

**Integrated Infrastructures for an Urban Lake in Wuhan, China:  
A Proposal for Flood Management, Urbanism, Agriculture and Ecosystem.**

by

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### **Author's Declaration**

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners. I understand that my thesis may be made electronically available to the public.

*Jason Hong*



## Abstract

One of the consequences of China's rapid urbanization is the disappearance, or at least, mismanagement of the many lakes of the Central Yangtze River Basin. The thesis investigates the situation by conducting a complex system analysis, revealing four most pressing issues surrounding the lakes: flood management, sustaining agricultural practice, controlling urban development and maintaining a healthy ecosystem. The inadequacy in Central Yangtze River Basin's flood capacity requires that the many lakes in the region be preserved and connected to form a flood retention network. Unfortunately, this preservation is threatened by urban development that seeks to infill the lakes. As well, many of the lakes are now divided into independent lotus farms and fish ponds which do not provide for a sustainable aquatic ecosystem. The city of Wuhan and its Lake Shahu is the focus of this thesis. Lake Shahu is a microcosm of the regional condition, and its centrality within the city of Wuhan brings about a particular set of problems, namely, the lake is perceived as an obstacle for communication and transit as well as an impediment for much needed city expansion.

The thesis proposes a solution to the complex problem surrounding Lake Shahu by synthesizing a system of integrated infrastructure which would reconnect the lake and the Yangtze River, as well as provide a flood berm, public spaces, lotus farms, fisheries, wetlands and an artificial platform as land for city expansion. The infrastructural system is to instigate a process of transformation which sets up a symbiotic relationship among elements on site. For example, the Land Over Water project will allow penetration of sunlight to sustain the ecosystem below while staging a lively urban life above and supplying the lotus farms below with grey water collected from households. The design approach, known as Landscape Urbanism, is exemplified by Field Operation's Fresh Kills Landfill Rehabilitation project where agricultural techniques and strategic planting are used to create a diverse range of habitats and event spaces over the course of 30 years. In the case of Lake Shahu, the importance of agriculture is highlighted for its engineering potential as well as its economic capacity to support the remaining rural farming population in the area. Aided by the transformation of the landscape and given the tools for monitoring the lake's ecosystem, the farmers and fishermen can eventually become stewards of the land and water.

Not unlike Fresh Kills, the project of Lake Shahu is staged for a 35-year period. The project evolves along the rapid development of China at a much slower pace as the natural processes required to stabilize the landscape will take a long time. By the end of the transformation, a sustainable system capable of adapting to changes in the urban, agrarian and natural environment will be able to support generations to come.



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# Introduction

## China and James Corner's Landscape Urbanism

The Chinese tradition of environmental stewardship has its roots in its agricultural practices. Furrow irrigation, composting and terrace farming are derived from the idea of practical resource management. Through trial and error, this management achieved a form of harmony with nature, however, this harmony seems unintentional and uninformed, as the geographer Yi-Fu Tuan illustrates:

In central and South China, wherever elaborate rice terraces have been built, soil erosion is practically nil. But it would appear that farmers have achieved this erosion control largely by accident. Farmers construct level terraces, supported by walls, in order to hold back water for rice; and, as a by-product of their efforts, they manage to produce an effective system for erosion control. The proof of this belief lies in the fact that the farmer's sense for soil conservation totally deserts him when he plants up-land crops on unirrigated fields near the rice terraces; he does this in neat rows up and down the cleared hillside, and erosion is immediate.<sup>1</sup>

Because the farmers are bound to their land, observing this process of trial and error is limited to a local scale and over a short span of time. In an agricultural society, such practice may be acceptable but as an industrialized China continues to manage its natural resources with an under-informed pragmatism, large scale environmental deterioration is taking place across the continent. Because the centers of demand, manufacturing, and waste production lie within the urban areas, the most severe deterioration often takes place at these concentrated points. Chinese cities are in dire need of a new kind of urbanism that is in harmony with nature.

In China, the studies of urbanism and nature have long been treated as two unrelated disciplines, with the urban environment and nature considered as two separate and enclosed systems. Yet the same forces that act in the urban environment will ripple city boundaries, affecting the rural and the wild. Thus, ecology, the study of the dynamic relationship between all biotic and abiotic matters, can also help us define the role of urban design as landscape architect James Corner suggests:



01 Lake Shahu Divided: lotus farm to the left, fishery to the left, city in the distance

In conceptualizing a more organic, fluid urbanism, ecology itself becomes an extremely useful lens through which to analyze and project alternative urban futures. The lessons of ecology have aimed to show how all life on the planet is deeply bound into dynamic relationships. Moreover, the complexity of interaction between elements within ecological systems is such that linear, mechanistic models prove to be markedly inadequate to describe them. Rather, the discipline of ecology suggests that individual agents acting across a broad field of operation produce incremental and cumulative effects that continually evolve the shape of an environment over time. Thus dynamic relationships and agencies of process become highlighted in ecological thinking, accounting for a particular spatial form as merely a provisional state of matter, on its way to becoming something else.<sup>2</sup>

In arguing the importance of ecology, James Corner advocates the emerging idea of Landscape Urbanism as a new understanding for urban design – one that is not obsessed with form and aesthetics but of a process instigated by the design.

The process oriented approach treats design as a system rather than an object. In beginning to design a process of transformation and setting up healthy relationships within an environment, a complex system analysis based on the model of ecology will prove immensely useful.

The research process of this thesis began with the fascinating findings around Lake Shahu in Wuhan, China. The discoveries around the lake quickly led to an exploration of the urban and regional environment, unveiling a complex system across ecological, economic, social, and political domains. The particular method adopted to reveal the myriad relationship between disparate elements breaks the environment into categories of abiotic, biotic, cultural and energetics elements. Each of these categories contains several sub-categories to establish statistical and phenomenal facts which are then explained in their cause and effect relationship to other elements at play. The analysis is of four different scales, from largest to smallest: Yangtze River Basin, Central Yangtze River Basin, City of Wuhan and Lake Shahu. These scales establish a system of holarchy in which each particular environment is a whole on its own but also



parts of each other. The nested structure enables the elements at each scale to be observed for its local and regional effects, formulating a comprehensive understanding of the system on which design decisions are constructed.

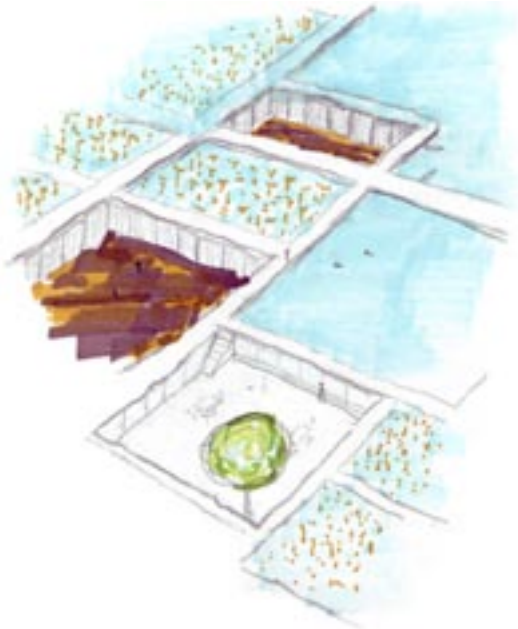
The exploration eventually points to four problematic issues surrounding the lakes of the Central Yangtze River Basin - flood management, agricultural practice, urban development and sustainable ecosystems. These four concerns have a deeply intertwined and conflicting relationships with each other: developers and municipal governments are plotting to infill the lakes while farmers try to protect the water where they cultivate fish ponds and lotus farms. At the same time, Yangtze's severe flood problem and its inadequate flood diversion system requires that the major lakes be restored to a network of flood basins. The dramatic loss of biodiversity due to the construction of the Three Gorges Dam also begs the reconnection of the lakes to Yangtze to make up for the loss of aquatic habitats and spawning grounds for aquatic organisms.

While Lake Shahu represents a microcosm of the general lake conditions in Central Yangtze, its location within the city of Wuhan signifies a particular set of problems of its own. Most notably the lake is perceived as an obstacle and

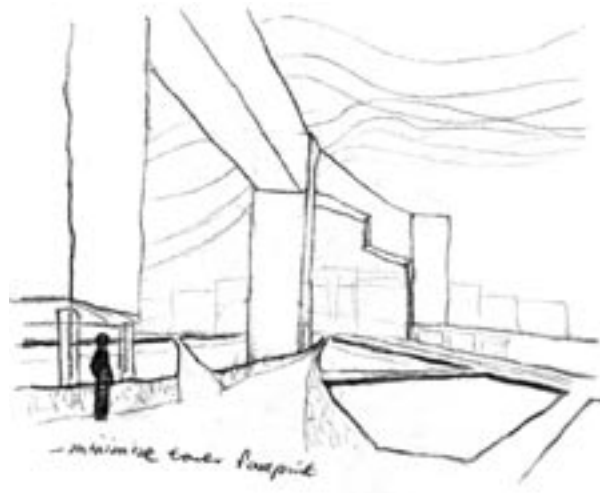
void at the very center of the city. The tri-city structure of Wuhan across the Yangtze and Han River poses a challenge for communication and transit for a city whose reliance on the automobile is rapidly growing. A lake at the center of the city only adds to this problem. By year 2020 the municipal government is planning to infill the lake to a quarter of its original size. The incentive behind is two fold: to create land for the growing population, and, to connect the traffic across the lake.

The reasoning behind infilling Lake Shahu is rational and practical. However, not unlike the under-informed farmers of Yi-Fu Tuan's example whose practical farming methods caused hillside soil erosion, Wuhan's development and infilling of Lake Shahu will have serious detrimental side effects on the environment. In contrast, by returning Lake Shahu to the Yangtze River system, one will discover its significance as one of the few possible points of reconnection along Central Yangtze. As a plea of environmental remediation, Lake Shahu is indispensable as a waterway but also valuable as potential urban space. Thus the challenge for the city of Wuhan is thus: the preservation of the lake for flood retention with its transformation to accommodate city expansion.

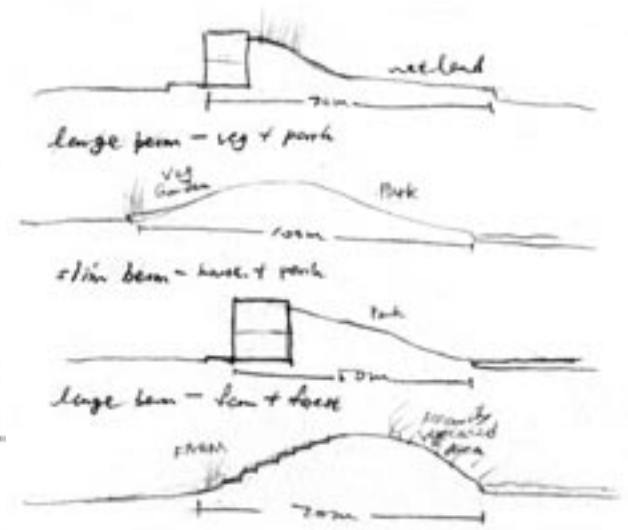
The design synthesis of the thesis proposes an infrastructural system for



02 Spatial Potential of Lake Shahu: The very first sketch showing a lotus farm compartmentalized and drained only during harvesting. An easier strategy of draining by the natural change in water level and reshaping of topography was conceived later.



03 Towers in Lake Shahu: Early sketch for urban development over water. The approach is scraped because it was impossible to introduce an urban fabric.



04 Berm Shaping: Early sketch sections for the various formation of flood berm and their different land use.

reconnection with the river basin and flood retention at Lake Shahu. This entails a flood berm surrounding the lakes which will also provide usable land, and a flood gate at the confluence between the new reconnection canal and Yangtze. A sample area of 150,000 m<sup>2</sup> at the south side of Lake Shahu will demonstrate how a densely woven urban fabric can accommodate and improve access to the lake even with the presence of the berm. The sample design aims at a reasonably dense neighborhood, denser than regulation standard but not as dense as possible, housing between 13,5000 to 18,000 people.

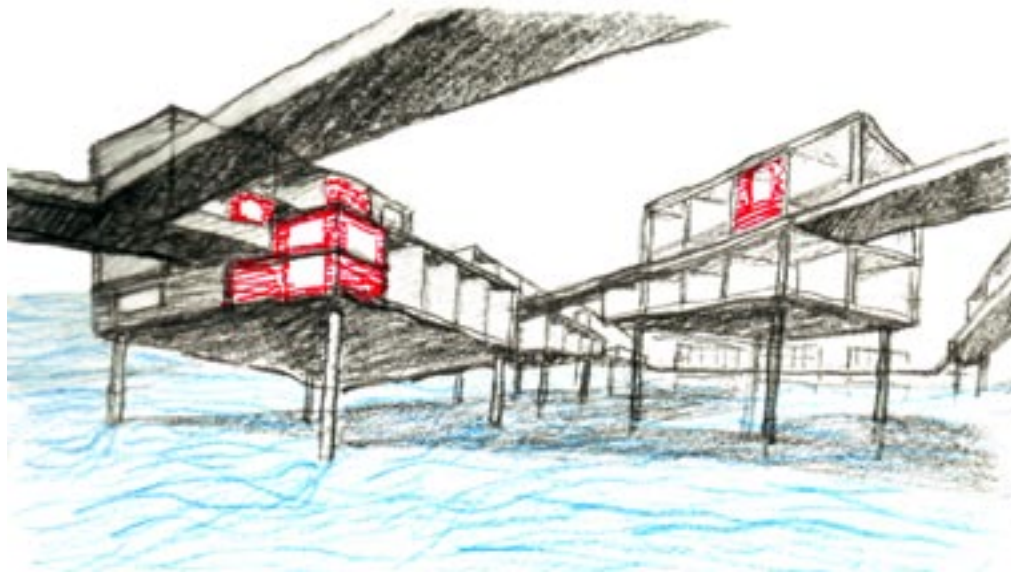
The second major element of the design puts forth the proposal of an infrastructure that is at once land and bridge across the lake. The Land Over Water (LOW) system is a network of artificial platform erected above the water to accommodate urban expansion while allowing penetration of sunlight to sustain the ecosystem below. Because of its unique circumstance, the density on the LOW is not expected to match the norm of the city, however it is still enough for a lively neighborhood. The entire coverage of LOW is to house 72,000 people on 2,380,000m<sup>2</sup> of space.

The Reconnection Project requires that Lake Shahu be excavated two meters

since the current datum for the lake bed is the same as the average water height of Yangtze. The reshaping of the lake bed will create shallow water areas along the shore that can be planted as lotus farms. Unlike the segregated lotus ponds currently found in Wuhan, the new farms will be naturally drained by the seasonal change of water level.

LOW will also contribute to sustainable agriculture by supplying local farmers with grey water collected from households. The logistics between the Reconnection Project, LOW and local farming is just one relationship in the integrated system. Together, the different projects of this thesis: the Reconnection Project, the flood berm, Land Over Water, parks, lotus farms, fisheries, and wetlands will form a integrated system of infrastructures – a living machine operating at the scale of a city. Thus design in this project encompasses the design of symbiotic relationships between separate site elements as much as it includes the design of physical and formal infrastructure.

In one of his most celebrated proposals under construction, the Fresh Kills Landfill Rehabilitation<sup>3</sup>, James Corner and his office devised agricultural practices to restore organic content to the soil and initiate the semi-natural re-veg-



05 Land Over Water Preliminary Perspective: First attempt at the Land Over Water system in perspective. The idea of separating the platform from the buildings was not yet conceived.



06 Land Over Water Preliminary Section: First attempt at the Land Over Water system in section. The buildings are designed to clip onto the central platform.

