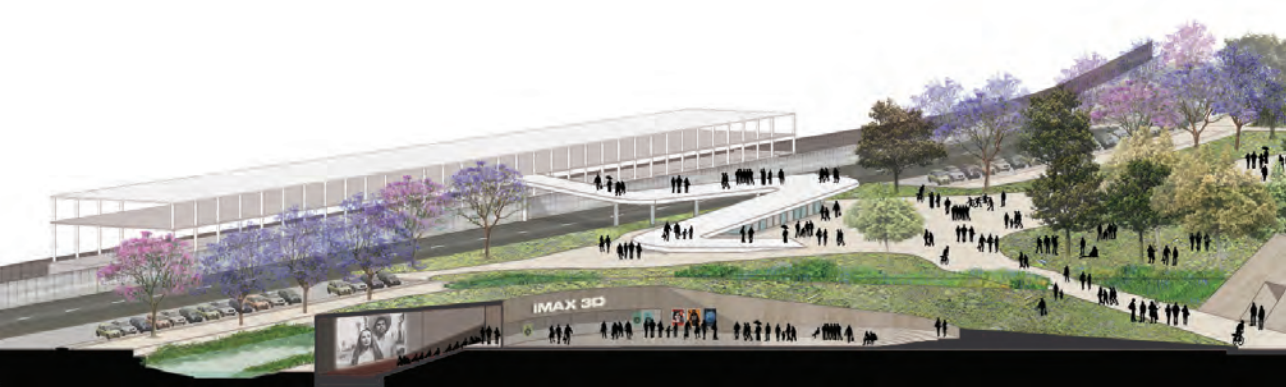
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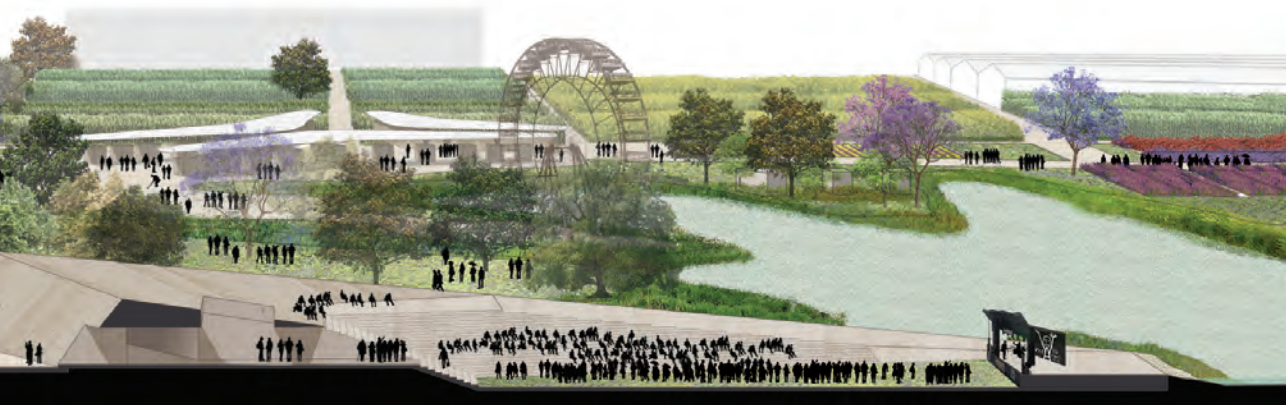
# REGENERATING WATERFRONT CITIES



# Mexico City: Redefining its Waterscape

Mexico City, Mexico

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Abstract: The ancient Tenochtitlan, born as a water sensitive city, understood how to blend with its natural context, retrieving its defining characteristics from it. The city of canals and *chinampas* was conquered by Spain in 1525. Together with the political and social transformation, it also went through an urban reorganization. The Spanish city was built out of stone and earth, gaining land by desiccating the lakes that conformed its waterscape. The modern Mexico City still rests upon what was once a lake system, a clayish ground that is continuously deformed by the weight and action of a 22 million-inhabitant megalopolis. The city deals with recurring flash floods and the insufficient supply of drinking water through a complex and expensive system of tubes and tunnels that solve the larger risk of a mega flood but are not enough to manage smaller events. Several solutions regarding a more sustainable management of the city's hydraulic system and water ecosystem have been presented coming from a large number of specialists. At the Taller Hidrico Urbano of the School of Architecture of UNAM we design to achieve sustainable water management in Mexico City, developing acupuncture solutions that understand a complex social, political, economical, urban, and natural context and proposing projects that will have a domino effect. Such is the case of Tlaltenco Water Connective Tissue and Hydropark Quebradora.

Key words: Mexico City, desiccation, lakes, infrastructure.

Mexico City was built upon the unstable ground provided by a lakebed. This situation has determined the city's urban form, as it has completely transformed itself since its foundation in 1325. The former city of water channels has become a megalopolis of viaducts, elevated highways, and a never-ending urban fabric where the only element that has disappeared is water. What was once a place where landscape played a very important role has become one where infrastructure such as tubes, pipes, and pumps, have absorbed the function of regulating water. The latest are not capable of managing water by them selves. The city desperately needs the intervention of softer infrastructures related to water administration. The ideas behind the understanding of Landscape as Infrastructure[2] are potentially a solution for the city's current water situation.

The Basin of Mexico was formed thousands of years ago as the result of a se-

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2. Definition of Landscape as Infrastructure

ries of geological accidents. The latest one, the appearance of Sierra Chichinautzin, is what gave it its endorheic[3] character (Mooser, 2008). Jorge Legorreta, an expert on water management in Mexico City, described the basin's form as that of a bowl or molcajete[4], receiving water runoffs from the surrounding mountains without any natural exit, therefore becoming the perfect scenario for a system of seasonal lakes. La Gran Tenochtitlan (the pre-Columbian Mexico City), was built in this setting, precisely in the center of lake Texcoco, the largest water body of the basin. Although some may like to imagine Mexico City as a riverine metropolis, these venues have never been present, not even in Tenochtitlan, the pre-Columbian city. Rivers were part of the surrounding landscape. About fifty streams and waterways ran down the mountains, but before crossing the basin or appearing in the urban area, they flowed into the lake system. However, manmade hydraulic infrastructure as transportation canals, ditches, and floating islands or chinampas[5] were very present in the city's life.

*Fig.1. Image of Tenochtitlan before the arrival of the Spanish. Tanoch Ewalth Fildinger*

La Gran Tenochtitlan was very similar to today's Xochimilco. Its urban form

3 en.wikipedia.org
An endorheic basin (from the Ancient Greek: ἔνδον, éndon, "within" and ῥεῖν, rheîn, "to flow") is a closed drainage basin that retains water and allows no outflow to other external bodies of water, such as rivers or oceans, but converges instead into lakes or swamps, permanent or seasonal, that equilibrate through evaporation. Such a basin may also be referred to as a closed or terminal basin or as an internal drainage system.
4. www.rae.es. Large stone mortar supported by three short legs used to prepare salsa.
5 www.rae.es Small site placed in the lakes of Mexico City where flowers and vegetables grow. Historically these were floating orchards.

