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Exploration of an Environmentally Friendly Form of City Development Combined with a River: An Example of a Four-Dimensional Analysis Based on the Expansion of the City of Jinan across the Yellow River

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***Abstract*—**In order to study the topic of cities crossing rivers, a Four-Dimensional Analysis Method consisting of timeline, X-axis, Y-axis, and Z-axis is proposed. Policies, plans, and their implications are summarized and researched along with the timeline. The X-axis is the direction which is parallel to the river. The research area was chosen because of its important connection function. It is proposed that more surface water network should be built because of the ecological orientation of the research area. And the analysis of groundwater makes it for sure that the proposal is feasible. After the blue water network is settled, the green landscape network which is surrounded by it could be planned. The direction which is transversal to the river (Y-axis) should run through the transportation axis so that the urban texture could stretch in an ecological way. Therefore, it is suggested that the work of the planning bureau and river bureau should be coordinated. The Z-axis research is on the section view of the river, especially on the Yellow River's special feature of being a perched river. Based on water control safety demands, river parks could be constructed on the embankment buffer zone, whereas many kinds of ornamental trees could be used to build the buffer zone.

City Crossing River is a typical case where we make use of landscaping to build a symbiotic relationship between the urban landscape architecture and the environment. The local environment should be respected in the process of city expansion. The planning order of "Benefit- Flood Control Safety" should be replaced by "Flood Control Safety - Landscape Architecture- People - Benefit".

***Keywords*—**Blue-Green landscape network, city crossing river, four-dimensional analysis method, planning order.

I. Introduction

THE Yellow River in China is a suspended river with a large amount of sediment. It has been ignored for a long time in the city plan of Jinan and locates some distance to the north of the city. Since the reservoir construction of the 1950s and the standardization of embankment construction in 2002, the flood control capacity of the Yellow River has been greatly increased. Due to its location between the mountains to the south and the river to the north, Jinan's urban form has become narrower and narrower as the city has expanded. The policy encouraging Jinan to cross the river and develop to the north was introduced in May 2003 and has been the focus of urban planning since April 2017. This paper takes the relationship between the Yellow River and the city of Jinan as an example, and mainly researches on the environmentally friendly form of city development combined with a river.

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II. The Inevitability of City Development Combined with a River

A. The Yellow River in China

The Yellow River is the second largest river in China, with a total length of 5464 km (sorted by river length). It originates from the basin of Yueguzonglie with an altitude of about 4500 m, which is located in the northern foot of Bayan Har Mountain in Qinghai Province. It passes through 9 provinces and regions, including Qinghai, Sichuan, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Henan and Shandong, and in the end, flows into Bohai Sea in Kenli County, Dongying City, Shandong Province. Yellow River's watershed area is 752,400 km^2 and its average annual runoff is 58 billion m^3 [2].

The Yellow River is divided into three distinct parts: The mountainous upper course, the middle course across a plateau, and the lower course across a low plain [3].

The upper course is with larger water flow and is rich in water sources. The middle course is with many tributaries. The river takes away a large amount of sediment from the plateau, which causes water loss and soil erosion. The yellow river rechanneled much in history and causes frequent floods. Since the last diversion in 1855, the river goes slowly in the lower course because of the flat terrain. Due to silt silting, the Yellow River in lower reach is a suspended river [2]. But in recent decades it is under control, because of irrigation, reservoirs and hydraulic engineering.

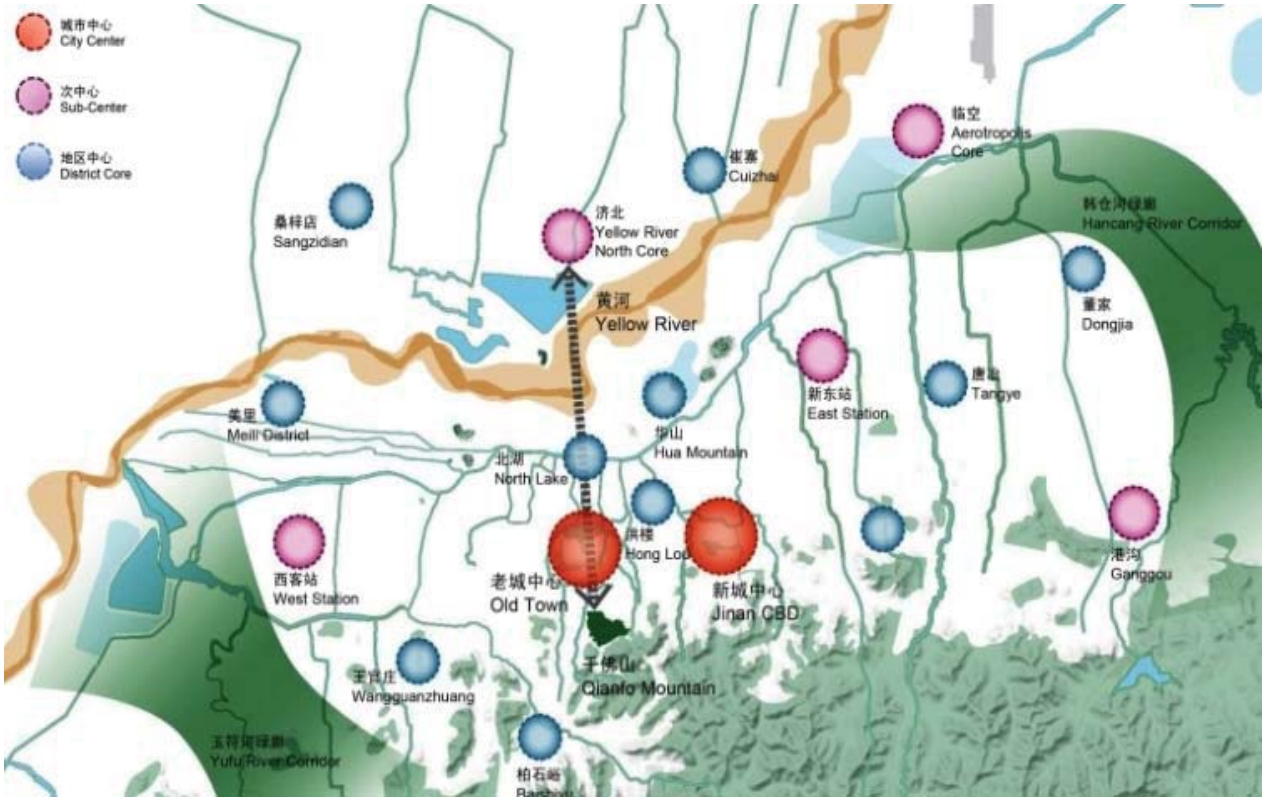

Fig. 1 Jinan city development along the river [1]

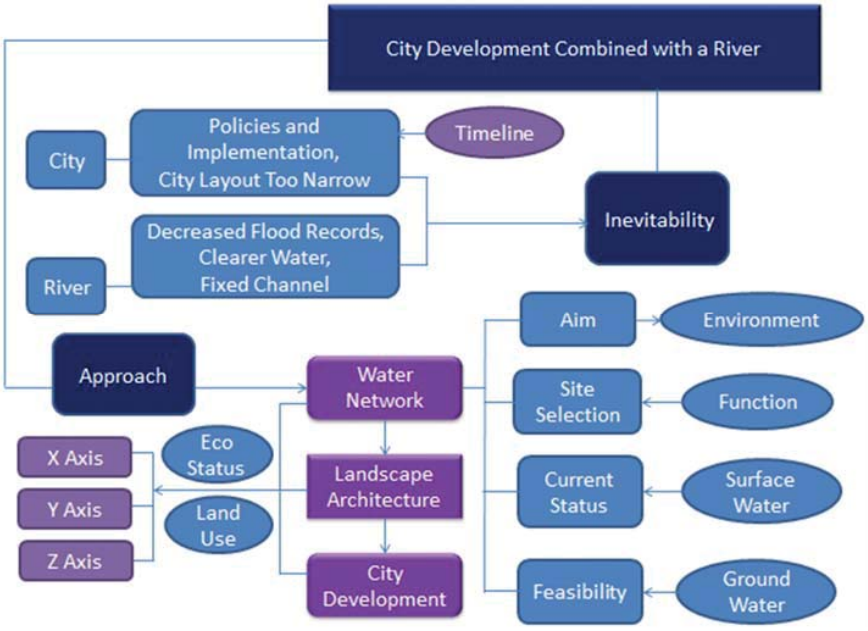

Fig. 2 The whole structure of this thesis

Fig. 3 The Yellow River and the city of Jinan in China

Fig. 4 Three distinct parts of the Yellow River

B. Sediment Deposition and Suspended River throughout History

The study area is in the lower course. The main tributaries to the lower course are Jindi River, Daqing River, and Yufu River. The main features of Yellow River lower course are flat gradient and serious sediment deposition. The middle reaches of the Yellow River run through the Loess Plateau, therefore the tributaries carry a large amount of sediment, making the Yellow River the world's highest sediment-laden river. The maximum annual sediment discharge amounted to 3.91 billion tons (1933). The highest sediment concentration in 1977 reached 920 kg/m^3 [2]. The river bed has been rising year by year and it has been higher than the ground on both sides of river. Among them, the Yellow River Section in Jinan is 4～6 meters higher than the ground of the banks. That is why the river is known as "Suspended River" [4].

C. Three Good Changes of the Yellow River in Modern Times

1. Fewer Flood Records Since 1970s

Since the 1970s, there are fewer flood records in the Yellow River. There are 3 main reasons for the decrease [5]. The Yellow river's annual flow into the sea in recent years is only about 7.5~25 billion m3. Compared to the Yellow River annual water for irrigation of 35~40 billion m3 (Summary according to the Yellow River Water Resources Bulletin from the Yellow River Commission of the Ministry of Water Resources), and the amount of reservoirs storage of over 50 billion m3, the water in the Yellow River is basically controlled. Besides, the standardization of embankment construction since 2002 makes the channel of certain design standards, which is another guarantee for the safety.