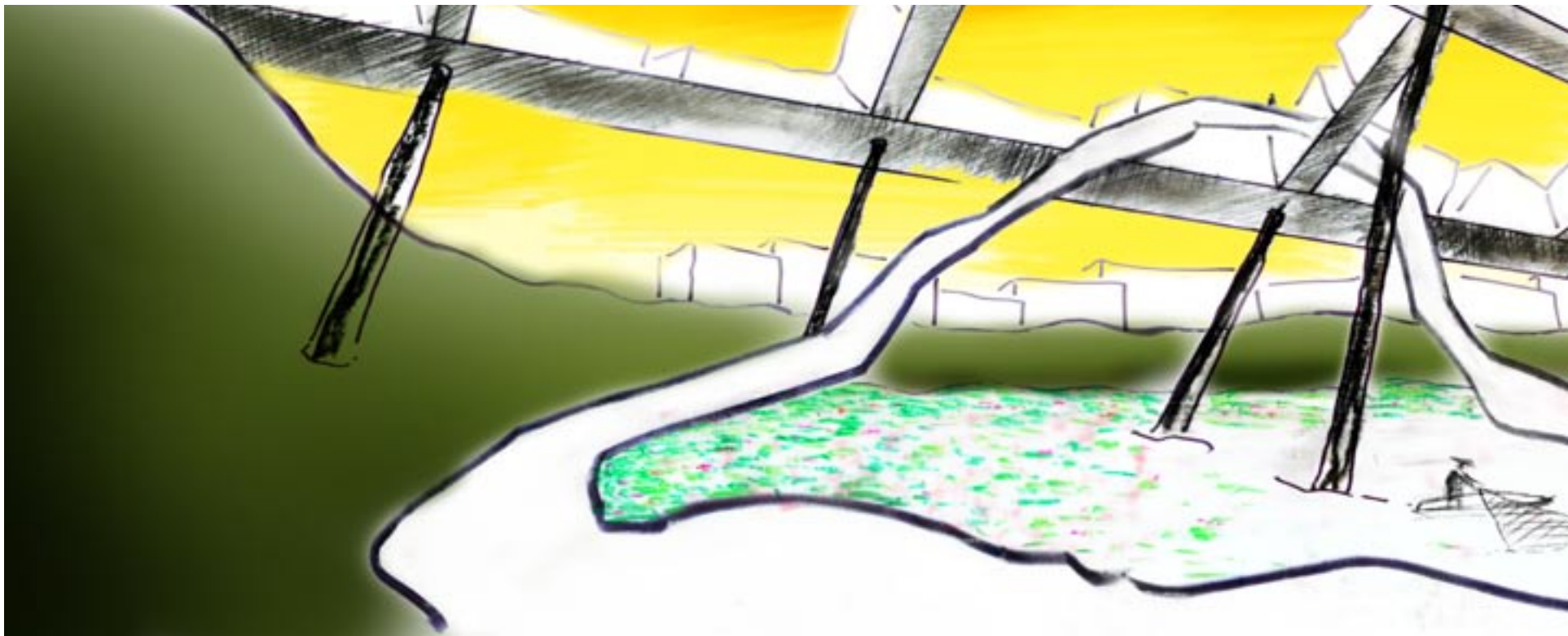
etation process of the land through careful selection of species and strategic planting patterns. Fresh Kills Landfill Rehabilitation is to create a diverse range of habitats including grasslands, forests, and wetland, and bring ecological awareness to people as well as providing grounds for recreational activities and event spaces. The project was designed to be carried out in five phases over thirty years, allowing the landscape to mature and evolve with the aid of carefully devised engineering strategies. Through this project, James Corner demonstrates how infrastructure acts as an environmental instigator. He writes:

Unlike architecture, which consumes the potential of a site in order to project, urban infrastructure sows the seeds of future possibility, staging the ground for both uncertainty and promise. The preparation of surfaces for future appropriation differs from merely formal interest in single surface construction. It is much more strategic, emphasizing means over ends and

operational logic over compositional design.<sup>4</sup>

The design proposal of this thesis takes on a similar approach, synthesizing the existing and proposed operational mechanics into a codependent system and allowing the symbiotic nature of the system to come together through a series of procedures to be carried out over a long time line. Such procedures include: the excavation of a floodway by year 4; excavation, phytoremediation and settlement for floodplain soil by year 16; construction of bridges across lake by year 20; construction of LOW by year 35. The massive transformation of the lake cannot be rushed, as it depends on the incremental efforts of natural processes to re-establish stability to the environment. Similarly, the process also helps the rural farming population on site adapt slowly to urbanization, altering their modes of operation instead of simply obliterating agriculture from the city.

Although the design proposals for Lake Shahu implements agricultural techniques to rehabilitate the soil, the significance of agriculture to the project is



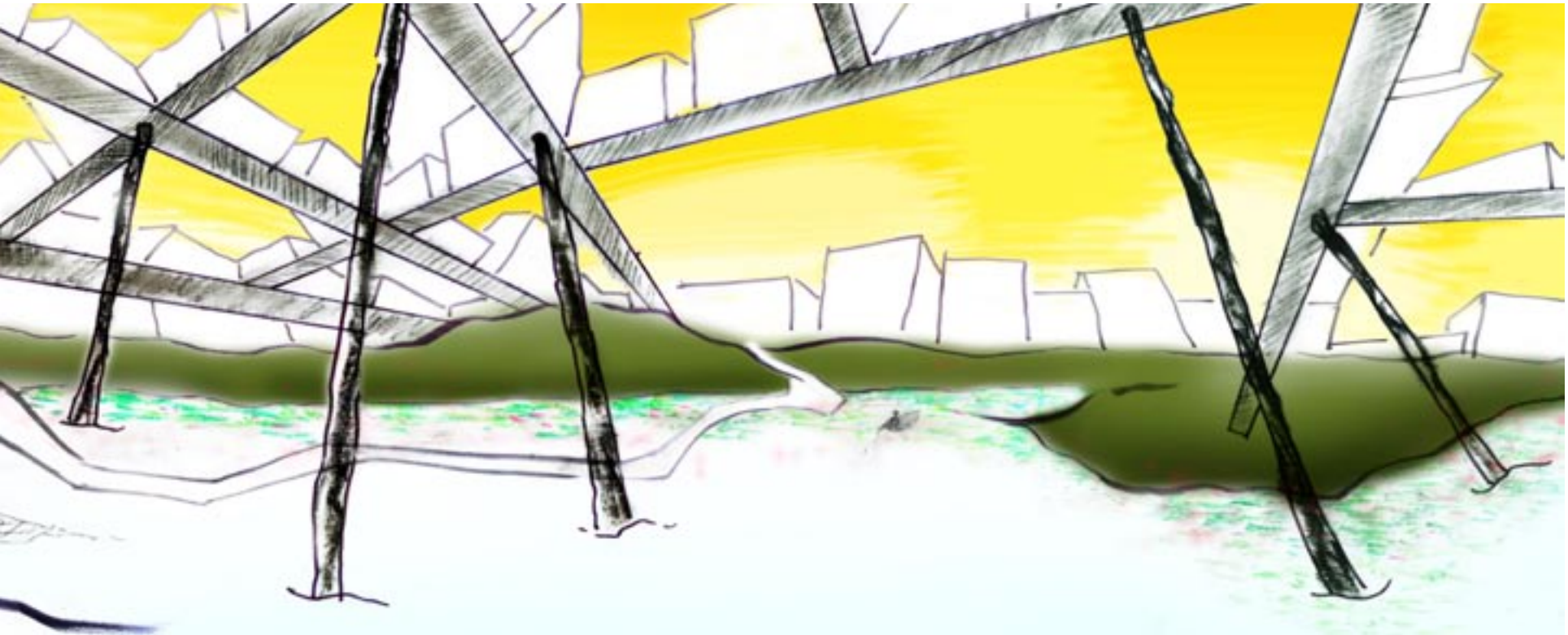
07 Integrated Infrastructures Preliminary Perspective: drawing of Land Over Water, flood berm and lotus farms

beyond its temporary instrumentality. The lotus fields are designed to realize the productive potential of the land, supporting the hundreds of farmers in the area while providing the local market with a range of lotus based products. While advocating a dynamic relationship between urbanity and nature, landscape urbanism in China also has to account for the sustenance of agricultural practice because of China's large rural population, its dire shortage of arable land, and the unique presence of rural-like environments within city limits.

If given the knowledge and tools for observation, lotus farmers and fishermen can be transformed into stewards of land and water. The economic incentive for them is obvious as carefully managed ecosystem means larger yield and better quality products. Farmers and fishermen can begin to evaluate the health of their agricultural environment and the effects of their actions have on the rest of lake by monitoring things such as biochemical oxygen demand, fish population, and sedimentation depth. Adjustments then can be made to the lake's ecosystem to

offset negative impacts that would eventually affect the crops and captures. By binding agriculture and ecosystem into a symbiotic entity, farmers and fishermen enter the food chain not just as consumers but also as an agency of active management.

The landscape urbanist approach that encompasses the ideas of symbiotic relationships, process of transformation, and active management can be seen as a renewed sense of pragmatism rooted in the Chinese agrarian culture – a sort of critical pragmatism facilitated by the understanding of a complex system. The new found pragmatism is not singularly profit driven in its purposes, hence it will not necessarily be the most economically rewarding in the short term. Over the long-term however, this approach is the most sound, economically, as well as ecologically and socially, as the most pragmatic proposal are to sustain use for generations to come and to adapt to changes over time.







# Complex System Analysis









Cities Along Yangtze River Basin

02	03	04	05	06	07	08	09
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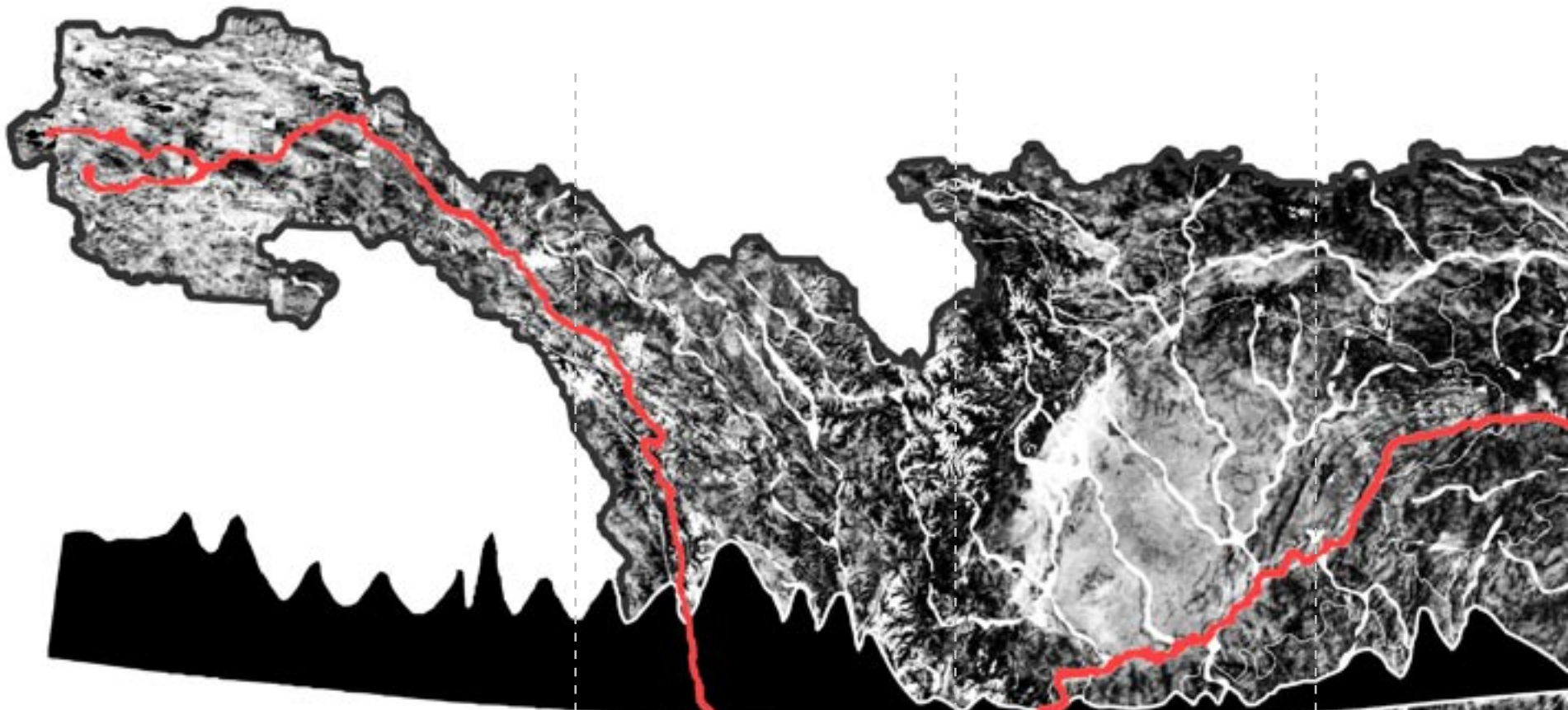
- 02** Yangtze Headwater Tuotuo River at Qinghai Province
- 03** Yangtze at Yunnan Province
- 04** Yangtze at Chongqing City
- 05** Yangtze at Three Gorges Dam
- 06** Yangtze at Nanjing City
- 07** Yangtze at Three Gorges
- 08** Yangtze at Wuhan City
- 09** Yangtze at Shanghai City

## History and Character

The flourishing of the Chinese civilization is closely related to the abundance of water. The two mother rivers - the Yellow River and the Yangtze River, are central to the nurturing process of this ancient land.

Historically speaking, the Yellow River Basin of the north has been the political center of China. The Yangtze River Basin of the south was gradually populated by immigrants from North China and became the agricultural and commercial center of the nation as early as the Han Dynasty (206 BC - 220 AD).<sup>1</sup> The operative difference between the north and south China is largely predetermined by the climatic and geological condition of the two regions; the north is arid and rich in minerals reserves while the south being abundant in water and fertile soil. The focus on commerce instead of politics brought to the south a more liberal milieu, which fostered the cultural and artistic movements of the nation over its imperial history. The various distinctions between the north and the south have persisted into the development patterns of modern China and remains one of the fundamental perceptions with which the northern and southern Chinese differentiate themselves.

While the cross section between the north and south reveals a range of cultural differences due to geographical conditions, the section across the Yangtze River Basin reveals an equally diverse range of cultures - the highland of the west remains the hinterland of the nation with its unspoiled nature; the Sichuan Basin is home to vast reaches of terrace farms; the Jiangnan plain is covered in fishponds and rice paddies, and the estuary at Shanghai is crowded with freights around the world. The diversity in landscape and development has resulted in a vast range of economic progress amongst the different regions. Shanghai is the richest city in China due to its location on Yangtze, with many major cities in the central and upper reaches significantly poorer although they are developing at breakneck speed as their infrastructural network matures. Regional urban centers such as Nanchang, Wuhan, Changsha, Chongqing and Chengdu have begun to catch up to the coast, transforming themselves from industrial and agricultural heartlands into commercial metropolises. This process of economic development is beginning to erode cultural diversity, bringing to all regions a tyrannical uniformity of lifestyles that seeks to flatten everything, even the landscape. Housing development has filled in the lakes of Wuhan and the construction of the Three Gorges Dam has flooded the hilly river banks of Chongqing. The history of Yangtze once shaped by the course of its water is now being shaped by the flow of capital.

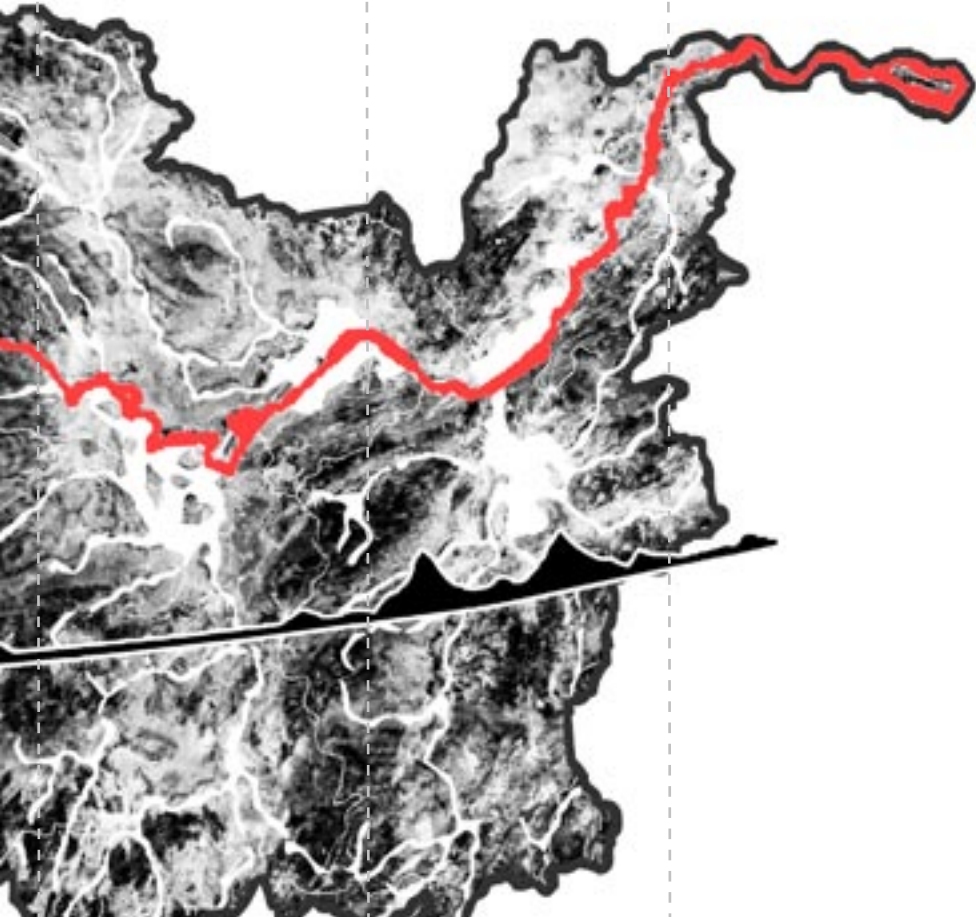


10 (top) Geomorphology of Yangtze River Basin

Landscape of the Yangtze River Basin (left to right)

- 11 Landscape of Qinghai Province: herding on the highland
- 12 Landscape of Yunnan Province: terraced rice field
- 13 Landscape of Sichuan Province: Yading village
- 14 Landscape of Chongqing City: the Three Gorges
- 15 Landscape of Hubei Province: farmland on Jiangnan plain
- 16 Landscape of Anhui Province: Hongcun village
- 17 Landscape of Jiangsu Province: Zhujiqiao village





## Abiotic, Biotic, Cultural and Energetics Analysis

### Geography

<i>Origin of Name</i>	The name Yangtze is the name for the river's lower reaches. The river is commonly known to the Chinese as Chang Jiang: Chang (长) – long; Jiang (江) – river
<i>Coverage</i>	Provinces: Qinghai, Sichuan, Yunnan, Guizhou, Hubei, Hunan, Anhui, Jiangxi, Jiangsu, Zhejiang Provincial Level Municipalities: Chongqing and Shanghai
<i>Major Cities</i>	Chengdu, Kunming, Chongqing, Guiyang, Wuhan, Changsha, Hefei, Nanchang, Nanjing, Hangzhou, Shanghai
<i>Co-ordinates</i>	33°28'05"N, 91°11'45"E <sup>2</sup>
<i>Headwater/Estuary</i>	Qinghai-Tibetan plateau / Shanghai city
<i>Area</i>	1,800,000 km <sup>2</sup> – 20% of PRC <sup>3</sup>
<i>Terrain</i>	Mountains, highland & hills 85% Plain 11% Lakes and Rivers 4% <sup>4</sup>
<i>Headwater Elev.</i>	6621 m ASL <sup>5</sup>

### Geomorphology

Originating from the glacier of the Qinghai-Tibetan plateau, the Yangtze River travels south towards the Yunnan-Guizhou plateau and enters the Sichuan basin as it turns back north, dropping from 5000 m ASL to 1000 m ASL. Heading eastward, the river cuts through Mt. Wushan, forming the Three Gorges along the way, and enters the Central Yangtze Basin where Hubei and Hunan are located. The river bed drops from 1000 m ASL to below 500 m ASL during this course and continues to descend to the sea level. <sup>6</sup>

After collecting from its tributaries in Sichuan basin, the river volume expands considerably. This huge volume of water caused the formation of thousands of lakes in the middle and lower reaches of Yangtze and brought along an immense coverage of fertile soil. The condition gives rise to thousands of fishponds and rice paddies, forming an drastic contrast to the sheep herding at the headwater area.