*Fig.2. Mexico city as seen today*

responded to its natural context. Through built waterways and dams the mexicas[6] had a system able to control and pulverize periodic floods around the city.

Even though these were never stopped, the city was resilient to them. Moreover, the same system structured mobility, agriculture practices, and defense strategies. Tenochtitlan was one of the best examples of what we call today Landscape Infrastructure.

In 1512 Hernán Cortés first arrived to the Basin of Mexico, finding such a landscape. Even though he did appreciate the city he had just discovered, the Spanish conquer destroyed most of the infrastructure that kept the system alive. This fact, together with the series of events it unchained, became a turning point in the history of the city. It involved a complete reorganization of its economic, political, and social systems, as well as an absolute restructuring of its urban form. Actually, an entire new urban system, based on the "Leyes de Indias" substituted the ancient channel and chinampa one. This transformation converted the city into the prototype of a renaissance one, based on an earth and stone grid, completely denying its natural context.
With the city's design transformation, water became an important menace once again. The city continuously flooded as channels were canceled, eliminating space for water. In 1604, as a solution for this situation, the first efforts to drain water out of the basin started. The construction of the Tajo de Nochistongo, literally a gash traversing the northern mountains, was the first in a chain of actions dedicated to the desiccation of the 1100 km2 lake system. The naturally closed basin has since suffered several perforations with the objective of draining water out.

6. www.rae.es. Aztec

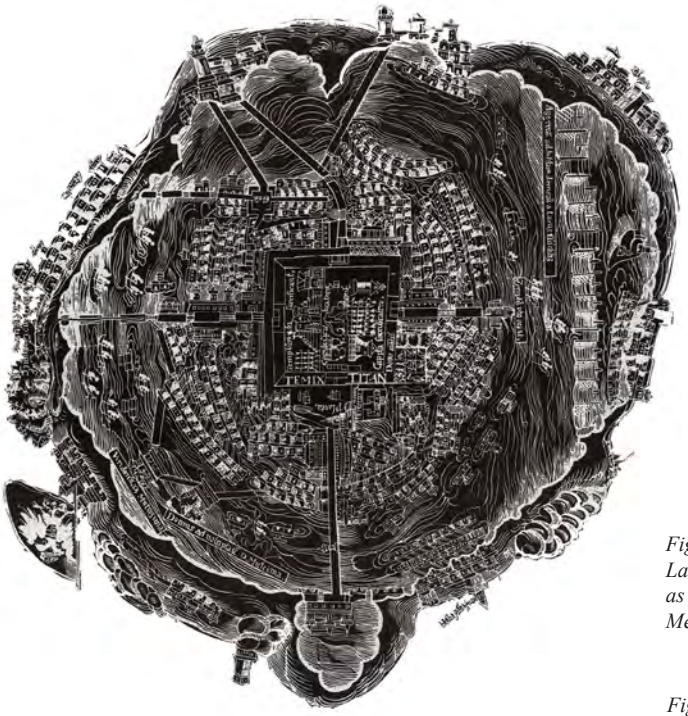


*Fig.3. Map of Cortés. La Gran Tenochtitlán as described by himself. Mexico City_1523*

*Fig.4. Nochistongo Gash*

The most drastic change happened during the XX century. Celebrating 100 years of independence, in 1900 the Gran Canal (Great Channel) was inaugurated. This infrastructure was built to definitely safeguard the city from floods, taking sewage water, lake water and rainwater out of the basin through a series of pipes and open-air channels. This system evolved into the Deep Drainage System, serving the same purposes. A lot of dry land appeared as a result of the implementation of these infrastructures, bringing up the possibility of expanding the urban grid on this arid surface. As this happened, a population boom took place. During the entire XX century, the city augmented its dwellers by twenty times. From a 1 million-inhabitant city in the 1920's it became a 20 million-inhabitant megalopolis by 1990's. From having a 1,100-km2 lake-system, it currently holds less than 50 km2 of water bodies.

The previously mentioned events derived into the construction of an infinite city on the unstable ground of a lakebed. A large area of Mexico City suffers from periodical floods and ground subsidence. Also, the city lacks freshwater sources, having to dig deep wells and import and pump its fresh water from places as far as 128 km. The present day megalopolis completely depends on mechanical systems of tubes, pipes, and pumps, consuming large quantities of energy and enormous volumes of water that have depleted its aquifer and those of the nearby basins.

The water management situation to which Mexico City is subject desperately calls for solutions that could help create an alternate and sustainable option to manage the resource within the basin. Since 2011 the *Taller Hídrico Urbano*, a thesis semi-

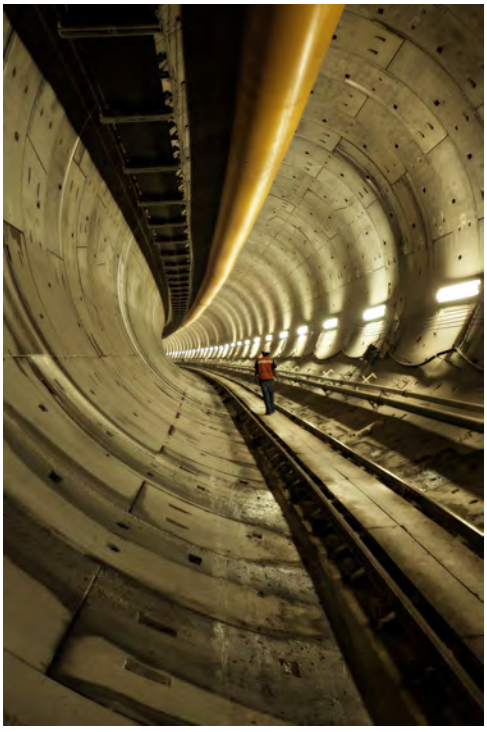

*Fig.5. Túnel Emisor Oriente, the biggest sewage infrastructure under construction in the world. TEO by CONAGUA*

