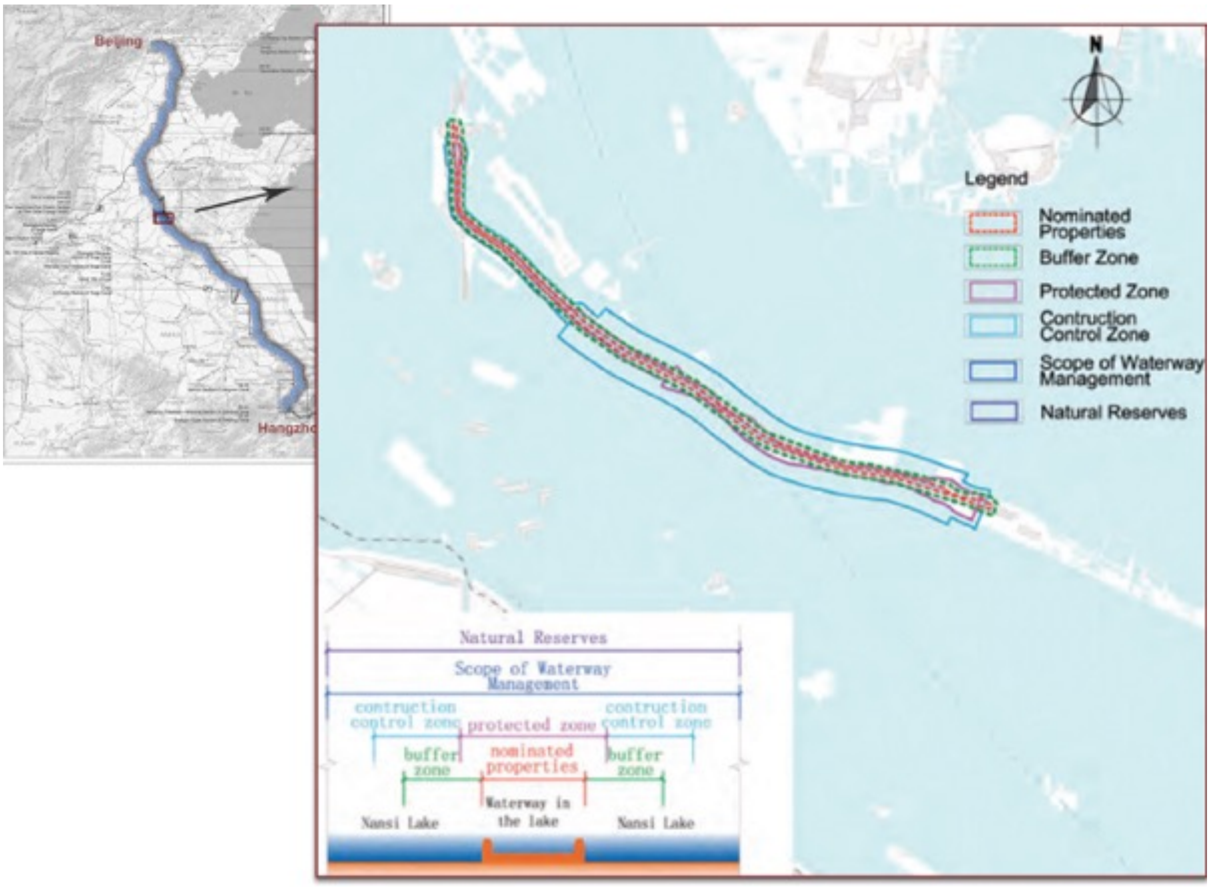

Figure 6.20 The boundary of the nominated area and buffer zone of the Wei Shan section. Source: State Administration of Cultural Heritage of People's Republic of China, p. 659.

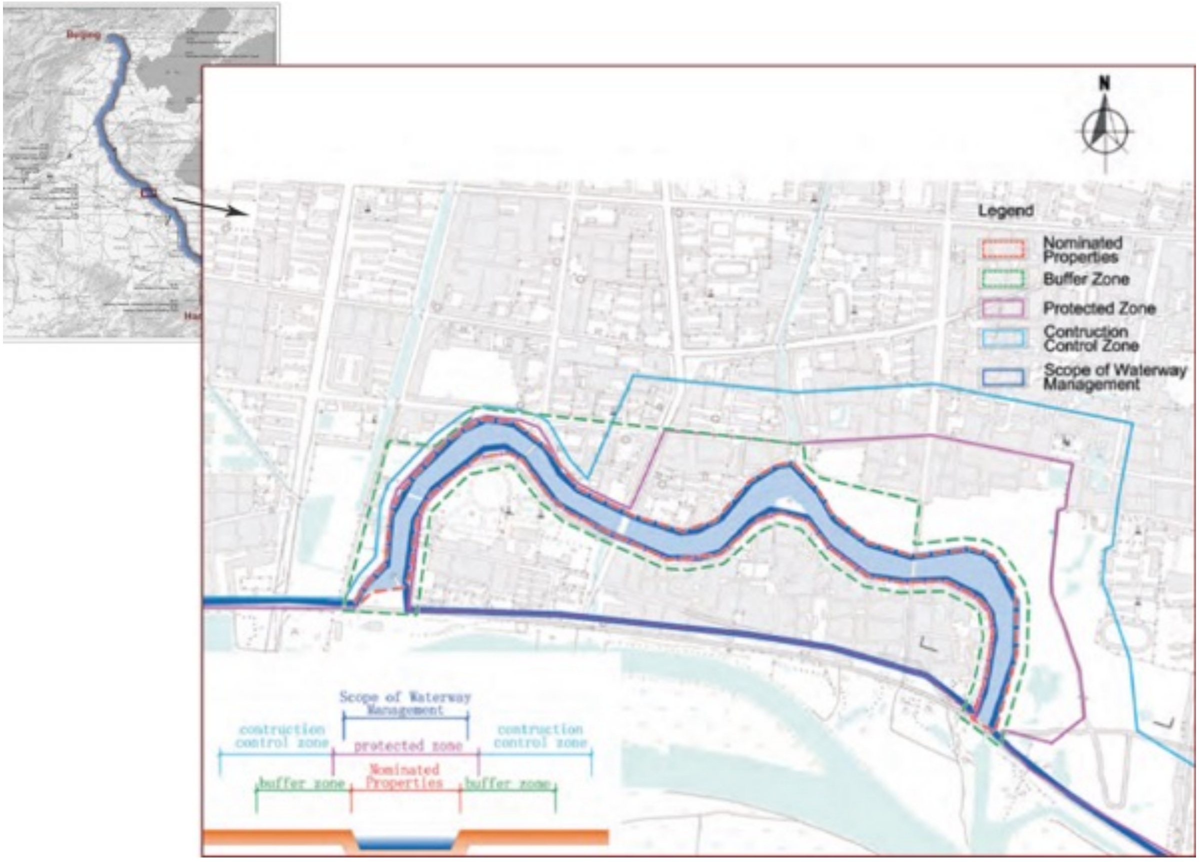

Figure 6. 21 The boundary of the nominated area and buffer zone of the Tai'er Zhuang section of Zhong Canal. Source: State Administration of Cultural Heritage of People's Republic of China, p. 660.

According to the table and maps of the boundaries and buffer zones of the Shandong section, it is clear that the nominated preservation area was often limited to the waterway itself, and to minimal buffer zones along its banks. The landscapes of the wider area around the canal were often excluded and may not be carefully protected. Regarding this issue, ICOMOS has stressed their concern and asked whether the Chinese government could extend the buffer zones to include the 'neighbouring landscape components: paths, tree lining the canal banks, the facades of buildings along the canal'. In responding to that, the State Party extended four buffer zones, including the Lin Qing section in Shandong province (Figure 6.17); the area of the buffer zone of the Lin Qing section was increased from 56 to 152 hectares.[769]

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[769] State Administration of Cultural Heritage of People's Republic of China, Additional Information II, pp. 5-6.

According to the requirements concerning the Outstanding Univerial Value of nominated property, in the Operational Guidelines for the Implementation of the World Heritage Convention (revised in 2015), the Chinese government made a statement of the OUV of the Grand Canal which meets the ICOMOS criteria (i), (iii), (iv) and (vi).[770]

Policy framework

Legislation on the protection of the Grand Canal

The state party has set up the objective for the conservation of the Grand Canal. 'Truly and completely protect the historical information and all the value of the Grand Canal's heritage, continue and promote the vitality of the Grand Canal to play an important role in boosting the harmonious evolution of culture, society, economy and ecology in the heritage sites.'[771]

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[770] Evaluations of Nominations of Cultural and Mixed Properties, ICOMOS report for the World Heritage Committee, 38th Ordinary Session, Doha, June 2014, pp. 117-118. See Chapter One for details of the statement of each criterion.

[771] State Administration of Cultural Heritage of People's Republic of China. Nomination documentation submitted to the World Heritage Convention Cultural Heritage. p 2-c-38

Table 6.2 List of major relevant laws and regulations. Source: State Administration of Cultural Heritage of People's Republic of China, pp. 669-677.

Field	Type	Name	Implementation scope of protective measures	Authority	Time of issue (revise)
Cultural heritage	Laws	Laws of the People's Republic of China on the Protection of Culture Relics	Property area, buffer zone and environment	Standing Committee of the National People's Congress of the People's Republic of China	2007
Water conservancy	Administrative regulations	Regulation for the Implementation of the Law of the People's Republic of China on the Protection of Cultural Relics	Property area, buffer zone	State Council	2003
		Regulations on the Protection of Famous Historical and Cultural Cities, Towns, and Villages			2008
	Departmental regulations	Measures on the Protection and Management of WHS		Ministry of Culture	2006
		Measures for the Administration of the Grand Canal			2012

	Local regulations	Regulations of Shandong Province on the Protection and Management of Cultural Relics		Standing Committee of Shandong Provincial People's Congress	2010
	Laws	Flood Control Law of the People's Republic of China		Standing Committee of the National People's Congress of the P.R. China	2009
		Water Law of the P. R. China			2002
		Water Pollution Prevention and Control law of the P. R. China			2008
	Administrative regulations	Regulation on River Administration of People's Republic of China		State Council	1988
		Flood Control Regulation of the P.R. China			2005
		Hydrology Regulation of the P.R. China			2007
	Departmental regulations	Measures for the Administration of Water Conservancy Scenic Resorts		Ministry of Water Resource	2004

	Local regulations	Measures of Shandong Province for the Implementation of Regulation on River Administration of the P.R. China		People's Government of Shandong Province	2004
Shipping	Administration regulations	Chinese Regulation of on Water Transport		State Council	2012
	Local regulations	Regulations of Shandong Province on the Administration of Shipping Lanes		People's Government of Shandong Province	1999
construction	Administration regulations	Scenic Area Regulations		State Council	2006
Forestry		Regulation of the P.R. China on National Reserves			1994
Others	laws	Environmental Protection Law of the P.R. China		Standing Committee of the National People's Congress of the P.R. China	1989
		Land Administration Law of the P.R. China			2004
		Urban and Rural Planning Law of the P.R. China			2007
		Water and Soil Conservation Law of the P.R. China			2010

	Local regulations	Regulations of Shandong Province on Environmental Protection		People's Government of Shandong Province	2001

To achieve the objective of conserving the canal, various laws and regulations (table 6.2) were made, which aim to protect all the nominated properties and part of the elements within the buffer zones of the Shandong section. It is notable that most of these laws were issued after 2000: the Grand Canal was not legally protected before then. Although the *Laws of the People's Republic of China on the Protection of Cultural Relics* was issued in 1982, and states 'no construction of additional projects or such operation as blasting, drilling or digging may be conducted within the area of protection for a historical and cultural site', and 'where immovable cultural relics are totally damaged, the ruins shall be protected and damaged relics may not be rebuilt on the original site';[772] it did not apply to the canal until the twenty-first century, because none of the canal heritage was then considered a relic.