## Meteorology

### Climate

Generally hotter and more humid towards east:  
Plains: mostly subtropical monsoon weather  
Highland at 2000 m: semi-arid on lower plateaus  
Headwater at 5000 m: cold and arid<sup>7</sup>

### Temperature January

Central and Lower Yangtze Basin 4–6°C  
Sichuan Basin >6°C  
Yungui Plateau >6°C  
Qinghai-Tibetan plateau headwater area -16°C<sup>8</sup>

### Temperature July

Central and Lower Yangtze Basin 28°C  
Sichuan Basin 26-28°C  
Yungui Plateau 24-26°C  
Qinghai-Tibetan Plateau head water area 8°C<sup>9</sup>

### Avg. Annual Precipitation

70-90% concentrated from May to October:  
Central and Lower Yangtze Basin 800 – 1600mm  
Sichuan Basin > 1600 mm  
Qinghai, W. Sichuan Plateau, and mid. of Han River 400-800 mm  
Qinghai-Tibetan headwater area <400 mm<sup>10</sup>

## Water - General Statistics

### Yangtze River

Average flow rate 31,900 m<sup>3</sup>/s  
Average width 1 km to 2 km  
Length 6,380 km – 3rd of World<sup>11</sup>

### Lakes

Middle to lower reaches:

### (Flood basins

Lake Dongting (Hunan) 3,900 (avg.) - 20,000 km<sup>2</sup> (flood)<sup>12</sup>

### Still connected

Lake Poyang (Jiangxi) 140 (winter) - 3,914 (avg.) - 5,100 km<sup>2</sup> (flood)<sup>13</sup>

### to Yangtze)

Lake Chao (Anhui) 760 km<sup>2</sup><sup>14</sup>

Lake Hongze (Jiangsu) 2,200 km<sup>2</sup><sup>15</sup>

Lake Tai (Jiangsu) 2,250 km<sup>2</sup><sup>16</sup>

## Water - Pollution

### Waste Water

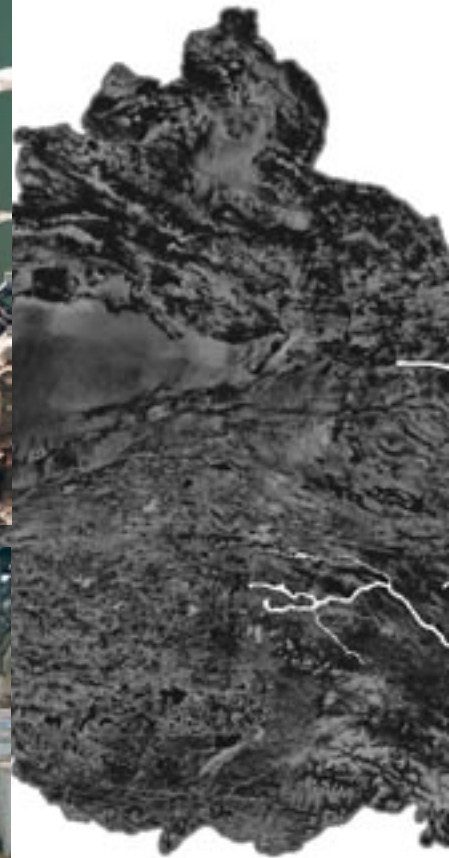
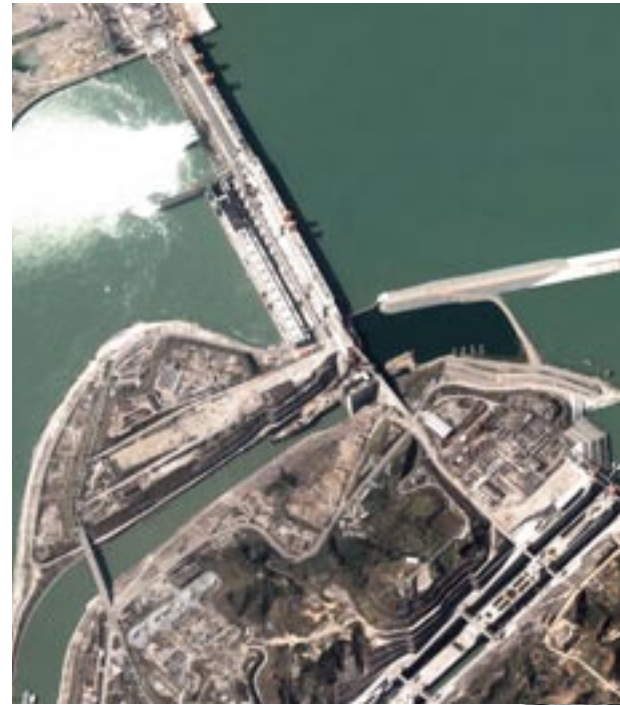
22.05 billion tons<sup>17</sup> (Year 2001)

28.81 billion tons<sup>18</sup> (Year 2004)

30.66% increase over 3 years

### Major Pollutant

Petroleum and ammonia nitrogen

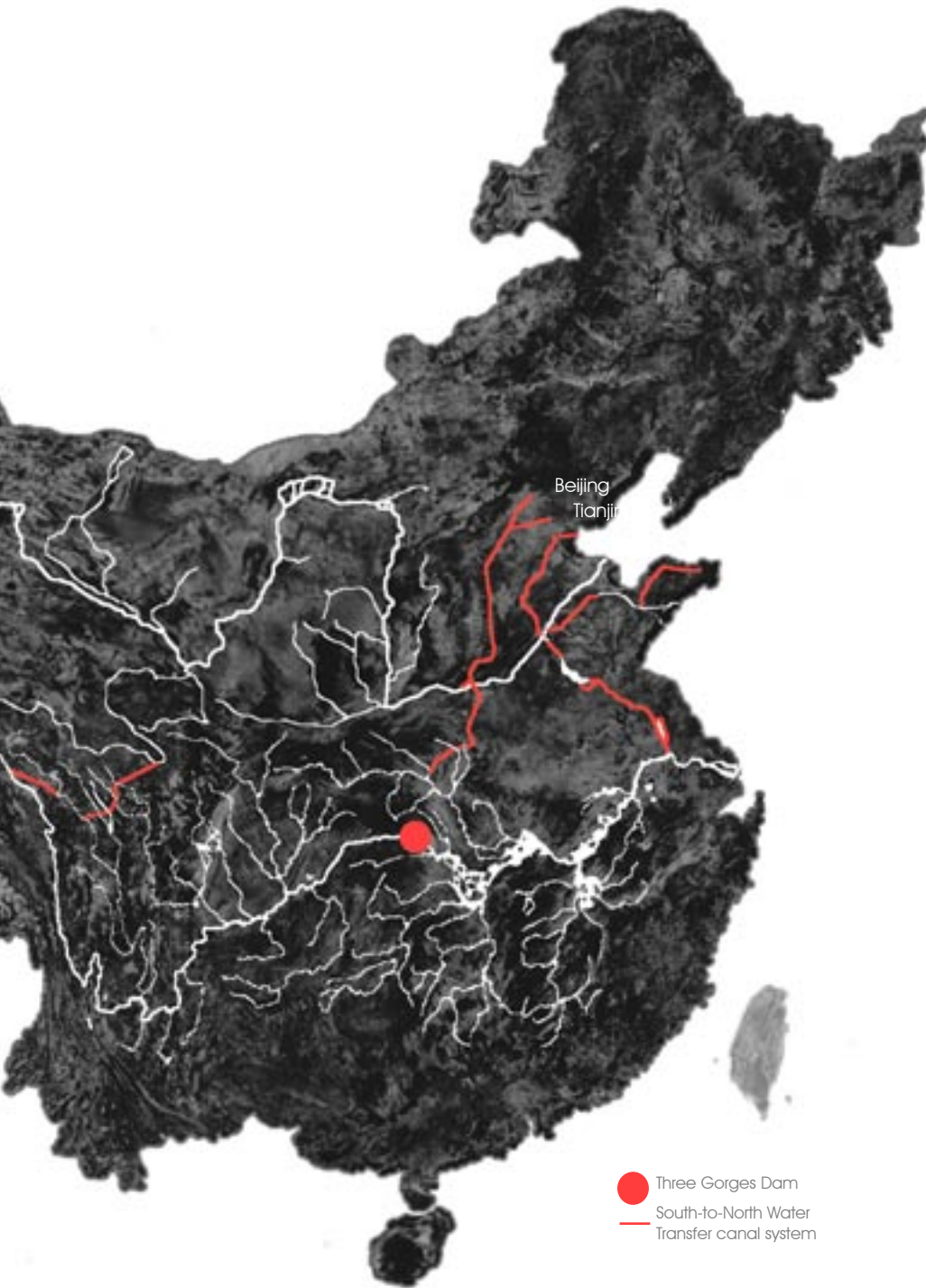


18 (top) Three Gorges Dam Satellite Photo

19 (btm.) Three Gorges Dam under Construction

20 (right) Large Scale Hydraulic Projects in China





Water Quality	Grade	I(%)	II(%)	III(%)	IV(%)	V(%)	<V(%)
Y. 2001		4.9	58.4	13.4	8.5	8.5	6.3 <sup>19</sup>
Y. 2004		11.5	42.3	18.3	15.4	2.9	9.6 <sup>20</sup>
Growth%		6.6	-16.1	4.9	6.9	-5.6	3.3

**Water Pollution** Most water sections with grade I and II test results are taken from the Yangtze mainstream whose greater cross section is able to dilute the pollutants. Considering that grades I to III are considered acceptable quality, with a 16.1% drop in the grade II quality between 2001 and 2004, it is clear that the over all quality of Yangtze is still declining. In year 2004, there is only an average of 10% water treated in the entire basin, a situation that is in desperate need of improvement to match the growing population and increase in industrial production.<sup>21</sup>

#### **Water - Scarcity**

**Water per Capita** Average 2,400 m<sup>3</sup>/capita<sup>22</sup> (Year 2002)  
Slightly above national average but it is 25% of the world average.

**Water Scarcity** The average water per capita continues to decline due to population growth and pollution. The United Nations Food and Agriculture Organization considers 1,000 m<sup>3</sup>/capita<sup>23</sup> a severe constraint on socio-economic development and environmental protection; 2,000 m<sup>3</sup>/capita as serious constraint in drought years. In cities like Shanghai where the population density is 2,750 per km<sup>2</sup>, its 1,049 m<sup>3</sup>/capita supply is a limit that cannot be stretched any thinner.<sup>24</sup>

#### **Water – Hydraulic Projects**

**Three Gorges Dam** The Three Gorges Dam has left thousands homeless due to site clearance, resulting in immense deforestation, the flooding and destruction of many cultural sites, and the destruction of countless habitats for species that are near extinction. These sacrifices were made to meet 10% of China's electricity demand and to prevent flood damage in the Central Yangtze Basin. Whether these objectives can be met is questionable considering the technical difficulties of the project and the different water levels required for flood retention and electricity generation.<sup>25</sup>

**South-to-North Water Transfer** The South-to-North Water Transfer canal project commenced in 2002. The project will put a canal in east, central and west China to connect Yangtze with the Yellow River in order to supply for the semi-arid regions of the north. On an even greater scale than the Three

Gorges Dam, the project is the singularly most environmental damaging construction in the history of China. Considering the 2,400 m<sup>3</sup>/capita average water volume and the population growth, the water resource of the south is quickly becoming inadequate for itself. Even without pollution, the Yangtze watershed system has little water to spare outside its monsoon season. The project will cover an immense distance, displacing millions of people. It will destroy numerous natural habitats and possibly spread pollution. The diminished water pressure at the estuary will cause sea water to back flow into the Yangtze, rendering miles of the river unsuitable for drinking thereby exacerbating the issue of water scarcity in China's densest urban centers such as Shanghai and Nanjing. The amount of energy invested in pump stations to keep the flow of the canal is staggering and the attention needed to regulate the mammoth implies high risk. Just as the Three Gorges Dam, almost every aspect of the projects spells unsustainability.<sup>26</sup>

#### Water – Soil Erosion

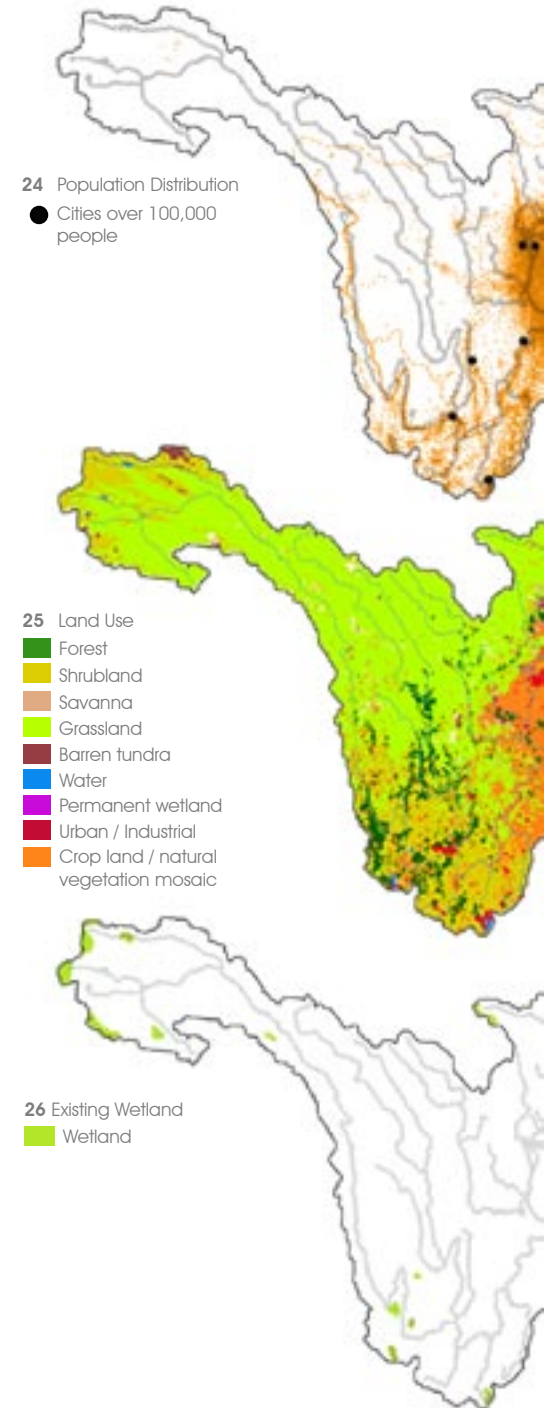
Soil Erosion Coverage  
 562,000 km<sup>2</sup> (Year 1985)<sup>27</sup>  
 620,000 km<sup>2</sup> (Year 2005)<sup>28</sup>  
 10.32% increase over 20 years

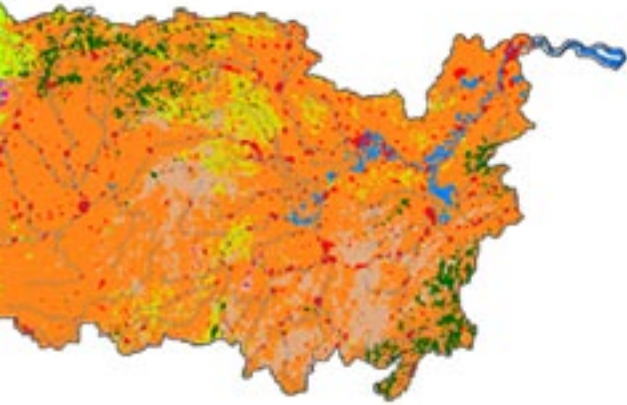
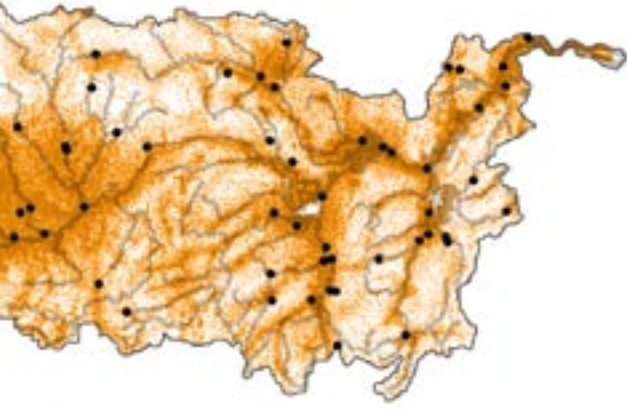
Soil Erosion Rate  
 22.40 tons/a (Year 1985)<sup>29</sup>  
 10.85 tons/a (Year 2002)<sup>30</sup>  
 10.54 tons/a (Year 2003)<sup>31</sup>  
 9.32 tons/a (Year 2004)<sup>32</sup>  
 58.39% decrease over 19 years

Improvement Intense deforestation from the upper reaches of the Yangtze dates back to the 1700's when New World crops, such as corn and barley, were introduced to the formerly unarable land.<sup>33</sup> Signs of improvement have been showing ever since the Central Government issued its reforestation program in the 1990's.<sup>34</sup> The construction of 12,000 reservoirs with 30 billion cubic meter of storage capacity in the upper reaches of Yangtze also help retain a considerable amount of silt.<sup>35</sup> Officials have claimed that the accumulation of silt in these dams will not become huge problems if reforestation on the Yangtze's upper reach persist. The reality is that many dams are already silted up halfway. Though the reported figures on soil erosion shows impressive improvement, it is hard to evaluate whether the success is due to reforestation or the construction of dams. No matter the cause, this means less sedimentation of silt in the lakes of the middle and lower reaches. The rate of



Soil Erosion and Highland (top to bottom)  
 21 Soil erosion at Yangtze's upper reaches, Yunnan.  
 22 Clearing the Field for Winter Planting: The available land for cultivation is below 0.067 ha/ca and farmers usually do not have any grain left over for sale.  
 23 Drying Corn on the Rooftop: Highlands of Yunnan.