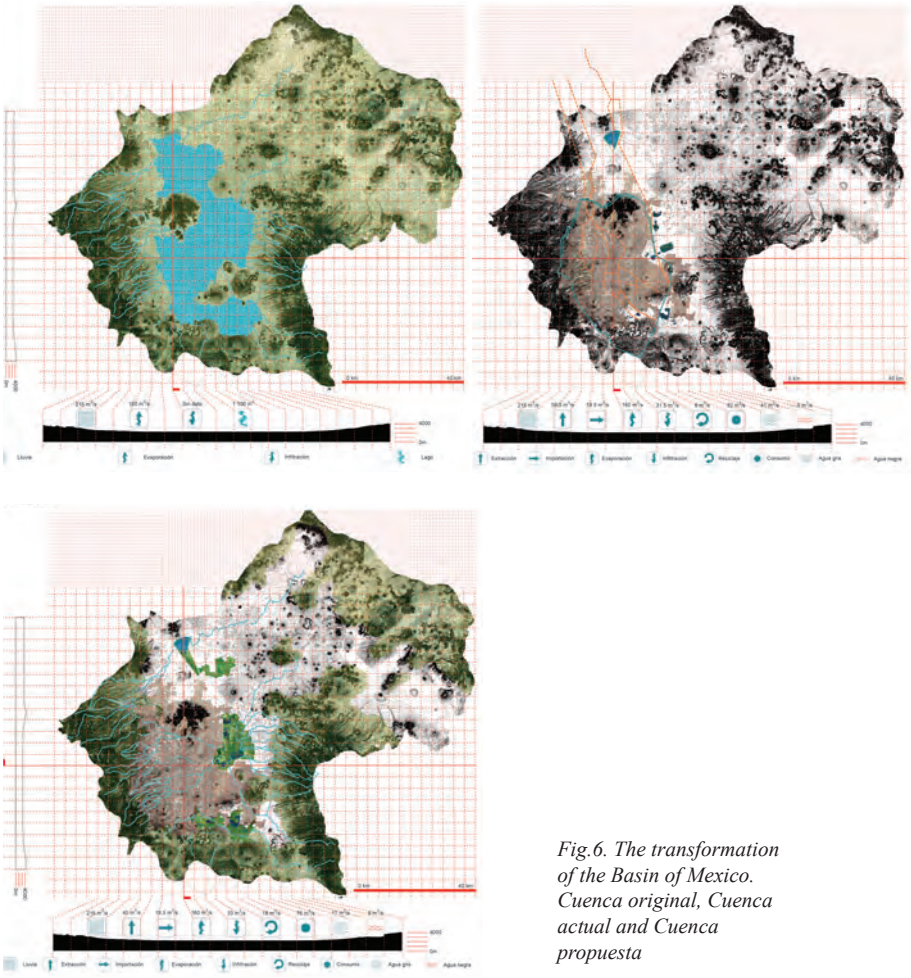

*Fig.6. The transformation of the Basin of Mexico. Cuenca original, Cuenca actual and Cuenca propuesta*

nar created in the School of Architecture of the National Autonomous University of Mexico, has focused on applying the understanding of Landscape as an Infrastructure to the solution of local problems. Several projects have been developed in this sense and can be known through the web page www.tallerhidrico.com. We envision a basin able to complete its water cycle within by understanding and applying new ways of urban design in which water becomes the factor determining urban form. In the words of James Corner *"(...)we believe in the power of the landshaft, acknowledging its potential to regulate and produce, generating better living conditions for the city".*

Tlaltenco Water Connective Tissue

This project is the first one developed by the THU, and it began as a bachelor´s degree thesis investigation of the workshop, in which a group of students contacted common land owners of the community San Francisco Tlaltenco, in Tlahuac, Mexico City, who were in need of a profitable project that could become a better alternative than to sell it for a few pesos[7]. With the assistance of a group of biologists that had developed guidelines about water management in the area, they were convinced that their land was an important piece for the conservation of natural areas in the Xochimilco, Chalco, and Tlahuac sub Basin. It is located in the southern east part of the Basin of Mexico, where we can still find some of the remaining water bodies, portions of the traditional waterscapes of Mexico City, that used to be part of the five lake system, as described before. The area is characterized by a deteriorated environment, of polluted soil and water channels, lack of order in regulation and urban planning, where irregular development is imperative, a representative image of the city´s peripheral urban condition. On the other hand, there are still some elements in the landscape, like surrounding mountains, vegetated areas, and remaining chinampas, towards a territorial reconfiguration. We believe in its potential to establish a better relationship between the urban and natural landscape, to cope together in harmony, enabling a controlled and planned growth. The site´s condition has been threatened by the arrival of a new subway line along its northern side with a station inside. In opposition, the southern border is adjacent to a natural conservation area, protected by UNESCO. The eastern and western borders are menaced by dense urban grid of Tlahuac. Determined by a quickly irregular construction tendency of growing in the last few years, it is highly possible that this site could become part of this dense grid. Obviously, this has a lot of negative implications, not only for the natural area destruction but also for the lack of hydraulic infrastructure available. However we aim to implement a project in which the site becomes a productive hydric infrastructure redefining the entire waterscape of the area, as an example of their importance to the natural cycles, contributing to the restoration and maintenance of the last water bodies preserved on the basin. Due to it´s scale, the project is economically, socially and environmentally viable and has been a participative design result with the local people, the common land owners.

The main objective of the Tlaltenco Water Connective Tissue (TWCT) is to become the first hydro-cultural infrastructure with a metropolitan impact and access to the chinamps area by transforming a menace into the most important opportunity.

7.en.wikipedia.org
The Mexican peso (sign: $; code: MXN) is the currency of Mexico.


*Fig.8. Programing Tlaltenco´s surface. Zonificación*


*Fig.7. Tlaltenco current situation, negative forecast and positive forcast.*

It will also define a new way of urban development, a sample of how the city's border could be built in a sustainable way by not compromising it´s natural condition, allowing its cohabitation. It offers a recognizable and tangible strategy for generating programmed surface in the limits between the urban area and the remaining, traditional, productive landscape of Mexico City. Through a hydro-cultural infrastructure this project sets the first efforts towards a sustainable water system treatment for the megalopolis, promoting closed water cycle. The site has particular characteristics defining its own character; it is at the bottom of the Sierra Santa Catarina, a milestone in its landscape and in the basin, at the lowest part a sub basin, naturally receiving water runoff from it, making it suitable for flooding; a high voltage infrastructure across the site dividing it into two; a new subway line and an inside station with a metropolitan scale connection; irregular settlement invasion which has prevailed as the land speculation increase; polluted soil and dried land because water channels have been filled with rubbish materials from the metro line construction. We developed a program defined by systems and subsystems occupying the land; systems as an infrastructure

