

Resilient Development of Urban Waterfront in Fast-Changing Cities—A Case Study of Wuhan, China

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Abstract: Urban waterfronts, where the land of city meets a body of water, are unique and finite resources representing the best opportunities for community enhancement and enrichment. On the other hand, waterfronts are also high-risk areas, where the water-related disasters could seriously affect the long-term sustainability of urban environment. This paper focuses on the relationship of the cities with their waterfronts. It presents a case study of Wuhan—a Chinese metropolis, where waterfronts play an important role in its urban planning policy. It attempts to investigate the mechanism of waterfront transformation, and to find out which strategies to adapt and what resilience means in terms of urban waterfronts in a rapidly transforming city. This article examines some representative urban projects on the waterfront and summarizes spatial models applied on the waterfront with distinct policies. Finally, it demonstrates that an urban waterfront is an “osmotic interface” which should be more correctly envisaged as a network of places, functions, additions and hinges between the city and its water environment. It clarifies that waterfront areas represent a multidisciplinary and multitasking issue in perspective of urban resilient development.

Key words: Waterfront, resilient development, urban renewal, adaptive strategies.

1. Introduction

Living in the 21st century has provided many problems. We face climate change and a degraded environment, an uncertain economy and social inequality, cultural conflict and a loss of local identity. Improving urban quality, and reinforcing sustainability in dynamic and changing city contexts are challenges for urban communities everywhere. Some existing urban design processes have been rendered obsolete. And a new paradigm is required in order to develop resilient cities to adapt and thrive in changing global conditions, meet the requirements of environmental measures, and sustain compact urban populations by providing necessary and desirable amenities for urban residents. Consequently architects and urbanists are demanded to define compelling visions and integrated design measures for shaping resilient cities. We believe

that effective urban planning and building design could play an important role in facilitating the development of a greater capacity for future resilience. In this way, our paper focuses on waterfronts—a specific territory on the interface between land and water. This article will discuss what resilience means in terms of waterfronts and how development projects can enhance the “resilience” of cities, starting with the regeneration of waterfronts.

In fact, waterfront represents a specific transition area between urban space and aquatic environment. For some time in the late industrial age, there are still sites of old warehouses, rusty cranes, severely polluted wharfs and railway yards behind, in or near the city center, which laid a burden upon the city. The first waterfront redevelopment projects were started in the 1960s in north American cities, in particular Baltimore and Boston. From then on, across the world, great cities have been regenerating, transforming and seizing new urban opportunities on their historic waterfronts. Successful results can be seen in London,

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Barcelona, New York, and Rotterdam [1]. Nowadays, waterfront redevelopment has become a global trend [2]. Thousands of schemes are being carried out in large metropolises, medium-sized cities and even small towns all over the world. More and more cities began to perceive their waterfront as an asset rather than as a problem. Redevelopment of these particular sites is increasingly considered to return waterfronts to the urban property market, but also to offer a great potential to boost the postindustrial transformation [3]. Waterfronts have been imagined as a concentration of functions that can be productive, cultural, relational, recreational, residential and public. “Waterfront regeneration is seen as a cure-all for ailing cities in search of new self-images or ways of dealing with issues of competition for capital development or tourist dollars [4]”.

Paradoxically, in spite of all the opportunities related with the waterfront development, it is impossible to disregard that waterfronts are still high risk areas. In the last decades water-related disasters have seriously affected the long-term sustainability of the urban environment. The need to reconstruct waterfront areas has been a complex reality to deal with in the past and it is likely to become more and more an urgent reality for the future [5].

Considering all of the above, waterfront areas represent a multidisciplinary and multitasking issue in perspective of urban resilient development. These areas should not be considered as a simple line between land and water, but also the dense and hybrid places where resources, opportunities, aspirations and ambitions held by the city could become envisioned. Waterfront strategies and projects are capable of generating a new urban form and producing a new landscape to make cities more vital, communicative and competitive.

2. The Case of Wuhan

This paper employs a case study of the Chinese city of Wuhan. Wuhan, a capital city in central China, is a

typical waterfront city. Over a quarter of its metropolitan area is occupied by bodies of water, representing an area of 2,117.6 km². The world’s third largest river—Yangtze and its longest tributary—Han run through the city dividing it into three parts: Wuchang, Hankou and Hanyang (Fig. 1). 164 lakes spread throughout the agglomeration, in which 27 locate in the city center. This aquatic environment forms 413 km of waterfront in Wuhan’s main urban area. The shorelines are central to the city’s history, essential to its economy, environment and crucial to its future.