All the nominated properties of the Shandong section are protected under five main protective designations, China's World Cultural Heritage Tentative List, Important Priority Protected Site, Areas of Waterway Management and Dike Protection, Historical Cities, Towns and Conservations, and Nature Reserves.[773]

The entire Grand Canal was added to China's World Cultural Heritage Tentative List in 2006 and 2012[774] according to the nomination requirements of the Operational Guideline, and to the seventh batch of Important Priority Protected Sites in 2013.[775] As a heritage site on the Tentative List, the Shandong section is protected and managed according to *Measures on the Protection and Management of World Cultural Heritage* (2006) issued by the ministry of

[772] Laws of the People's Republic of China on the Protection of the Cultural Relics, Article 17.
[773] State Administration of Cultural Heritage of People's Republic of China, p. 602.
[774] An updated World Cultural Heritage Tentative List was issued in 2012, which is why the Grand Canal was added to the list twice.
[775] State Administration of Cultural Heritage of People's Republic of China, p. 603.

Culture, and *Administrative Measures for the Monitoring and Inspection of World Cultural Heritage* issued by SACH in the same year.[776] As a Priority Protected Site the Shandong section is protected under the *Law of the People's Republic China on the Protection of the Cultural Relics*.[777]

The waterway management and dyke protection of the Shandong section is covered by the regulation on *River Administration of the People's Republic of China* issued in 1988, and *Measures of Shandong Province for the Implementation of Regulation on River Administration of the People's Republic of China* (revised in 2004),[778] which outline specific measures to strengthen river management, flood control and safety.[779]

The *River Administration* regulation states that 'waterway authorities should delimit a dyke protection area in proximity to the area of waterway management, according to the degree of importance of the dyke, and the soil condition of its foundations. Within the dyke protection area, activities that endanger the safety of the dyke are prohibited, such as well digging, drilling, blasting, fish pond digging and building, quarrying, earth removal and so on.'[780] The *Implementation Measures of the Shandong Province* says that the dyke of the Shandong section of the canal is under the administration of the local people's government, together with provincial river management administration or designated waterway authorities. Any construction must be approved by local river management administrations before it is carried out.[781]

The historic cities, towns and villages along the Grand Canal are protected under the

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776 State Administration of Cultural Heritage of People's Republic of China, p. 602.
777 Ibid., p. 615.
778 Ibid., pp. 616-617.
779 Measures of Shandong Province for the Implementation of Regulation on River Administration of the People's Republic of China (revised in 2004), Chapter 1, http://www.chinalaw.gov.cn/article/fgkd/xfg/dfzfgz/200504/20050400012748.shtml [accessed 1 August 2016]
780 State Administration of Cultural Heritage of People's Republic of China, p. 616.
781 Measures of Shandong Province for the Implementation of Regulation on River Administration of the People's Republic of China (revised in 2004), Chapter 2, http://www.chinalaw.gov.cn/article/fgkd/xfg/dfzfgz/200504/20050400012748.shtml [accessed 1 August 2016]

Regulations on the Protection of Famous Historical and Cultural Cities, Towns, Villages and Conservation Areas issued in 2008. This ensures the highest degree of national protection. However, this only applies to the four national historic cities, one conservation area and one historic town crossed by the canal, all of them located in southern China,[782] so this law does not directly protect the towns and settlements of the Shandong section.

With respect to nature reserves, Shandong has one provincial level Natural Reserve, Nan Si Hu in Wei Shan county.[783] It is protected under the *Regulations of the People's Republic of China on Natural Reserves* (1994).[784] The Nansihu Provincial Natural Reserve Management Bureau of Jining city is in charge of its protection. Their duties include the management of the reserve and the delivery of duties and responsibilities in accordance with national laws and regulations, such as the *Environmental Protection Law of the People's Republic of China*.[785]

Apart from these five designations on the protection of the Grand Canal, there are also specific policies that apply directly to canal heritage. In 2008 an advanced protection plan for cultural heritage was issued, and by 2012 this document, the *Joint Agreement for the Protection of the Grand Canal*, had been signed by all the local governments concerned. It sets out the basis for cooperation between the cities.[786] The *Administrative Measures for the Conservation of Grand Canal Heritage* (2012) were issued to regulate the utilization of the Grand Canal's heritage, aiming to strengthen its conservation.[787]

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[782] State Administration of Cultural Heritage of People's Republic of China, p. 618.
[783] Ibid., p. 620.
[784] Ibid.
[785] Ibid., p. 667.
[786] Evaluations of Nominations of Cultural and Mixed Properties, ICOMOS report for the World Heritage Committee, p. 120.
[787] Administrative Measures for the Conservation of Grand Canal Heritage, Article 1.

Guidance on the preservation of the Shandong section

Principles for the Conservation of Heritage Sites in China were issued in 2002 by China ICOMOS, which provides guidelines for the conservation of Chinese heritage sites. It shares unified ideas and concepts about heritage preservation with international ICOMOS charters, which ensures that heritage sites are protected in a more appropriate way.

Guidance for Protection and Coordinated Management of the Surrounding Landscape of the Grand Canal was issued in 2013 to preserve the surrounding landscape of all the nominated properties of the canal. It classifies the landscape of the canal into four main types, historical city, modern city, rural area and natural environment. The Shandong section includes examples of all of these (Table 6.3).[788]

Table 6. 3 The surrounding landscape type of the Shandong section. Source: State Administration of Cultural Heritage of People's Republic of China, Additional Information II, p. 49.

Component Part	Historical city	Modern city	Rural area	Natural en-vironment
Cangzhou-Hengshui-Dezhou Section of Nan Canal	—	—	▲	—
Linqing Section of Huitong Canal	▲	—	—	—
Yanggu Section of Huitong Canal	—	△	▲	—
Nanwang Complex	—	△	▲	—
Weishan Section of Huitong Canal	—	—	△	▲
Taierzhuang Section of Zhong Canal	▲	△	—	—

Relevancy of surrounding landscape types:
▲ Dominant △ Related — Unrelated

[788] State Administration of Cultural Heritage of People's Republic of China, Additional Information II, pp. 45-46.

Historical city type landscape

This designation applies to the Linqing and Tai'er Zhuang sections of the Shandong section. The guidance says that the traditional characteristics of this type of landscape should be preserved, and that the greening along the canal should be improved based on traditional features, that the existing historical architecture should be preserved, and that buildings which are not in harmony with historical cities should be renovated to have the appearance of traditional architecture. This leaves questions about whether existing buildings should be rebuilt to have a traditional appearance, and the effect this would have on the reality and perceptions of authenticity.

Table 6.4 Details of the guidance for preserving historical city-type surrounding landscape. Source: State Administration of Cultural Heritage of People's Republic of China. Additional Information II, p. 51.

Landscape characteristic		Key points for protection and coordination
Spatial characteristics	Spatial layout	Protect the spatial layout of historical cities that were built and developed based on the Canal (the Canal goes through or around the cities); conserve the unique spatial layout of historical cities; preserve and pass on the interaction between the Canal and traditional habitat.
	Height and profile	Conserve the spatial size, height and profile of historical cities; preserve smooth view corridors; restrict building heights to no more than two stories (except traditional landmark buildings such as towers and pavilions).
	Road and transport	On the basis of preserving traditional street and lane system, firefighting passages and a few static transport spaces may be appropriately added to improve the transport along the Canal; traditional stone slabs, grey bricks and cobble stone pavements of streets and lanes shall be protected and preserved.
Landscape feature	Landscape diversity	Protection of the rich landscape effect consisting of the Canal, historical architecture (structures), trees and human activities.
	Landscape corridor	Preserve smooth view corridor and harmonious landscape along the Canal.
	Greening	Improve greening along the Canal according to traditional forms; add greenery, pot plants, flowers and trees where it is possible.
	Public service facilities	Add signage system, artistic landscape creations and public artworks to interpret and promote the Grand Canal; urban facilities and advertisement shall be harmonious with the historical and modern features of the city and the Canal; illumination shall add ancient and elegant instead of a bustling sense.
Architectural appearance	Protective buildings	Heritage buildings and historical buildings shall be protected in line with laws and regulations; appearance, main layout and structures of traditional buildings shall be protected. Focus shall be put on protection and utilization of industrial heritage along the canal.
	Existing buildings	Existing buildings in harmony with historical cities shall be preserved, otherwise be renovated by means of reducing the stories, and adjusting the colors and materials; illegal buildings and added buildings that impair original layout and spatial appearance of the city shall be demolished.
	Building appearance	Layout, height and size of traditional buildings shall be preserved; buildings in northern China shall be mainly one-story gable roofed and partially flat-roofed, and in southern China be mainly two-story gable roofed.
	Architectural characteristics	Architectural characteristics of traditional buildings shall be preserved, with priority given to the characteristics of canal-side residential ensembles, as well as regional and ethnic characteristics.

Modern city type landscape

The modern city type landscape is exemplified by the Yang Gu, Nan Wang and Tai'er Zhuang section. The guidance says that on the canal-side area, the buildings should gradually become smaller as they come closer to the bank, to create a gradually fading skyline. Ecological corridors should be created with the canal as the centre and greenery on both sides. And existing buildings that do not harmonise with local architectural styles and the surroundings should be renovated; new buildings should follow local architectural style.[789]

[789] State Administration of Cultural Heritage of People's Republic of China. Additional Information II, p. 52.

Table 6.5 The details of the guidance for preserving the modern city type surrounding landscape. Source: State Administration of Cultural Heritage of People's Republic of China. Additional Information II, p. 52.