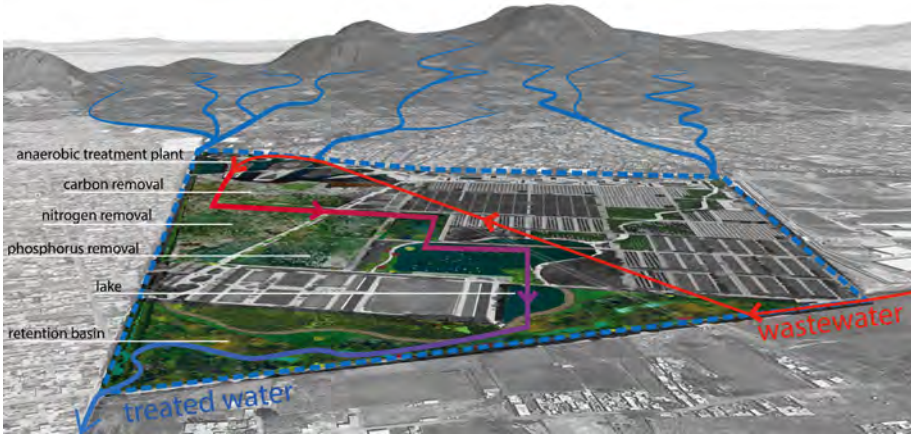


*Fig.9. Hydraulic and occupation strategy. Láminas Holcim.*


*Fig.10. TWCT. Láminas Holcim*

capable of solving the site problems and allowing subsystems to provide activities held by the people. The program must adapt to its urban and natural condition. For colliding sides to the dense grid we respond with the Hydric System and control the irregular invasion. The Agricultural System is located in the most protected area, far from the urban grid. Open Space System occupies the entire site, with bicycle and pedestrian paths all along for the enjoyment and education of the community. (fig. 8) The strategy of occupation responds to the characteristics of the site, allowing the

natural trails of the land, pathways and natural runoffs from the mountain chain, become the trace of the project. The Hydraulic System begins with an Anaerobic Water Treatment Plant, taking 100 lt/s of waste water from the city sewage system, relieving it from saturation. It removes solid components, supported then through a series of sub superficial and superficial wetlands that take over the rest of the pollutants, as carbon, nitrogen, phosphorous, allowing the water become clean enough to irrigate the adjacent field crops. At the end of the treatment, water is kept in an artificial lake for recreational activities and in a vegetated floodplain that will spill southwards, reconnecting with water channels and the chinampa area of Tlahuac and Xochimilco. The Agricultural System is planned with suitable endemic crop fields that could cope with a polluted soil and mineral salty water. The Open Space System with bicycle and pedestrian paths all along for the enjoyment and education of the community. (fig. 9) Subsystems are conformed by Culture, Commerce Recreation, Housing, and Management. The Cultural program consists in an educational one, with an interactive Water Museum incorporating an anaerobic treatment plant, a library, an Imax and cinemas, multifunctional workshops, open air forum for concerts and events, and a botanical nursery garden in relation with the agricultural system. The Commercial contains


*Fig.11. Image of the artificial wetland system and phasing. Láminas Holcim*

*Fig.12. Cultural center section showing Cinemas, Forum, wetlands. PA_110 CINES FORO*

a farmers market selling the products harvested and transformed in the place. The Recreational system is conformed by an artificial lake and sport facilities. Housing proposed as a sustainable example for this peripheral border, and Management capable of administrating the park, with a research and agronomic training center. (fig.10) Phases are part of a designed process that gradually enables the site occupation with its conformation. First phase begins with the cleaning of the surrounding water channels, second by the hydric, third the agricultural, commerce and management, and at the end the housing one, to be fully operating in a six years term. (fig. 11-12)

Quebradora Hydric Park

This project is the result of a one-year research and participatory design initiative in the community of Iztapalapa in Mexico City, the most populated, poorest, and deficiently served regarding water and sanitation. A specific site in this demarcation was chosen among many because it combined a set of characteristics that, when well managed, support a very powerful action. In the slope of Sierra Sta. Catarina, this four-hectare plot is used by the demarcation's urban services as a place where runoff is diverted and naturally filtered. Its soil is formed from volcanic stone, permitting the fast absorption of water. Besides this important function, the place has no other use. In

*Fig.13. Iztapalapa seen from North to South. www.imagenesaereasdemexico.com*

*Fig.14. Quebradora site view. Panorama hacia el sur.*

*Fig.15. Infiltrating water through the rocks. Skatepark.*

fact, it looks like an abandoned piece of land, occupied by homeless and beggar dwellers. A very dense, self-constructed housing area surrounds it, evidently developed with no regulatory support. There are not enough public and open spaces to serve the population of the area and efficient mobility is hard to achieve (fig. 13-14).

In this situation, a team coordinated by Manuel Perlo, PhD. Loreta Castro Reguera MAUD decided to transform the site into an iconic open space that would show the virtues of the landscape as an important media through which water can be better managed. The project consists on a multilevel system that addresses infrastructure, public space, mobility, and services including an education vein. The main purpose is to make out of water-infiltration a show, where the surrounding population can understand the necessity of this open space as essential for the best performance of hydraulic infrastructure in the area. (fig.15) To achieve the before mentioned, the project is designed by composing three main elements: a wetland spiral conducting runoffs from the adjacent streets into the soil, an infiltration skate park and auditorium that filters rainwater through permeable pavement, and two soccer courts that are constructed upon a cistern for rainwater catchment. The space between these elements is an area destined for jogging, cycling, open-air gyms, and picnic spots. Above this level, a net of elevated paths foster non-motorized mobility facilitating connections between the housing areas and the main street where buses pick up and deliver passage. In the center of the plot and connecting the elevated paths, a small building concentrates sanitary services and a vernacular water technology center. (fig. 16) The aim of this team is to build this project during the next months. There is still work that must be done regarding the socialization of the plan with the community, however the contact we have had up to date has been very receptive. On the other hand, there is still work that must be done with the government as the plot belongs to the demarcation and most of the investment should come from them. Even though it is not a large project, its characteristic of understanding landscape as infrastructure should