2.1 The Long History of Wuhan’s Waterfront Development

Wuhan has a long history of waterfront development. As early as 1,800 years ago, Wuchang and Hanyang each built a fortification on opposite sides of the Yangtze. They progressively developed into urban settlements, and formed a twin-city during the Tang Dynasty (618-907 A.D.). Depending on their strategic position in the regional water network (rivers, lakes, etc.) this twin-city became the biggest commercial and transit center in central and south China. The urban space extended along the waterways and the waterfronts becoming the scene of citizen’s everyday needs and activities. The third part of the city—Hankou was formed by separating from Hanyang after a diversion of the Han River in 1474. By taking advantage of the traffic at the junction of the Yangtze and the Han, the port trade in Hankou grew rapidly, which made it become the biggest inland port in central China and one of the four most famous towns in the Qing Dynasty (1644-1912 A.D.).

In the industrial age, Hanyang’s waterfront became a precedent for the Chinese modern industry. Hanyang Iron Works and Hanyang Arsenal were founded along the Han River, in late Qing Dynasty, as the most advanced industry in Asia at that time. Meanwhile, several great textile factories were erected in front

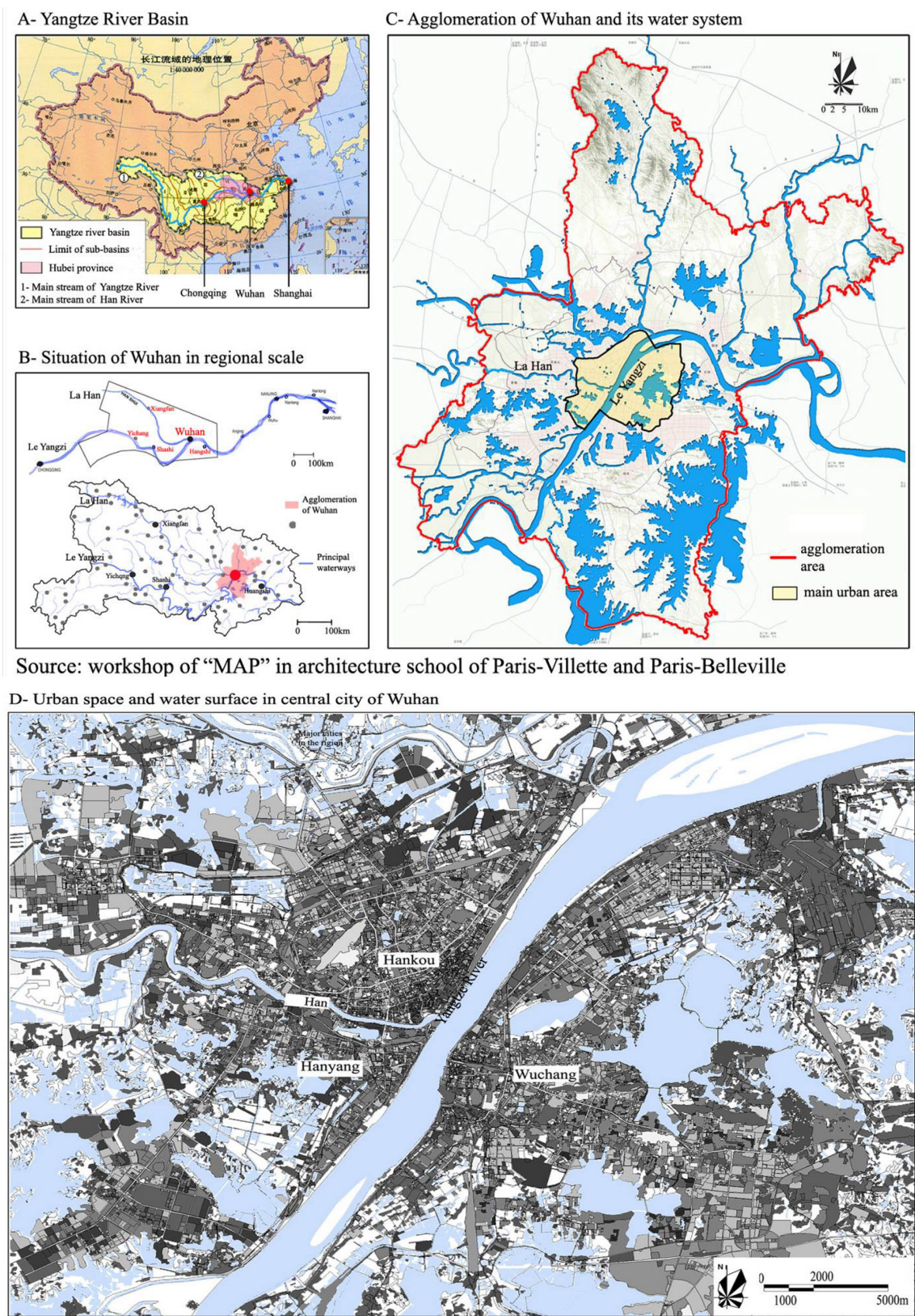


Fig. 1 Location of Wuhan and its water system on different scales.

of the Yangtze outside the fortified city of Wuchang. And in Hankou, from 1861 to 1949, the port was opened to western powers. Britain, France, Germany, Japan and Russia successively established their concessions downstream the Yangtze River, in a bund area of 2.2 km². Western urban constructions and architectural styles were introduced in large quantities. The waterfronts, largely artificial, began to be transformed as a special area separated from the rest of the city and contributed to the port and industrial activities. After 1949, a number of important infrastructures, modern factories and residential units were continually built along the great rivers including the first bridge across the Yangtze finished in 1957.