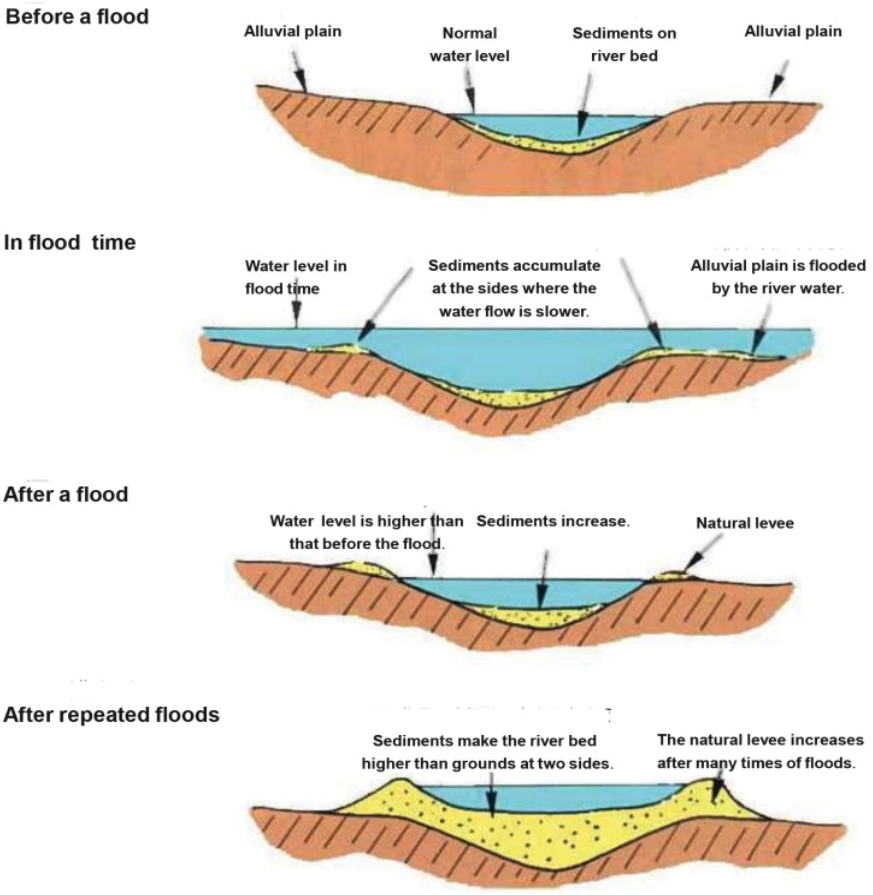

Fig. 5 The formation of the suspended river

Fig. 6 The main Reservoirs on the Yellow River

2. Fixed Channel Since 2002

The standardization of embankment construction on the lower reaches of the Yellow River has been under construction since 2002 and is constructed according to the flood control design standards. The embankment top width is 12m. The embankment hardening part width is 6m. Two rows of landscape trees are planted on both sides of the embankments. Flowers are planted on the embankment slopes. 50 meters wide anti-wave forests are planted in the flat sections along the river. On the back of the river is 100 meters wide buffer zone, the elevation of which is as high as the water level of the fortification in 2000. Suitable forests would be planted after the siltation area construction is finished [6].

Because of the standardization of embankment construction on the lower reaches of the Yellow River since 2002, the channel is basically fixed.

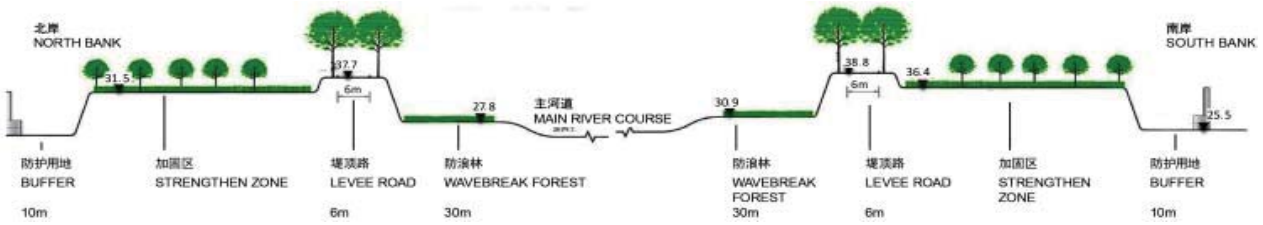

Fig. 7 Section Standard from Yellow River Authority

3. Clearer Water Since 2002

Since the project of withdrawing from cultivated land for ecology in 2002, the Yellow River has been clearer and clearer [7].

D.Jinan Landform and Hydrology Introduction

1. Jinan Landform

Jinan locates in the northern anticlise in the western of Shandong Province and it is generally a gentle incline. The terrain of Jinan is high in the southeast and low in the northwest with a transition from low mountains and hilly to piedmont plain and yellow river floodplain. The elevation of mountainous area is mostly between 150 and 700m, with a height difference of 100 ~ 500m, while the elevation in plain area is mostly at 20 ~ 60m. The overall stratigraphy slopes northward, with an inclination of 5°～10° [8].

Confined to the topography and geological formations, karst groundwater runs from southeast to the northwest, at the same time infiltrated through the Ordovician limestone into the ground. It is blocked by the magmatic rock in the old city area, and the groundwater rises up, the groundwater gush out to make the famous spring groups.

Jinan is located in the mid-latitude zone and is a typical warm temperate continental monsoon climate. Jinan's average annual rainfall is 643mm, while the average evaporation of Jinan is 1250mm.

The river system of Jinan is mainly divided into Yellow River system and Xiaoqing River system.

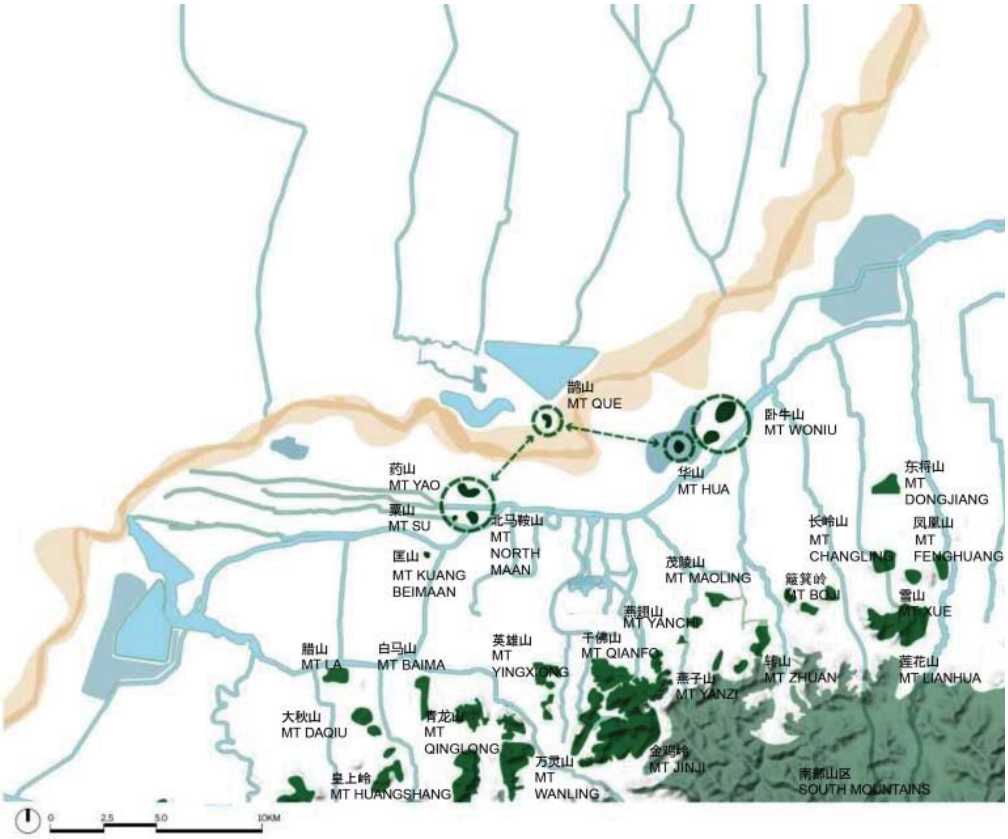

Fig. 8 Jinan landform. Repainted from SOM design

2. Jinan Hydrology

i. The Yellow River in Jinan

Due to the three good changes of the Yellow River in modern times, the Yellow River has great potential to be developed as a landscape river.

ii. Introduction to the Xiaoqing River

The mainstream of Xiaoqing River is an artificially excavated canal. Its tributaries are mostly from natural rivers. Since the 1960s, a large amount of industrial wastewater and domestic sewage have been poured into Xiaoqing River, causing extremely serious pollution. However, over the last 10 years' massive efforts with comprehensive management projects, the water quality and the landscape of Xiaoqing River have been significantly improved [9].

There are five main sources of Xiaoqing River water: firstly, the spring water from the old city; secondly, the treated urban sewage; thirdly, the rainfall from the southern mountainous areas from June to September; fourthly, Yufu River (a tributary of the Yellow River) diversion; fifthly, groundwater lateral seepage from its riverbanks (because the banks are high than the river).