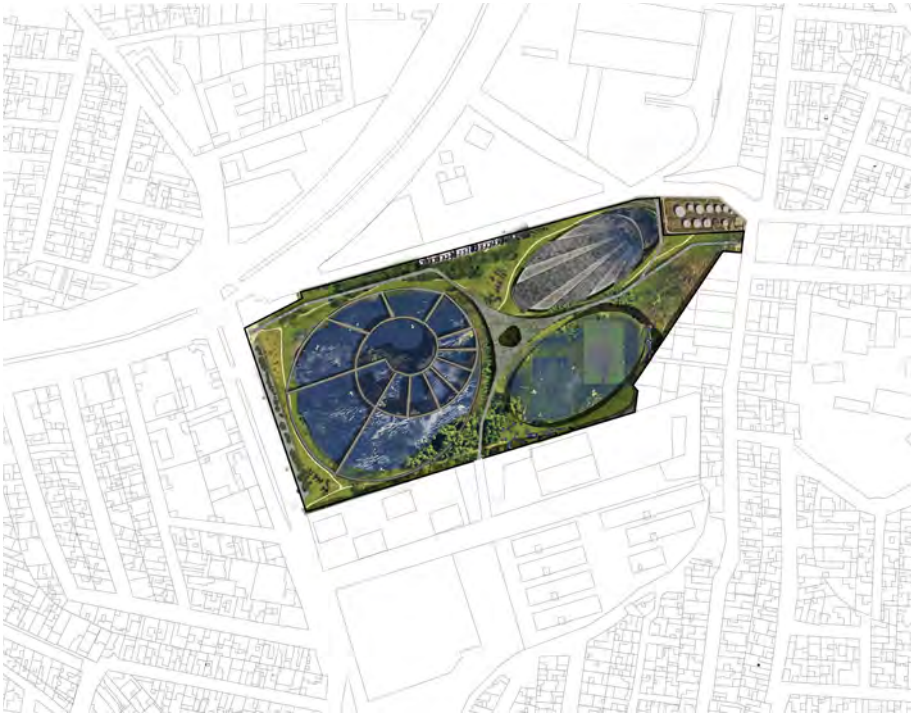

*Fig.16. Site plan during rainy season. PlantadeConjuntoQuebradoraHumedo*

*Fig.17. Making of water infiltration a show. VistaCamino*

set a paradigm for landscape design in Mexico City. (fig.17) Through projects such as the above described, the THU is trying very hard to set important milestones in a more sustainable way of managing water in the Basin of Mexico. The existing hard infrastructure system is very necessary for the survival of the city. However it is imminent to provide the landscape with part of the hydraulic responsibility. The sole dependence on tubes and pipes is what has placed the city in the current risky situation. When understanding the capabilities of the ground and when designing a city able to incorporate water, this risk will diminish. Hard infrastructures will comfortably work, depending on the buffering capabilities of the landscape for facing stressful conditions. The ability to understand Landscape as an Infrastructure is definitive in building a more resilient city, one capable of holding this megalopolis for several more centuries. (fig.18)

*Fig.18. THU Vision for the Basin of Mexico.*

# Transforming waterfront: from urban renewal to resilient development

## A case study of Wuhan, China

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Abstract: Creating more resilient and livable waterfront cities is a critical element of planning for our future. 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 changing city. This article examines some representative urban projects on the waterfront and summarizes spatial models applied on the waterfront with distinct policies. Finally, it establishes a framework of understanding waterfronts on two crucial dimensions: temporal dimension and spatial dimension. It demonstrates that an urban waterfront should be more correctly envisaged as a network of places, functions, additions and hinges between the city and its water environment.

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

### 1. Introduction

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. Meanwhile, waterfronts are also high-risk areas, where the water-related disasters could seriously affect the long-term sustainability of urban environment.

Nowadays, waterfront redevelopment has become a global trend.[3] [4] Waterfront areas represent a multidisciplinary and multitasking issue in perspective of urban resilient development. 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] Architects and urbanists are demanded to define compelling visions and integrated design measures for shaping resilient waterfronts. In this way,

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2. Wuhan Land Resources and Planning Bureau, Wuhan 430014, China.
3. Breen A., Rigby D., *The New Waterfront. A Worldwide Urban Success Story,* Thames and Hudson, London, 1996.
4. H. Meyer, *City and port: Urban planning as a cultural venture in London, Barcelona, New York, and Rotterdam*, International Books, Rotterdam, 1999.
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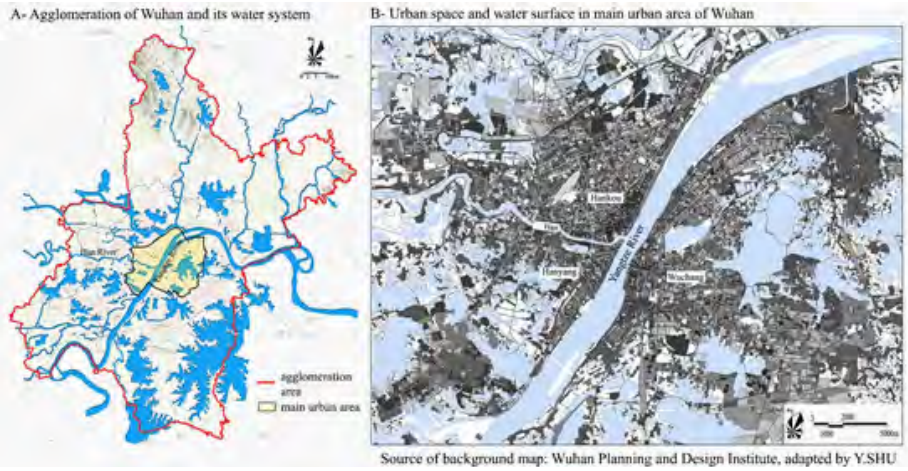



*Fig.1. Water system and urban space of Wuhan*

our paper focuses on waterfronts and discusses what resilience means in terms of waterfronts and how development projects can enhance the "resilience" of cities, starting with the regeneration of waterfronts. We employ a case study of Wuhan, a typical waterfront city in central China. Over a quarter of its metropolitan area is occupied by water, representing an area of 2,117.6 km$^2$. 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. 164 lakes spread throughout the agglomeration (Fig. 1). The shorelines are central to the city's history and also crucial to its future.

## 2. Historic Perspective: Evolution of Wuhan's Waterfront

Wuhan has a long history of waterfront development. The urban space on waterfronts has been formed and transformed according to different urban policies and strategies. The following historic survey can perhaps shed light on context of current operations on Wuhan's waterfronts.

### 2.1 Fortified City with a Defensive Strategy

As early as 1,800 years ago, Wuchang and Hanyang each built a fortification on opposite sides of the great river of Yangtze. Following a defensive strategy, appeared two military capitals on the waterfronts. In use of an enclosed city model, these capitals were protected by the fortification walls. Two cross streets made the frame of the street grid, and the compounds with quadrangle houses around a courtyard formed the urban fabric.[6] The waterfronts were characterized by the fortress, watchtowers and military ports (Fig. 2).

### 2.2 Commercial Port-City Structured by the Waterway

From the Tang Dynasty (618-907 A.D.), with the commercial development, the twin-city took advantage of a strategic position in the regional water network, became

6. Yang 2011.

the biggest commercial and transit center in central and south China. The urban space extended along the waterways and a number of towns appeared around commercial ports. Especially at the junction of the Yangtze and the Han, Hankou grew rapidly and became the biggest inland port of central China in this period.[7] A linear structure of urban space connected ports with their hinterland. The low rise, high-density buildings, with mixed-use residential and commercial, dominated riversides. Numerous pile dwellings were created in flood areas. And the dikes were built to protect the city against flooding (Fig. 3). The waterfronts becoming the scene of citizen's everyday needs and activities.

2.3 Radical Changes in Process of Industrialization

In the industrial age, the iron works, arsenal, great textile factories were erected one after another in front of great rivers and outside the city wall. Furthermore, the port of Hankou was opened to western powers from 1861, the foreign concessions were established on a Bund area of 2.2 km$^2$. The waterfronts, largely artificial, were transformed as a special zone separated from the rest of the city. They were contributed to the industrial ports and productive activities. They became henceforth an exhibition place of the fruits of new industrial civilization. The scale of building and neighborhood was enlarged, the roads were widened, and the new system of street grid was formed in adaptation for the automobile circulation and industrial production[8]. The urban space extended discontinuously on shore and several new axes appeared to inland following the development of highway and railway (Fig. 4). In 1926, the three towns: Wuchang, Hankou and Hanyang, separated long time by the great rivers, were united in one city named "Wuhan". This administrative combination promoted a further integration of urban space. In the late 1920s, the fortification walls around the old towns were destroyed, and the ring roads took their places. In 1957, the first bridge was built cross the Yangtze, the urban spaces of three towns were finally joined together. Consequently, the waterfronts originally at the frontier of each town, became the center of the new city.