From the 1980s, under the influence of the Chinese economic reform, introducing market principles began in 1978, Wuhan city experienced huge economic progress and development of the tertiary sector. This big change of local economic structure stimulated the reorientation and reorganization of urban functions, especially concerning industry and port sectors in the center of the city. As a result, Wuhan's waterfronts went through a large transition.

2.2 Public Space-Led Waterfront Regeneration

In 1996, Wuhan envisaged the transformation of the waterfront of the Yangtze in Hankou. The waterfront with the dimensions of 150-420 m wide, 7,000 m long, and about 2,000,000 m², is located in front of the old foreign concessions in the center of city. It was abandoned after the decline of the ancient industrial port. The community chose to introduce a public green walkway along the great river. In fact, this choice was a local response to a national competition named "garden city", carried out by the Ministry of Construction. In evaluation of its candidature, forest coverage rate, green coverage rate, and the per capita green area are three main factors. In order to improve the "green coverage rate", the city of Wuhan took strategies to integrate the existing open spaces and to build more public green space in the city center [6]. In

this way, the waterfront became a hot area for the local managers.

Meanwhile, the regeneration of the waterfront in Hankou was also in view of the flood protection. In fact, in 1998, the basin of the Yangtze (including Wuhan) underwent a flood catastrophe which caused the loss of millions of lives and serious economic damage. During this catastrophe, the abandoned constructions on Hankou's waterfront, strongly prevented the flow of water. This caused a very dangerous acceleration of the rise of water level at the flood's peak.

Consequently, the public green walkway led the renewal of waterfronts in Wuhan in this period. The waterfront in Hankou was reconstructed. 200,000 m² of old warehouses and factories were removed. And a huge greenway park was created along the river. This park was built in three levels according to the water level in different seasons. The first level was equivalent to the Yangtze River's perennial water level, which would be submerged for nine months per year and a lot of wetlands were reserved there. The second level was equivalent to the city's water level for flood control, which would be submerged three months per year, and a lot of water-resistant trees were planted on this level. The third level was equivalent to the flood water level one time per twenty years. The landscape walkway and a number of recreational green spaces were created on this level to form a relatively permanent open space.

The creation of this public walkway park has improved the lack of open green space in Hankou's central area. By reforming the city's riverside, citizens and tourists can enjoy the urban waterfront landscape both in the dry and the flood season, and the waterfront became an important urban public space. Subsequently, this strategy to create open green space on urban waterfront was executed in the entire city. The total length of riverside landscape walkway reached 26 km, covering an area of 1,810,000 ha, including almost all of the oldest part and the densest

part of the city [7]. Reconstruction of waterfront has improved the urban image and played an active role in regeneration of city center.

2.3 New Strategy of Renaturation

In the last ten years, a new trend of “back to nature” appeared. This new tendency inspired a set of new projects, of which we intend to present one of the most representative projects of the reconstruction of Wuhan’s water network.

In fact, this operation was been considered to solve the water pollution problem of lakes in the urban area. The lakes have been isolated one from the other in the process of urbanization. The idea is by digging new canals or using the existing waterways, to join the lakes with the big rivers. The principle is to imitate the waters in their natural state by creating a

semi-artificial water network, in which water can circulate and auto-purify.

This ambitious project was set in motion in 2007. At first, it was a small experimental operation. The lake of the Moon in Hanyang (surface of 37.3 ha) has been joined artificially with the Han River. In only one week, 70% of the water has been renewed, and the quality of the water has been improved considerably. After this operation, three large-scale projects have been put in place simultaneously: in Hanyang, a project to connect the six lakes; in Wuchang, a project to create a water network of the East lake; in Hankou, the project to create a water network of the Jinyin lake (Fig. 2). Thanks to an environmental strategy, these projects have got the financial and political support not only from the local government but also from the central government.