Landscape characteristic		Key points for protection and coordination
Spatial characteristics	Height and profile	Buildings shall be gradually smaller to the bank, to create a gradually fading skyline with rich profile. Modern cities can be more flexible with building heights; while in towns, buildings along Canal shall be mainly restricted to two stories, and three stories in certain places.
	Road and transport	Focus shall be put on construction of low-speed transport system along the Canal by integrating canal-side walkways and bicycle lanes into urban transport system, while improving accessibility of urban trunk roads and byways to canal-side greenery and public areas, and considering the demands on the grade and width of road systems in cities of different sizes. Low-speed transport roads shall be paved as per local traditions.
	Spatial points	Traditional cultural landscape elements such as ports and bridges may be integrated into modern urban layout to create new public areas where modern people's participating consciousness and interaction is highlighted along the Canal.
Landscape feature	Ecological corridor	Ecological corridors shall be formed with the waterway as the center and greenery system on both sides, and smooth canal-side view corridor shall be preserved. Ecological corridors shall focus on preservation and protection of traditional two- or three-storied residences along the Canal.
	Greening and urban greenery system	Canal-side greeneries shall be integrated and renovated in consideration of the ecological requirement of plants and their important roles in improving modern urban ecology. According to functions and social benefits of greeneries, the relationship between canal-side green spaces and leisure spaces shall be integrated; local varieties shall be the main plants to make use of their seasonal characteristics to present all-season landscape along the Canal.
	Public service facilities	Signage system, artistic landscape creations and public artworks shall be added to the canal-side low-speed transport system and public area to interpret and promote the Grand Canal. Public facilities shall present elements and signs of the Grand Canal and be in harmony with the historical and modern attributes of the city and the Grand Canal.
Architectural appearance	Existing buildings	Illegal buildings and added buildings (structures) shall be demolished. Existing buildings with inharmonious appearances shall be renovated by means of local architectural styles and elements to make them harmonious with the surroundings and appearance of the Canal.
	Building appearance	New buildings shall follow and carry forward local architectural style in terms of size, material, form and color, and give priority to traditional elements and signs.
	Architectural characteristics	Features of traditional canal-side residential ensembles shall be studied and incorporated into design of the size and functions of new buildings to present the architectural, regional and ethnic characteristics in a new era.

Rural area type landscape

The De Zhou, Yang Gu and Nan Wang section have a rural type surrounding landscape. The Guidance for this kind of landscape focuses on the construction and land use of traditional villages, vernacular buildings and rural eco-systems which say that the layout, spatial size, profile, landscape and historical buildings of canal-side villages should be preserved. The canal-side greenery natural ecological environment should be improved, and vernacular architectural characteristics should be preserved, with priority to be given to the canal-side residential ensembles.[790]

It says that 'illegal and added buildings' should be demolished,[791] but these can be hard to identify with certainty: it is a commonplace that forming the spatial layout of a rural area is a spontaneously process that is not like urban housing planning. All the houses that have been built are part of the formation of a village's local culture and dwelling characteristics, and should not be seen as illegal or added buildings. If a house is defined as 'illegal' because it is built within the heritage preservation zone, it should be seen as part of the evolution of the local residential layout, and should not be demolished. If it has a negative impact on the preservation of heritage, a more appropriate approach needs to be found to both protect both the characteristics of local dwellings and the heritage of the Grand Canal.

[790] State Administration of Cultural Heritage of People's Republic of China. Additional Information II, p. 53.
[791] Ibid.

Table 6.6 Details of the guidance for preserving rural area type surrounding landscape. Source: State Administration of Cultural Heritage of People's Republic of China. Additional Information II, p53.

Landscape characteristic		Key points for protection and coordination
Spatial character-istics	Spatial layout	The layout of canal-side villages shall be protected to preserve and pass on the interaction between the Canal and traditional residential ensembles; the environment and quality of traditional villages shall be improved via the "building beautiful rural area" project and by inheriting and developing traditional village characteristics.
	Height and profile	Conserve the spatial size, height and profile of traditional villages; maintain smooth view corridors; buildings are restricted to no more than two stories (except traditional landmark buildings such as towers and pavilions) .
	Road and transport	On the basis of preserving traditional village layout, firefighting passag-es and a few static transport spaces may be added in combination with dike-based low-speed transport system to improve the accessibility of transport along the Canal; traditional pavements shall be applied; gravel roads may be paved in farmlands.
	Spatial points	Traditional public areas such as ports, ferries, village entrances, bridges, banks and wells shall be protected.
Land-scape feature	Landscape diversity	The rich landscape effect contributed by the Canal, villages, farmlands, trees and people, as well as traditional farmlands shall be protected.
	Landscape corridor	Maintain smooth view corridor and harmonious landscape along the Canal.
	Greening	Based on existing greenery, canal-side greenery shall be improved ac-cording to traditional greening styles. Original natural ecological envi-ronment shall be preserved; regional gene shall be highlighted; regional and local plants shall be selected as the main variety.
	Public service facilities	Signage system and artistic landscape creations shall be added to interpret and promote the property; leisure facilities shall be in harmony with the historical and modern characteristics of local villages and the Canal.
Architec-tural ap-pearance	Protective buildings	Heritage buildings and historical buildings shall be protected in line with laws and regulations; appearance, major layout and structures of traditional buildings shall be protected.
	Existing buildings	Existing buildings in harmony with traditional villages shall be pre-served, otherwise be renovated by means of reducing the stories, and adjusting the colors and materials; illegal buildings and added buildings shall be demolished.
	Building ap-pearance	The layout, height and size of traditional buildings shall be preserved. Buildings in northern China shall be mainly one-storied and restricted to no more than two stories, and in southern China be mainly two-storied and restricted to no more than three stories.
	Architectural characteristics	Architectural characteristics of vernacular buildings shall be preserved, with priority given to the characteristics of canal-side residential en-sembles, regional and ethnic characteristics.

Natural environment type landscape

Only the Wei Shan section has a natural environment type landscape. The guidance focuses on the protection of eco-systems with distinctive natural characteristics, interpretation of the relation between the Grand Canal and mountains and waters, and preservation of the habitats of wild animals. The guidelines are shown Table 6.7 below.

Table 6.7 Details of the guidance for preserving natural environment type surrounding landscape. Source: State Administration of Cultural Heritage of People's Republic of China. Additional Information II, p. 54.

Landscape characteristic		Key points for protection and coordination
Spatial characteristics	Spatial layout	The complete mountain and water spatial layout, the form of natural waterway and waterway slopes, and the relationship between the Grand Canal and other rivers and lakes shall be protected.
	Height and profile	The canal-side landscape and skyline composed of mountains and trees shall be protected.
	Road and transport	Dikes may be used as walkways paved with simply processed gravels.
Landscape feature	Landscape diversity	The land ecological landscape and wetland system constituted by the Canal and mountains and waters, as well as the biodiversity shall be protected.
	Landscape corridor	The smooth canal-side view corridor shall be preserved; the spatial interaction between the Canal and the mountains and waters shall be protected.
	Greening	Primary greening styles, famous trees and rare plants shall be protected; urbanization and gardening approaches shall be prevented.
Architectural appearance		Constructions are prohibited except those related to conservation and presentation of the component parts of the Grand Canal; conservation and presentation projects shall abide by the minimal intervention principle; building style and appearance shall be in harmony with the property and natural environment; buildings shall be as small in size as possible and materials shall mainly be natural such as wood, bamboo and straw; height of buildings shall be restricted to one story.

Management plan

The objectives of the Management Plan are to 'truly and completely protect and continue the OUV of the Grand Canal, extend and enhance the vitality of the Grand Canal, and promote recognition. Preservation and transmission of the heritage value so as to enable it to play an important role in boosting the harmonious evolution of culture, society, economy and ecology in the heritage sites.'[792] It contains a General Master Plan (2012-2030) and a Management Plan for components parts.[793]

The key contents of the Management Plan include the identification of the characteristics of the OUV of the canal. It sets the principles and the general vision for the OUV's protection and conservation, and aims to improve the planning of measures to be taken according to the conservation objectives of the Grand Canal. It also sets out principles for delimiting the boundaries of nominated properties and buffer zones for World Heritage nomination. For example when it delimits the boundary of a waterway with embankment it says, 'go along the outboard toe line of the dyke, the property area is a strip-shaped area including the river bed, river beach, levee crest and levee slopes.'[794]

The main strategy of the Management Plan is to protect the nominated properties of the Grand Canal effectively by adopting preservation and management systems at all administrative levels, and to set up the preservation system focusing on the OUV of the canal.[795] This has been developed through the utilization plans and interpretation and presentation plans. The utilization plan focuses on the reasonable use and continuity of heritage values; and the interpretation and presentation plan concentrates on the sustainability and integrity of the Grand Canal.[796]

[792] State Administration of Cultural Heritage of People's Republic of China, p. 715.
[793] Ibid.
[794] Ibid., p. 714.
[795] Ibid., p. 716.
[796] Ibid.

The Management Plan outlines rules on the preservation of nominated properties and areas within the buffer zones. In the property protection areas, behaviours such as 'construction, explosion, borehole surveying or excavation', 'construction of facilities that pollute the Grand Canal and its environment', and 'activities that have a potential impact on the safety of the Grand Canal' are prohibited. And historic remains or other heritage site must not be damaged or removed.[797]

In the management rules on areas within the buffer zones, there are prohibitions on constructions that damage the historical setting and spatial landscape of the canal, or are inharmonious in style, size and colour. They say that land within buffer zones which is wanted for construction must be included in local master plans and annual plans for land use.[798]

On protecting heritage elements, the Plan is set out in the *Law of the People's Republic of China on the Protection of Cultural Relics*, and includes rules such as 'not altering the original state'. It says that 'utilization function of canal-related elements shall be combined with their OUV', and 'original physical, spatial and cultural association between canal-related elements and waterways shall be protected'.[799]

Monitoring

The monitoring of the Grand Canal conservation is focused on four categories: the physical fabrics; factors affecting the conservation; conservation and management exercises; and security.[800] The plan of establishing the Grand Canal Heritage Monitoring and Archive Centre was also made in 2012, which aims to carry out monitoring work to all the Grand Canal property areas. However, this plan of setting up the Centre, together with 41 local

797 State Administration of Cultural Heritage of People's Republic of China, pp. 716-717.
798 Ibid., p. 717.
799 Ibid., pp. 718-719.
800 Ibid., p. 759.

agencies, will not be carried out until 2015.[801]

International context: ICOMOS Charters

The Venice Charter was issued at the Second International Congress of Architects and Technicians of Historic Monuments held in Venice in 1964, and provided guidelines for the conservation and restoration of monuments and sites. It defines the concept of the historical monument as 'not only the sing le architectural work but also the urban or rural setting in which is found the evidence of a particular civilization, a significant development or a historic event', and it applies 'not only to great works of art but also to more modest works of the past which have acquired cultural significance with the passing of time'.[802] The Grand Canal, a traditional inland waterway with large numbers of heritage components, is covered by the Venice Charter, and its preservation should follow the guidelines. It says in the Charter that the sites of monuments must be taken special care of, in order to safeguard their integrity and ensure 'they are cleared and presented in a seemly manner'.[803]

As well as the Venice Charter, which provides guidelines for historical monuments and site conservation, guidance for the conservation of historical towns and urban areas was also made in 1987, and is usually referred to as the Washington Charter. As shown in Table 6.3, the canal-side areas of two cities along the Shandong section, Linqing and Tai'er Zhuang, are classified as historical city, so their conservation plan should take the Washington Charter as a reference.