3. Urban Project Reality: towards a Resilient Development

From the 1990s, under the influence of the Chinese economic reform, Wuhan experienced huge economic progress and development of the tertiary sector.[9] This change of local economic structure stimulated the reorientation and reorganization of urban functions, especially concerning industry and port sectors in the center of city. As a result, Wuhan's waterfronts went through a large transition.

3.1 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 km long, and

7. Chen 2006.
8. Li 2005.
9. Wuhan Annals Committee, *Wuhan Annals* (1985-2009) Presses de Wuhan, Wuhan, 2010. [En ligne] the official website of Wuhan's Monograph Office http://www.whfz.gov.cn:8080/pub/dqwx/whnj.

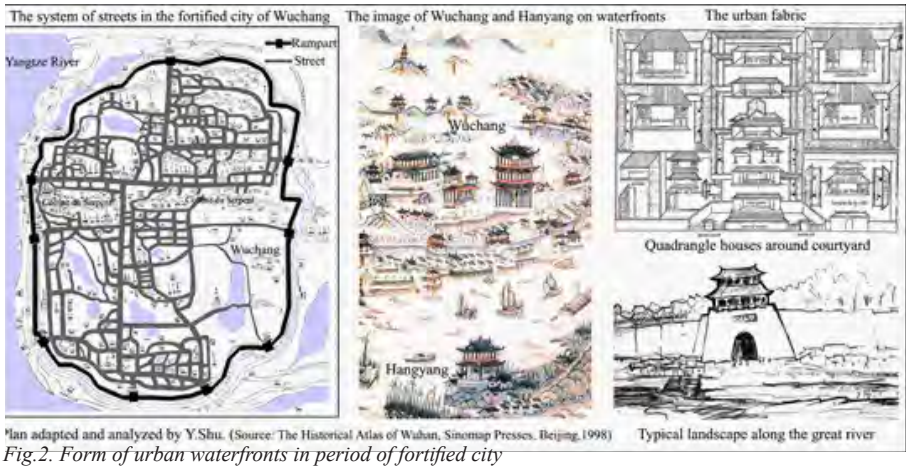



*Fig.2. Form of urban waterfronts in period of fortified city*

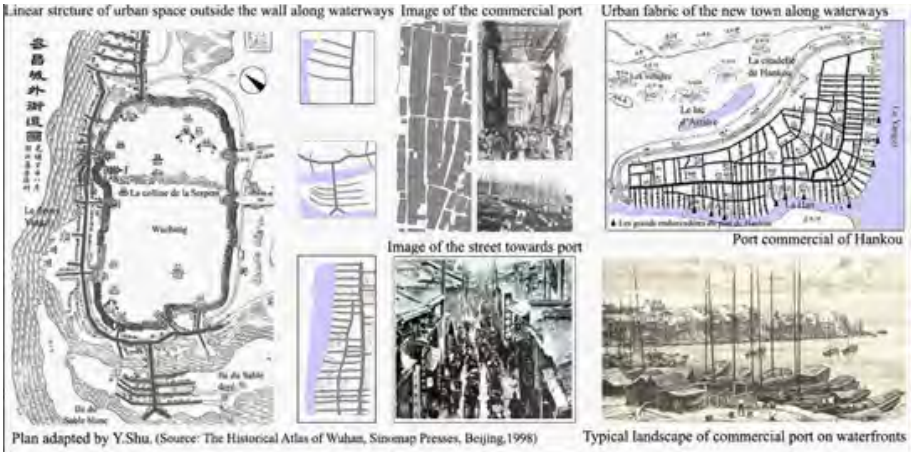



*Fig.3. Form of urban waterfronts in period of commercial-port city*

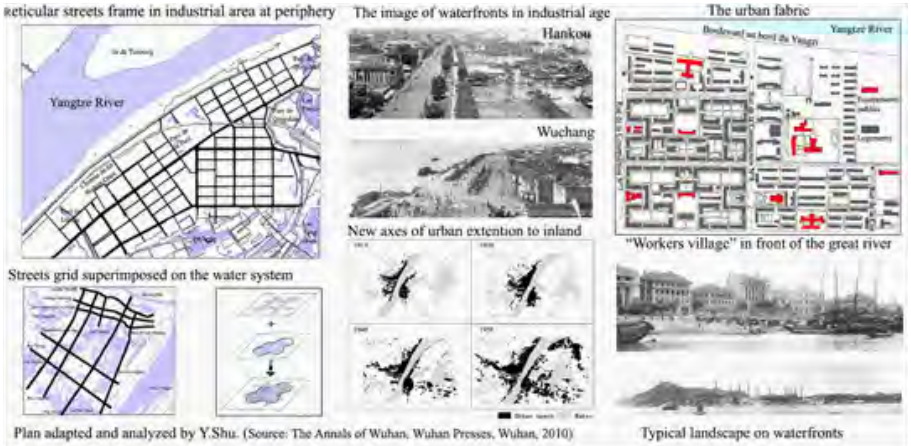



*Fig.4. Form of urban waterfronts in industrial age*

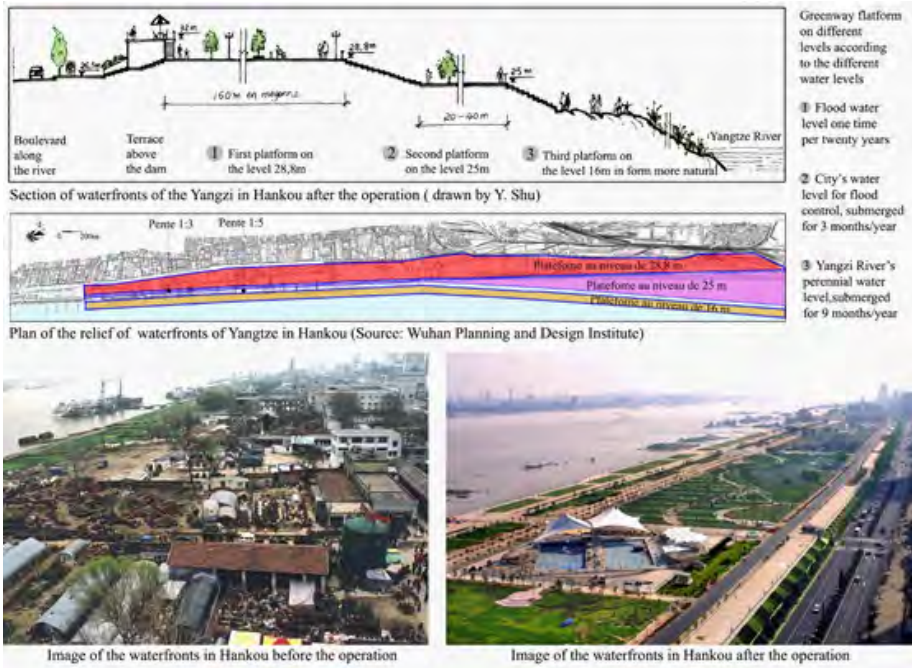



*Fig.5. Transformation of the waterfronts of the Yangtze in Hankou*

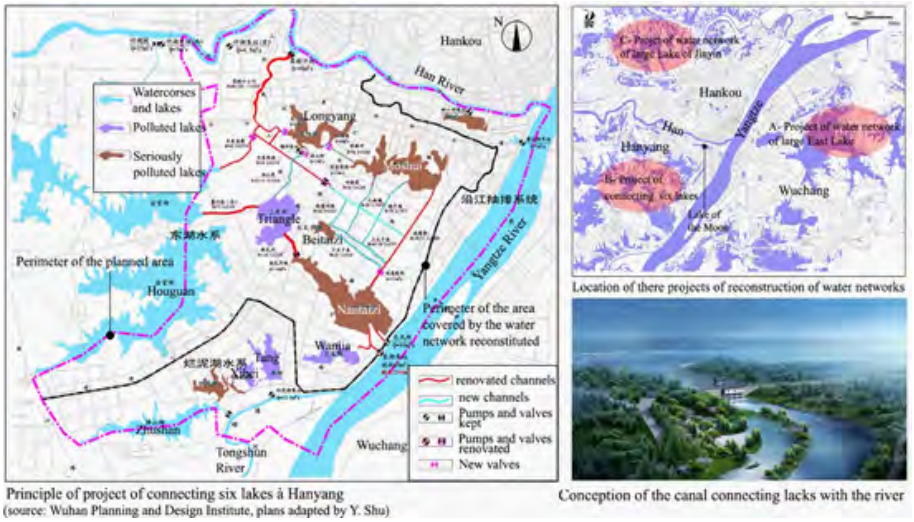
about 2,000,000 m$^2$, is located in front of the old foreign concessions in the center of city. It was abandoned after the decline of the ancient industrial port. The community decided to introduce a public green walkway along the great river. In fact, this huge project had two objects. Firstly, it was a local response to a national competition named "garden city", carried out by the Ministry of Construction in 1990s. The waterfront, as main existing open space in the city center, was reconsidered as a strategic area[10]. Secondly, the regeneration of waterfront 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 a loss of thousands of lives and a serious economic damage. During this catastrophe, the abandoned constructions on Wuhan's waterfronts, strongly prevented the flow of water and caused a very dangerous acceleration of the rise of water level. Consequently, after almost five years of study and countless community meetings, the project of Hankou's waterfronts was implemented in 2001. The municipality financed RMB 750 million (US$120 million) in three phases. 200,000 m$^2$ of old warehouses and factories were removed, the infrastructures were improved, and a huge greenway park was created along the great river. The park was built on three different levels according to the water level in different seasons, so the people can enjoy the riverside both in the dry and the flood season. The landscape walkway and a number of recreational green spaces were created. The abandoned waterfronts

10. Principles for creation of Wuhan Garden City, Planning Report, Wuhan Planning and Design Institute, Wuhan, 1998.

have been turned into an important urban public space (Fig.5). The influence was not limited on the riverbank, but also on its inland neighborhood. The creation of new public space and the improvement of infrastructure have attracted more peoples and more activities. A great benefit was gotten from the real estate market. The average price of a new apartment on the waterfront quadrupled in just six years, and the highest price has increased from RMB 3,300 / m² to 16,850 / m²[11]. The land value