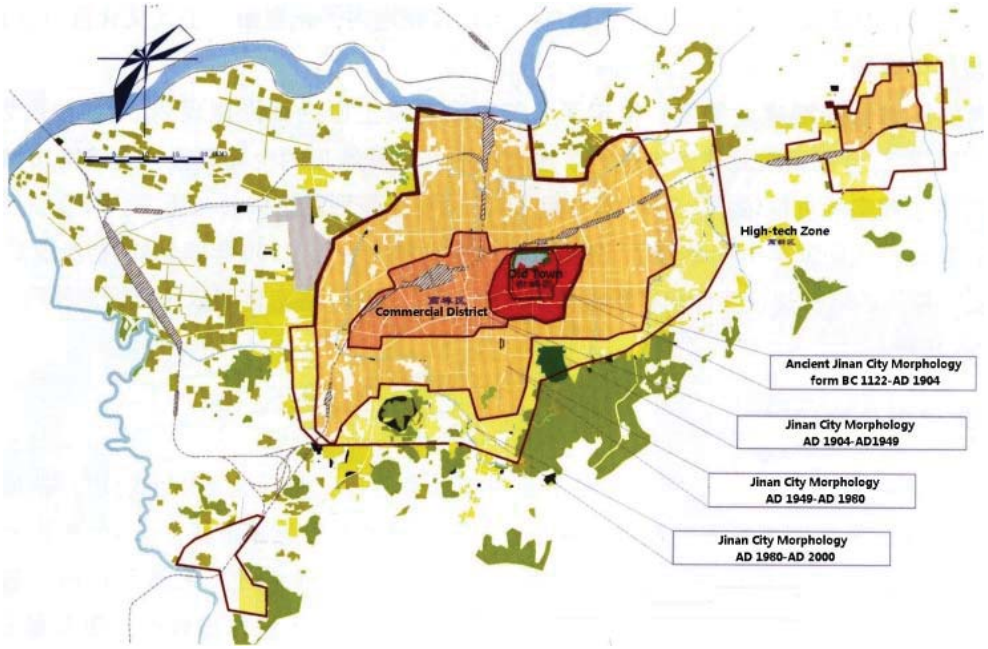

Fig. 9 Jinan city layout development From "Planning the Spring City"

E. Jinan City Layout

1. Jinan City Layout Development

The city of Jinan has developed rapidly since the year 1904. Due to the natural geographical conditions of Jinan—mountains to the south and the Yellow River to the north—without guidance, the city development would be bound to the east and west. Not only would the traffic efficiency suffer from the narrow city form, but also the potential Yellow River landscape cannot play a role [10]. Since the south mountain area is to be protected, the issue that Jinan people are currently facing now is how to deal with the relationship between the river and the city as the city develops.

2. Existing Jinan City Layout: Development without the *Yellow River*

The river is an integral part of the city [7]. But in Jinan, the Yellow River has been for years a barrage of city development. The existing city layout is long and narrow. The city has developed without the Yellow River.

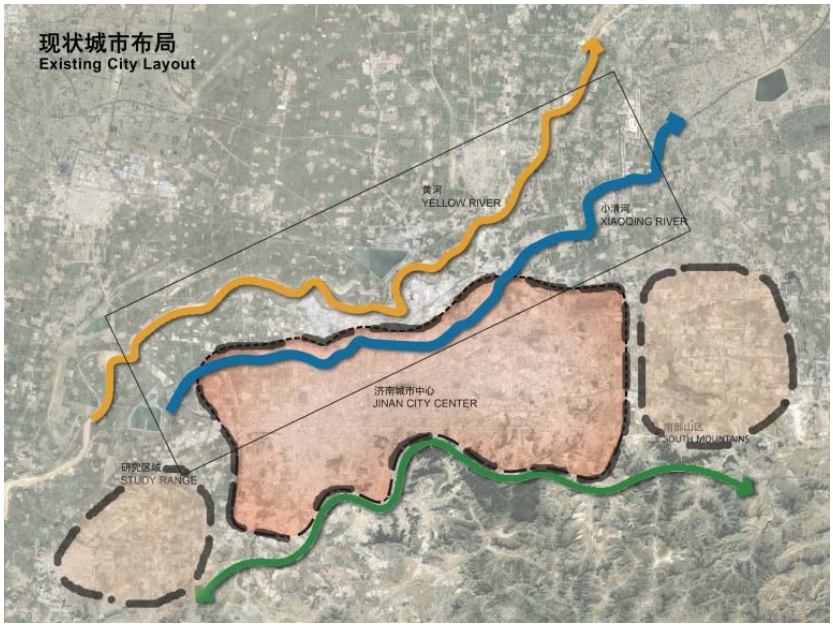

Fig. 10 Existing City Layout of Jinan

3. Policies and Implementation

i. Development on the South Side of the Yellow River

The Hundred-Mile Yellow River Scenic Area is sine 1992 in construction, with a total length of 51.98 kilometers, an area of more than 50 square kilometers. The scenic area is mainly along the meandering Yellow River and is consisted of the Yellow River flooding zone, embankments, buffer zone and vulnerable spots.

The Mother River Park is built in 2003. The North Lake is in construction since 2015. Hua Mountain Scenic Area, Yao Mountain Scenic Area, Jinniu Mountain Scenic Area, and Meili Lake are on and off reconstructed and expanded in recent decades. They are scenic areas which have been existed since ancient times.

Jinan Culture Expo Park Covers an area of 1,000 mu and costs 2.8 billion yuan. It has been built since 2013 and is the largest culture expo park in China.

ii. Development on the North Side of the Yellow River

The North Crossing Process can be divided into three phases.

(1) In May 2003, the proposal of the North-Crossing Policy was first proposed.

The Dragon Lake was built in 2005.

In order to prepare for the October 2009 the 11th National Games of the People's Republic of China, the Chemical Industry Park was urgently moved from Yuxing Chemical Factory to the current Chemical Industry Park.

The Dinghui Temple was built in 2009.

(2) Qihe actively develops projects, responding to the Jinan North-Cross Policy.

The Ocean Polar World was built in 2011, the Europark Dream World in 2014.

The Qihe Science and Technology Town is still under construction.

And the Qihe Hot Spring Town is in Planning.

(3) In December 2016, the Policy of City Development Combined with a River was issued, indicating turning the Yellow River into an inland river.

In April 2017, the **Instruction of the pre-construction area of the National Comprehensive Test Area for New and Old Kinetic Energy Conversion** was made by prime minister, making the North-Cross Policy the Focus of Current Planning.

In June 2017, large-scale demolition of "Illegal Buildings" was carried on.

F. Conclusion: The Inevitability of City Development Combined with a River

In terms of natural conditions, the flood control security is guaranteed. The water quality turned much better, and the Yellow River is now much clearer than a decade ago.

In terms of social conditions, the government, which plays a large role in a socialist country, encourages the city of Jinan to develop with the Yellow River.

Therefore, the inevitability of Jinan developing combined with the Yellow River is proved.

III. Analysis of Surface Water to Build Water Network in X-Axis

A. The Reason to Choose the Study Range

Normally, it is comprised of three gradient spaces: the new district, the transitional river belt, and the urban area. The three gradient spaces are mainly divided based on the urban density transition, which is the outward manifestation of the urban expansion process.

Fig. 11 Three gradient spaces of Jinan

From the urban areas in the South to the Yellow River in the North, the farther to the north, the smaller the city density is, as well as the smaller the radiation influence of the urban area is. In order to be connected with the urban development, the transition area between the urban area in the South and the new area in the North should be firstly considered. And then with the help of its connection, the new area can be spread.

As the development on south side of the Yellow River are more about ecological projects, the area on the south side of the Yellow River which goes to the edge of Xiaoqing River is chosen to be the study range, since the area between two rivers is more correspondent to the theme of ecology.

B. Surface Water Network Status Analysis

There are mainly two water sources:

(1) Surface water from the southern mountain area

(2) Water from the Yellow River

To analyze with the terrain, the surface water goes from the highest southern mountainous terrain (with an elevation of 100~900m: Qianfoshan 270m, Ladder Hill 900m) to the Xiaoqing River.

The Yellow River (with an elevation of 33.5~40.5m) is higher than the banks (with an elevation of 24~36m) since it is a suspended river. Therefore, there are a few water networks stretching from the Yellow River.

The elevation of the bank of Xiaoqing River is 5~8m lower than the south bank of the Yellow River. The tailwater from the Yellow River Irrigation flows into the three tributaries of the Xiaoqing River, forming the only water network in the western part of the current research area.

C. Groundwater Network Status Analysis

The groundwater table on the riversides is generally stable and has been for years. The depth of the underground water in the river transitional belt is less than 2 meters. Therefore, it is feasible for artificial rivers to be disclosed, and for green spaces to be built along them.