Endangered Species (top to bottom)  
 27 Yangtze River Dolphin  
 28 Golden Snub-nose Monkey  
 29 Finless Porpoise  
 30 Pandas

erosion is still overwhelming and the problem remains a potential threat to the Three Gorges Dam's controversial silt-flushing sluice.

**Ecology - Biodiversity**

*Species* Birds: 350 types, Water plants: 600 types, Fish: 400 types.

*Ecology Types* Glaciers, grass highlands, high altitude wetlands, wetlands, bamboo groves, deciduous forests, coniferous forests, rivers and etc.

**Ecology - Preservation**

*Natural Reserves* 93 reserves totalling 16,200 km<sup>2</sup> <sup>37</sup> (Year 1986)

*Protected Endangered Species* Yangtze River dolphin (白鱀豚), Chinese alligator (扬子鳄), Giant panda (熊猫), Finless porpoise (江豚), Chinese sturgeon (中华鲟), Père David's deer (麋鹿), Siberian crane (白鹭), South China tiger (南中国虎), Golden Snub-nose Monkey (金丝猴) <sup>38</sup>

**Urbanization**

*Population* 0.49 billion – 38% of PRC <sup>39</sup> (Year 2004)  
 56 cities with population over 100,000 <sup>40</sup>

*Population Density* Average 224 / km<sup>2</sup>, Max. (Shanghai) 2,750 / km<sup>2</sup> <sup>41</sup> (Year 2004)

*Railway* 16,400 km <sup>42</sup>

*Waterway* Named "Golden Waterway" of China:  
 80% of inland freight of China, 5,887 ports <sup>43</sup>

**Agriculture and Land**

*Arable Land* 23 m. ha – 25% of PRC's arable <sup>44</sup> (Year 1999)

*Arable Land per Capita* 0.045 ha / capita <sup>45</sup> (Year 1997)  
 0.053 ha / capita (FAO warning level)

**Economy**

*GDP* 654.75 b. USD/a – 45% of PRC <sup>46</sup> (Year 2004)

*GDP per Capita* 1,336.22 USD/capita.a <sup>47</sup> (Year 2004)

**Energy**

*Coal* 7.7% of China <sup>48</sup>

*Hydro Electricity* 197x106 kw of potential – 53.4% of China <sup>49</sup>





**Central Yangtze River Basin**





## History and Character

The Kingdom of Chu was established on the Central Yangtze River Basin during the Spring and Autumn Period (722-481 BC) and the Warring States Period (481-212 BC) until Qin Shihuang, the first emperor of China, united the fragmented China under the Qin Dynasty.<sup>1</sup> Since then, the region never regained any political importance but remains one of the most agriculturally productive areas of the nation. Unfortunately, the land that is blessed by the Yangtze's carriage of fertile soil is also cursed by its floods. The instability of the river course has formed the largest marshland, the Yunmeng Marshland, and created two of China's largest lakes, Dongting Lake and Poyang Lake. Although the majority of the Yunmeng Marshland has been reclaimed by farmers, fragments of it still remain in the form of lakes and wetlands. The history of the region is characterized by the struggle against the wrath of Yangtze and the exploitation of its marshlands and lakes.

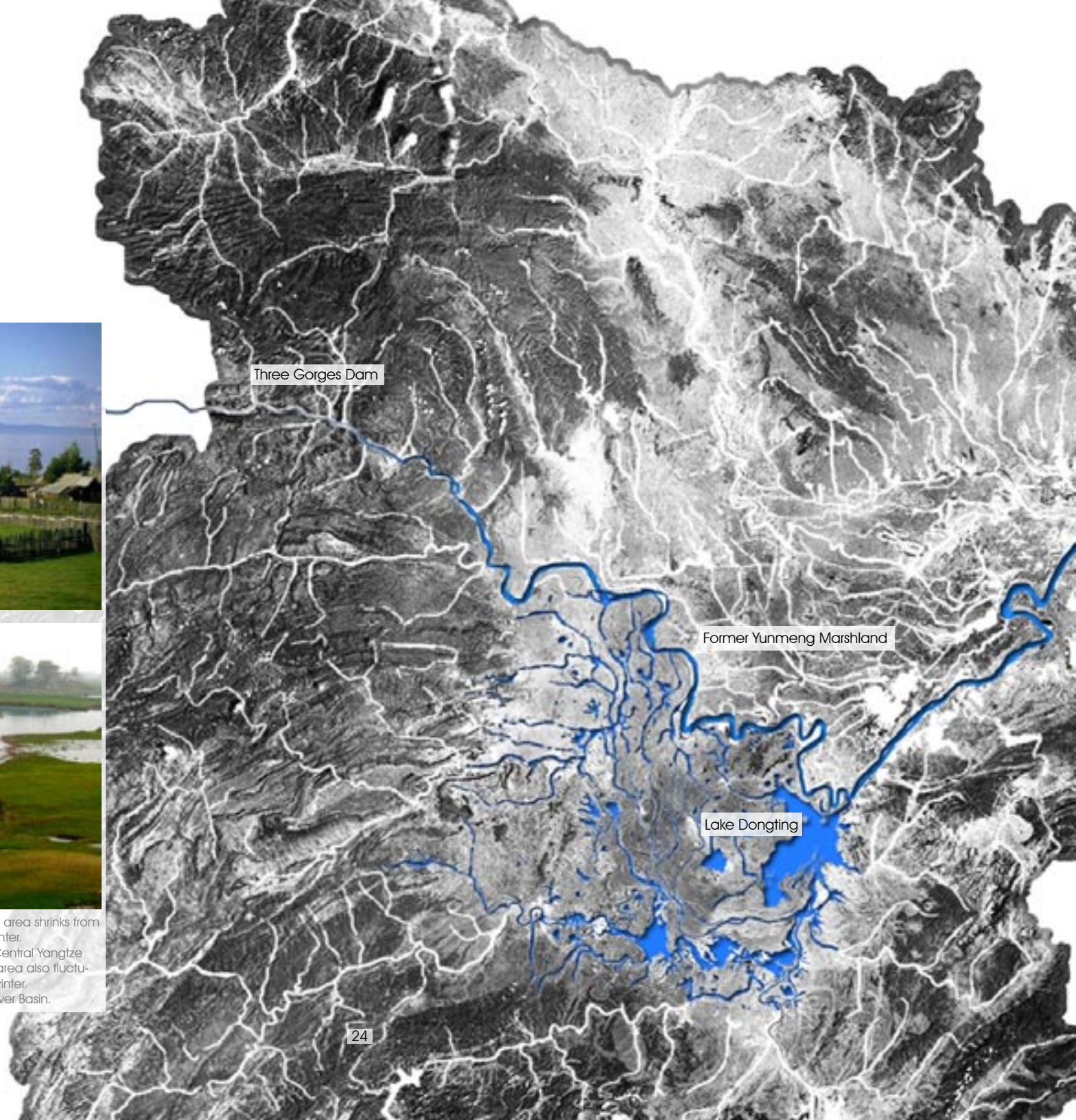
**02** Water Landscape of Hubei Province: A photo taken from a plane passing over the rural areas near the airport of Wuhan city. The picture shows a landscape of fishponds and farmlands converted from lake areas



03 (top) Lake Poyang: largest lake in China. Its lake area shrinks from 5,100 km<sup>2</sup> during flood season to 140 km<sup>2</sup> in winter.

04 (btm.) Lake Dongting: the main flood basin in Central Yangtze River Basin. Like Lake Poyang, its water surface area also fluctuates dramatically between flood season and winter.

05 (spread) Geomorphology of Central Yangtze River Basin.

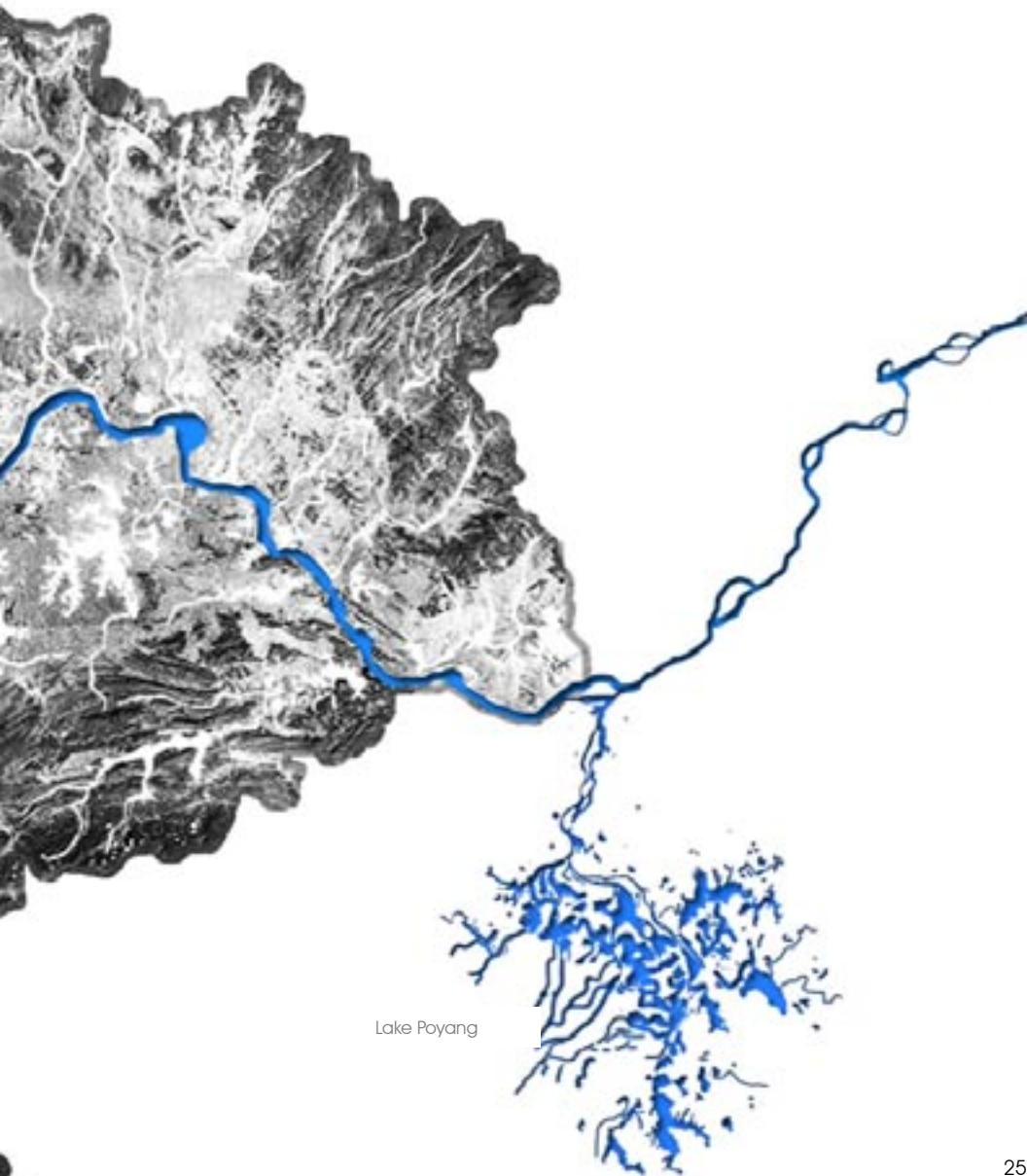


Three Gorges Dam

Former Yunmeng Marshland

Lake Dongting





## Abiotic, Biotic, Cultural and Energetics Analysis

### Geography

<i>Origin of Name</i>	Hubei: Hu (湖) – Lake; Bei (北) – North Hunan: Hu (湖) – Lake; Nan (南) – South Region South and North of Dongting Lake.
<i>Coverage</i>	Hubei and Hunan province
<i>Location</i>	Center of Yangtze River - Yichang (Three Gorges site) to Hukou city (estuary of Lake Poyang) Center of China - West to the Sichuan basin, east to Yangtze Delta, north to the loess plateau, south to Pearl River Delta
<i>Coordinates</i>	29° 20' 0" N, 112° 55' 0"E
<i>Area</i>	397,700 km <sup>2</sup> - 4.15% of nation <sup>2,3</sup>

### Geomorphology

The terrain on the west side of the region is the highest rim of the basin, featuring the Three Gorges and the Shennong Peak (3,105m ASL). Descending down the mountains, the Yangtze River cuts through the region from west to east to form an alluvial plain. The river abruptly bends mid course through the basin, branching off into Lake Dongting. After having been tamed by the giant lake, the diverted water rejoins its mainstream and continues to twist its way across the plain, altering its course and leaving behind thousands of pockets of water over geological time.

### Meteorology

<i>Climate</i>	Subtropics Monsoon: Humid and hot summers; mildly cold winters <sup>4</sup>
<i>Temperature</i>	Jan. 1-6 °C; July 24-30 °C / High 40.9 °C; low -9.6 °C <sup>5</sup>
<i>Avg. Precipitation</i>	750-1,700 mm/a, Increasing from west to east <sup>6</sup>
<i>Wind</i>	NE for winter (arid), SW for summer (humid) <sup>7</sup>
<i>Wind Speed</i>	2.4-2.8 m/s (mean) <sup>8</sup>
<i>Relative Humidity</i>	74-77% (mean) <sup>9</sup>

### Soil

<i>Bedrock</i>	Mostly limestone and some quartz <sup>10</sup>
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**Soil Types**

Luvisol 32.54%  
 Anthrosol 24.76%  
 Skeletal Primitive Soil 8.35%  
 Dark Semi-hydromorphic 8.27%<sup>11</sup>  
 Fertile alluvial soil covers most of the plains. The bottom of lakes is especially fertile due to the accumulation of decomposed plant and animal parts.

**Air**

Air Quality	Grade	I(%)	II(%)	III(%)	<III(%)
Y. 2000		2.94	17.65	67.65	11.76 <sup>12, 13</sup>
Y. 2004		3.23	29.03	54.84	12.90 <sup>14, 15</sup>
Growth%		0.29	11.38	-12.81	1.41

**SO<sub>2</sub> Emission**

1,253,000 tons (Year 2000)  
 1,564,800 tons (Year 2004)<sup>16</sup>  
 24.88% increase over 4 years

**Air Pollution**

Vehicles, industries and power generation are the three main sources of air pollution for China. In major urban areas of the Central Yangtze Basin, vehicles are the main source of CO<sub>2</sub> emission. With 70% of the nation's electricity generated by coal-fire generators, a large amount of SO<sub>2</sub> is emitted into the air, resulting in a severe situation in acid rain.<sup>17</sup> In addition, Central Yangtze's role as a major automobile, steel and non-ferrous metal producer further exacerbates the SO<sub>2</sub> emission in the region.<sup>18</sup> The situation is not exclusive to urban areas as many townships and villages with poor production facilities are found throughout the region. This causes the reduction in agricultural production and the deterioration of aquatic ecosystems. The overall atmospheric SO<sub>2</sub> amount continues to rise as population growth demands more energy consumption.

**Water - General Statistics**

Tributaries	Length	Flow Rate
Han River	1,577 km	1,710 m <sup>3</sup> /s
Xiang River	844 km	2,370 m <sup>3</sup> /s <sup>19</sup>

Lakes	Area	Area Flood	Avg Depth	Max Depth	Volume
Lake Dongting	3,900	20,000 km <sup>2</sup>	7 m	15 m	20 km <sup>3</sup> <sup>20</sup>
Lake Poyang	3,914	5,100 km <sup>2</sup>	8 m	16 m	30 km <sup>3</sup> <sup>21</sup>



06 Drainage system of the Central Yangtze River Basin (top) & the Great Lakes Basin (bottom)



### Water - River Basin Size Comparison

Displayed at the same scale, China's largest lakes, Lake Dongting and Poyang, appear to be miniature landscape features in comparison to the Great Lakes. Considering the average annual precipitation for Toronto is 834mm and the average annual precipitation for the City of Wuhan is 1,200mm, the Yangtze River Basin is facing a serious challenge for flood control.