increased and the real estate investment stimulated the regeneration of the entire zone le long the waterfront. Subsequently, this strategy to create public open space on urban waterfront was executed in the entire city. In nearly eight years, 26 km of landscape walkways were created on the waterfronts not only in Hankou, but also in Wuchang and Hanyang, covering an area of 1,810,000 ha, including almost all of the densest parts of the city[12]. Reconstruction of waterfront has improved the urban image and played an active role in regeneration of city center.

3.2 New Strategy of Renaturation

In the last ten years, a new trend of "back to nature" appeared. We present here one of the most representative projects – the reconstruction of urban water network. This operation was aimed to solve the water pollution problem of lakes which have been isolated one from the other in the process of urbanization.




Principle of project of connecting six lakes à Hanyang
(source: Wuhan Planning and Design Institute, plans adapted by Y. Shu)

Conception of the canal connecting lacks with the river

*Fig.6. Projects of reconstruction of water networks in Wuhan*

The idea is to join the lakes with the big rivers by digging new canals or using the existing waterways. 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.

11. Huang 2007, p.

12. Research on the Development of Entire Urban Environment on the Waterfronts of Yangtze River in Wuhan, Planning report, Wuhan Planning and Design Institute, Wuhan, 2005.

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 the water network of the East lake; in Hankou, the project to create the water network of the Jinyin lake (Fig. 6). These projects have got the financial and political support not only from the local government but also from the central government. Wuhan has even been designated 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 wetlands restoration plan has been elaborated by the local urbanism service in 2006. After two years of study, a big project implemented in 2009. This project envisaged to transform the waterfronts of the East lake (with a surface of water of 33 $km^2$, it is the biggest urban lake in China) into a national wetland park. Numerous aquatic floras have been planted and the mineral banks have been refitted with more natural materials.

## 4. Reflections and Conclusions

Through the observation of the case of Wuhan, we will identify some general factors of waterfront resilience on two crucial dimensions: temporal and spatial.

### 4.1 On a Temporal Scale: Permanence and Rupture

The interaction between city and water is the main character of an urban waterfront. 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. 7). In this way, we generalize 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. Waterfronts were widely accessible to all people and used for a variety activities: dwelling, commerce, leisure, fishing, sacrifice... This fragile balance was broken in the second stage, named according to Wackermann[13] *"artificialization of territory"*.With a process of industrialization, water became 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. The city experienced a process of *"metropolisation"* with the renewal of the old city center and the development of new urban centers on the periphery. In a new social and economic