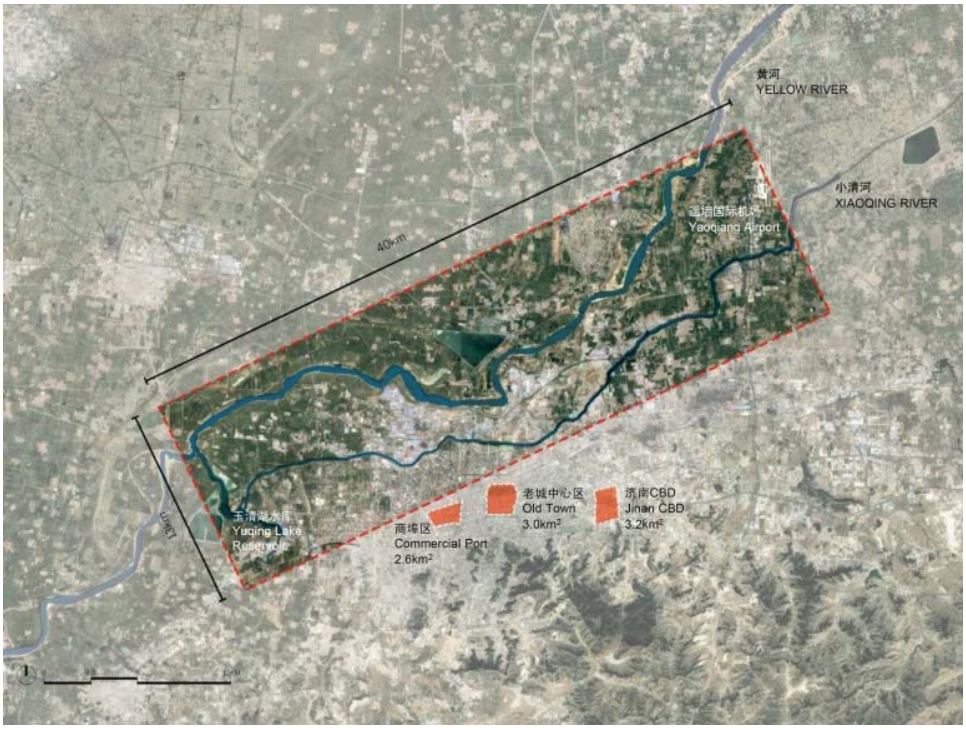

Fig. 12 Site selection of the research. Repainted from SOM design

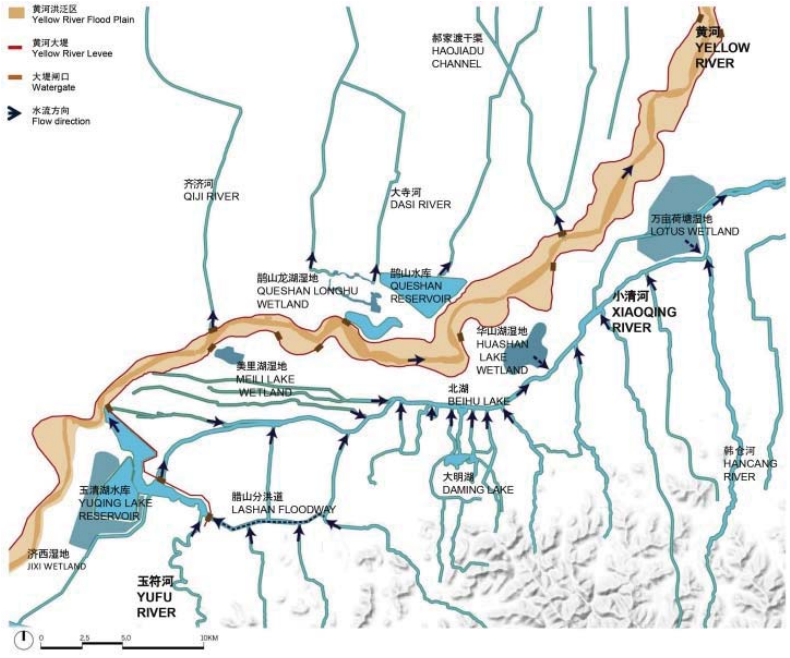

Fig. 13 Surface water in Jinan. Repainted from SOM

1. Groundwater Classification Based on Aquifer Medium

Based on the aquifer medium classification, the groundwater which is stored in the pores of loose rock and soil (such as sand and soil layers) is called porewater; the groundwater which is stored in the soluble karst caves or the miarolitic is called karst water; the groundwater which is stored in the fractures of non-soluble rocks is called fissure water.

The groundwater in the area between Yellow River and Xiaoqing River belongs to porewater since the it mainly exists in loose formation pores.

The porewater is distributed in layers and is spatially

continuous and uniform. The hydraulic connection within the water system is good. Therefore, to disclose the porewater is of a high success rate.

TABLE I
GROUNDWATER CLASSIFICATION BASED ON AQUIFER MEDIUM

Aquifer Medium Classification	Groundwater Classification
Stored in the pores of loose rock and soil	Porewater
Stored in the soluble karst caves or the miarolitic	Karst Water
Stored in the fractures of non-soluble rocks demagnetizing factor	Fissure Water

2. Groundwater Classification Based on Groundwater Confining Layer

Classified according to groundwater confining layer, Confined Water is the gravity water which fills between two stable aquicludes. Phreatic Water is the gravity water with free water surface, which is stored in the first aquifer under the ground.

In other words, if there is a continuous water-resisting layer above the aquifer, this type of groundwater is confined water; if not, it is phreatic water.

Due to no continuous water-resisting layer above the aquifer, the groundwater in the Transitional River Belt between Yellow River and Xiaoqing River belongs to phreatic water. It is buried in a relative shallow depth.

TABLE II
GROUNDWATER CLASSIFICATION BASED ON GROUNDWATER CONFINING LAYER

Whether there is a continuous water-resisting layer above the aquifer	Groundwater Classification
Yes	Confined water
No	Phreatic water

Evaporation occurs when the buried depth of groundwater table is less than 4m. Since the depth of the groundwater in this area is generally less than 2m, the evaporation here is relatively strong. Therefore, evaporation of phreatic water becomes one of the main drainage of groundwater in this area.

Under the same conditions, the natural water quality of the confined water is better than that of the phreatic water.

3. The Aquifer and Its Water Yield Property

The aquifer in this area lacks water-bearing sand layer and gravel layer, instead, it is consisted of clay sand or sandy clay. The aquifer's water yield property is relative weak. If strongly mined, it is easy to be drained.

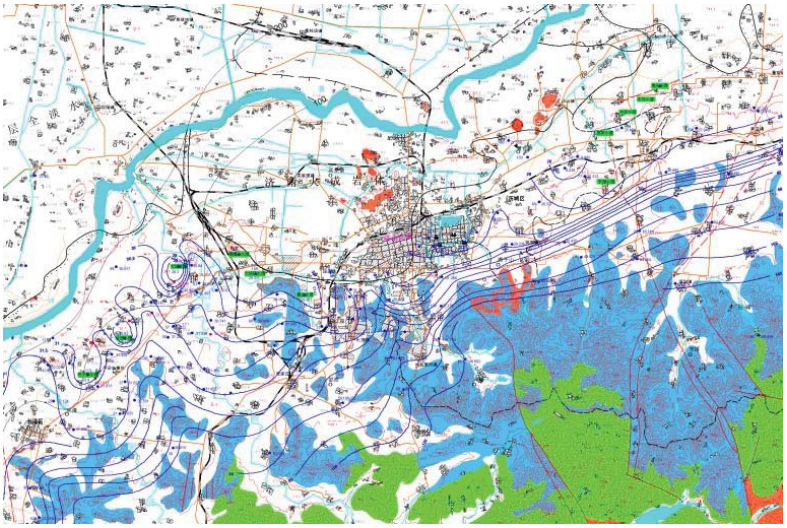

Fig. 14 Jinan contour of water table. From Hydrological Survey Bureau

4. Conditions of Groundwater Recharge, Runoff, and Discharge

After analyzing the contour of water table in Jinan, the groundwater recharge, runoff, and discharge is shown as follows:

i. Groundwater Recharge

Yellow River lateral seepage, the upper reaches of the lateral runoff recharge as well as direct rainfall (little impact) infiltration are the three main sources of groundwater recharge in this region. The water sources supply is relative stable and guaranteed.

ii. Groundwater Discharge

The groundwater seep into Xiaoqing River surface water. (Xiaoqing River locates 1 ~ 2m lower the groundwater level of is its river banks, indicating that Xiaoqing River continuously receives the seepage supply of groundwater from the river banks.) Besides converting to surface water of Xiaoqing River, amount of groundwater is evaporated as shallow phreatic water, or it runs to the lower course in the direction of NEE (North, East, East).

5. Conclusion: Groundwater Available Value to Build Blue-

Green Network

i. Relatively Stable Groundwater Table

The groundwater table for years in this area is generally stable, with fluctuations in the range of 1 ~ 1.5m for years. Fluctuation of the groundwater table per year is about 1m. The depth of the groundwater is generally less than 2m, which is a relative shallow depth. The water sources supply is stable and guaranteed.

ii. Suitable for Disclosing Ground Water

The pore water is suitable to be disclosed as surface water. The phreatic water is in a shallow depth and is also suitable to be disclosed.

iii. Not the Best Choice to Be Used as Drinking Water

Runoff conditions have a great impact on the natural water quality of groundwater. The terrain in this area flat, the permeability of rock-soil is weak, so the groundwater flows slowly. Under the same conditions, the natural water quality of the still water is not as good as the flowing water. Since the in this area is relative still, the water quality here is not very good.

iv. Groundwater Available Value to Build Blue-Green Network

Since the groundwater here belongs to phreatic water as well as still water, the water quality here is not good enough to be drinking water. But instead, it is **suitable to be used as landscape water**.

Due to the weak water yield property, the groundwater in this area is **easy to be drained**. Here is not suitable form a large-scale centralized water supply source. However, small-scale decentralized water supply such as landscape water is acceptable.

Since this area locates in the **crucial area for the city crossing river**, it is feasible that we take full use of the favorable conditions of **guaranteed sources of water supply**, **shallow depth of stable groundwater table**, to excavate artificial rivers and form green space around to form a blue-green landscape network.

v. The Aim to Build a Water Network

The aim to build a water network is to have a blue-green network for people. The landscape axis is later designed based on the need of people. The sequence of the design should be Blue Network- Green Network- Yellow Network, with the keywords sequence of River- Park- People.

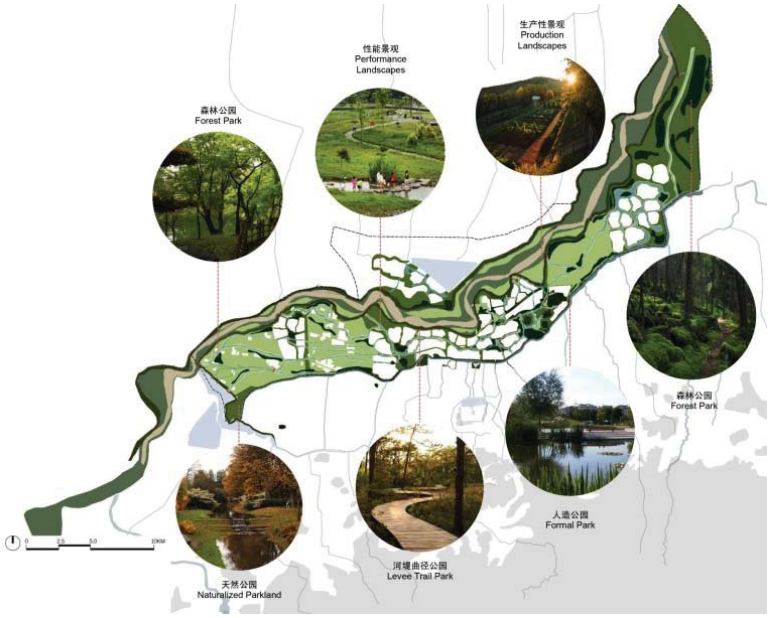

Fig. 15 Blue Network- Green Network. From SOM design

IV. A Proposed Landscape Research Concept - Across-River Landscape Architecture

A. Water Network, Landscape Architecture and City Development

Firstly, the surface water network as the water network status quo should be analyzed. And then where to build the water network, is based on the need of the city development need. Thirdly, whether the groundwater can be disclosed as landscape water, is determined by the condition of the groundwater. The last step is belongs to the study of landscape architecture, that is how the surface water should be designed as a landscape water network. In this process, the four-dimension analysis is proposed, which is especially for the study of cities crossing rivers.