### Water - Pollution

#### Waste Water

Waste Water	Total (b. ton)	Industrial (b. ton)	Municipal (b. ton)
Y.2000	4.443	2.193	2.250 <sup>24, 25</sup>
Y.2004	4.826	2.206	2.620 <sup>26, 27</sup>
Growth%	8.62	0.59	16.44

#### River

Grade	I(%)	II(%)	III(%)	IV(%)	V(%)	<V(%)
Y. 2001	4.02	25.86	12.64	28.16	5.17	24.14 <sup>28, 29</sup>
Y. 2004	3.05	40.24	28.66	7.93	9.76	10.37 <sup>30, 31</sup>
Growth%	-1.03	14.38	16.02	-20.23	4.59	-13.77

#### Lakes of Hubei Province

Grade	I(%)	II(%)	III(%)	IV(%)	V(%)	<V(%)
Y. 2001	0.0	0.0	7.1	14.3	42.9	35.7 <sup>32, 33</sup>
Y. 2004	0.0	21.4	21.4	35.7	7.1	14.3 <sup>34, 35</sup>
Growth%	0.0	21.4	14.3	21.4	-35.8	-21.4

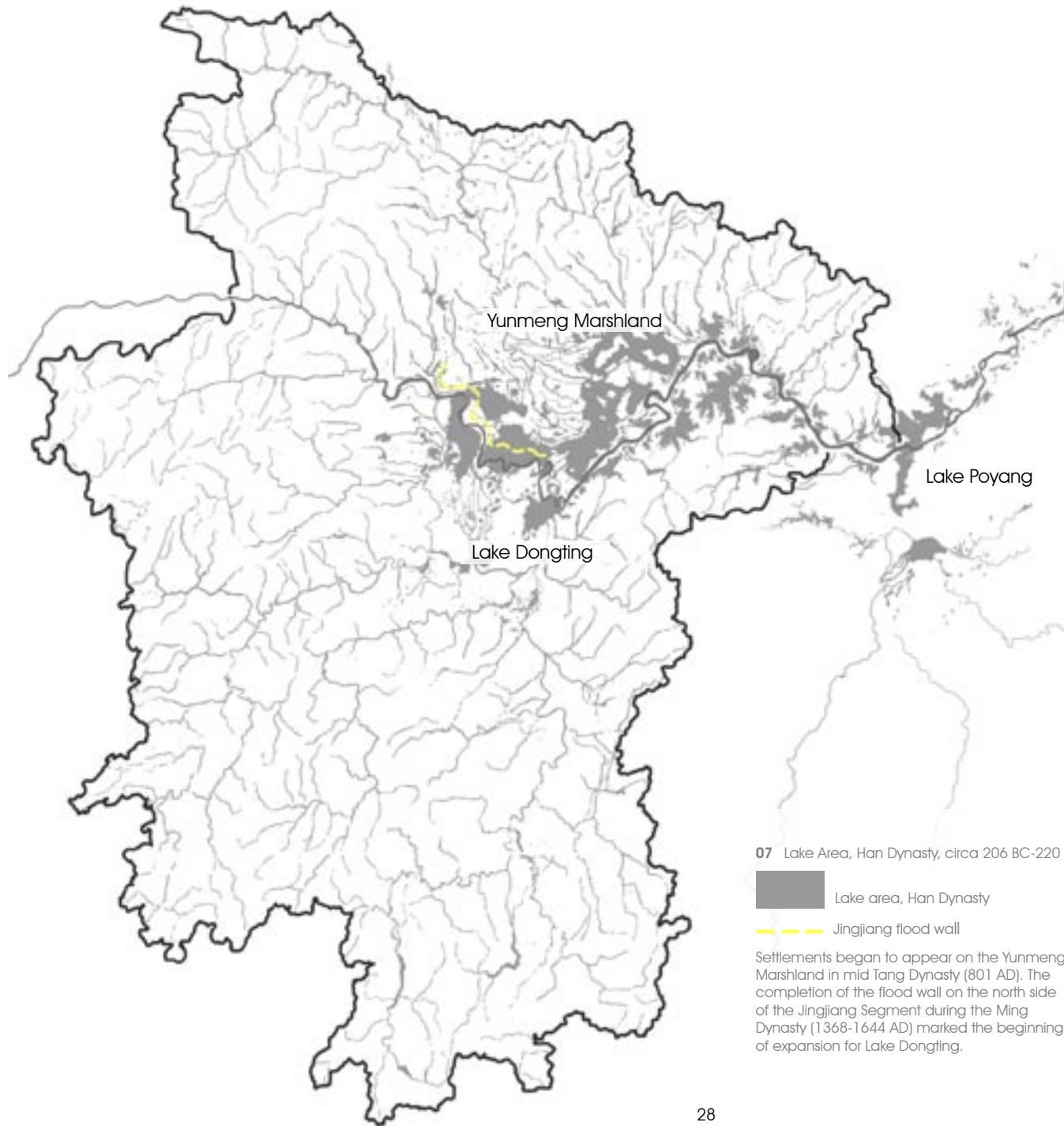
#### Urban Lake Quality

Almost all urban lakes, including Dongting and Poyang, remain at grade V or below from 2001 to 2004, showing little improvement.

#### Water Pollution

There are twenty six water treatment plants in Hubei and only a total of 18% of all municipal water is treated.<sup>36</sup> There are 17 plants in Hunan with 11% of all municipal water treated.<sup>37</sup> The theoretical capacity of treatment is around 60% but due to the lack of funding for sewer connections and subsidies for operation costs, a large number of these plants are running at below 50% of its expected treatment rate. Some of them have not even treated a single drop of water. Yet the construction of more treatment plants have been planned. The root of the problem is corruption at the municipal administration level.

Many cities along the Yangtze River house pulp and paper, chemical, and dark metal manufacturers. These three types of industries are notorious for the amount of high COD (Chemical Oxygen Demand) substances discharged into the region's water systems.<sup>38</sup> However, the contribution of high COD substance from



07 Lake Area, Han Dynasty, circa 206 BC-220 AD

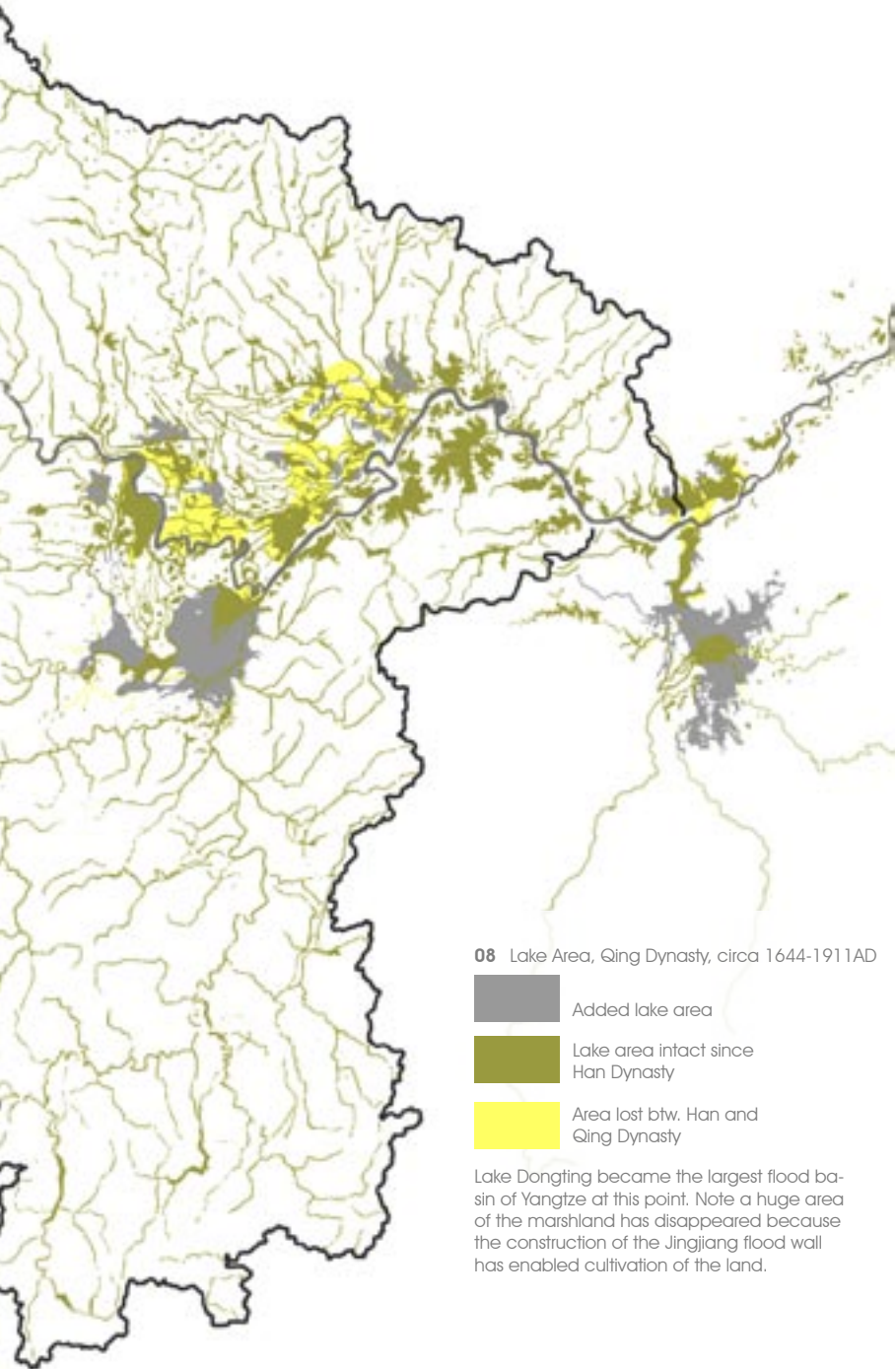


Lake area, Han Dynasty



Jingjiang flood wall

Settlements began to appear on the Yunmeng Marshland in mid Tang Dynasty (801 AD). The completion of the flood wall on the north side of the Jingjiang Segment during the Ming Dynasty (1368-1644 AD) marked the beginning of expansion for Lake Dongting.



the municipal level is almost double that of the industrial sector. The federal government issues an environmental improvement mandate every five years, demanding designated standards be met. This is achieved primarily by shutting down small plants with low production and high pollution rate. In the mean time, larger plants are asked to reduce their waste production and increase the water recycling rate. However, since the problems with the treatment plants and their sewer networks have not been significantly addressed, the rate of water treatment in most urban areas remains below 20%.

With an average flow rate of 23,400 m<sup>3</sup>/s, the Yangtze River manages to dilute the effluents and maintain a grade II water quality, thereby making it the primary source of extraction for water plants. On the other hand, many tributaries of Yangtze River are experiencing severe pollution due to their smaller cross sections.

Of all the water bodies, the lakes are the most severely polluted due to their shallow depth, stagnation and severed links to the Yangtze River. Eutrophication is a common phenomenon for these lakes. Nitrate and phosphate found in these water bodies have their sources in agricultural fertilizer runoff, industrial effluent and municipal effluent. Almost all urban lakes show portions of algal bloom.

### Water - Diminishing lakes

#### Chronology of Lakes

Lakes of Hubei (Former Yunmeng Marshland + Jiangnan Lake Group);  
 8,300 km<sup>2</sup> – 1,066 lakes (Year 1949)<sup>39</sup>  
 2,657 km<sup>2</sup> – 309 lakes (1980's)<sup>40</sup>  
 2,417 km<sup>2</sup> – 182 lakes (Year 2003)<sup>41</sup>  
 The total area of lake in Hubei is 70.88% less than its original area in 1949 and 884 lakes have disappeared since then.



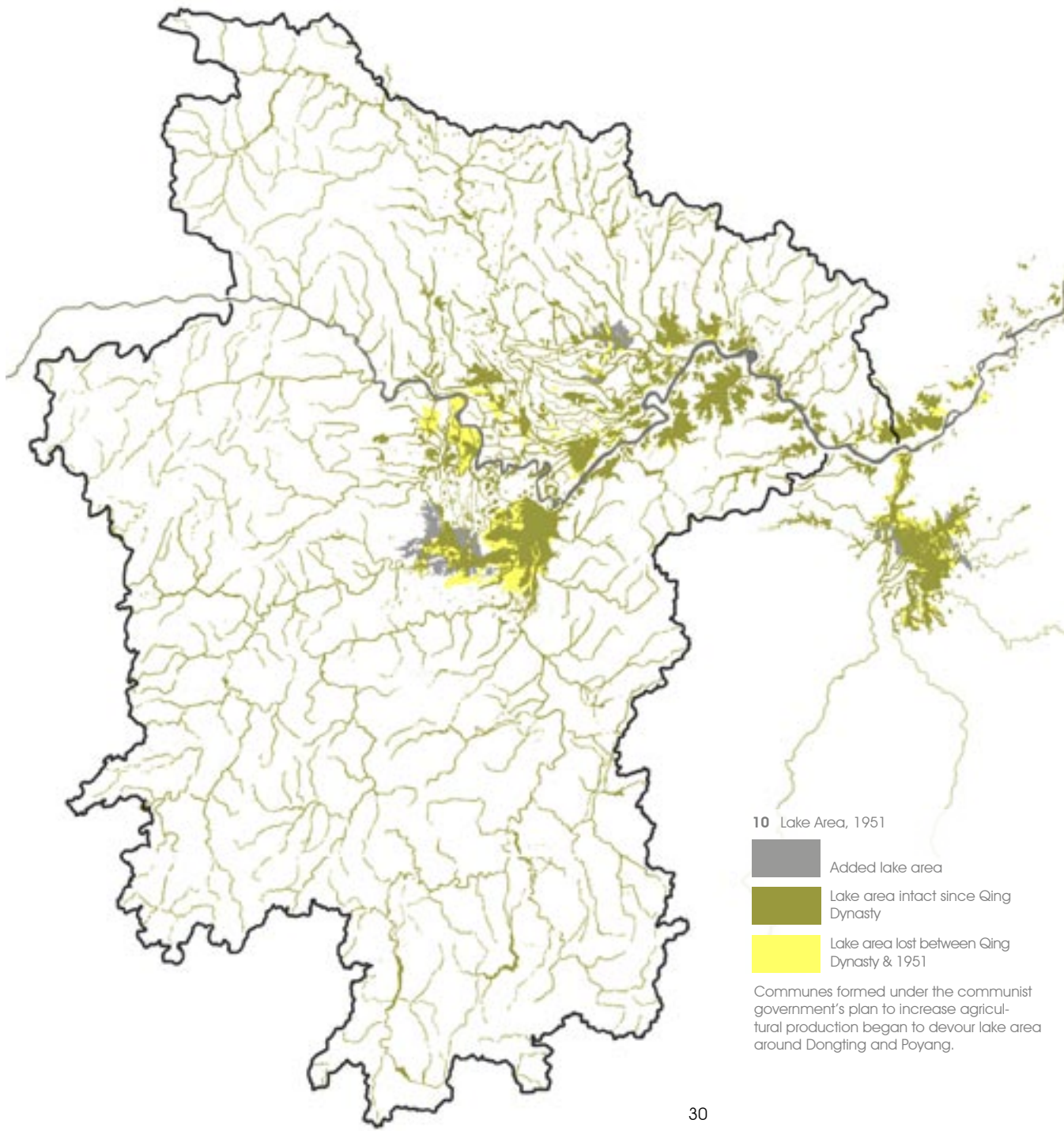
**09** Lakes in Yunmeng area divided into fishponds

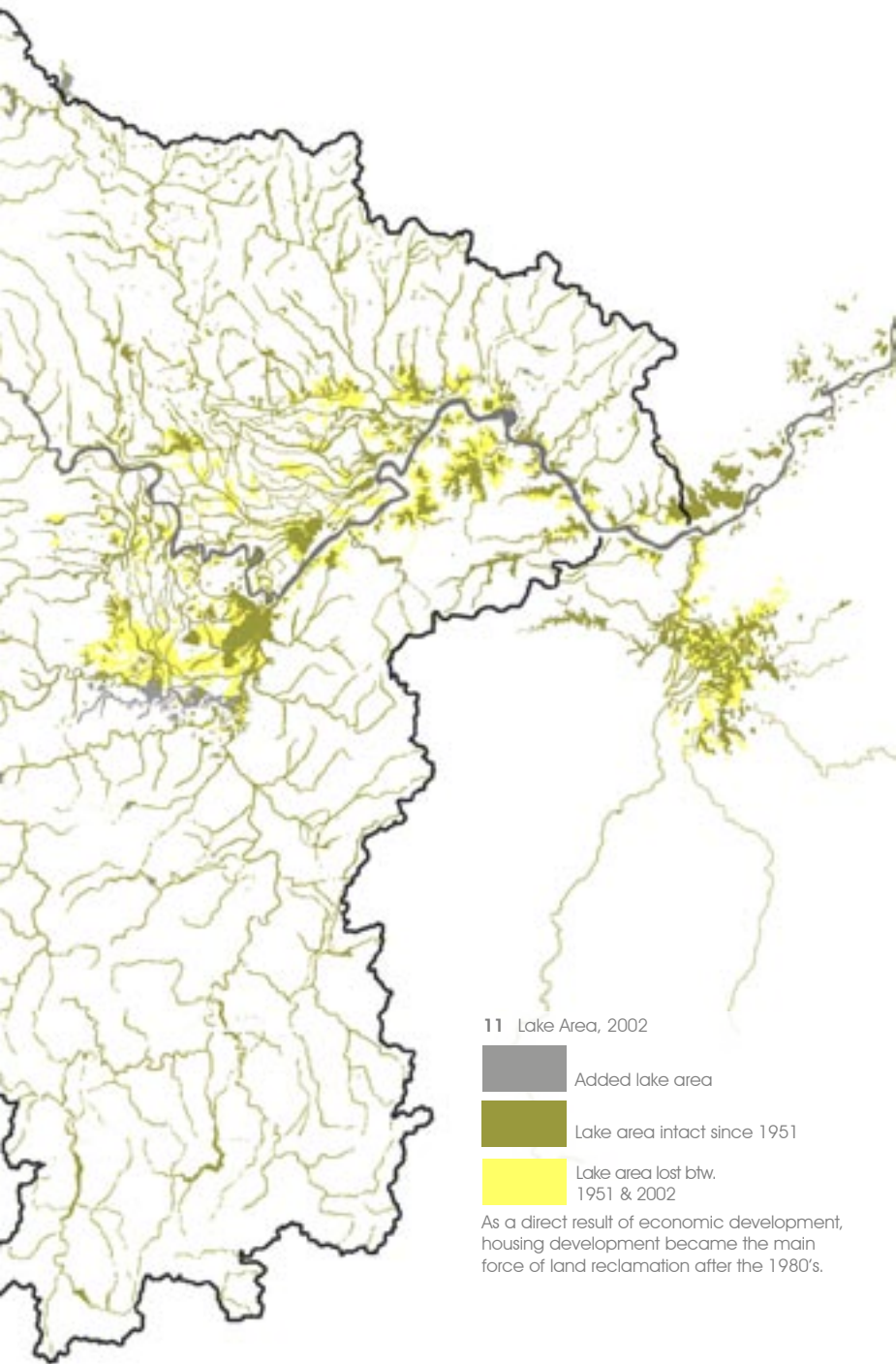
#### Lake Dongting (middle of Central Yangtze)<sup>42</sup>

6,200 km<sup>2</sup> (Year 1825)  
 4,350 km<sup>2</sup> (Year 1949)  
 2,625 km<sup>2</sup> (Year 1998)  
 3,900 km<sup>2</sup> (Year 2003)  
 The lake is 37.1% less than its original area in 1825.