Assessment of the conservation of the Shandong section

Various laws and plans have covered all necessary aspects of the Grand Canal's protection, reflecting the aim to meet conservation objectives, and develop the OUV of the canal. This

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801 State Administration of Cultural Heritage of People's Republic of China, Annex III, pp. 41-42.
802 ICOMOS, International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter 1964). Definition, Article 1.
803 Ibid., Historical Sites, Article 14.

effort has contributed to the significant improvement in the canal's pollution levels, which were very bad before the canal was legally protected. Pollutants such as household garbage and industrial sewage are now strictly forbidden, but as this policy only applies to the nominated sections, many of the ordinary sections are still very polluted (Figure 6.22).

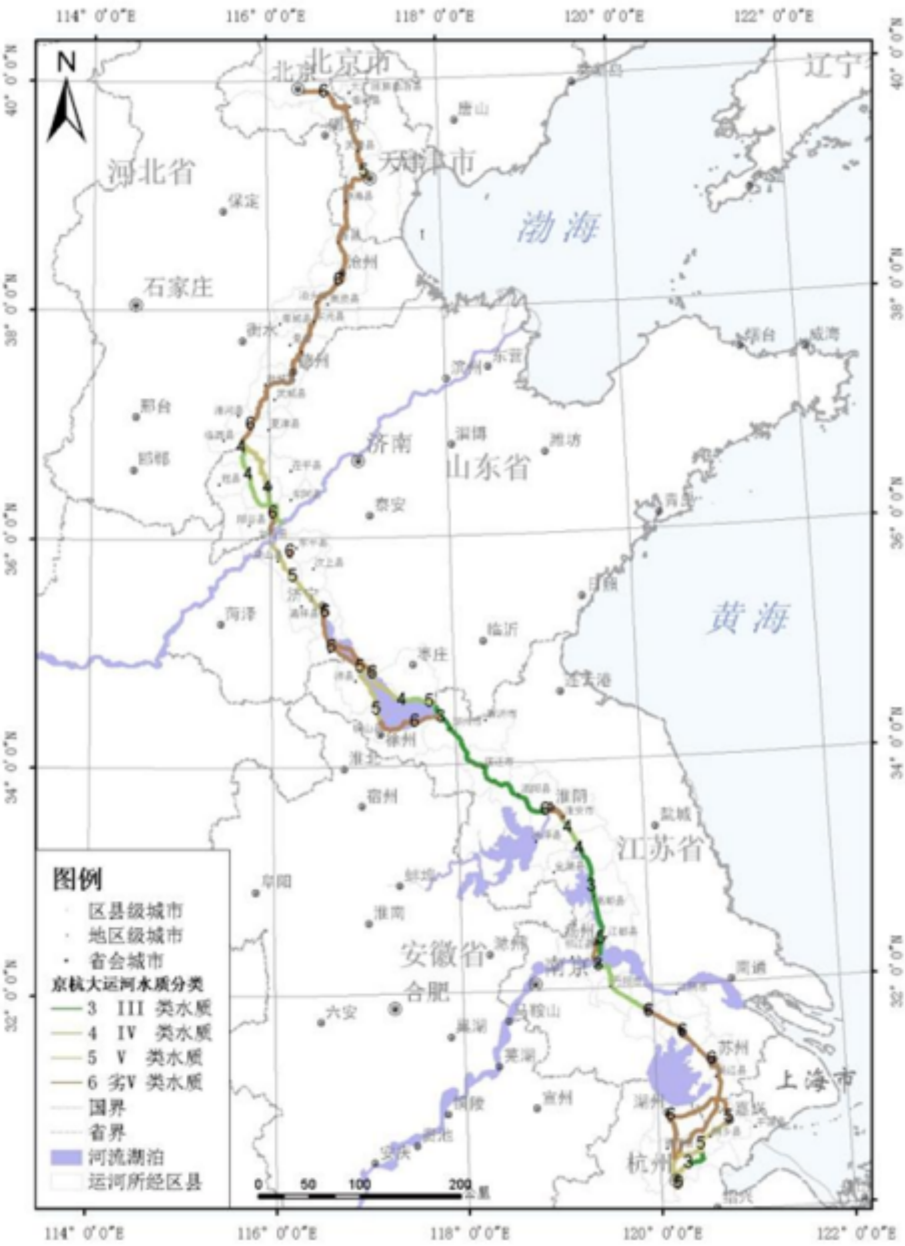

Figure 6.22 This map shows the water quality of the Grand Canal in 2004. Numbers from 3 to 6 relate to the level of pollution; the higher the number, the more polluted the water is. It can be seen that the water quality of this section of the canal was at a very bad level. Source: Yu, p. 31.

Figure 6.23 The photograph taken by the author shows the badly polluted water of the Zhang Qiu section of the canal. This section has not been navigable since the 1960s, and is now only used for the discharge of water. The pollution is not controlled here because this section is not included amongst the nomination properties.

Inadequate buffer zones

There are other problems with the policies. The most serious of these is that the buffer zones for controlling the construction pressure are often too small. The Management Plan of the Grand Canal establishes the principle of setting buffer zones 30 metres outwards from the boundaries of the waterway in areas of dense building, 80 metres in the suburbs and rural areas, and 300 metres on farm land and large areas of water.[804] These buffer zones could only cover a very small area, especially important because only properties within the buffer zones are legally protected. The ordinary sections of the canal which do not have specific attributions are not protected in the same way as the historic sections; except for the canal's

804 State Administration of Cultural Heritage of People's Republic of China, p. 2-a-21.

banks, all the other elements such as footpaths and trees are not protected by the current buffer zones.[805]

This has happened partly because of the difficulties the State Administration of Cultural Heritage encountered when making protection plans for World Heritage nomination. As mentioned above, the section south to Ji Qing is still in use, mainly for coal transportation, and the entire canal route is utilized to transfer water for the south-north water transfer project. The various relevant authorities, including the Department of Transportation and the South-North Water Transfer Office, would like the protection area and as the conservation work to have as little impact on their utilization of the canal as possible.[806]

The ICOMOS also concerned about this issue and have requested the state party to extend the buffer zones of the Grand Canal heritage.[807] In responding to this, the extension of buffer zones for four components parts, which are the Lin Qing, Wu Xi city, Shang Qiu Nan Guan section of the canal, and the site of Li Yang Granary, were completed to include a larger area of neighboring landscape.[808] However, the extension of only four buffer zones could not effectively improve the situation, and this gap in the policies allows the possibility for construction plans to be carried out near the Grand Canal waterway, a matter for concern. Even though the various laws have attempted to cover all aspects of the canal's heritage conservation, its small protection boundary makes it impossible to control the development pressures around the canal.

805 Evaluations of Nominations of Cultural and Mixed Properties, ICOMOS report for the World Heritage Committee, p. 120.
806 Liu Huan, 'Jing Hang Da Yun He Shen Yi Yin Fen Qi: Wen Hua Yi Chan Hai Shi Nei He Hang Yun (The Conflicts of the Nomination of the Grand Canal: the Cultural Heritage or Inland Waterway?)', *Chinese News* E-news, 22 August 2012. http://www.chinanews.com/cul/2012/08-22/4125165.shtml [accessed 23 July 2016]
807 State Administration of Cultural Heritage of People's Republic of China, Additional Information II, p. 005.
808 Ibid., p. 006.

Over developed heritage tourism

The narrow buffer zones have contributed to the over developed heritage tourism along the Shandong section, because local governments have attempted to take advantage of this weakness in the policy in order to fulfil their private interests. Large numbers of fake heritage sites have been built around the canal to attract tourists, so as to increase local revenue. A good example of this is the Tai'er Zhuang replica town.

The Tai'er Zhuang section has an updated modern waterway which serves as a coal transport route, as well as an old course which dropped out of the canal route when a new straighter route was formed after 1959. Because it is not used as a navigation waterway, this section has not undergone large-scale modernization and construction, and has kept its twelve old docks and a 200 metre long stone embankment.[809]

The replica town was located along this old course, whose heritage became one of the main selling points of this project. Its promoters say that this town is 'the living fossil of Grand Canal culture'.[810] However, the truth is that apart from this old watercourse, most of the attractions on this 2 kilometres hectare area are newly built, including the ancient-looking architecture and streets, as well as the water-related facilities. It is said that it aims to reproduce the real appearance of this old town, which flourished during the heyday of the Grand Canal, but declined with the dereliction of canal in the early twentieth century and was further damaged in the war with Japan in 1938.[811]

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809 The compilation Committee of Annals of Zaozhuang. *Zaozhuang Shi Zhi (Annals of Zao Zhuang)* (Beijing: Zhong Hua Shu Ju, 1993) <http://lib.sdsqw.cn/bin/mse.exe?seachword=&K=b4&A=2&rec=694&run=13> [accessed 17 May 2016]

810 Unknown, '*Zhong Hua Gu Shui Cheng Ying Xiong Tai Er Zhuang* (The Historical Waterside Town, the Hero Tai'er Zhuang)', *Official Website of the Tai'er Zhuang Town* (undated) <http://www.tezgc.com/dmgc/txdyz/detail2015-03-01-1.html> [17 May 2016] (para. 2).

811 Ibid. (para.8)

Figure 6.24 The aerial photo shows the Tai'er Zhuang replica town and the contrast between it and the surrounding landscape. All the ancient looking buildings with black roofs are newly built to develop heritage tourism, and more buildings under construction can be seen on the left side of the picture. Source: State Administration of Cultural Heritage of People's Republic of China, p. 312.

Figure 6.25 The two photographs show how the Tai'er Zhuang town looked during the 1930s (above) and how it looks now that it has been reconstructed (below). The ancient-looking architecture was built on a site which was originally a residential area, and the buildings are intended to be let as commercial shops to cover the investment in this project; many of the shops are still not rented out now. Source: the photo above is from the Committee of the Exhibition Hall at the Tai'er Zhuang Ancient Town, and the one below is from Baidu website <http://d.hiphotos.baidu.com/baike/c0%3Dbaike220%2C5%2C5%2C220%2C73/sign=2a1032a10efa513d45a7648c5c043e9e/6159252dd42a28348f0491765db5c9ea15cebf29.jpg> [accessed 30 May 2016]

Tai'er Zhuang claims to represent an authentic ancient canal-side town, but its developers removed almost all the local residential houses and shops located within the construction boundary, in order to free the land for new building.[812] For just the second phase of the project, 1200 households including 3860 people were relocated to other areas. The freed land was then covered with various commercial shops of an ancient appearance. This so called 'living fossil' does not have any residents, only commercial shops and attractions, a paradoxical contradiction of its promotional concept. It is also inconsistent with many

[812] Land in China is either state-owned or collectively-owned (see Appendix 2). Individuals do not have the ownership of any lands, which makes it easy for authorities to claim the land back and use for other purposes.

conservation guidelines. In the Washington Charter it says that a conservation plan should have the consent of the residents of a historic area.[813] The *Guidance for Protection and Coordinated Management of the Surrounding Landscape of the Grand Canal* says that the layout, spatial size, profile, landscape and historical buildings of canal-side villages should be preserved.[814]

Figure 6.26 This photo taken by the author shows the current condition of one of the local villages, Xing long, after the residents were forced to moved out on the order of the local construction committee. It is going to be rebuilt as an attraction showing the trackers' culture of the Grand Canal, as it is said that all the villagers here worked as trackers along the canal in the past. The name of the village has been changed to Qian Fu (trackers) Village, to try and emphasize this, but without local residents, it is hard to imagine how it is going to show the culture. It is uncertain, too, whether this village was really formed by trackers.