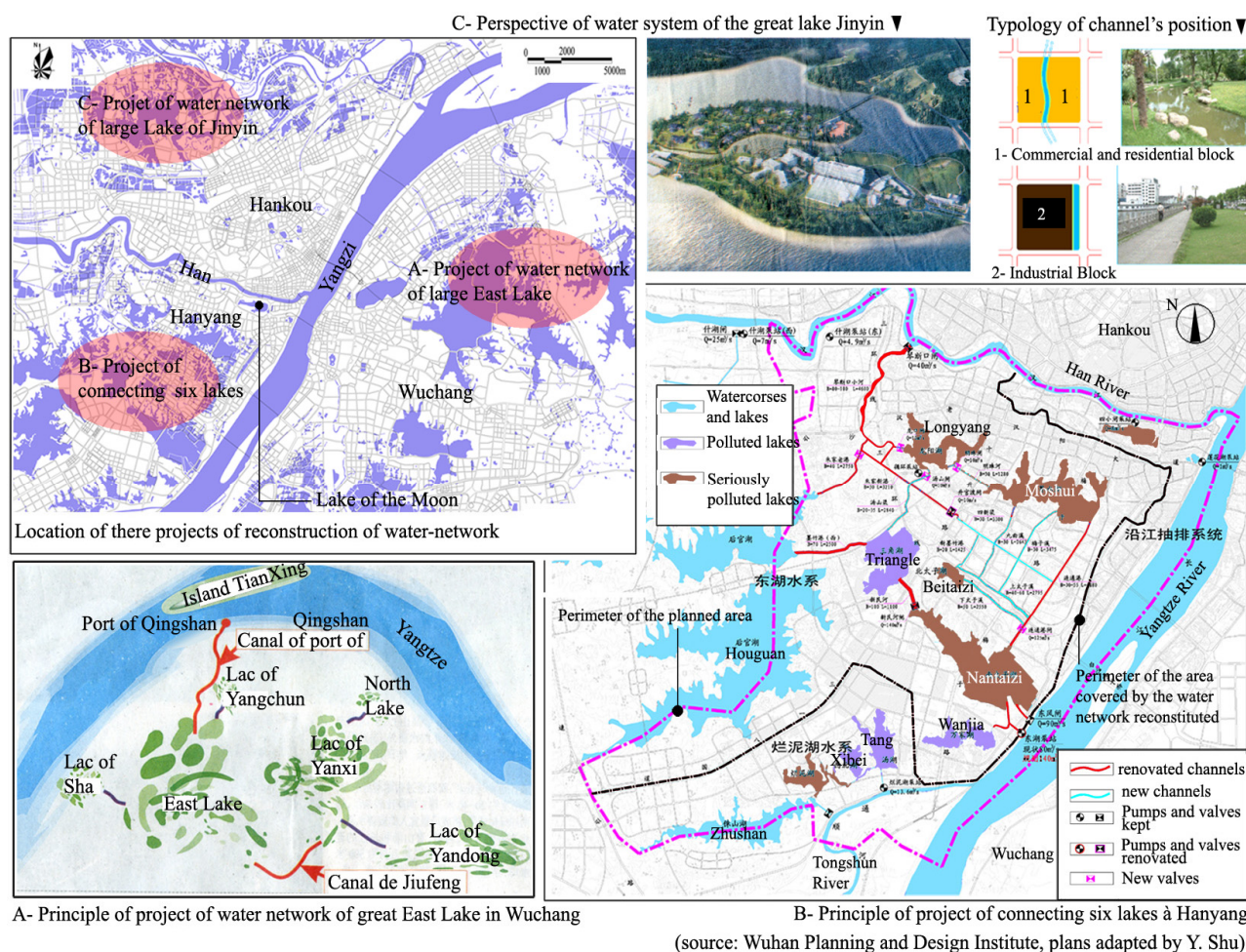


Fig. 2 Projects of reconstruction of Wuhan’s water network.

Wuhan has even been designated, by the state, as one of the first three cities of experimentation on the protection and the restoration of urban water environment.

In addition to the reconstruction of water networks, Wuhan also took advantage of a new program of “wetland parks”. A plan to restore the wetland has been elaborated by the local urbanism service in 2006. In 2009, after two years of study, the city decided to start a big project. It transforms the picturesque site around the East lake (with a surface of water of 33 km², it is the biggest urban lake in China) into a national wetland park. Some aquatic floras have been planted and the mineral banks have been refitted with more natural materials.

3. Two Crucial Dimensions of Waterfront Resilience

Through the observation of urban renewal operations in waterfront areas in Wuhan, we can identify some general factors of waterfront resilience on two crucial dimensions: temporal dimension and spatial dimension.