#### Lake Poyang (end of Central Yangtze Basin)

6,000 km<sup>2</sup> (1800's)<sup>43</sup>  
 5,100 km<sup>2</sup> (Year 1949)<sup>44</sup>  
 3,900 km<sup>2</sup> (Year 1998)<sup>45</sup>  
 5,100 km<sup>2</sup> (Year 2003)<sup>46</sup>  
 The lake is 15% less than its original area in the 1800's.





### Water - Land Reclamation

Land reclamation dates back to the Tang Dynasty when massive settlement took place on the Yunmeng Marshland. Since the establishment of the PRC, rapid settlement began to emerge not only on the Former Yunmeng Marshland but also around Lake Dongting and Poyang. The 1950's saw the largest conversion of lake shores into rice paddies and fish ponds due to the communist government's urge to resolve food shortages. The 1970's marked the beginning of the government's initiative to control land reclamation but many lakes were still shrinking. When Deng Xiao-ping's economic reform began in the 1980's, real estate development became the new threat to the lakes. Many agricultural conversions in urban centers were taken over and new landfills were added to the already polluted and shrunken lakes.<sup>47</sup>

Although the province of Hunan does not have as many lakes as Hubei does, it does have the second largest fresh water lake in the nation. Dongting Lake boasted 6,200 km<sup>2</sup> during early Qing dynasty (1644-1911) but only 2,626 m<sup>2</sup> remained by the time of the catastrophic flood in 1998. After the devastation of the flood, the Central Government issued a program to restore lake areas lost to farmlands. It is reported in 2003 that the area has been restored to 3,404 km<sup>2</sup> and should continue to grow until it reaches 4,350 km<sup>2</sup>, which is precisely the area measured at the establishment of the PRC regime. A similar program is also in effect at Poyang Lake.<sup>48</sup>

### Water - Sedimentation

#### Threat from Upstream

Soil erosion from the upper reaches of the Yangtze has caused massive sedimentation of silt in the lakes of in the Central Yangtze River Basin. Efforts have been made to disconnect the lakes from Yangtze and other rivers connected to them in order to prevent further accumulation of silt. However, there are still several lakes connected to Yangtze's tributaries and the two giant lakes, Lake Dongting and Poyang, are still connected to the main stream of Yangtze. It is estimated that the rate of sedimentation in these lakes ranges from 0.72 mm/a to 3.4 mm/a. After the flood of 1998, the central government began reforestation programs on the two main Yangtze tributaries connected to Dongting and Poyang. Most importantly, the program also involves the upper reaches of Yangtze. Ironically, at the completion of the Three Gorges Dam, the reduction of Yangtze's silt carriage will result in a faster stream that has the tendency to alter course and erode the embankments.<sup>49</sup>







#### **Flood - Natural Phenomenon**

Of all the places along the Central Yangtze, it is the segment from Jingzhou to Yueyang, also known as the Jingjiang segment, that is most susceptible to flood damage. This is a phenomenon caused by the geomorphology of the region, in which the steep riverbed of the Three Gorges flattens out into the Central Yangtze River Plain. While the riverbed flattens, the immense momentum from the steep gorges continues, resulting in an unstable river course that twists its way across the landscape. Combined with soil erosion from the upper reaches of Yangtze, this geological condition leads to severe sedimentation in riverbeds and lakes.<sup>50</sup>

#### **Flood - Consequence of Human Activities**

Despite the threat of flood, settlements on the Yunmeng Marshland, just north of Jingjiang, began to emerge in Tang Dynasty (801 AD) and brought the lakes in this area to near extinction. For the protection of the settlements in his hometown, one of the chief officials of Ming Dynasty, Zhang Ju-zheng (1525-1582 AD) undertook the project to complete a flood wall on the north side of Jingjiang, leaving Lake Dongting the only available flood diversion area to this critical river bend. As a result, Dongting expanded to become China's largest lake. However, land reclamation also began to take place around Dongting Lake at the end of Qing Dynasty (1644-1911 AD). The complicated situation forced the Communist government to build a flood wall along the south side of Jingjiang and left two gates for controlled influx into Dongting Lake and one gate for outflow. One after another inappropriate human exploitation eventually led to a severely compromised flood control system.<sup>51</sup>

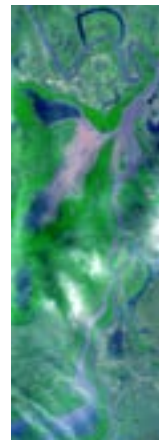
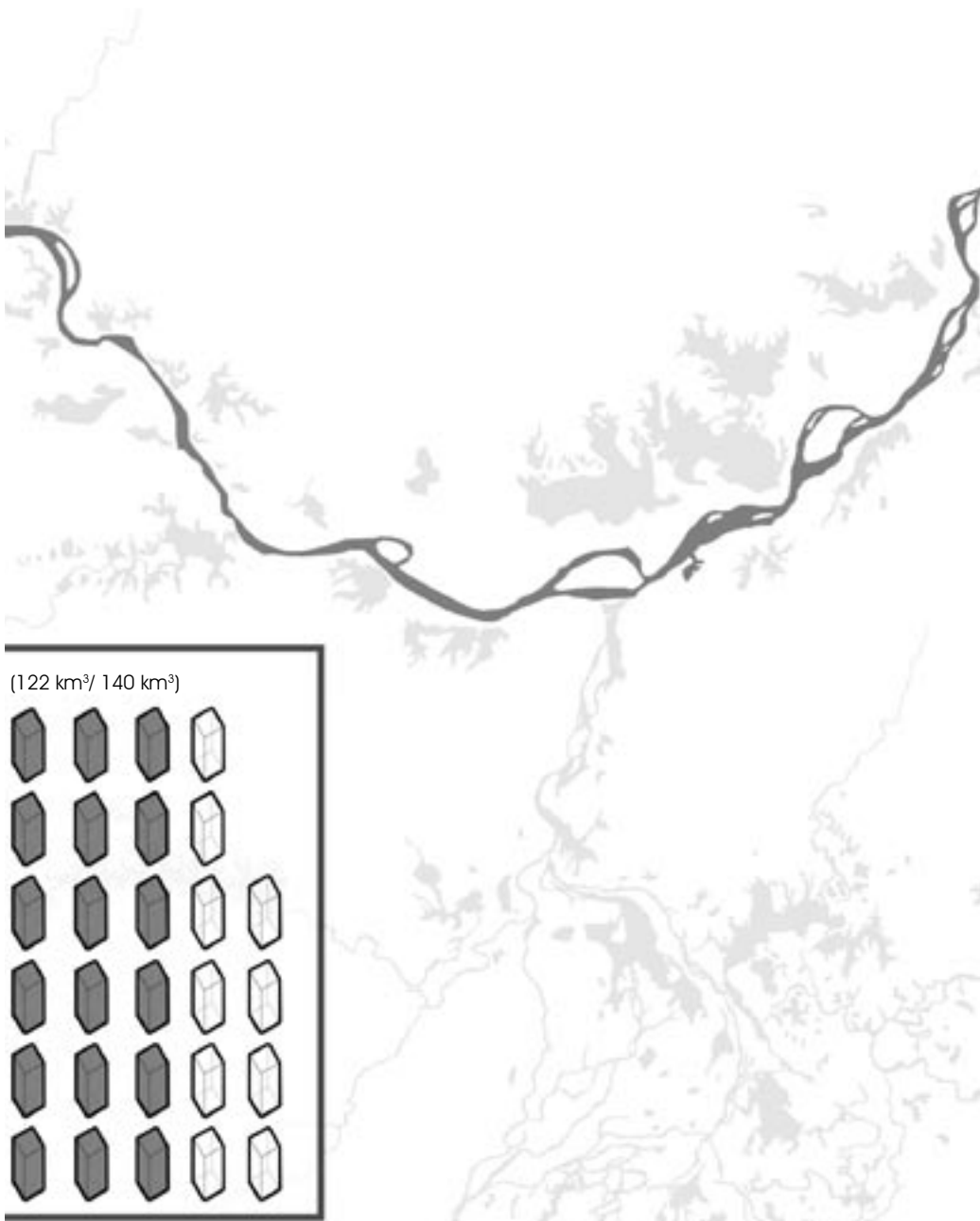
#### **Flood - City of Wuhan**

The central Yangtze River starts from Yichang and ends at Hukou. Between these two cities lies the areas most susceptible to flood damage. The city of Wuhan is the most populated city in this area. Therefore, the flood pressure must be relieved before it reaches Wuhan. Since Lake Poyang, the largest lakes in China, is downstream from Wuhan, its flood control function does little to help the situation.<sup>52</sup>

#### **Flood - Retention Capacity of the Basin**

In light of the need for more flood diversion area, the Communist government planned for another security measure - the Jingjiang Floodplain between the south portion of Dongting and the Jingjiang segment. Corruption in the Yangtze River Basin Planning Author-





ity eventually led to 500,000 people settling down in the area. In 1998, the flood wall in the area was penetrated by a hundred-year flood, inundating countless homes and farmlands. After the flood, the Central Government felt the urge to plan for more diversion areas. Restoration work of Lake Dongting and Poyang began and a large scale reforestation program finally arrived. The thousands of lakes north of Jingjiang, however, were never planned for restoration due to their crucial contribution to the nation's agricultural production.<sup>53</sup>

By 2003, Lake Dongting was restored to a maximum capacity of 20.18 km<sup>3</sup> from its former capacity of 16.7 km<sup>3</sup>. Since the maximum thirty-day capacity of Yangtze is 89.46 km<sup>3</sup> and the hundred-year flood capacity is about 138.66 km<sup>3</sup>, a total of 49.2 km<sup>3</sup> flood water must be diverted elsewhere. An initial planning was to pool together 17.2 km<sup>3</sup> from the area around Wuhan, Hukou and the Jingjiang Floodplain and rely on Lake Dongting to accommodate the remaining 32.0 km<sup>3</sup>. However, this is no longer feasible given Lake Dongting's current capacity. The Yangtze River Basin Planning Authority, the same people who planned the settlements on the Jingjiang Floodplain, claimed that at the completion of the Three Gorges Dam, the reservoir will be able to hold 22.15 km<sup>3</sup> of flood water and reduce the diversion demand of Lake Dongting to 21.8 km<sup>3</sup>, a figure that is close to its current maximum capacity. The claim is an obvious folly as it relies on accurate prediction of flood occurrence to lower the high reservoir level in time. The claim also requires parts of Chongqing, the largest city upstream, to be inundated. Even in an ideal situation, the Three Gorges Dam will not be able to save the Central Yangtze River Basin when a thousand-year flood hits the cities with a staggering 165.0 km<sup>3</sup> of water as it happened in year 1870 when soil erosion was not yet a serious threat. A possible sustainable solution, is to form a retention network by linking existing groups of lakes in the area.<sup>54</sup>

14 (top & center) Lake Dongting Fluctuation: March 2002 (top) & Sept. 2002 (center).  
 15 (left) 1998 Flood at Lake Dongting: many homes destroyed in the natural disaster.

### Ecology - Preservation

Number of 35 in Hubei<sup>55</sup>

Natural Reserves 82 in Hunan<sup>56</sup> (Year 2004)

### Ecology - Aquatic Habitats

#### Threats

The alteration of the aquatic environment is the most pressing threat to biodiversity in the Central Yangtze River Basin. There are three major causes of change: the construction of the Three Gorges Dam, the disconnection of the lakes from the Yangtze River, and the reclamation of land from lakes. The dam will block off migration routes for fishes and raise the water temperature, making the river unfit for both reproduction and living. The disconnection of lakes from the Yangtze River reduces the available spawning grounds for fish seeking to return to lakes. The reclamation of land around lakes reduces the available habitats for fishes living in the shallow water at the edges of lakes.

Water pollution can also change the aquatic habitat. In the Central Yangtze Basin, there are three main sources of pollution: fertilizer runoff, industrial effluents and municipal effluents. The pollution deprives the water of oxygen and encourages algal bloom and murky water, destroying the ecological balance and rendering the water unsafe for human use. To date, most lakes remain polluted except for few that are undergoing treatment initiated by the World Wide Fund for Nature.

Excessive fishing also puts considerable stress on the aquatic ecology. Desperate local fishermen often capture fish regardless of age and size, leaving few survivors to repopulate the system. Other unsustainable fishery practice includes overloading chemical feed, elimination of carnivorous fishes, clearing of water plants and the introduction of foreign species. Although there are laws against these practices, ignorance and corruption often prevail.<sup>57</sup>

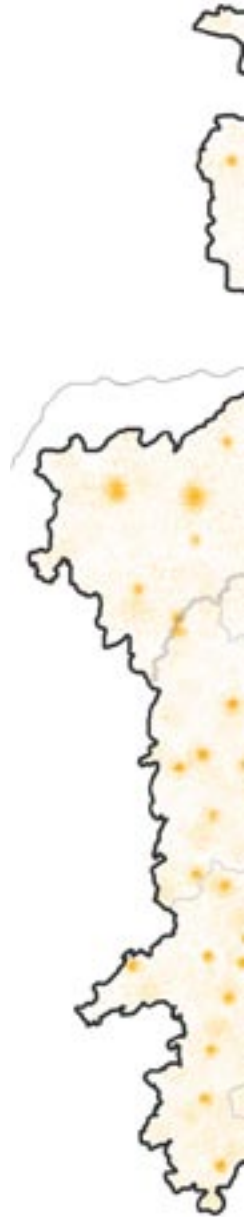
### Ecology - Wetland Habitats

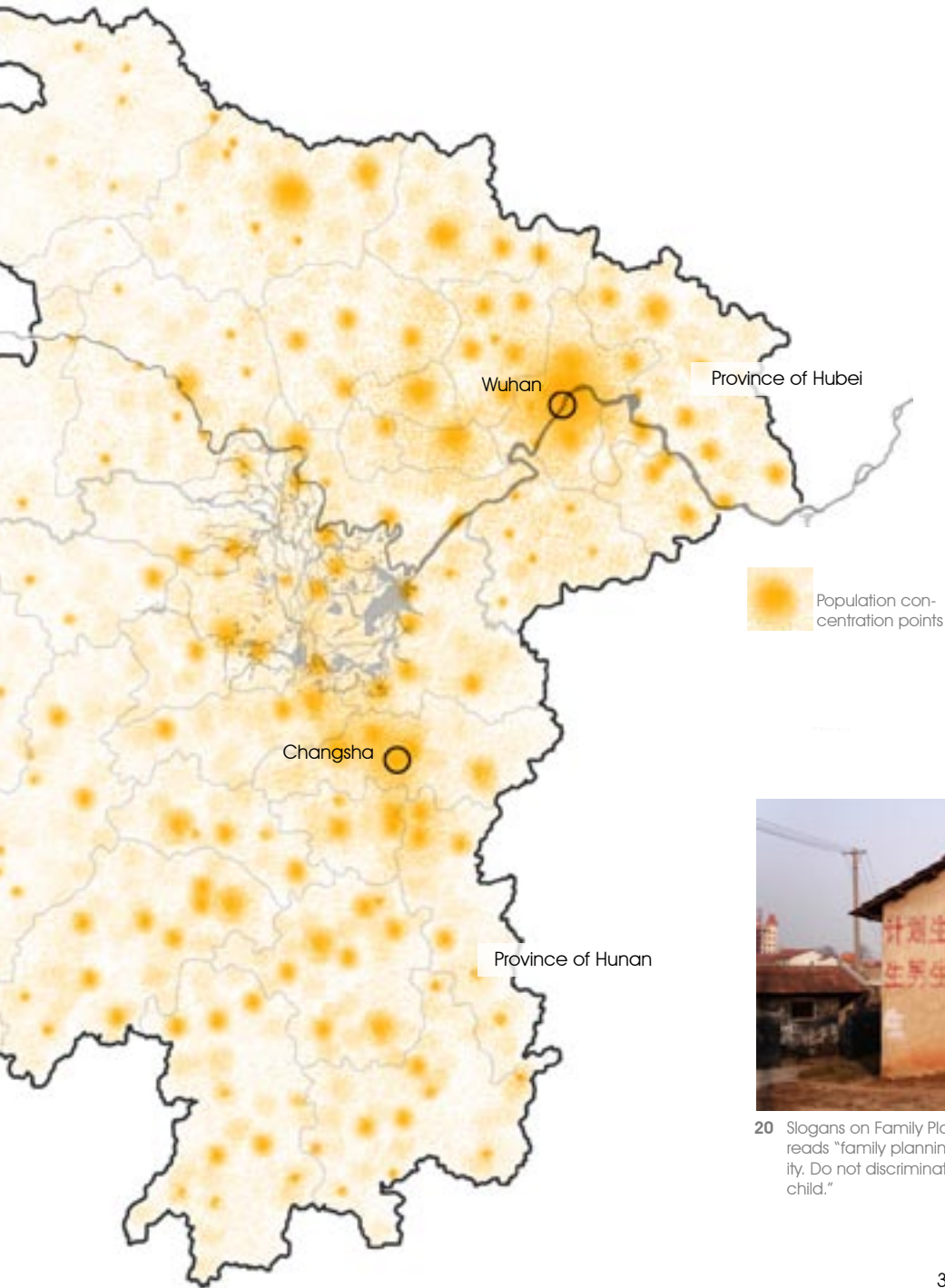
#### Threats

The disappearance of wetlands due to agricultural or real estate land reclamation has destroyed countless habitats for migratory birds such as the Siberian crane. Of the few remaining wetlands, pollution has resulted in low fish population and consequently low food resources for the migratory birds. This has led to the decline of waterbird species from 110 to 80 varieties.<sup>58</sup> Through the efforts of the World Wide Fund of Nature and municipalities, however, six wetlands in the Central Yangtze River Basin have been gradually restored to healthy conditions in the last decade and the birds are returning gradually.