B. The Aim to Build a Four-Dimension Analysis for the Cities Crossing Rivers

To learn from the history and to know more about the status quo, the timeline of the city development should be first

summarized.

Usually, the side which is near to the urban area is the focus of the research, since it plays a role in connecting the urban area to the new area. The area along the river belongs to the research X direction. The research about it should first respect the natural conditions. In the river crossing process, it is the blue surface water and the green landscape space. To develop the Blue-Green Network, the groundwater in this area should be firstly analyzed, as a basis of the blue water network.

The Crossing River Process is a process in the direction of Y-axis. The role of transportation should be studied. The research of bridges is the basis, and then is the research of railways and airports. It is also suggested that the bridges should go through the landscape axes. Therefore, the coordination of city planning office and the river case office is also proposed.

Since the Yellow River is a suspended river, the Z- axis is needed. The anti-wave forest in the buffer zone and the strengthen zone which is on the back side of the embankment, are the research focus in the aspect of landscape.

C.Analyze of the Timeline of City Development with the River

1. The South Side of the Yellow River

The projects on the south side of the Yellow River are mainly the places of interests with historical culture and ecological value.

The Hua Mountain Scenic Area, Yao Mountain Scenic Area, Jinniu Mountain Scenic Area, and Meili Lake are the scenic areas with history.

All the projects on the map are of color blue or green, which means water or park. The implementation of the city development on the south side of the river is focused on the ecological construction, which is correspondent to the geographical condition of the area.

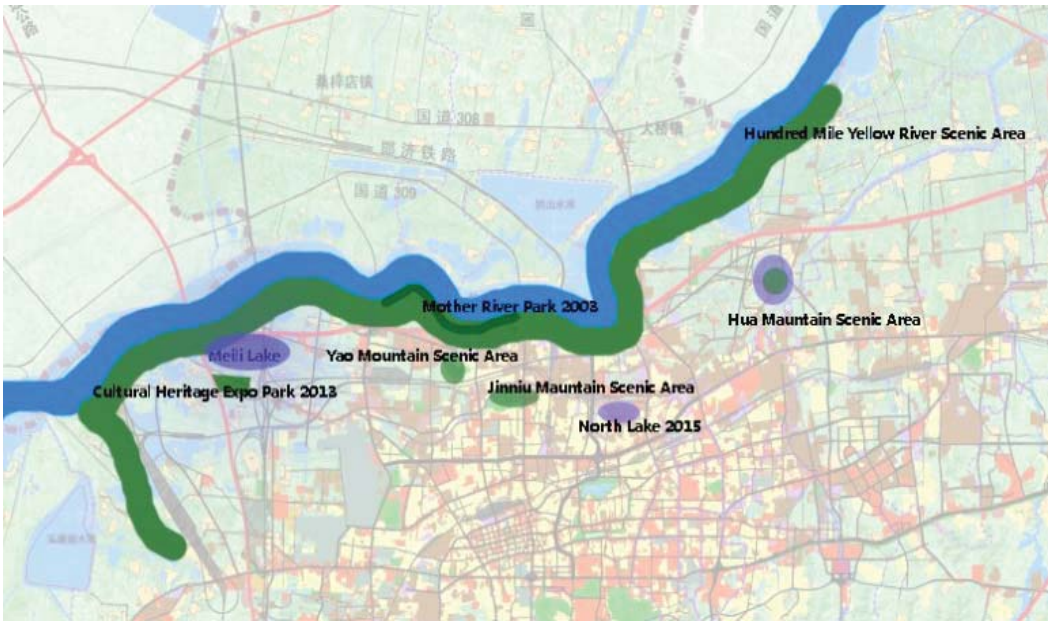

Fig. 16 Projects on the south side of the river

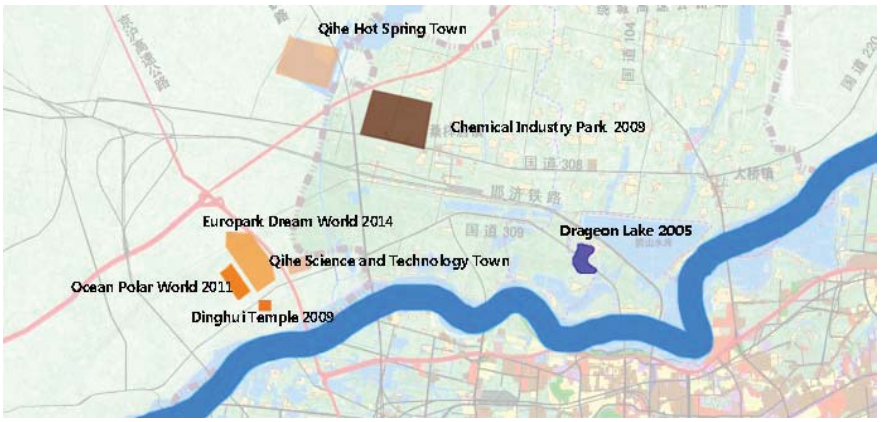

Fig. 17 Projects on the north side of the river

2. The North Side of the Yellow River

The projects on the north side of the Yellow River are mainly recreational playgrounds or new towns. The aim of the construction on the north side of the Yellow River is to develop the new area. The construction in the municipal district of Qihe is built very quickly, which is coincident to the Jinan North-Cross Policy very well.

3. Conclusion

The policy of city development combined with the river is consisted of two parts: the south part and the north part. The policy to develop on the north side of the Yellow River is called North-Cross Policy.

From the two timeline maps above, we can conclude that the focus of the south part is ecological connection, and that of the north part is new town. We can also see that the progress of city combining the river can be more scientific and logical so that the parcels are not only fragments here and there.

D.Landscape Architecture X-Axis: How Can the River Landscape Characteristics Be Highlighted?

1. Existing Ecological Condition

Jinan is south to Tai Mountain, with the Yellow River crossing the northern area of city, high-lying in south and low-lying in north. Jinan has two major east-west rivers of Yellow River and Xiaoqing River, with a large number of rivers and springs in urban area. The Yellow River is an earth suspended river in Jinan area, which interrupts the extension of ecological system between Xiaoqing River and the Yellow River. An ecological link between the southern mountainous area and the northern Yellow River within Jinan urban area should be established.

2. Existing Land Use and Fixed Parcels

The map of existing land use shows the current development of the city. Firstly, there is a large area of agricultural/ undeveloped land, which could be developed based on the subject of landscape design. Secondly, there is also a certain area of industry. It is apparent that in the ecological transitional area, the industry should not account for a large amount of area. Thirdly, the residential/village area is all along the river in the X direction, but their forms are fragments and not well planned. Fourthly, there is a small area of commercial /recreation area. As a whole, this transitional area could be reused as a ecological river transitional belt. Whether the parcels are fixed or not, should be paid attention to in the city plan.

The map of fixed parcels shows that the possibility of the Land to be planned and improved. The red and the orange parcels are fixed and therefore cannot be moved. When making a plan, these fixed parcels should be respected and preserved. Whereas, the yellow parcels are the land which have been sold but not yet fixed. When making landscape design, the yellow parcels could be moved and they have potential to be changed and improved.

This map of fixed parcel is a basis for the future urban planning.

3. Blue-Green Landscape Network along the X-Axis

The blue network should connect the Yellow River to the Xiaoqing River, and provide areas for gathering, conveying and purifying rainwater. The channels, as well as the river edges, are supposed to be designed in a natural way, in order to enhance the water quality and reduce flooding.

The green network is supposed to be built on a basis of the blue network. Based on the map of projects on the south side of the Yellow River, the green space such as landscape parks as well as residential areas could be designed. The relevant landscape green space design along the river such as the cologne right bank, which is consisted of Grünzug Charlier and Rheinboulevard, can be taken a reference to.

In order to build the community surrounded by high-quality open space, t is proposed that the atmosphere of the landscape park influence each development plot, in order to help the plot to have an interaction with nature. The self-sufficient community is intended to be designed with green infrastructure in a low carbon design way.