3.1 Temporal Dimension: Permanence and Rupture

The interaction between city and water is the main character of an urban waterfront. As an interface, waterfront stimulates a duality of time [8]. On one hand, waters themselves are in perpetual movement and renewal under natural forces and artificial forces. On the other hand, the city grows on the new form based on the previous state. Different urban fabrics in different times are replaced, overlaid or more often juxtaposed in the city [9]. Often the oldest parts of city face the most recent developments, including the waterfront. However, among these changes, there is one thing that never changes: the need for water control. As Bethemont explained [10]: “From one end to the other of the chain of time, the control of water in various forms and its association with plants of civilization and social systems characterized by

rigorous organization appear as a constant”. As a result, in terms of waterfront, the precondition to understand resilience is to compare the age of the water with the age of the city, to show the interactions between these two time channels coexisting in the same space and complementing one another (Fig. 3).

In this way, we generalize the numerous particular operations and divide the transformation of urban waterfronts into three stages:

- Stage 1: constitution of urban territory in dependence on aquatic environment;
- Stage 2: artificialization of territory and banalization of water;
- Stage 3: metropolization and reconciliation between city and water.

The first stage lasted a long time, since the origin of the city until the dawn of the industrial era. It includes two periods of “city-fortification” and “city-port commercial”. In this stage, the city had a tight and direct link with the water, which modeled the lands, offered a vital life source and served as the principal form of communication. Waterfronts became a veritable life space. They were widely accessible to all people and used for a variety activities: dwelling, fishing, commerce, leisure, sacrifice, etc.. The harmony between human and nature was determined by the environment.

This fragile balance has been finally broken in the following stage, named according to Wackermann [11] “artificialization of territory”. Based on our progress of knowledge and expertise, this second stage developed with a process of industrialization. Water was an element of utility and an auxiliary of production. Waterfront was specialized for production activities and gradually lost its amenity. This resulted in a rupture between living spaces and waterfronts, even a rupture between the city and water.

The third stage is characterized in recent decades since the 1990s (in the case of Wuhan). During this period, the city experienced a process of “metropolisation” with the renewal of the old city center