13. Wackermann 2005.

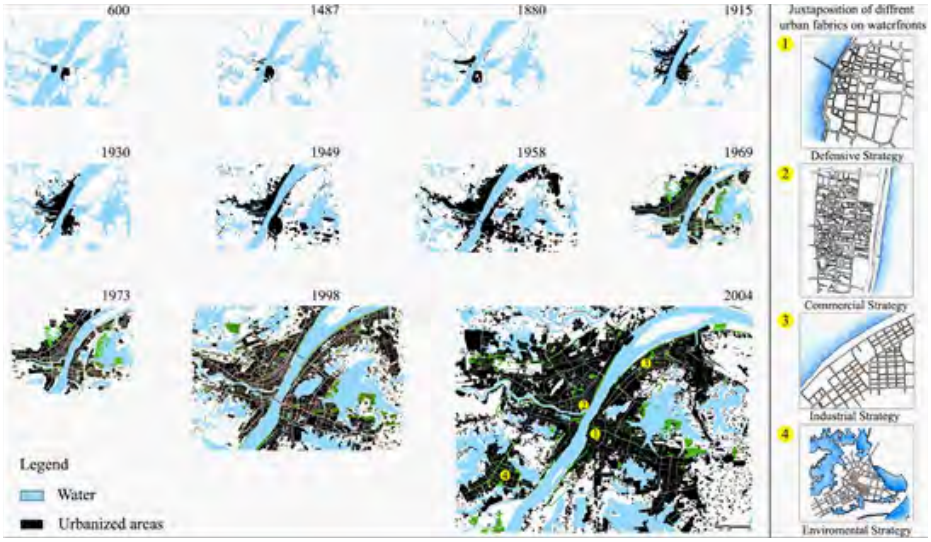



*Fig.6. Projects of reconstruction of water networks in Wuhan*

context, implemented an essential environmental policy, which led waterfront regeneration across a number of projects. All these projects show a new relation between the city and water, that of co-dependence and mutual adaptation: reconciled rather than separate. 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. Public administration must give impulses on a political level to ensure that the objectives are realized while balancing short and long term interests. Resilient development is also an ongoing process. The ambition of strategies on waterfronts produces an effective interpretation of the past.

4.2 On a Spatial Scale: Fluidity and Connection

Waterfront represents a specific transition area between urban space and aquatic environment. On a spatial scale, the presence of water renders waterfronts distinct from the other spaces. All resilience linked with waterfronts are branded by the spatial property of fluidity. Fluidity represents a direction which engenders axis of mobility; fluidity implies a variable boundary which stimulates creative architectural experiences; and fluidity facilitates a transverse link in which we can integrate center and periphery, upstream and downstream (Fig.8). Meanwhile, waterfronts are also a part of the existing urban fabric. They should be conceived as an integral part of the city and contribute to its vitality. In this regard, creating connections between city and water is critical, and public access is a prerequisite. Waterfronts should be both physically and visually accessible for all users, and public spaces should be constructed with high quality to allow intensive use. Resilient waterfronts should 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. Nowadays, in dynamic and changing city context, there are a variety of

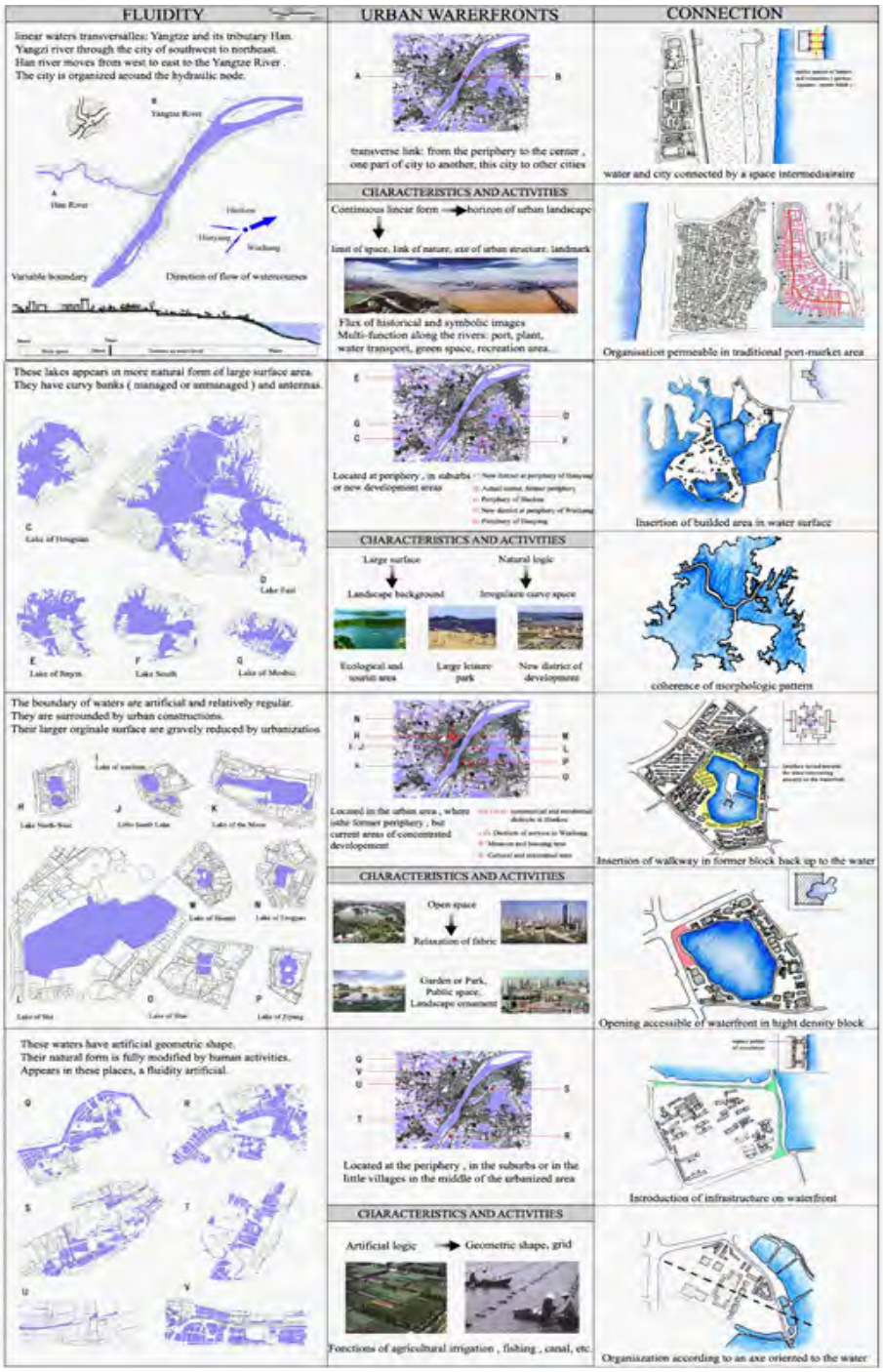



*Fig.8 Fluidity and waterfront connection: an illustration of Wuhan*

potential strategies to adapt waterfront areas to be more resilient. The experiences in Wuhan demonstrate that waterfront strategies and projects are capable of generating a new urban form and producing a new landscape to make cities more vital and competitive. All the adaptive strategies are rooted in local and metropolitan aspirations. While Wuhan is unique in many respects, the challenges we face are shared by many communities in the region, as well as elsewhere around the world. We established, in this paper, a framework of consideration based on temporal and spatial dimensions of waterfront, which can guide thoughtful and ongoing planning process for any city confronting an increasing resilience in the urban context.

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