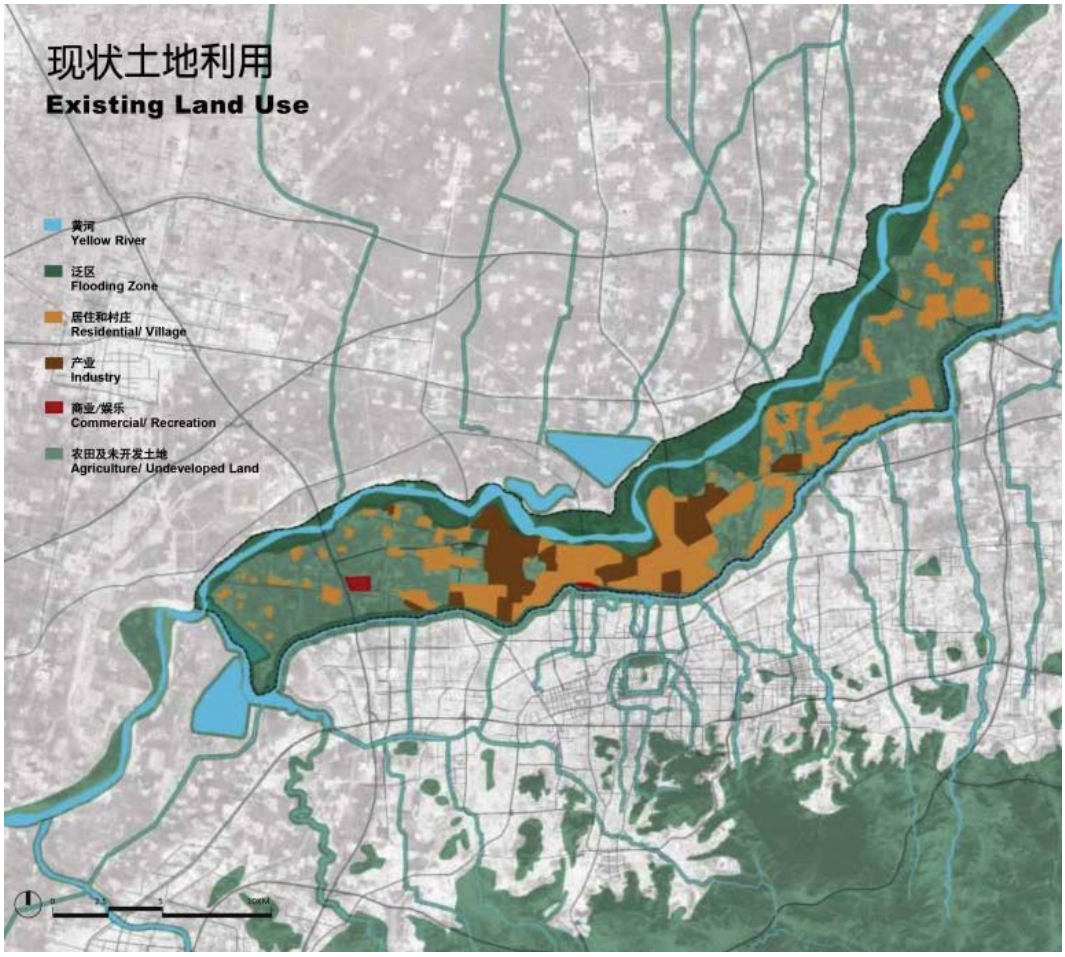

Fig. 18 Existing Land Use. From SOM design

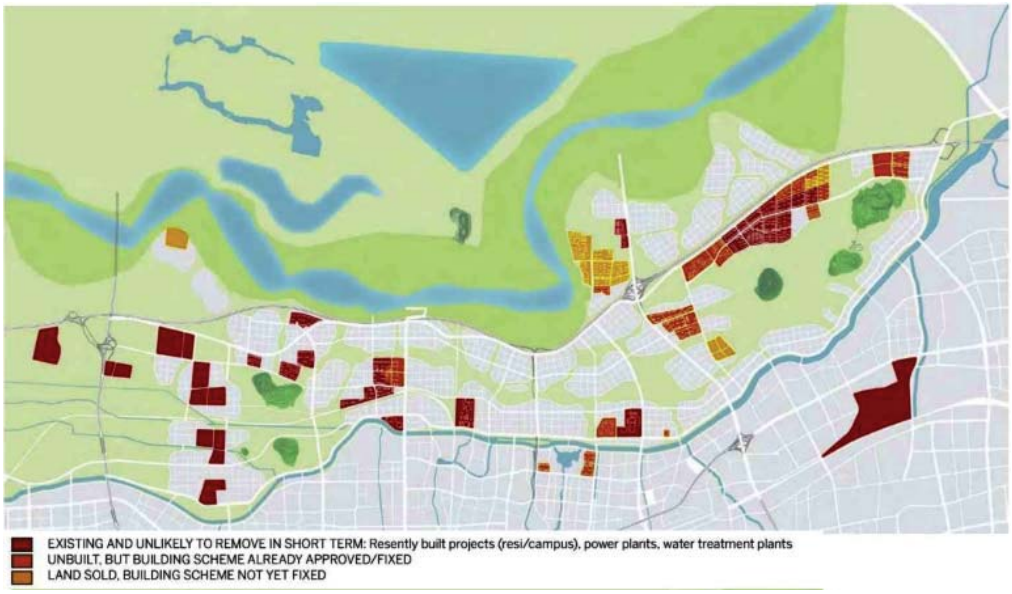

Fig. 19 Fixed parcels. From SOM design

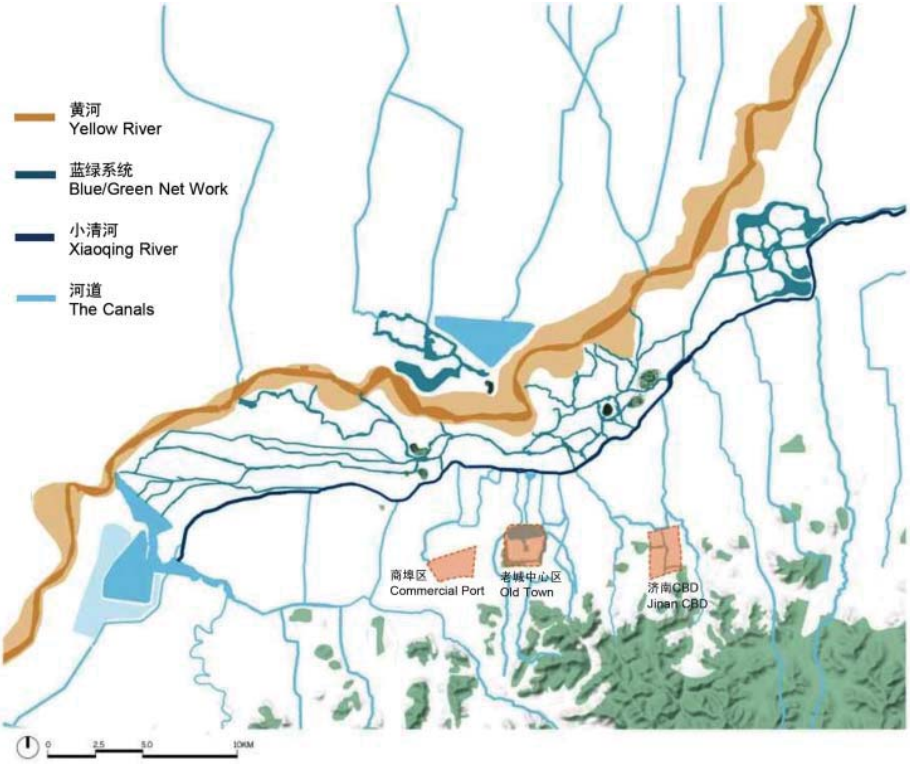

Fig. 20 Blue network. From SOM design

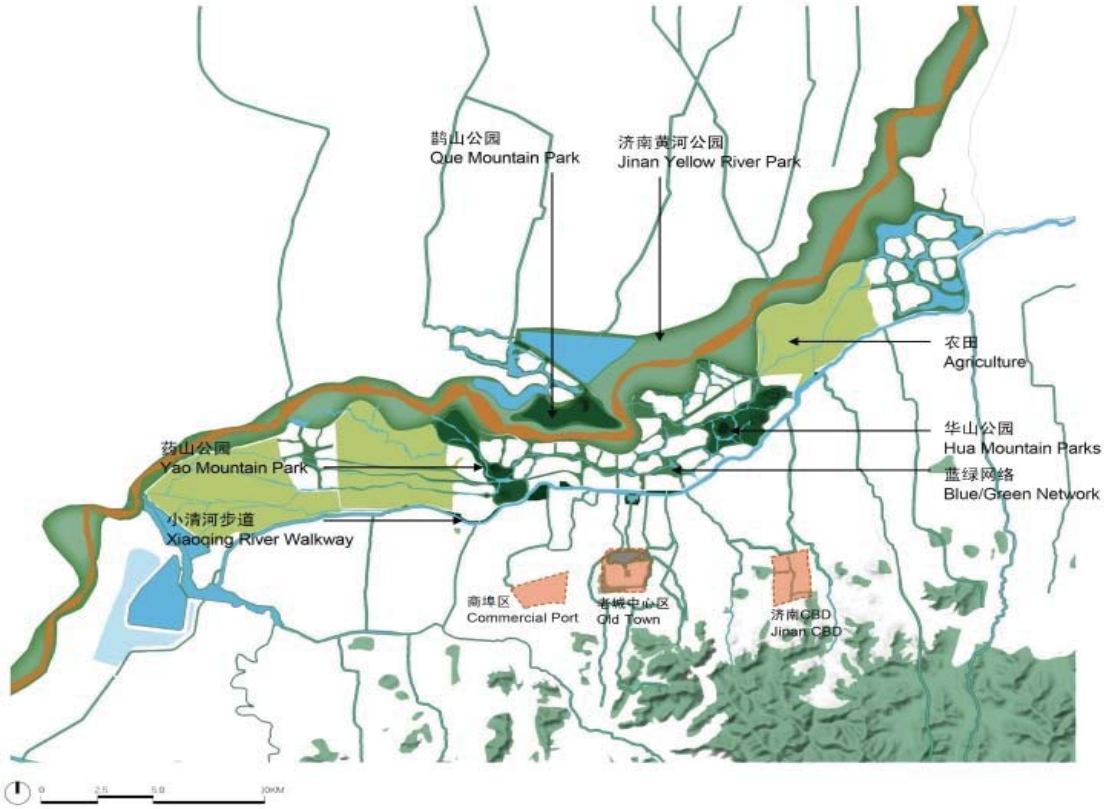

Fig. 21 Green network. From SOM design

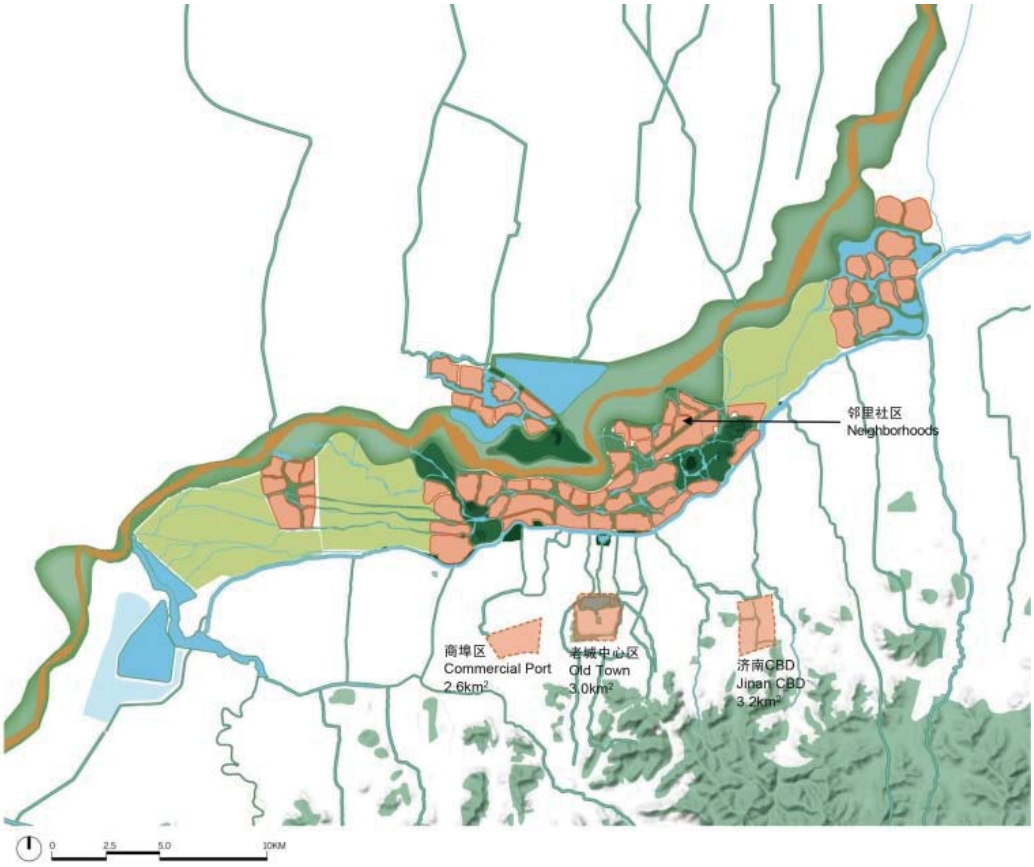

Fig. 22 Orange/Yellow network. From SOM design

Fig. 23 Community surrounded by high-quality open space. From SOM design

E. Y-Axis: How Can People on Both Sides of the River Reach Each Other Satisfactorily?

1. Study Case: Prague

From the google map of the city of Prague, it is clear that the city centers are connected with the bridges. The bridge is a useful tool for the city expansion.

In Jinan, there have been 9 main bridges, which connect the south of the city to the north. Based on the bridges, the railway and airport are designed to help the city communicate with the areas around.