Another selling point of this town is its multicultural environment, reflected in eight architectural features of both western and eastern style on its buildings. This claim is based

[813] ICOMOS, Charter for the Conservation of Historical Towns and Urban Areas (Washington Charter 1987). Methods and Instruments, Article 5 and 9.
[814] State Administration of Cultural Heritage of People's Republic of China. Additional Information II, p. 53.

on various historical research projects, according to the local authority. But the large numbers of shops at the entrance to the town have been rebuilt in a *Hui* architectural style,[815] which should be very rare in a northern Chinese town. It is true that the Tai'er Zhuang section sits at the junction point between the northern and southern sections of the Grand Canal, making it a more multicultural town than others, something which might well have been evident in its architecture. However, it is highly unlikely that all these different architectural styles would be present in the same period within a 2,000 square metre area. Not really a multicultural town, it is more like a Disneyland for tourists.

Figure 6.27 This aerial photo shows the inharmonious relationship between the newly built replica town area and the original town area. The guidelines in the Washington Charter say, 'the conservation plan should aim at ensuring a harmonious relationship between the historical urban area and the town as a whole'. Source: Yan Yu (photographer), 'zhou you qi lu man you tai'er Zhuang (travel around Qilu and Tai'er Zhuang)', *The People's Website* (2015): <http://tour.dzwww.com/lvnews/201505/t20150512_12365457.htm> [accessed 10th June 2016]

[815] 徽派 (Hui style) architecture is an ancient Chinese architectural feature, of which the most typical look is the grey-tile and white-walled. Hui is short for Huizhou, which is a historical region in the south-eastern China.

Figure 6.28 One section of the waterside landscape in Tai'er Zhuang ancient town. All the ancient looking buildings are newly built, and it is obvious that it has been deliberately made in a southern Chinese landscape style which has always been popular in northern China. Source: *Baidu Webasite* (undated) http://www.eztravel.com.tw/img/pm/FRN/FRN0000011256D07.gif [accessed 1 June 2016]

Figure 6.29 The two photos show how one of the docks inside the town looked (left) before the 'ancient' town was built, and how it looks now (right). It can be seen that few modifications have been made.

According to the local authority, the stones used to repair the docks were from local villagers who took the stones before the docks became recognised as heritage. Source: photo on the left is from a local politician, photo on the right was taken by author in winter 2014.

Figure 6.30 The two photos show how one of the lanes looked before and after the town was reconstructed. The lane has lost its original beauty, as artificial components have been added in an attempt to emphasize its historical appearance. Source: photo on the left is from local politician, photo on the right is from 'Dream Searching in the Tai'er Zhuang Town', *Sina Blog* (2013) <http://blog.sina.com.cn/s/blog_4a8b547a0102ebpt.html> [accessed 1 June 2016]

Figure 6.31 This photo by the author shows the original embankment of the Grand Canal in the replica town. Although this is one of the few pieces of original heritage, because of the uneven development of different zones and its relatively distant location, only very few tourists come to or even know about this area, compared to the main commercial streets.

The very small amount of real heritage which remains includes the residential houses which survived the war of 1938, twelve docks and a 200 metres long original stone embankment. Many of them have been added to the national heritage relics list, and they have been carefully separated from other attractions, in order to protect them. There is a strong contrast between these authentic relics and the other, newly built and perfect looking structures. It raises the question of whether it was necessary to build the new attractions.

Figure 6.32 This photo by the author shows two residential houses that survived the war against Japan in 1938. They show a typical northern vernacular architecture and are built with black brick. This tells us that they might have been owned by middle class people. Now they are carefully protected with a boundary, and are separated from the other attractions.

It is not hard to notice that the purpose of reconstructing the replica town was to improve the local economy. This is mentioned in almost all the news reports about this project. Tai'er Zhuang is one of the districts of Zao Zhuang city, of which the mainstay industry has been coal mining. However, because of over mining, the resources of Zao Zhuang have been exhausted. A new mainstay industry is to be created, and the development of tourism is one of the options, though there are no well-known attractions in this area. With the Grand Canal being prepared for WHS designation, the local authority discovered an opportunity to develop heritage tourism to increase local income, and set up the goal of receiving two million tourists in 2012.[816]

It is not so easy to improve the economy, though, and the company who made the investment is struggling to recover the four hundred million yuan that was spent. To make it up, apart from the numerous commercial shops, the price of tickets was set high, at 180 yuan for a day visit and 100 yuan for the night.[817]

According to the local authority, the architectural features originally from other regions were built by their local craftsmen and local materials, keeping the true traditional techniques and features. It is hard to find out how true this is, but at least it shows a level of awareness of authenticity. It cannot change the fact that the Tai'er Zhuang replica town is a tool for the local authority to increase its revenue rather than an example of heritage conservation.

Excessive numbers of archaeological excavations

The current conservation policy has encouraged conducting as many archaeological excavations as possible, in order to collect data of all the unearthed heritage of the canal.[818] This was done for the purpose of World Heritage nomination, and has resulted in the remarkable increase in the number of excavations related to the canal, especially those of its remains which survive underground. The intention is to contribute to the volume of heritage exemplars associated with the canal.

Among the 21 archaeological excavation reports on the heritage sites of the Grand Canal that had been discovered before 2012, including the discovery of the Nan Wang complex of the

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816 Guo Liping, 'Tai Er Zhuang Gu Cheng Nie Pan Chong Sheng (The Rebirth of the Tai'er Zhuang Ancient Town)', *Time-weekly E-news*, 1 November 2012. <http://www.time-weekly.com/story/2012-11-01/127572.html >[accessed 31 May 2016]

817 The tickets booking information from the Tai'er Zhuang Town official website. http://www.tezgc.com/ydzx/pwyd.html [accessed 10 May 2016]

818 State Administration of Cultural Heritage of People's Republic of China, p. 762.

Shandon section, 19 were carried out after 2005. And new archaeological excavations are still going on.[819] As most of the original features of the canal had long gone by the time it was nominated as WHS, the state government attempted to increase the appearance of its historical significance for the nomination by discovering more heritage underground.

Unfortunately the policy of seeking out more heritage underground has had a negative impact on the conservation of the Grand Canal. Some of the work was not carried out carefully, and it put the excavated sites at risk of deterioration or intrusion.[820] A good example of this is the Qi Ji dock, located in the Yang Gu section of the Grand Canal. It was discovered in 2011, by the Archaeological Institute of Shandong Province and the Department of Cultural Heritage of Liaocheng city. The main discovery of the excavation was its original stone stairs, which was said to be built in 1745.[821]

However, after the site was excavated, the original stone stairs were left totally exposed, no sign of any caring job had been carried out, and no protection measures could be seen either. What is even worse, as this section of the canal is part of the route used by the South-north water division project, large scale undertaking is taken place around it, bring in the uncovered heritage to an even more risky situation. This shows a very low professional standard in the project, and did not follow the rules given in various conservation guidelines like the Venice Charter, which says 'excavations should be carried out in accordance with scientific standards and the recommendation defining international principles to be applied in the case of archaeological excavation adopted by UNESCO in 1956', and 'ruins must be maintained and measures necessary for the permanent conservation and protection of architectural features and of objects discovered must be taken'.[822]

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819 State Administration of Cultural Heritage of People's Republic of China, pp. 764-765. Appendix 6-1.
820 Evaluations of Nominations of Cultural and Mixed Properties, p. 121.
821 From the archeological documents provided by the Qiji Town government.
822 ICOMOS, International Charter for the Conservation and Restoration of Monuments and Sites (The Venice Charter 1964). Excavations. Article 15.

Figure 6.33 The photo taken by author shows part of the excavated Qi Ji dock in 2013. The stairs were left uncovered after it was excavated, and no evidence of any protection measures could be found.

Some projects have been effectively managed and have found interesting material, like the Nanwang complex archeological site, which was excavated by the Shandong Provincial Institute of Archaeology in 2011.[823] This discovered elements including the original brick embankment of the canal (Figure 6.32), part of the facilities of the water-diverting project undertaken in Nanwang from the time of the Ming dynasty, and the original location of the Long Wang Temple.[824]

823 State Administration of Cultural Heritage of People's Republic of China, p. 765. Appendix 6-1.
824 Data collected from the fieldwork at Nanwang town in winter 2014.

Figure 6.34 The original brick embankment of the canal discovered in Nanwang complex. Each brick is 0.42m long, 0.21m wide and 0.08m thick. This was built in or after 1497 according to archaeological investigations. Source: State Administration of Cultural Heritage of People's Republic of China, p. 301.

After the Nan Wang site was excavated, although it was only covered with plastic sheeting in a rather casual way, it shows a level of awareness for heritage caring, and a sign with its information could also be found near it. However, greater effort needs to be put on its caring and protection.

Figure 6.35 Photo taken by author in winter 2014 showing the excavated brick embankment of the Nan Wang complex.

Despite the reasonably successful founding the archaeological job shows, the local government however made a plan to build a Nan Wang Heritage Park whose main selling points would be the Nan Wang water-diverting project and Long Wang Temple. The plan has been approved by the State Bureau of Cultural Relics.[825] Because most of the original elements have gone from the site, it is planned to rebuild the entire operating mechanism diverting water from the Wen River to the canal, reconstructing the canal course and all its related facilities including the docks, locks and the water division dam. They are even going to reconstruct the Ma Ta water reservoir and the temples built on its bank.[826]

[825] Wan Jinhong and others, 'Design of Relic Garden of Ancient Hydro projects-Case Study of Nanwang Archaeological Site', *China Water Resources*, 21 (2012), 17-19 (p. 18).
[826] Unknown, 'Wen Shang Xian Da Zao Nan Wang Lv You Ming Zhen, Shen Wa Yun He Wen Hua Zi Yuan (Making Nanwang a Famous Tourism Town of Wenshang County, and Excavating deep to discover the Grand Canal Resource)', *Qilu Culture* (undated), <http://qlwh.com/newsdisp.asp?id=3767> [accessed 1 June 2016]

Figure 6.36 The huge board of the reconstruction plan of the Water-dragon King Temple group, an important part of this heritage park. All these buildings are going to be newly built. Source: photograph taken by the author.

This is inconsistent with many conservation policies, including those in the *Laws of the People's Republic of China on the Protection of Cultural Relics* where it says, 'where immovable cultural relics are totally damaged, the ruins shall be protected and damaged relics may not be rebuilt on the original site'.