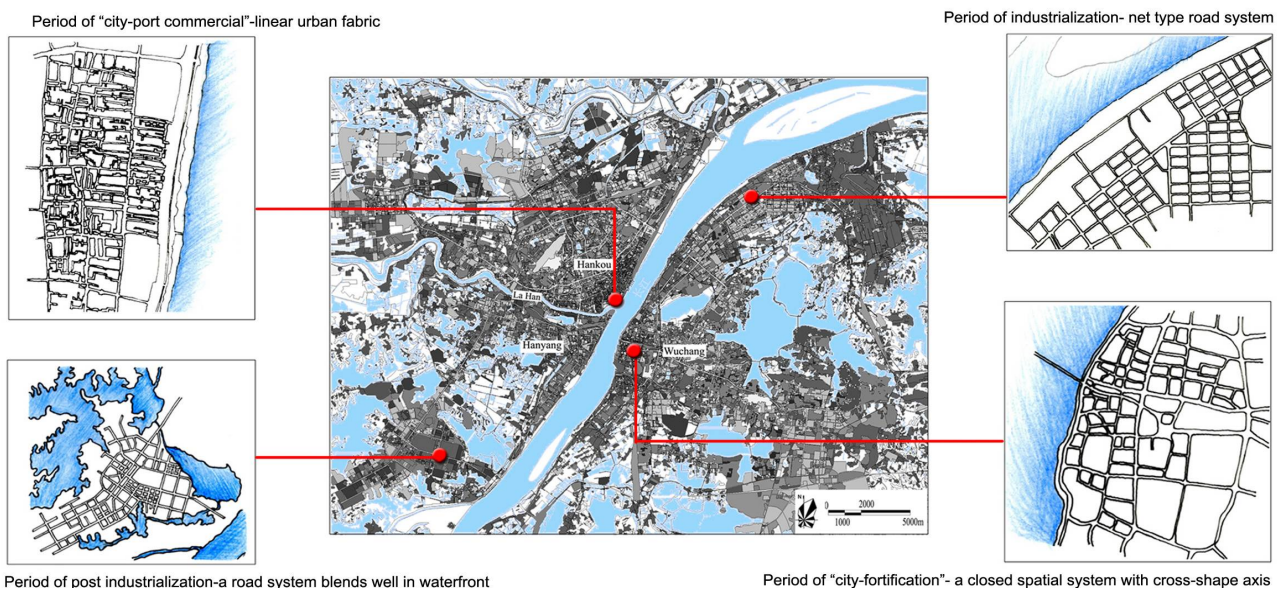
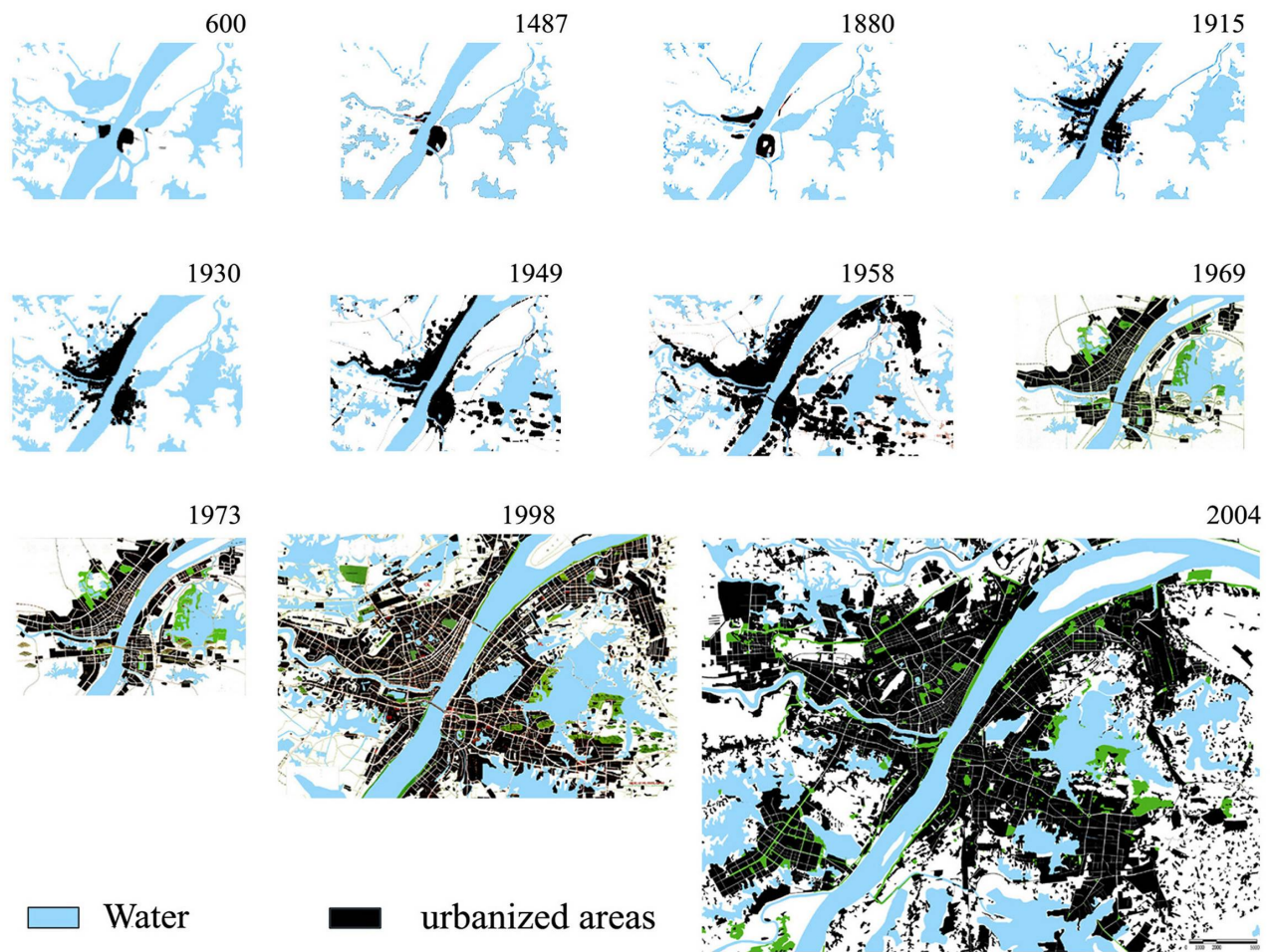
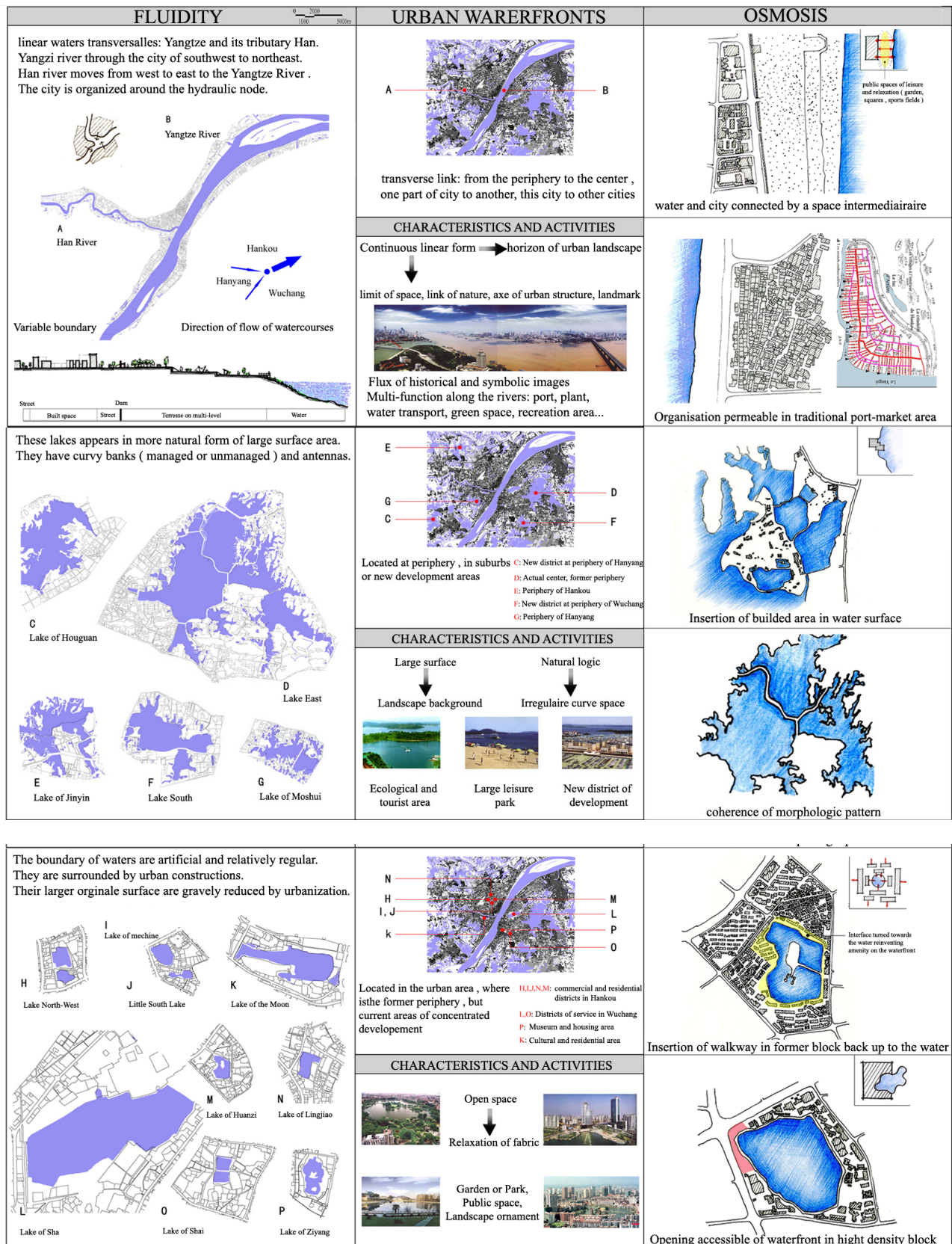