- 16 (top right) Fish Nets Strung Across Bamboo Sticks: net enclosures for fish farming occupy large areas at Lake Hong.
- 17 (btm. left) Fish farmers of Lake Hong Clearing Away Water Weeds: weed harvested from open water and fed to the net enclosures.
- 18 (btm. right) Siberian Cranes: some cranes have returned to parts of Lake Dongting and Poyang.
- 19 (center of spread) Population Distribution





**Forest Habitats**

*Threats*

Deforestation as a result of population pressure is comparable to the phenomenon of land reclamation around lakes. The disappearance of forests directly affects the giant pandas, south China tigers and golden snub-nosed monkeys. Illegal hunting is a persistent problem due to the demand for rare animal parts as ingredients for Chinese medicine and gourmet food.

**Urbanization**

*Population*

Hubei 60,160,000 – 9th of PRC <sup>59</sup>  
 Hunan 66,980,000 – 7th of PRC <sup>60</sup>  
 Total 127,140,000 (Year 2004)

*Population Density*

Hubei 324 / Km<sup>2</sup> – 12th of PRC <sup>61</sup>  
 Hunan 316 / Km<sup>2</sup> – 13th of PRC <sup>62</sup> (Year 2004)

*Municipalities*

Hubei	Hunan
13 prefectures	14 prefectures
102 counties	122 counties
1,235 townships <sup>63</sup>	2576 townships <sup>64</sup>

*Rapid Development*

The measure of urbanization in China is based on the percentage of people dependent on non-agricultural practice for living. The current rate of urbanization in Hubei province is 44.7% and 33.5% for Hunan. China as a whole has 41.8% of urban population. According to government documents, by 2010 the goal is to reach 50% <sup>65</sup> urbanization for Hubei, 45% <sup>66</sup> for Hunan and 45% for the national average. The urbanization process indicates almost 1% average annual growth for the nation. This staggering rate of development suggests a massive migration of rural population to the cities as well as the transformation or growth of formerly rural villages into small towns. The Central Government is encouraging municipalities to urbanize as fast as they can, ignoring the fact that, as a result, the rural population is losing their means of living. Unfortunately, the idea of an organized urban agriculture is foreign to municipal officials and any piece of farmland found in a city is considered as a sign of backwardness. A strategically organized and executed plan for urban agriculture as part of the sustainable mechanisms for urbanization must be introduced.



20 Slogans on Family Planning in Rural Wuhan: sign reads “family planning is the husband’s responsibility. Do not discriminate against the gender of your child.”

## Agricultural and Land

### Loss of Arable Land

The arable land per capita rate has been steadily dropping all over China for years due to vast soil erosion, rapid urban development, and restoration of farmland to former lakes and forests. As of 2004, Hubei and Hunan have an average of 0.056 ha/capita<sup>67</sup> and 0.075 ha/capita<sup>68</sup> respectively. Considering the cautionary limit established by the Food and Agriculture Organization of the United Nations is 0.053 ha/capita, a food crisis is in plain sight as arable land continues to diminish. The degradation of soil quality due to petroleum based fertilizers and monoculture also further reduces food production. The most troublesome factor is the population growth due to the practice of child gender discrimination and selection in the rural areas. At an average national growth rate of 0.59% for a current total of 1.3 billion people, it is estimated that by 2050, China will not be able to feed its 1.6 billion citizens. The combination of these factors signals urgency to increase arable land and improve agricultural practices while educating the rural population.

### Economy

#### GDP

Hubei 78.77 b. USD – 10th of PRC<sup>69</sup>  
Hunan 70.05 b. USD – 12th of PRC<sup>70</sup>  
Total 148.82 b. USD (Year 2004)

#### GDP per Capita

Hubei 1310.70 USD – 15th of PRC<sup>71</sup>  
Hunan 1046.06 USD – 21st of PRC<sup>72</sup>  
Average 1171.28 USD (Year 2004)

### Energy

#### Heating & Cooling

The consumption of energy in the region has its peak in the summer when many households rely on air conditioning. Electricity generation is solely dependent on coal from other provinces, making it extremely vulnerable during frequent mining accidents when the supply of coal is cut off. The demand for electricity for cooling continues to grow at an alarming rate as urbanization takes place.

Although the temperature drops to -1 to -3°C in winter, heating is not a common amenity for the region. To protect oneself against the cold, locals layer themselves in thick clothing. Their preference for hot and spicy food also helps keep bodies warm. Heating has become more common for households in the recent years but it remains a luxury.

#### Three Gorges Hydro Electric Plant

At its completion, it is estimated that the Three Gorges Dam will meet 10% of the nation's electricity demand, providing some relief to the coal-fire electricity plants.<sup>73</sup>



21 (top left) A Rural Village at Central Yangtze River Basin Before Formation of Communist Communes: the farmlands are fragmented and interspersed by water bodies. They were usually divided by siblings in a family again and again through several generations.

22 (b/m. left) Consolidated Farmland Established by Communists Communes in Hubei Province: the increase of farmland has helped boost the population. As the population continues to grow, China faces an unprecedented demand for food but also the disappearance of arable land.

23 (below) Air Conditioning and Facade: since few buildings have central air conditioning in China, most families have individual units hanging outside the building. The appearance of the disarrayed air conditioners on the facade has become one of the common design challenges for architects. The solution is almost always the use of metal louver screens operable only from the outside of the building.















## Character and History

The city of Wuhan consists of the three cities separated by the confluence between the Yangtze River and Han River – Wuchang, Hankou and Hanyang. The city began its history as a military stronghold for the Kingdom of Chu during the Spring and Autumn Period (722-481 BC). It was not until the Tang Dynasty (618-907 AD), Wuhan began to transform itself into a regional center of political, economic and cultural importance. During the Yuan Dynasty (1271-1368 AD), it was made the capital of the Huguang province. Since then Wuhan has maintained its status as a provincial capital and gradually grew to become one of the largest cities along the Yangtze River.<sup>1</sup>

In 1861, British, Russian, German, French and Japanese concessions were established in Hankou along with trading ports open to foreign ships. Since then, Hankou has remained the commercial center of the trio despite its late development. The opening of the ports transformed Wuhan into the largest trade city in China next to Shanghai during late 19th century and made it one of the earliest Chinese cities to undergo industrialization. Wuhan also became the city to stage the successful Wuchang Uprising, which eventually led to the fall of Qing Dynasty and the establishment of the Republic of China.<sup>2</sup>

When the Communist Party began its economic reform in the 1980's, it was clear that Wuhan had lost its advantage as an inland port city to the coastal cities' proximity to foreign nations. It remains one of the largest commercial hubs and education centers of central China but now pales in comparison to the coast.

The Chinese character "wu" (武) means martial. It is associated with action and aggressiveness. The character "han" (汉) means that which pertains to the Han Chinese race. One would expect a sophisticated cultural milieu from a trade city that once rivalled Shanghai but, as its name suggests, the urban culture of Wuhan is dominated by an intensity of "impulsiveness" - the Wuhanese are known for acting rather than thinking. On the other hand, the energy of the city produces a vibrant street culture exemplified by the ubiquitous street vendors, spontaneous gatherings of citizens socializing and exercising. Although not the most successful economic powerhouse, the city of Wuhan is easily the most charming and lively urban center of China.

02	03	04	05
06	07	08	09
11	12	13	10

Mosaic of Wuhan

02 Lake Shahu at Sunset.

03 Old Men Playing Chess by the Number One Bridge.

04 Pigs in a Fishing Village Near Lake Shahu.

05 Jiangnan Road Shopping Area.

06 Fishing Village by Lake Shahu: entire village undergoing renovation.

07 Aerial of Wuhan: confluence between Yangtze and Han River, lake Shahu in the distance.

08 Typical Apartments Built in the 1970's: balconies enclosed to make more room.

09 Duck Necks Prepared in Special Spice: a local delicacy.

10 Old Building in Wuhan University Built in 1930.

11 Street Vendors Near Yuemachang, Wuchang.

12 Old Lady and Boat for Hire in Lake Donghu.

13 Number One bridge Crossing Yangtze River.



14 (right) Wuhan, Distribution of Water and Land, 2005.

15 (btm.) Wuhan, Structure of Communication.

-  Ring road completed
-  Ring road to be completed
-  Light rail completed
-  Light rail to be completed
-  Tunnel to be completed
-  Ferry routes
-  Railway





## Abiotic, Biotic, Cultural and Energetics Analysis

### Geography

*Origin of Name* Wuhan is the conglomeration of the three cities divided by the Yangtze and Han River confluence. The names of the three cities are Wuchang (武昌), Hankou (汉口), and Hanyang (汉阳). The name Wuhan is an abbreviation of the three cities:  
 Wu (武) – martial or militant      Chang (昌) – flourishing  
 Han (汉) – the Han Chinese ethnicity      Kou (口) – mouth or gate  
 Yang (阳) – the sun, that which pertains to the male

*Location* At the confluence of Han River and Yangtze River

*Coordinates* 30° 34'21" N, 114°16'45"E<sup>3</sup>

*Area* 8467.11 km<sup>2</sup><sup>4</sup>

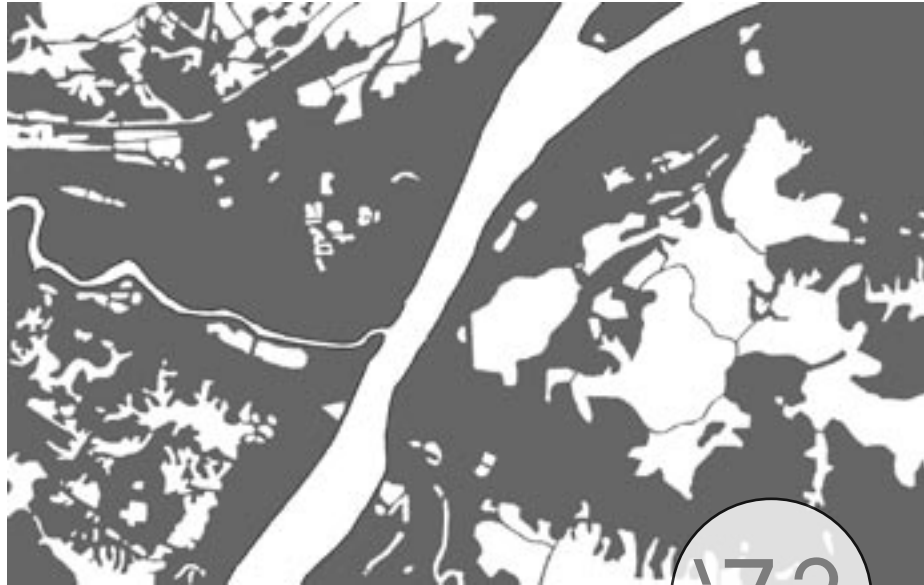
### Geomorphology

The urban centers are concentrated near the edges of Yangtze. The density of the built environment thins out as the city is pulled away from the river. At the present stage of its development, the city is struggling to establish itself on any space. The relationship between the land and the lake is an intricate swirl of yin and yang.

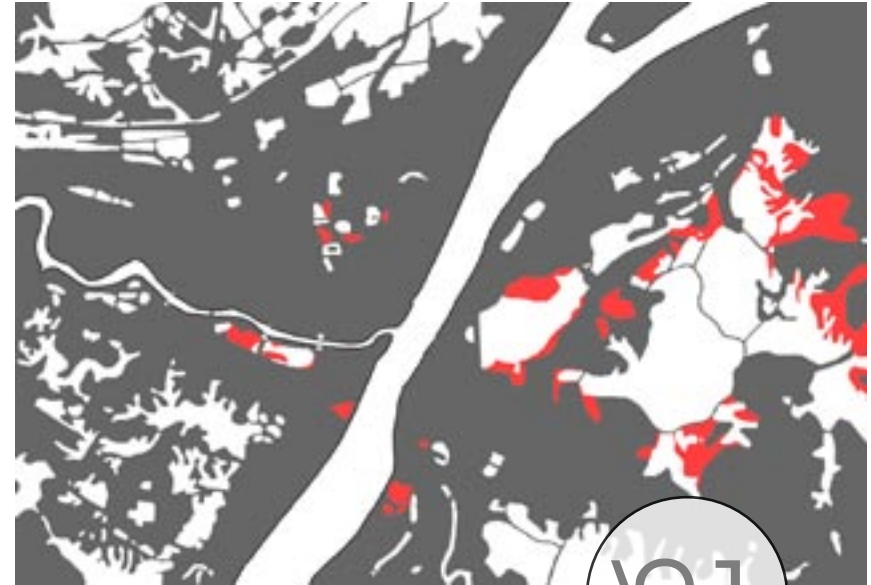
### Geomorphology - Urban Development

The geographic character of Wuhan poses a set of special challenges to its development. Firstly the huge collection of water bodies limits the size of its built area. Secondly, the interspersed water makes it difficult to communicate between parts of the city. This leads to massive landfill projects and construction of roads across water. While the government is investing in the construction of several tunnels across the Yangtze and a light rail system to link the three sides of the city together, there has not been any proposal to resolve the landfill problem besides imposing fragile regulations. If the Wuhan Lake Protection Regulation passed in 2005 is to be thoroughly enforced, the only possible solution for accommodating the growing population would be large scale suburbanization, which, again leads to landfill in the suburban lakes.<sup>5</sup> The added volume of cars as a result of suburbanization will also lead to severe congestions in a city that relies on few fragile conduits to communicate. Before the infrastructure system is improved, Wuhan cannot afford to relocate a huge portion of its population to the outskirts.

Lake Coverage 1973



Lake Coverage 2001

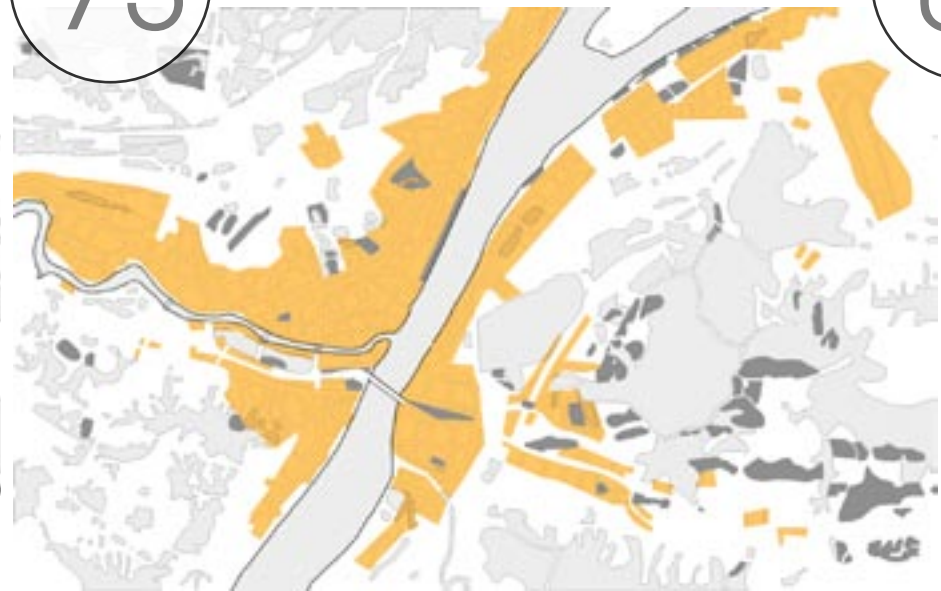


'11



Urban Area Late Qing Dynasty (1644-1911)

'73

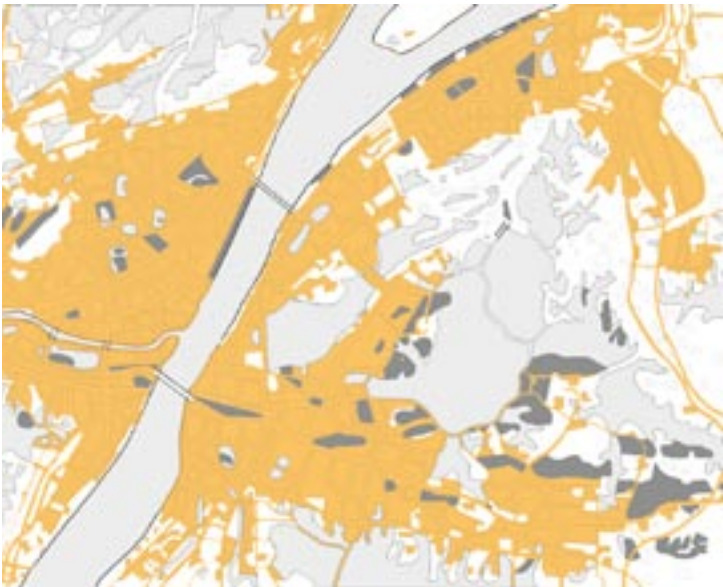
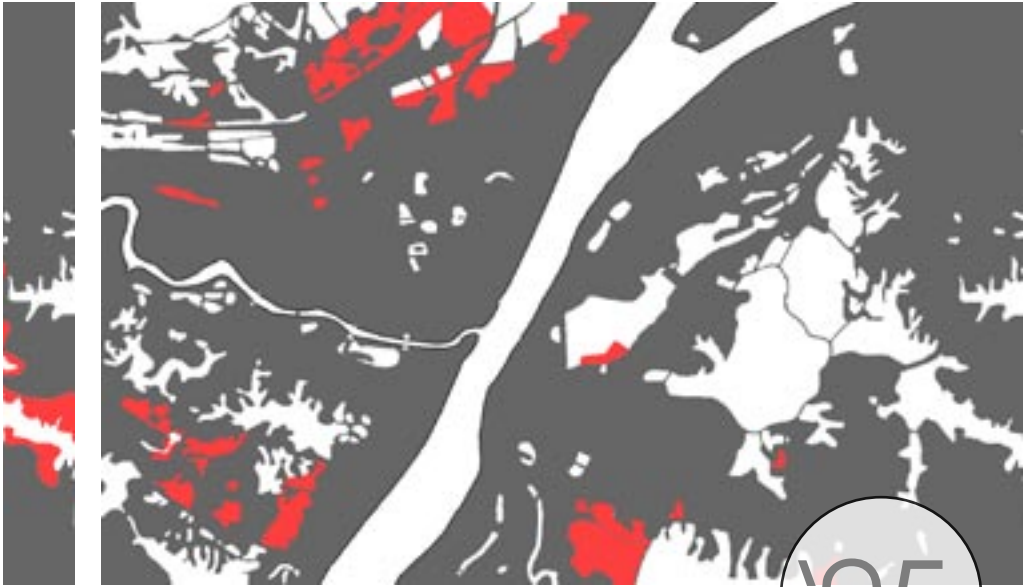


Urban Area 1973

'01



Lake Coverage 2005



Urban Area 2001

- 16 (top left) Lake Coverage Narrative, 1973.
- 17 (top center) Lake Coverage Narrative, 2001.
- 18 (top right) Lake Coverage Narrative, 2005.
- 19 (btm. left) Urban Development Narrative, circa 1911.
- 20 (btm. center) Urban Development Narrative, 1973.
- 21 (btm. right) Urban Development Narrative, 2001.