Lack of professional knowledge and historical research

To meet the citation of OUV for World Heritage nomination, numerous emergency repair projects have been carried out along the canal, mainly because the original fabric disappeared long ago. Unfortunately most of this work was done in a very unprofessional way, not only damaging the original heritage, but also raising doubts about the authenticity of what was left. Many projects were paused after ICOSS experts carried out a site investigation:[827] many of these projects were probably done for the purpose of WHS inscription, rather than heritage protection.

These poorly repaired heritage often show mistakes on understanding the historical values as well as the traditional techniques and materials of the Grand Canal, which suggests these works were done without support of historical research. This has led to the inaccurate presentation of the Grand Canal. Specific examples were given below for discussing this issue.

Figure 6.37 A good example of this is the Liao Cheng urban section of the Shandong canal, with a reconstructed towpath and weeping willows, which attempt to recreate the ancient appearance of the canal. However, as discussed in Chapter Four, the weeping willows were very rarely planted along the canal in northern China (apart from in the royal area) because of its dry, cold climate. The main willow type planted in northern China was the Chinese willow. This mistake must have been made because of the popular stereotype of canal side landscapes showing weeping willows on the southern section. Source: Unknown, 'jing hang gu yun he liao cheng duan lv you chan ye fa zhan gai nian ce hua chu lu (The Strategy of Toursim Development of the Liaocheng Section of the Grand Canal)', *Fenghuang News* (2017) <http://share.iclient.ifeng.com/shareNews?aid=132054452> [accessed 6 June 2017]

827 The argument is made based on the information collected from the fieldwork in canal-side towns and villages in winter 2013 and 2014.

Figure 6.38 The reconstructed Nanyang lock in the Nan Yang section. It can be seen that the lock does not have the correct shape of a canal lock, and components such as the stone crane arms required to control the lock gate are entirely missing; instead, there are four giant concrete objects built with confusion about their function. Information about the substitution cannot be found in any historic records. Such cases raise concerns about the lack of professional knowledge and historical research. Source: photograph taken by author.

Ignorance of historical values is also a concern in relation to local residents, whose behaviour can affect the protection of the Grand Canal. For example, villagers might take down their old houses to build more modern ones as soon as their earnings allow, perhaps as a sign of their improved living standard, or to help the sons in the family to find a wife more easily.[828] This is one of the factors which led to the loss of the traditional canal-side dwellings.

[828] According to the informal interview with local villagers. Traditionally speaking, in China whether to have a decent house is an important condition for a man to be considered as a good husband option.

Figure 6.39 One of the abandoned houses in the canal-side town of Zhang Qiu. Many vernacular houses are being abandoned by owners, who would like to build modern style houses on the same site, or elsewhere in the village, after pulling down the old ones. Source: photograph taken by the author.

Ineffective monitoring

As briefly mentioned above, plans to establish a monitoring mechanism for the Grand Canal conservation were not considered until 2012, when the main reason for the state government to set them up was probably for the purpose of World Heritage nomination. The Grand Canal Heritage Monitoring and Archive Centre has only just been established, in 2015. So the condition of the Grand Canal's heritage, as well as conservation approaches to it, were not properly monitored until 2015, which is very concerning as the issues that could affect it would not be completed in time. This is inconsistent with many conservation guidelines, such as the *Principles for the Conservation of Heritage Sites in China*, which says that for the conservation process, 'a routine maintenance program should be established to carry out regular monitoring, to identify and eliminate potential threats, and to repair minor deterioration.'[829]

[829] China ICOMOS, *Principles for the Conservation of Heritage Sites in China* (Los Angeles: Paul Getty

The south-north water transfer project

The south-north water transfer project will also have an impact on the canal's conservation. Its construction requires a large amount of work to be completed within a limited time, so it will be less able to consider heritage conservation, especially as a large part of the work will be underwater, a challenge for heritage protection.[830]

Conclusion

This chapter represents an evidence-based picture of the Grand Canal's current condition, through issues of one of its sections- the Shandong section. Through the critical examination of the conservation approaches taken for the canal properties of this section, it can be seen that instead of protecting the canal, most of these approaches have in fact had a very negative impact on the remaining heritage, such as the over emphasis on heritage tourism, and the low professional knowledge used in repairing and reconstructing practices. The current conservation circumstances of the Grand Canal are worrying.

This assessment questions the government's motives for making conservation plans and critically analyses the various related legislation, which have failed to 'truly and completely protect the historical information and all the value of the Grand Canal's heritage', the conservation objectives announced by the government. If these inappropriate approaches are to be continued, the few remaining features of the canal will soon be irrevocably lost too.

Trust, 2004 second edition), p. 63.

830 Ma Wenbo and Gong Xiaoyuan, 'Nan Shui Bei Diao Dong Xian Gong Cheng Yu Yun He Wen hua Yi Chan Bao Hu (The South-north Water Transfer Project and the Cultural Heritage Protection of the Grand Canal)', *Dong Yue Tribune*, 28: 1 (2007), 199-200 (p. 199).

Chapter Seven. Conclusion

The first act of this thesis was set by the news that the Grand Canal had been inscribed on the UNESCO World Heritage List on 22 June 2014, as the 'world's largest and most extensive civil engineering project prior to the Industrial Revolution'. However, most of the original fabric relating to the canal had long disappeared, thus many features were re-created or unprofessionally repaired to overcome shortcomings in order to meet the criteria for World Heritage inscription. As a result it seemed important and timely to examine more closely the historic value of the Grand Canal, and whether the conservation approaches taken previously, and currently, can be deemed appropriate and effective. The latter constituted the key questions of this study.

This thesis reviewed a large number of studies about the history and culture of the Grand Canal, such as the research conducted by the Liaocheng and Peking Universities, and key scholars like Yao Hanyuan and Zou Yilin. However, these works have only covered one or two aspects of the canal, rather than providing a comprehensive picture. Most importantly, following the discourse created by the government's propaganda initiatives, most of the previous research has tended to emphasize the canal's significance, and focused on the idea of the 'world's oldest canal' or the 'world's longest artificial river'. Therefore, the present thesis aimed to fill these gaps for the first time through a more critical assessment of the historical development of the Grand Canal.

As discussed in Chapter Two, *Han Gou*, which is commonly seen as the oldest section of the Grand Canal, dates back to the fifth century BC. However, as noted in the present thesis, the earliest nationwide canal system, the Sui Canal, was not completed until the late seventh century, and the current form of the Grand Canal linking Beijing to Hangzhou was only completed in the late thirteenth century. Therefore, the author argued that to maintain historical accuracy the Grand Canal's origin should be deemed to date from the late seventh century. The later argument is further supported by the fact that it was only then that the Grand Canal was used for shipping imperial grain, a purpose which *Han Gou* did not share.

Chapter Three highlights that, despite the claim made by the Chinese government for it to be the longest artificial river in the world, the Grand Canal is actually composed of a large number of natural and regularized waterways. As a result, completely man-made waterways compose a relatively reduced portion of the Grand Canal. For example, the Tong Ji River which was built in 605 made use of various rivers including Yang Qu, Yellow, Bian and the Huai River. Additionally, most of the Tong River, built in 1291, made use of the canalized Ji Zhou River. Therefore, in the author's opinion, it is inaccurate to claim that the Grand Canal is an entirely artificial river, which would in turn suggest that it is not the world's longest canal.

Additionally, the name 'Grand Canal' was devised by the government in an attempt to exaggerate its historical status, to promote it as the most important inland waterway of imperial China. However, the author has shown that the Grand Canal did not in fact become a significant waterway until the sixteenth century. Although the Grand Canal was made with the intention to serve as the primary route for transporting grain before that time, the shallow water level resulting from insufficient water sources made it impossible to carry large grain barges. Hence, before the sixteenth century, grain transport in the Chinese empire was in fact reliant on sea transport.

Chapter Four uncovered an extensive amount of knowledge focusing on traditional river engineering of the Grand Canal, by reviewing both historical literature, and the author's own contribution derived from her fieldwork and interviews. This part of the research attempted to correct many common misunderstandings regarding canal river work. One of such example concerns the different types of willow trees planted on different sections of the canal, and another related to the structure of the canal gates, which were composed of stacked wooden planks instead of one singular large door.

This chapter corrected numerous misconceptions while drawing attention to the canal's true historic significance. Due to its ingenuity, traditional river engineering contributed significantly to the historic value of the Grand Canal. Most of the work relied on the engineers' accumulated experience in the field, yet several engineers invented innovative methods along the way: such are Pan Jixun's *shu shui gong sha* which made the canal water self-scour, and Jin Fu's *jiu shui zhu di* which enabled the embankments to be constructed more swiftly.

One of the most prominent characteristic of traditional river engineering uncovered was the use of ordinary local resources. In other words, these materials consisted overwhelmingly of stones, kaoliang stalks and earth that were easy to find locally, or convenient to plant, such as willows. Moreover, another good example of traditional river engineering concerned the way in which the issue of the water source of the Hui Tong River was slowly overcome: the whole water division project led by Song Li represents the highest level of traditional river engineering of the Grand Canal, and shows how it was adapted to a diverse and complex circumstance. Particular policies were developed to adapt to the challenge posed by the shallow water level of the Hui Tong River, such as the invention of shallow-drought barges. These examples show how different methodologies were adopted to solve difficulties during this essential period in the history of the canal.

In the same chapter the heyday of the Grand Canal between the sixteenth and eighteenth centuries was also explored. The author showed how the Grand Canal created a unique commercial culture that emanated not only from the waterway, but also spread to the canal-side towns and cities. As a consequence the corresponding north-south axis became the most developed area in China, and sparked the creation of unique canal-side lifestyles and dwellings that form part of the historic value of the canal.

Unfortunately, most of the original features representing the largest part of the historical value of the Grand Canal have now disappeared. Chapter Five discussed the massive modification of the Grand Canal over time, in particular after the new communist government was established, in order to accomplish their ambitious water conservancy goals. It showed how most of the canal features were removed during the process of building a ‘modern’ China. However, due to an environment of pervasive propaganda, this has not been mentioned in most modern studies. It is shown here how these modifications have caused irreparable harm to the canal properties, which is in turn what made the attribution of World Heritage status to the Grand Canal questionable.

The author’s critical assessment of the development of the Grand Canal has for the first time challenged and revised common misunderstandings in modern studies, most of which were purposely created to emphasize the significance of the canal in contemporary political contexts. It also showed that the name ‘Grand Canal’ was nowhere to be found during its historical development, and was only given by the Chinese government in very recent times, to market its greatness.

Most importantly, the examination of the canal’s history for the first time brought up the apparent truth that, although the canal used to be a significant waterway in Chinese history, most of the Grand Canal features have been destroyed under the drastic transformation to a modern China. Thus one of the key questions posed at the beginning of this study was answered, concluding that the material value of the Grand Canal has now mostly been erased.

Ironically, despite being responsible for most of this loss, the Chinese government also decided to nominate the Grand Canal as a World Heritage Site. In the Outstanding Universal Values statement for the canal as well its conservation objectives, the Chinese government pledged to ‘truly and completely protect the historical information and all the value of the Grand Canal’s heritage’. The later statement made it necessary for the author to critically examine the conservation approaches taken by the government: hence Chapter Six investigates these issues, using the Shandong section of the Grand Canal as a case study.