Fig. 3 Interactions between city and water over time and different urban fabrics in different periods juxtaposed in the city (Wuhan).



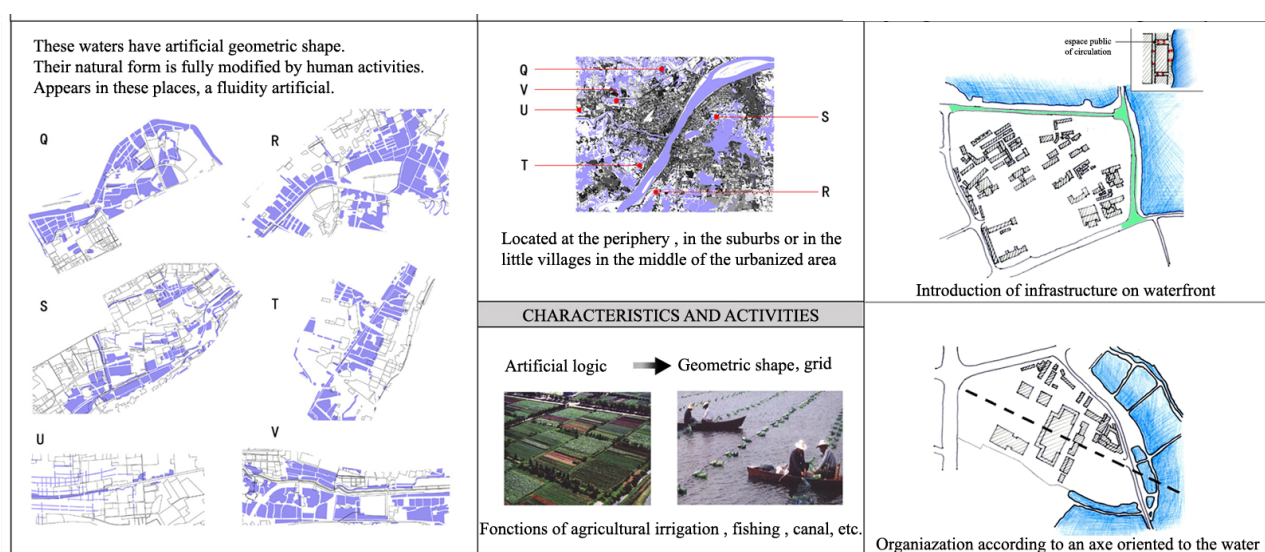


Fig. 4 Fluidity and osmosis of waterfronts: an illustration of Wuhan.