Fig. 24 Connected city centers with bridges in Prague. Repainted from Google map

2. Bridges, Railways and Airports in Y-Axis in Jinan

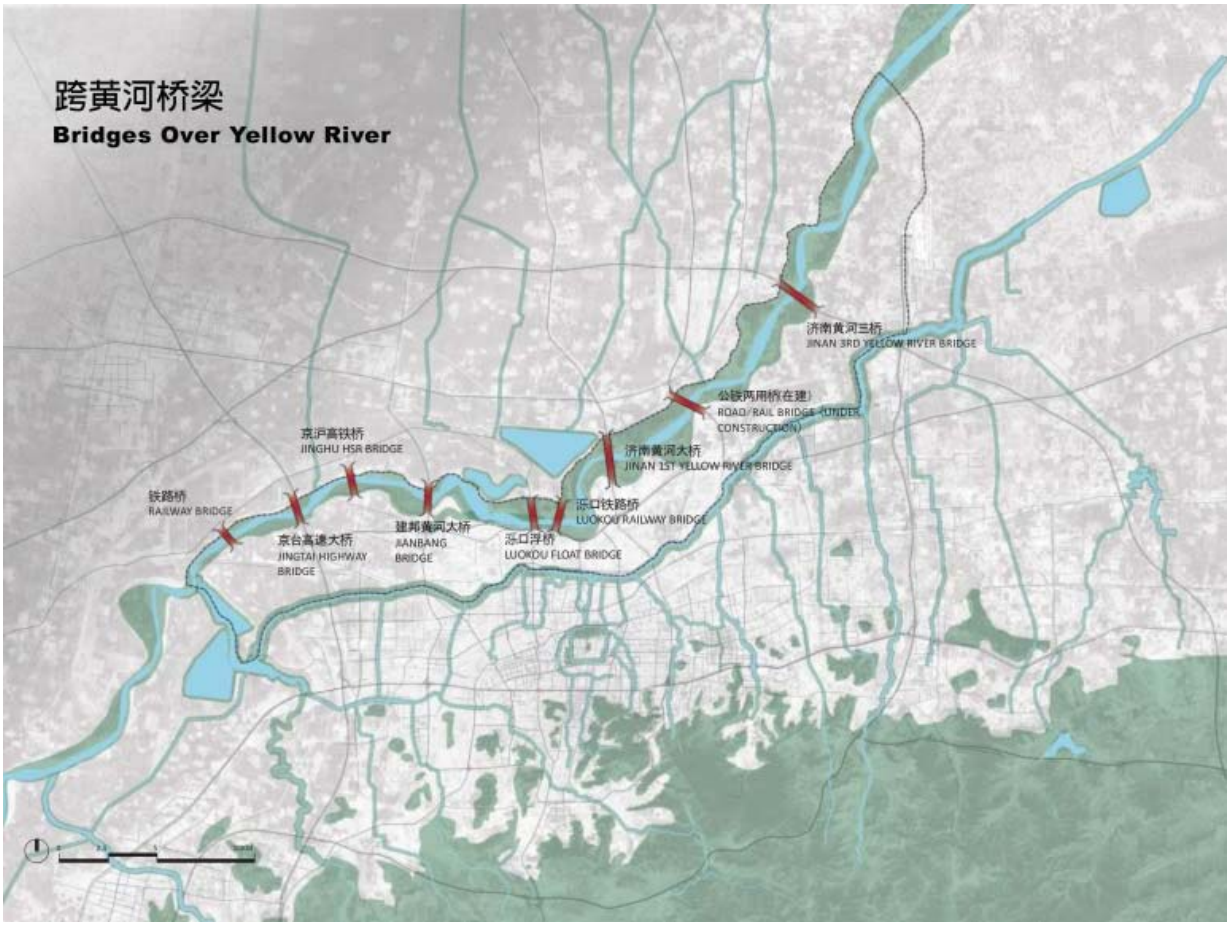

Fig. 25 Jinan main bridges. From SOM

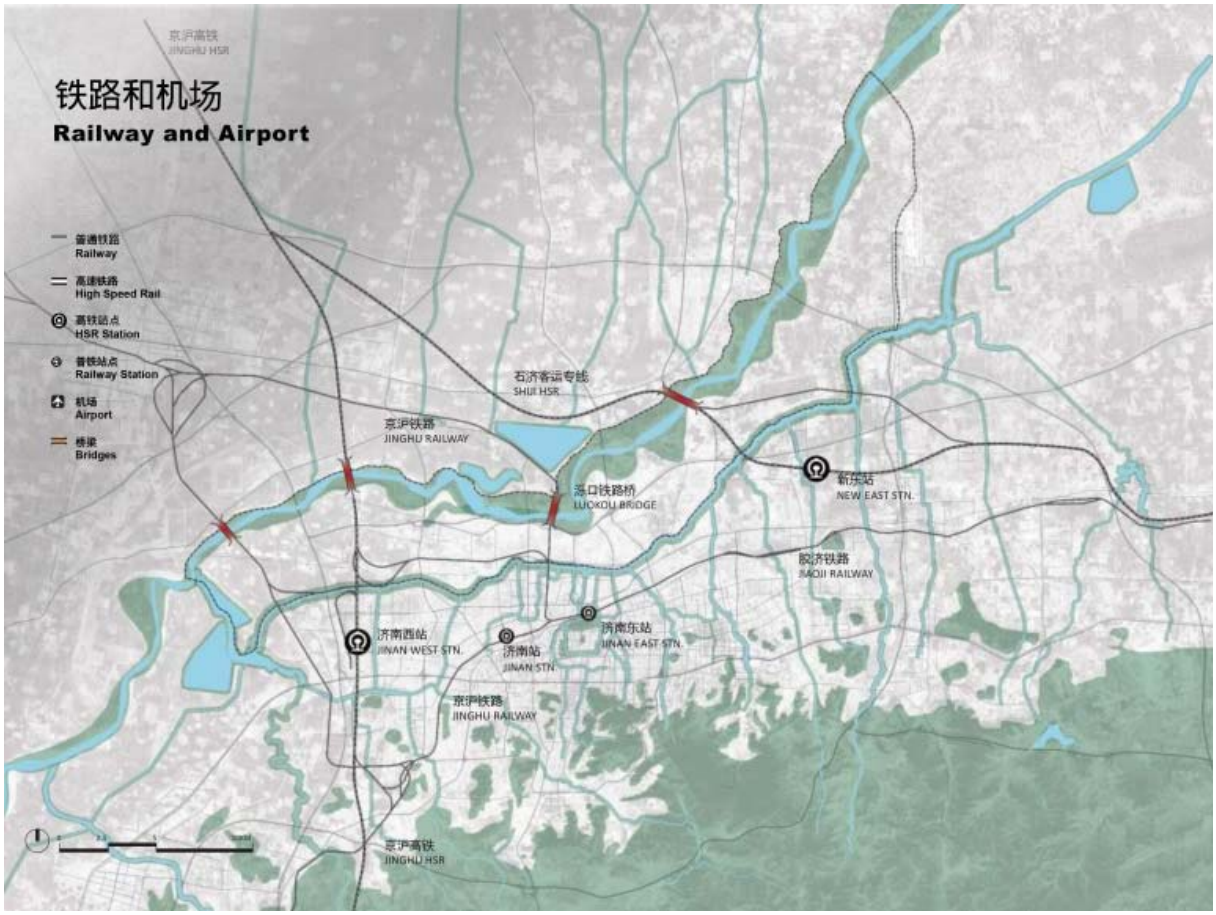

Fig. 26 Jinan main railways and airports. From SOM

3. The Proposal of the Consistency of Landscape and Transportation

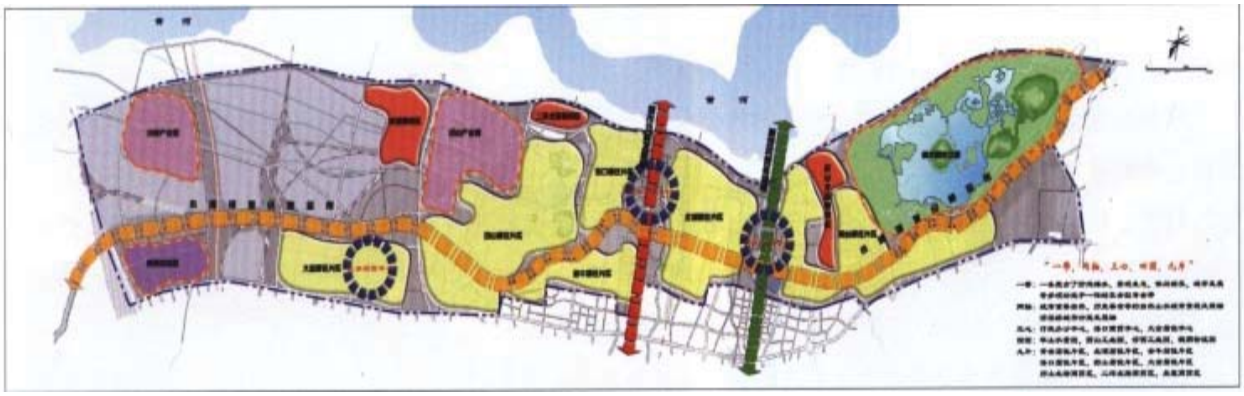

Fig. 27 X-axis design in Jinan. From “Planning the Spring City”

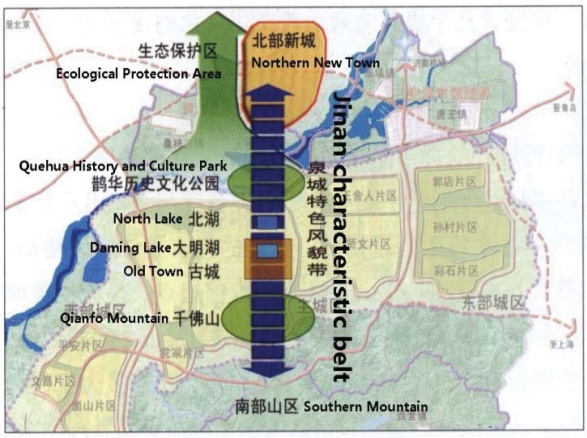

Fig. 28 Y-axis design in Jinan. Repainted from "Planning the Spring City"

Above are the river crossing plans in Jinan in the direction of X and Y. We can see that there is little consideration of bridges. According to the river case office, the work for the bridges has also very little to do with the city plan. The work division in the two offices is not clear and the cooperation is not enough.

In order to help people on both sides of the river reach each other satisfactorily with the beauty of landscape, the coordination of city planning office and the river case office is suggested.

F. Z-Axis: Landscape on the Embankment

1. Starting and Ending Points of the Yellow River Bank Embankments

Fig. 29 Plan of Yellow River Embankments

The south embankment of the river originated from Songzhuang in Huaiyin District, and goes to the lower boundary of Gaoguanzhai Town in the municipal district of Zhangqiu, with a total length of 72.8 kilometers. The north embankment of the river starts from Sangzidian in Tianqiao District, and stops at the lower boundary the Jiyang Subdistrict Office, with a total length of 60.8 km.

2. Section View of the Embankments

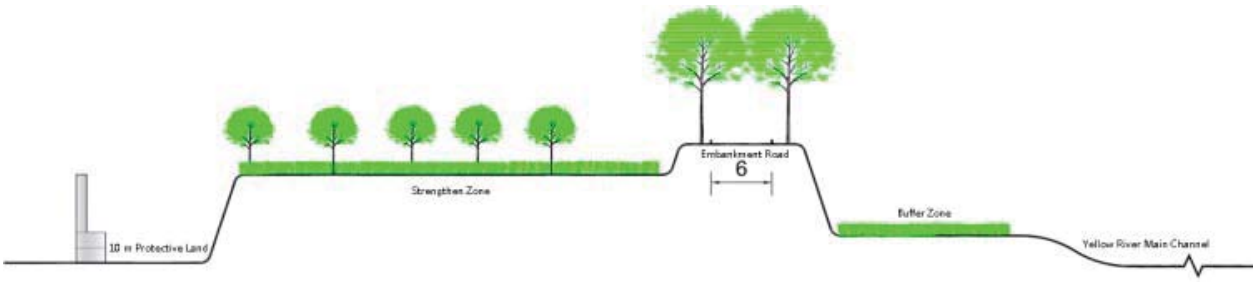

Fig. 30 Section view of a Yellow River embankment. Repainted from Yellow River Authority

Based on the Standardization of Embankment Construction, the section data is strictly ruled. The construction of buffer zone, embankment road, as well as strengthen zone can be planned with the help of landscape architecture.

Fig. 31 Bird view of the model of a Yellow River embankment

The anti-wave forest in the buffer zone is shown in dark green color in the model above. The strengthen area is presented in the light green color. The two areas, especially the strengthen zone, has potential to be developed as landscape Forrest. At present, there has been some, but usually, they are pure forest, which is not well planned. The construction of landscape park is allowed by the river case office in the strengthen zone [5].

3. Wide Use of Z-Axis for the Research of Cities Crossing *Rivers*

Z-axis research can also be made for the whole research area of a section view between the Yellow River and Xiaoqing River, not only for the terrain of the suspended river. Widely speaking, the Z-axis research is suitable for the elements with altitude, when a city crosses a river.

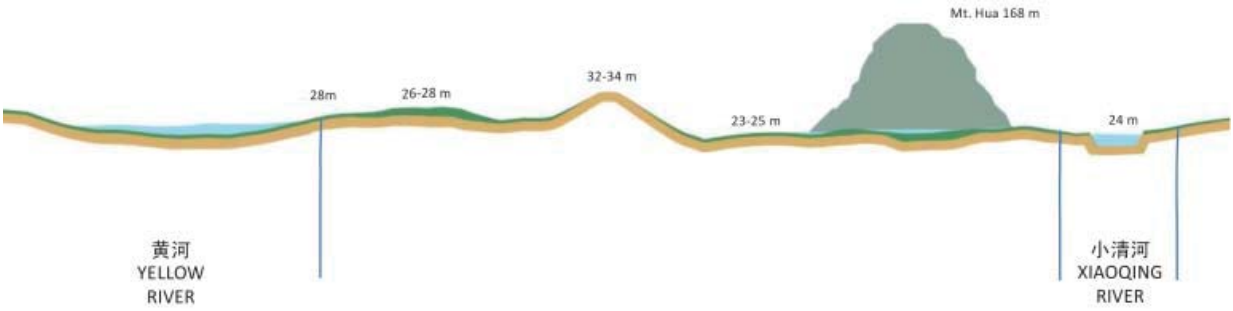

Fig. 32 One section view of the research area

V. Considerations and Suggestions on Urban Design in China

A. River and City

In the spatial pattern analysis of river landscapes, river corridors can be studied in the four-dimensional direction, including three-dimensional changes in spatial scale and changes in timescale [10]. The method of four-dimensional analysis was used in this study.