As a result of this critical analysis, gaps in the legislative framework have become apparent. The principles which have determined the size of buffer zones have resulted in protection boundaries that are often too narrow. The narrow buffer zones also contribute to over-developed heritage tourism along the Grand Canal, as the local governments of canal-side cities take advantage of this weakness, and use the canal heritage as a tool for increasing footfall and improving local revenue. For many of these local authorities, the value of the Grand Canal is not its historical significance, but its World Heritage status, which helps them to achieve their political goals.

In this chapter examples of how the heritage tourism developed along the Shandong section were examined, demonstrating that in order to increase the diversity of attractions for canal tourism, large amounts of replica heritage have emerged. These re-created features have had a negative impact on the canal heritage, as they bring the overall authenticity of the Grand Canal into question. What is worse, in order to build what could be deemed as ‘Disneyland’ projects on a large scale, many local residents have been relocated to free necessary land.

The populations affected by these land requisitions were usually canal-side village communities that truly represented traditional canal-side lifestyle and dwellings, and should have been deemed an important part of the real heritage of the Grand Canal. The demolition of the Xinglong Village in order to construct the Tai'er Zhuang Replica Town is an example of such paradox.

Other issues relating to the conservation of the Shandong section were also discussed in Chapter Six, including the large number of excavations undergone in that area, and the lack of professional knowledge and research that went into the latter. As a result, additional mistakes were made even though the aim was to repair canal features. Local residents' scarce understanding of historical value has been another factor compounding the lack of conservation efforts towards the canal, when added to the Chinese authorities' inadequate monitoring. One example is the latter's lack of pressure on regulating the current usage of the canal in the on-going south-north water division project.

Both recent and current approaches used towards the Grand Canal's conservation have had a considerable negative impact on its preservation. As a result one of the thesis's research questions regarding the appropriateness and effectiveness of the management of the Grand Canal was answered. It appears that the current practice of conservation for the canal does not meet the objectives set up by the state government, and is both inappropriate and ineffective. An alternative conservation framework is urgently needed, one led by individuals that recognize and truly understand the various values of the Grand Canal.

To sum up, in this thesis the author critically reviewed the historical development of the Grand Canal, and pointed out many common misunderstandings of its history. The latter mainly resulted from gaps in contemporary studies, which were consciously adapted to align with the official narrative that the Grand Canal constituted the greatest waterway in the world. The author's assessment of the canal's history shows that the Grand Canal did have great cultural and historical importance, yet since in its current form most of its original fabric has been altered or destroyed, the original canal is no longer recognizable. The author suggests that the historic value of the canal has been mostly lost, and that the Chinese government claims with respect to the Outstanding Universal Values attributed to it are inaccurate. In addition, the current conservation practices do not meet the conservation objectives set up by the state government, and are therefore both inappropriate and ineffective.

The issues stated above suggest that the Grand Canal, together with its conservation practices should not have met the requirements for a World Heritage Site. However, a few original fragments of the Grand Canal remain, which must be preserved to ensure that some link to its past appearance and function are retained for posterity. The designation of World Heritage Site should ideally provide the impetus for safeguarding the Grand Canal from further damage; as well as the opportunity for the regeneration of canal-side settlements, and the chance for people to reconnect with a way of living that pre-dates urbanization, pollution and distance from nature.

However, these ideas may not be realized: due to the Chinese political context where it is difficult to voice criticism, differing perceptions about the Grand Canal's conservation were not raised. This lack of criticism led to the failure of the state government to recognize and act upon the various issues surrounding the conservation of the Grand Canal, so that inappropriate strategies continue to be implemented to this day. To improve the situation of the canal and save the last fragments of the canal's heritage, it is a matter of urgency to raise these concerns and develop more effective policies for future conservation. Such approach is also required for other such heritage sites which have encountered similar difficulties: a revised approach to the Grand Canal could perhaps form a basis for an alternative development approach to historical conservation in China, addressing a new agenda regarding sustainability, climate change and mounting health problems in the general population. As an effort towards such a new, suitable approaches, the author would like to suggest a number of recommendations as follows.

Recommendations

Vision for the future of the Grand Canal

The Chinese Ministry of Culture is in charge of the overall protection of the Grand Canal and of delivering the state government's vision for it. Since the aforementioned overall objective for the conservation of the Grand Canal is rather vague and superficial, a vision of the appearance of the canal in the future needs to be generated. Such a vision is to be based on a deep understanding and recognition of the values of the Grand Canal, and is to be achieved through an alternative conservation framework.

The author's suggested vision for the future is to make the Grand Canal a living heritage corridor where people live and work, and which provides reference to pre-Cultural Revolution ways of life in both physical and spiritual environments.

Such a vision might be achieved by:

- The government and local residents should both value the canal heritage, and endeavor to safeguard it for the benefits of future generations, by fully recognizing the historical values of the Grand Canal and making them understood by decision makers, local communities and visitors.
- The Ministry of Culture working together with local branches of government should promote greater awareness, understanding and appreciation of the heritage values of the Grand Canal.
- Local and especially long-term residents should be encouraged to remain in the area and be assisted to adapt to the challenges of change in order to perpetuate aspects of intangible heritage, in other words, to encourage localism.
- The canal's traditional usage as a navigable and accessible waterway should be maintained, and the public understanding, appreciation and enjoyment of the canal encouraged.
- The fact that sustainability should be taken into account in the regeneration and management of the Grand Canal should be recognized and enforced through the different sections of the canal.

In order to accomplish the above, it is important to ensure that the last fragments of canal heritage are safeguarded for future generations. Therefore, an alternative conservation framework needs to be generated to guide the management of the Grand Canal.

Firstly, beyond political motivations, it is vital for decision makers to protect the Grand Canal with a true understanding of its heritage values. To achieve this, an alternative narrative of a more objective view of the canal history is needed, with the recognition of its various historical values. Although it may prove difficult to correct the current way of telling the Grand Canal history, considering the political environment, it is worth challenging the decision makers' knowledge and attitude as the canal heritages would otherwise continue to receive inappropriate protection.

A more thorough research on the Grand Canal needs to be undergone in order to provide a more critical narrative of its history. This requires a closer cooperation with various research institutions: the Ministry of Culture should encourage and fund more academic research. The latter would spark more numerous and thorough analyses of current available archaeological and written evidence, to ensure the quality and accuracy of canal stories proposals, and to subject projected reconstructed features to peer review.

Materials and findings from such research projects should be made available for the public to expand their understanding of their heritage. It is recommended to establish an official website of the Grand Canal heritage, that would include information issued from professional research. Such a website could also link to a public-accessible Grand Canal Online Archive, to enable data to be conveniently located and accessed. Such materials could in time be linked to the current school curriculum and be edited to suit different age groups. An education committee of each local government could be established along their respective sections of the Grand Canal, and given the responsibility of presenting canal heritage responsibly, and organizing educational tours for different age groups. Such measures could potentially enable the Grand Canal artery to reach its real potential as a living cultural heritage learning experience corridor, attracting more public involvement.

To recognize the values of the canal heritage, as well as to assuage the concerns of the ICOMOS, it is important that all the authorities, especially the ones that are utilizing the canal route, such as the Water Resources and Transport Department, cooperate together to preserve it. An agreement between the various related authorities could be established by the Ministry of Culture, to provide details of how to manage both the utilization and conservation of the Grand Canal. This should help to ease the current conflicts caused by different interests from different authorities.[831]

[831] This is inspired by the Pontcysyllte Aqueduct and Canal conservation project, see Pontcysyllte Aqueduct and Canal World Heritage Steering Group, *Pontcysyllte Aqueduct & Canal Nomination as a World Heritage Site*,

In addition, conservation guidelines from national and international organizations, such as ICOMOS and Historic England,[832] should be critically studied and introduced to the Chinese central and local governments. It should also be considered for the Chinese ICOMOS, which is currently under the authorization of the Ministry of Culture, to become a more independent advisory body in charge of conservation advice and implementation. Ideally, every canal-side town should have an ICOMOS local office in charge of delivering training sessions for stakeholders and monitoring local conservation approaches. It is hoped that a deeper understanding and recognition of heritage values would also hopefully bring authorities of variant interests together, with new appreciation increasing the willingness to share responsibilities.

It is also extremely important for the local communities' understanding of the canal heritage to be recognized and valued. Local residents, especially those who are already attached to their historical environment, should be able to contribute their knowledge to the effort of protection of canal heritages.[833] In order to uncover local knowledge, focus groups could be organized regularly by local governmental seats, to gather oral history of local residents' memories and perceptions about the canal history. This would help experts and decision makers to gain a deeper understanding of the heritage values, which would then ensure more appropriate conservation approaches.

Ideally, local residents should also be able to participate in the conservation process and decision-making. However, due to the centralized system of Chinese government, and the fact that all the lands of the canal are either owned by the state or collectively owned by local communities,[834] this 'democratic' approach would be hard to achieve. Nevertheless, changes can still be made: local residents should be well informed of the governmental conservation decisions; laws could be passed to ensure that the land of residential areas including the adjacent rural area are not compromised, and the interests of residents should be respected.

Nomination Document, 2008, p. 170.

832 All the ICOMOS Charters are available at ICOMOS official website <http://www.icomos.org/en/charters-and-texts>. And the Conservation Principles can be found at the Historic England official website <https://content.historicengland.org.uk/images-books/publications/conservation-principles-sustainable-management-historic-environment/conservationprinciplespoliciesguidanceapr08web.pdf/>.

833 English Heritage, p. 36.

834 See Appendix 2, 'Relevant laws and regulations of land ownership of the People's Republic of China'.

Most crucially, any proposals of modification should only be approved under special circumstances, after professional research has been conducted.

Moreover, residents that understand their heritage better are more likely to care about, and take care of their heritage. By establishing local canal museums and learning centres, the local governments, could encourage the public to learn and understand the historical, economical and cultural values of the Grand Canal, which will in turn raise greater awareness and appreciation for this heritage site.

On the other hand, to guarantee the authenticity of canal heritages, the State Administration of Cultural Heritage should control excessive tourism development. The proliferation of initiatives created in the name of 'World Heritage Site' should be regulated, and the building of any re-created features either prohibited or regulated. Such new features should be clearly labeled as being new, and clearly distinguishable from the original canal heritage, in order to avoid misleading the public.

Realistically, the above approaches would probably result in a less attractive business opportunity for many private investors, as the Grand Canal may not be considered as popular without the label of 'World Heritage Site'. However, private investments are still to be encouraged in a more regulated fashion, and in the central government should provide any additional funding needed for the overall protection and maintenance of canal. In either case, investment decisions should not be made based only on short-term economic interest, but rather on long-term heritage and environmental factors that ensure sustainability.

Currently, access to numerous sections of the canal is not available to the public, ostensibly to 'protect' the canal heritage. This is unnecessary and inconsistent with the Grand Canal's traditional role. The public should still be able to enjoy using the canal as a form of public space, which provides opportunities for users to engage in healthy living, to connect with nature and with each other, and finding a respite from the rapid and stressful pace of modern life.