and the development of new urban centers on the periphery. During this process, an essential environmental policy has been also implemented in a new social and economic context. It led waterfront regeneration across a number of projects. All these projects show a new relation between the city and water. This relationship tries to overcome both the strict geographical determinism of the first stage and the abstract urban planning based on the absolute utility value of the second stage, thus entering the third phase in the history of city and water, that of co-dependence, mutual adaptation: reconciled rather than separate.

3.2 Spatial Dimension: Fluidity and Osmosis

The presence of water renders waterfronts distinct from the other spaces in the city. All resilience linked with waterfronts: economic, social, cultural, ecological, etc., are all branded by these spatial properties and the relationship between the spatial elements. In the case of Wuhan, we distinguish two major spatial characteristics which strongly affect the potential adaptation of waterfronts in urban resilient development (Fig. 4).

3.2.1 Fluidity

The fluidity originates from the movement of water which introduces one of the first sources of mobility

on land (like the waterways in Wuhan's case). It provides a dynamic of space engendering the flux of materials, people, energy, activities and images.

Fluidity represents a direction which engenders axis of mobility.

Fluidity implies a variable boundary which stimulates creative architectural experiences. The multilevel walkway on the waterfront in Hankou, the buildings on piles in the traditional commercial port, and the wetland park along the lake shoreline are all good examples.

Fluidity also facilitates a transverse link in which we can integrate center and periphery, upstream and downstream, in the past and future.

3.2.2 Osmosis

In view of resilient development, waterfront is not a closed and protected area (like the ports in the early industrial age which have created a rupture between water and city), but an osmotic interface, with a permeable perimeter. "A waterfront cannot be considered as a local hub, but more correctly as a crossroad of infrastructural strips on sea and land that run across, that nourish it: the core of an increasingly planetary network of relational energies" [12].

A waterfront with osmosis is an urban fabric easily accessible and passable. We can take the streets in front of the Yangtze of traditional port in Wuhan as an

example. These are in the shape of fishbone diagrams which is convenient for flux of merchandise and flux of passengers to pass through, bringing in the neighborhood vitality and prosperity.

4. Conclusions

Resilience is the ability to absorb disturbances, to be changed and then re-organized and still have the same identity, retain the same basic structure and ways of functioning. In terms of waterfront, resilience has specific connotations, stemming from its temporal and spatial dimension mentioned above. In conclusion, we clarify these connotations and the adaptive strategies in the following text.

4.1 On a Temporal Scale

A resilient waterfront is a place in which informed historic knowledge nurtures visions for the future, and in which the ambition of strategies produces an effective interpretation of the past. The collective heritage of water and city, events, landmarks and nature should be utilized to give the waterfront redevelopment character and meaning.

In practice, resilient waterfronts are long term projects. Waterfronts need to be redeveloped step by step, so the entire city can benefit from their potential. They are a challenge for more than one generation and need a variety of characteristics both in planning, architecture and public space. Public administration must give impulses on a political level to ensure that the objectives are realized while balancing short and long term interests. Furthermore, resilient development from the waterfront renewal is also an ongoing process. The master planning should be based on the detailed analysis of the principle functions of the waterfronts. All plans should adapt to changes and incorporate all relevant disciplines.

4.2 On a Spatial Scale

Waterfronts are a part of the existing urban fabric. They should be conceived as an integral part of the

existing city and contribute to its vitality. Waterfronts are also part of the urban landscape and should be utilized for specific functions such as waterborne transport, entertainment and culture, etc.. For all operations, the quality and the amount of water in aquatic system is a precondition.

When considering osmosis, creating connections is critical to successfully link the waterfront to its adjacent communities, and public access is a prerequisite. Waterfronts should be both physically and visually accessible for locals and tourists of all ages and all incomes. Public spaces should be constructed with high quality to allow intensive use. Furthermore, waterfronts should also celebrate water and facilitate the fluidity by offering a diversity of cultural, commercial and housing uses. In this way, mixed use is a priority, not only in waterfronts, but also in housing neighborhoods.

There are a variety of potential strategies to adapt waterfront areas to be more resilient in dynamic and changing city contexts. The brief review of the transformation of waterfront spaces in Wuhan points out that the adaptive strategies are rooted in local and metropolitan aspirations. The key consideration framework based on temporal and spatial dimensions of the waterfront described in this paper can guide thoughtful and ongoing planning process for increasing resilience in the urban context.

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