The idea of Blue-Green Network for Cities Crossing Rivers is first raised in the Quehua District Conceptual Urban Design. Based on this idea, the landscape innovation points of Four-Dimensional Analysis and the sequence of Surface Water-Groundwater- Landscape Water to be considered for Blue-Green Network are raised.

During the first step of the sequence, the groundwater in the research area is analyzed. The groundwater which is suitable for disclosing and which owns a relatively stable groundwater table has available value to be used to build blue-green network. The groundwater which belongs to pore water or phreatic water is relatively easy to be disclosed as surface water. The stable recharge and discharge of the groundwater cause a relatively stable groundwater table as a balance.

City development is determined by landscape design. Landscape design is determined by ecological water network. Ecological water network is determined on groundwater's potential to be disclosed. And all the process should be considered in a logical sequence.

B. Space and Value

China's present planning order is summarized as Benefit - Flood Control Safety. The city development is based on the need of benefit. The role of hydrology and landscape design in the process of city planning is missing [11]. As a result, the city development considers little about the river, the transportation and the feelings of people to enjoy the beautiful environment [12].

Instead, the ideal planning order is Flood Control Safety - Landscape Architecture-People – Benefit. The safety should be first taken into consideration, which has been done as a whole quite well in the last decades in China. It could be done even better if the water network designing in the city could be taken into consideration. After that, the landscape design for the people could be made. And with so harmonious space, to get a good benefit is an inevitability.

C. Value and Management

The coordination of the city planning office and river case office is suggested because the blue network and the green network are one network to be designed at the same time, also because the bridges are not only a means of transportation but also a tool to connect city centers.

In the process of doing this research, very little open and scientific information was found on the city official website. On the official websites are always the news of political conferences and the aim of the city planning. The government has invited some professional landscape designers from aboard, but on the website are only the words about how famous are the designing team is, not about how they make the design. As landscape designer, it is known to all that the status quo is the basis for all. But in China, it should be kept as a secret. The city plans, as well as some of the regional plans, are announced on the website, in order to have some feedback from the people. But without even making a land use map public, it is hard to propose some useful feedback even for a professional landscape designer.

In the socialist country, the government plays a big role. If the management method is improved by the government, the process of urban design in China would be safer and healthier.

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