To promote such a public use of the Grand Canal, a continuing towpath of the canal could be created to preserve the traditional canal-side lifestyle and to provide the opportunity for cycling and walking along it.[835] Local plant species should be the focus of the planting along the towpath, in order to provide a more pleasant environment for people to enjoy the outdoors. Relevant facilities such as cafés and sitting areas should also be built. This infrastructure could lead to social sports, such as cycling races, naturally evolving and potentially raising the profile of the canal. This might be achieved together by the coordination between the water resources authorities, transport authorities and urban development authorities, under the lead of the State Administration of Cultural Heritage.

Concerning the conservation buffer zones, the State Administration of Cultural Heritage should revise the principles determining buffer zones, and extend them to cover a larger area of the surrounding landscapes of the Grand Canal, in order to control development pressures.

It would be advisable that the State Administration of Cultural Heritage also includes the ordinary sections of the Grand Canal that are not included in the World Heritage inscription list, in a 'watch list' to receive similar protection as the nominated sections. It has been shown in previous studies that the protection boundary should not only cover the banks of the canal, but should also be widened to the surrounding landscapes such as towpaths and associated planting.[836] The local authorities such as Water sources and Transport departments should supervise and improve the handling of pollution problems on these ordinary sections of the canal, since such pollution in turn affects other sections.

The Cultural Heritage Departments in charge of routine operations, including protection, management and maintenance of the canal properties, should make sure that the work is only undertaken by qualified organizations to a high scientific standard. The number of archaeological excavations of the canal heritage should be reduced, and on-going projects should be monitored to ensure that they are carried out to a professional standard. The results of such diggings should be critically analyzed and set into context, as well as displayed in the afore-mentioned website, and in educational activities.

The monitoring of conservation work on the Grand Canal must be carried out over all its

835 Inspired by the good practices by the UK Canal & River Trust, see their website for examples of the various events and activities available on the waterways <https://canalrivertrust.org.uk/enjoy-the-waterways>.
836 See Chapter Six where this issue is discussed, pp. 335-336.

sections, and crucially to ensure that conservation efforts do not diminish compared to the time before it was added to the World Heritage Site List.[837] The monitoring mechanism should be consistent throughout the different Cultural Heritage Departments concerned. Additionally, the collected data should be analyzed timely and corresponding approaches should be chosen.

The conservation as well as development plan should focus on the sustainable management of the Grand Canal. More international cooperation should be encouraged, in order to exchange knowledge relating to canal conservation, and help improve the conservation standard.

Lastly, the above recommendations might be better achieved if they were added to the Grand Canal's Overall Management Plan. If that were the case, the suggested changes would be on-tract to be accomplished by 2030, which is consistent with the time scale of the Management Plan.[838]

837 See Chapter Six where this issue is discussed, pp. 350-351.
838 State Administration of Cultural Heritage of People's Republic of China, pp. 714-716.

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Appendices

Timeline of Chinese History and Dynasties.

Source: 'Timeline of Chinese Dynasties and Other Key Events', *East Asian Institute at Colombia* University (2009)

<http://afe.easia.columbia.edu/timelines/china_timeline.htm> [accessed 13 August 2016]

ca. 2100-1600 BCE	Xia (Hsia) Dynasty	
ca. 1600-1050 BCE	Shang Dynasty	Capitals: near present-day Zhengzhou and Anyang
ca. 1046-256 BCE	Zhou (Chou) Dynasty	Capitals: Hao (near present-day Xi'an) and Luoyang
	Western Zhou (ca. 1046-771 BCE)	
	Eastern Zhou (ca. 771-256 BCE)	Spring and Autumn Period (770-ca. 475 BCE)
		Confucius (ca. 551-479 BCE)
		Warring States Period (ca. 475-221 BCE)
221-206 BCE	Qin (Ch'in) Dynasty	Capital: Chang'an, present-day Xi'an
		Qin Shihuangdi dies, 210 BCE
206 BCE-220 CE	Han Dynasty	
	Western/Former Han (206 BCE-9 CE)	Capital: Chang'an
		Confucianism officially established as basis for Chinese state by Han Wudi (r. 141-86 BCE)
	Eastern/Later Han (25-220 CE)	Capital: Luoyang
220-589 CE	Six Dynasties Period	Period of disunity and instability following the fall of the Han; Buddhism introduced to China
	Three Kingdoms (220-265 CE)	Cao Wei, Shu Han, Dong Wu
	Jin Dynasty (265-420 CE)	
	Period of the Northern and Southern Dynasties (386-589 CE)	
581-618 CE	Sui Dynasty	Capital: Chang'an
618-906 CE	Tang (T'ang) Dynasty	Capitals: Chang'an and Luoyang
907-960 CE	Five Dynasties Period	
960-1279	Song (Sung) Dynasty	
	Northern Song (960-1127)	Capital: Bianjing (present-day Kaifeng)
	Southern Song (1127-1279)	Capital: Lin'an (present-day Hangzhou)
1279-1368	Yuan Dynasty	The reign of the Mongol empire; Capital: Dadu (present-day Beijing)
1368-1644	Ming Dynasty	Re-establishment of rule by Han ruling house; Capitals: Nanjing and Beijing
1644-1912	Qing (Ch'ing) Dynasty	Reign of the Manchus; Capital: Beijing
1912-1949	Republic Period	Capitals: Beijing, Wuhan, and Nanjing
1949-present	People's Republic of China	Capital: Beijing

Relevant laws and regulations of land ownership of the People's Republic of China.

Source: State Administration of Cultural Heritage of People's Republic of China. Annex 1, pp 21-23.

Constitution of the People's Republic of China

Article 9 All mineral resources, waters, forests, mountains, grassland, unreclaimed land, beaches and other natural resources are owned by the state, that is, by the whole people, with the exception of the forests, mountains, grasslands, unreclaimed land and beaches that are owned by collective in accordance with the law.

Article 10 Land in the cities is owned by the state.

Land in the rural and suburban areas is owned by collectives except for those portions which belong to the state in accordance with the law; house sites and privately farmed plots of cropland and hilly land are also owned by collectives.

The state may, in the public interest, requisition land for its use or requisition with compensation in accordance with the law.

No organization or individual may appropriate, buy, sell or lease land or otherwise engage in the transfer of land by unlawful means. The use right of land may be transferred in accordance with the law.

Land Administration Law of the People's Republic of China

Article 2 The People's Republic of China resorts to a socialist public ownership i.e. an ownership by the whole people and ownerships by collectives, of land.

In ownership by the whole people, the State Council is empowered to be on behalf of the State to administer the land owned by the State.

No unit or individual is allowed to occupy, trade or illegally transfer land by other means. Land use right may be transferred by law.

The State may requisition land owned by collectives according to law on public interests.

Article 8 land in urban districts shall be owned by the state.

Land in the rural areas and suburban areas, except otherwise provided for by the State, shall be col lectively owned by peasants including land for building houses, land and hills allowed to be retain ed by peasants.

Article 10 In lands collectively owned by peasants those have been allocated to villagers for colle ctive ownership according to law shall be operated and managed by village collective economic or ganizations or villagers' committee and those have allocated to two or more peasants collective ec onomic organizations of a village, shall be operated and managed jointly by the collective econom ic organizations of the village or villagers' groups; and those have allocated to township (town) pe asant collectives shall be operated and managed by the rural collective economic organizations of t he township (town).

Article 45 The requisition of the following land shall be approved by the State Council:

1. Basic farmland;
2. Land exceeding 35 hectares outside the basic farmland;
3. Other land exceeding 70 hectares.

Requisition of land other than prescribed in the preceding paragraph shall be approved by the people's governments of provinces, autonomous regions and municipalities and submitted to the State Council for the record.

Requisition of agricultural land should first of all go through the examination and approval procedure for converting agricultural land into land for construction purposes according to the provisions of Article 44 of this law. Whereas conversion of land is approved by the State Council, the land requisition examination and approval procedures should be completed concurrently with the procedures for converting agricultural land to construction uses and no separate procedures are required. Whereas the conversion of land is approved by people's governments of provinces, autonomous regions and municipalities within their terms of reference, land requisition examination and approval procedures should be completed at the same time and no separate procedures are required. Whereas the terms of reference has been exceeded, separate land requisition examination and approval procedures should be completed according to the provisions of the first paragraph of this article.

Article 46 For requisition of land by the State the local people's governments at and above the county level shall make an announcement and organize the implementation after the approval according to the legal procedures.

Owners or users of the land requisitioned should, within the time limit specified in the announcement, go through the compensation registration for requisitioned land with the land administrative departments of the local people's governments on the strength of the land certificate.

Article 47 In requisitioning land, compensation should be made according to the original purposes of the land requisitioned.

Compensation fees for land requisitioned include land compensation fees, resettlement fees and compensation for attachments to or green crops on the land. The land compensation fees shall be 6-10 times the average output value of the three years preceding the requisition of the cultivated land. The resettlement fee shall be calculated according to the number of agricultural population to be resettled. The number of agricultural population to be resettled shall be calculated by dividing the amount of cultivated land requisitioned by the per capital land occupied of the unit whose land is requisitioned. The resettlement fees for each agricultural person to be resettled shall be 4-6 times the average annual output value of the three years preceding the requisition of the cultivated land. But the maximum resettlement fee per hectare of land requisitioned shall not exceed 15 times of the average annual output value of the three years prior to the requisition.

The standards for land compensation and resettlement fees for land requisitioned shall be determined by various provinces, autonomous regions and municipalities in reference to the land compensation fees and resettlement fees for cultivated land requisitioned.

Property Law of the People's Republic of China

Article 42 In order to meet the demands of public interests, it is allowed to requisition lands owned collectively premises owned by entities and individuals or other real properties.

When requisitioning land owned collectively, it is required to, in accordance with law and in full amount, pay land compensation fees, placement subsidies, compensations for the above-ground fixtures of the lands and seedlings and other fees, arrange for social security fees for the farmers with land requisitioned, guarantee their livelihood and protect their lawful rights and interests.

Article 58 The collectively-owned real properties and personal properties shall contain:

Lands, forests, mountains, grassland, wastelands, and tidal flats that shall be in the ownership of collective as prescribed by law;

……

Article 61 As regards any realty or chattel owned by an urban collective, this urban collective has the rights to possess, use, seek profits from and dispose of it according to the related laws and administrative regulations.

Article 63 Collectively-owned properties shall be protected by law, and any entity or individual may not encroach, plunder, privately distribute, hold back or destroy them.

Regulations on the Implementation of the Land Administration Law of the Peoples Republic of China

(State Council Order 256 of December 27, 1998)

Article 25 After a land acquisition plan is approved according to law, such plan shall be implemented by the people's government at the municipal and/or county level in the place where the land is acquisitioned. Such people's government shall publish the land approval authority, approval document number, usage, scope and area of acquisitioned land, acquisition compensation system, agricultural personnel replacement measures, the timeline of handling acquisition compensation, etc. in the village (town) where the land is acquisitioned.