- Area lost since Previously recorded
- Urban area

## Meteorology

**Climate** Typical subtropical monsoon climate. Nicknamed one of the "three furnaces" of China. <sup>6</sup>

**Temperature** Avg.: Jan. 3.7°C; July 28.7°C / Absolute: High 42°C; low -18.1°C <sup>7</sup>

**Precipitation** Jan. 434/a; July 1,903 mm/a <sup>8</sup>

**Wind Direction** Northeast for winter (arid), Southwest for summer (humid) <sup>9</sup>

**Mean Wind Speed** 1.8-2.1 m/s <sup>10</sup>

**Relative Humidity** Mean: 74-80% <sup>11</sup>

## Air

**Air Quality** Grade II air quality is the expected standard for urban areas. The following is the percentage of the year with grade II air quality or higher:

61.10% (Year 2001) <sup>12</sup>

74.30% (Year 2005) <sup>13</sup>

13.30% increase, indicating steady improvement since 2001.

**Acid Rain** 11.0% sampled w/ harmful acidity (Year 2001) <sup>14</sup>

37.3% sampled w/ harmful acidity (Year 2005) <sup>15</sup>

26.3% increase, indicating a serious increase of SO<sub>2</sub> input from factories. Street vendors and restaurants still use coal for cooking, making SO<sub>2</sub> emission a serious problem at the municipal sector.

## Water – General Statistics

Major River	Yangtze <sup>16</sup>	Han River <sup>17</sup>
Flow rate	2,240 m <sup>3</sup> /s	1,220 m <sup>3</sup> /s
Average depth	19.18 m	20.76 m
Average width	1 km	300 m

## Lakes Within

<b>2nd Ring Road</b>	63.34 km <sup>2</sup> – 35 lakes (Year 1990)
	60 km <sup>2</sup> – 27 lakes (Year 2003) <sup>18</sup>
	3.34 km <sup>2</sup> reclaimed, taking up 5.27% of the original total. Eight lakes, ranging from 0.03 km <sup>2</sup> to 0.15 km <sup>2</sup> , completely disappeared.

## Water - Land Reclamation

Until recently, the pattern of reclamation in Wuhan was no different from the general situation in Central Yangtze River Basin. Rural land on the outskirts of Wuhan was developed for agricultural

and aquacultural uses. Due to its role as the largest urban center in the region, however the city is experiencing a new wave of land reclamation taking place at the fringes of the city for urban development. More and more lakes in the outskirts are being filled in. This indicates Wuhan is becoming suburbanized. The landfill situation is further complicated as one considers the flood retention problem that the diminishing lakes are creating. The complexity of the challenge points to the need for an alternative housing solution that could transform the spatial potential of the lakes with little or limited landfill.

### Water - Land Reclamation 1996-2020

The City of Wuhan has put forth a planning guideline for its development for the 1996-2020 period. The plan seeks to maximize the development inside the 2nd ring road but tells little of the planning outside the boundary besides the infilling of the lakes. Many of the major lakes within 2nd ring road will be developed into public parks, stripping away any traces of its past as rural areas. The city also plans to develop an eco corridor along the 2nd ring road and on the water fronts of Yangtze and Han River. <sup>19</sup>

### Water - Pollution

#### Waste Water Discharged

Waste Water	Total (th. ton)	Industrial (th. ton)	Municipal (th. ton)
Y.2001	684.56	330.66	353.90 <sup>20</sup>
Y.2005	656.65	260.01	396.64 <sup>21</sup>
Growth%	-4.08	-21.37	12.08

#### River Quality

Grade	I(%)	II(%)	III(%)	IV(%)	V(%)	<V(%)
Y. 2001	0.00	0.00	88.89	0.00	11.11	0.00 <sup>22</sup>
Y. 2005	0.00	0.00	54.55	36.37	0.00	9.09 <sup>23</sup>
Growth%	0.00	0.00	-34.34	36.37	-11.11	9.09

#### Lake Quality

Grade	I(%)	II(%)	III(%)	IV(%)	V(%)	<V(%)
Y. 2001	0.00	22.73	50.00	22.73	4.55	0.00 <sup>24</sup>
Y. 2005	0.00	4.00	9.00	25.00	13.00	49.00 <sup>25</sup>
Growth%	0.00	-18.73	-41.00	-2.73	8.45	49.00

#### Water Treatment

According to the official documents for the year 2005, there are six water treatment plants in Wuhan with a total capacity of 57.23 ton/day. A total of 45.01% of the city's municipal water is treated. It is currently behind its 50% expected rate and will have to speed



Wuhan Urban Planning Guide 1996-2020 Land Use

<b>22</b> Residential / commercial	<b>23</b> Institutional	<b>24</b> Green
Residential	Administration	Eco corridor
Low Residential	Special use	Scenic
Commercial	Public facilities	Public green
Mixed		
	<b>24</b> Industrial	<b>25</b> Educ./Sports/Culture
	Factories	University campus
	Storage	Sports/culture







#### *Sedimentation of Pollutants*

up its improvement process to meet its 80% treatment rate by year 2010.<sup>26</sup> The numbers reported are questionable considering the average overhead is 0.7 RMB for every ton of water treated versus the current rate charged at 0.2 to 0.5 RMB/ton. The local economy demands the price be kept low but government subsidy for plant operation is non-existent. The increase of water below grade III level conveys a more objective reality of the water treatment progress.<sup>27</sup>

Alternative treatment methods involving the construction of artificial wetlands have been developed by the Chinese Science Academy's department of aquabiology in Wuhan. The technology has been implemented successfully in Shenzhen and Beijing but has yet to make its debut in Wuhan. It is reported that the construction of artificial wetlands can reduce the overhead to 0.2 RMB/ton, making water treatment service in China sustainable at last.<sup>28</sup>

Sedimentation in Wuhan's urban lakes is not related to soil erosion since most lakes are not connected to a flowing water source. Instead, the problem here is caused by the large amount of industrial and municipal effluent accumulated at the bottom of the lakes. Since the lakes are self-enclosed water bodies, nothing gets flushed out, causing soil to mix with the effluents over time. The average depth of contaminated soil is about 0.74m in lakes, constituting 1/3 of their average depth. An environmental protection plan for the lakes have been issued, demanding all contaminated soil of the 27 lakes, roughly 44.4 million m<sup>3</sup>, be excavated and decontaminated by 2020. In addition, all waste water sources are required to connect their sewage to the water treatment plants by the same deadline. However, no plan has been announced for the separation between the sanitary sewer and the storm water sewer.<sup>29</sup>

#### **Ecology - Aquatic and Wetland Habitats**

##### *Urban Lakes*

The urban lakes suffer from land reclamation, sedimentation of effluents, and disconnection from the Yangtze.

Land reclamation reduces the available habitat for fish and renders water susceptible to nutrient runoff from adjacent farmland. Sedimentation of waste is hastening the process of wetland deterioration, turning them into marshes in dry seasons thereby depriving the waterbirds of their natural habitats. The disconnection from the Yangtze has left the lakes with no chance to replenish its fish population and introduce genetic diversity. Pollution from industrial and municipal sources is killing off large sums of fish and in turn reducing food source for waterbirds.

Rural Lakes

The rural lakes are in a similar grave condition. The main difference between the urban and rural lakes is the source of pollution and its quantity. The waste water input from industrial and municipal sources is far lower in the rural areas but the water is still polluted due to intense agricultural and aquacultural practices.

The surfaces of the lakes are usually divided into properties delineated by dykes at the rim of the water and nets strung across bamboo sticks at the center of the water. The fragmentation of the water body also causes ecological imbalance between the inside and outside of the enclosures. The waterweeds outside the enclosures are harvested and fed to the densely cultivated fish population within the enclosures while the fish outside the nets starve. The rate of nutrient circulation in the net enclosures is just as low as the dyke ponds since the decomposed waterweeds eventually cling to the tightly woven nets thereby blocking passage of anything.<sup>30</sup>

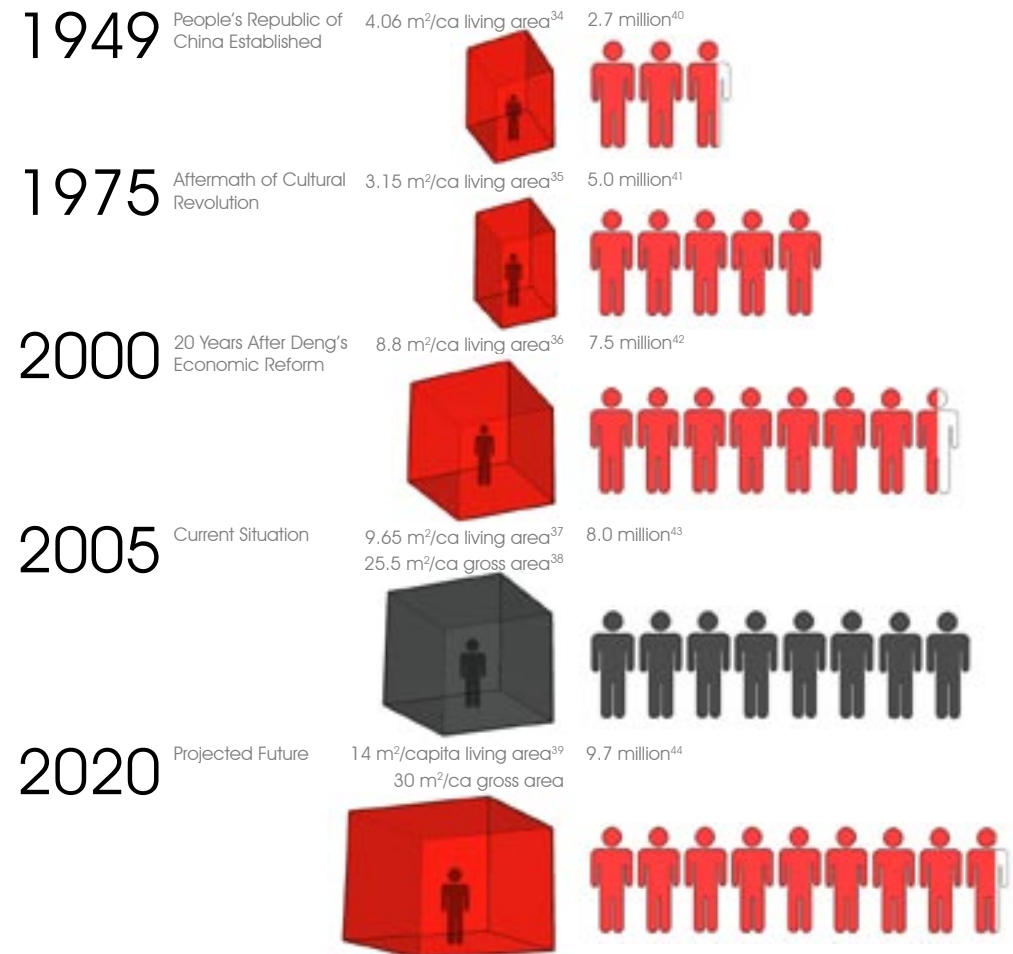
With few fish left in the open water, waterbirds resort to stealing from the fish ponds and net enclosures. As a result, the fish farmers hunt down or poison the waterbirds as pests.

Preservation Work

There are two wetlands in rural Wuhan under protection – Lake Chen and Lake Zhangdu. The former is protected by impotent regulations with no enforcement agents, education programs and agricultural planning. Lake Zhangdu, on the other hand, has re-established its connection with the Yangtze and recovered acres of lake area from rice fields and fish ponds. Its residents have been educated with the importance of ecological preservation and new sustainable agricultural productions, such as bamboo shoots planting, have been introduced. All these efforts were accomplished with the aid of World Wide Fund for Nature and the Hong Kong and Shanghai Banking Corporation. Since then, the number of fish species has increased, fishing production has grown, and migratory birds have gradually returned. The reconnection had to implement filtering technologies that uses iclosamide, acrolein, copper or sulfate to eliminate water-borne snails from Yangtze that carry schistosomiasis. The disease can cause serious illness such as hepatosplenomegaly and central nervous system lesions.<sup>31</sup>



Urban Development - Statistics		
Household	2,245,907	(Year 2002) <sup>32</sup>
	2,499,482	(Year 2005) <sup>33</sup>
	205,907 new households, showing 9.17% increase over 3 years.	





- 27 (opposite page, top) Zhangdu Lake Opening Its Sluice Gate, Connecting to the Yangtze for the First Time in 50 Years: The dam was built for irrigation, flood prevention and blocking off leeches from the Yangtze. The leech problem was resolved by a filtering program.
- 28 (opposite page, btm.) Population and Residential Floor Area Increase.
- 29 (top row) Change in Housing Strategy: an eight-storey apartment in Hankou (left) possibly built during the 70's. The small units prompted families to enclose their balconies with red bricks and various shades of glass. Right next to the building sits a brand new twenty-six storey apartment (right).
- 30 (center, left, btm. left) Comparison of Lake Area Between 2005 (center) and the Projection Put Forth by the 1996-2020 City Planning Guide (bottom): the disappearance of lakes outside the 2nd ring road is an indication of suburbanization.

<i>Population</i>	7,680,958 (Year 2002) <sup>45</sup>
	8,013,612 (Year 2005) <sup>46</sup>
	178,059 more people, showing 2.32% increase over 3 years.
<i>Population Density</i>	907.15/km <sup>2</sup> (Year 2002) <sup>47</sup>
	943.00/km <sup>2</sup> (Year 2005) <sup>48</sup>
	17.85 more people per km <sup>2</sup> , showing 1.97% increase over 3 years.
<i>Population per Household</i>	3.42/household (Year 2002) <sup>49</sup>
	3.21/household (Year 2005) <sup>50</sup>
	0.21 less person per household, showing 6.14% decrease over 3 years.
<i>Per Capita Residential Building Floor Area</i>	22.16 m <sup>2</sup> /capita (Year 2002) <sup>51</sup>
	25.50 m <sup>2</sup> /capita (Year 2005) <sup>52</sup>
	3.34 m <sup>2</sup> more per capita, showing 15.07% increase over 3 years.
<i>Arable Land</i>	3,775.59 km <sup>2</sup> (Year 2004 beginning)
	56.06 km <sup>2</sup> (loss in the year)
	16.16 km <sup>2</sup> (increase in the year)
	3,735.69 km <sup>2</sup> (Year 2004 end) <sup>53</sup>
	39.9 km <sup>2</sup> of farmland lost, showing 1.06% decrease in one year.
	The increase during the year is only 28.83% of the loss.
<i>Construction</i>	34.51 km <sup>2</sup> (Year 2004 construction)
	23.80 km <sup>2</sup> (taken from farmland) <sup>54</sup>
	31.03% of new construction is built upon former farmland.

#### Urban Development - Population and Housing Demand

Projected at 2020, the population of Wuhan will reach 9.7 million. Considering the number of migrant workers from the rural areas, the real number will be even higher as it only accounts for the city's permanent residents. The challenge is compounded with the rapid expansion of new residential units, which usually range from 100 to 140 m<sup>2</sup> in common practice. In 2006, the Central Government issued a mandate to have all new developments across the nation meeting a standard of 70% units under 90m<sup>2</sup>.<sup>55</sup> Since the population per household is around 3 in China, this results in 30 m<sup>2</sup> of gross area per person (市区居民住宅建筑面积), a reasonable and obtainable goal that allows room for growth considering the per capita gross area figure in 2005 is 25.5 m<sup>2</sup>. Note all figures before 2002 are calculated as per capita living area (人均住宅居住面积), which does not account for public space.



31 Monotonous Planning: photo showing vicinity of Pudong Airport, Shanghai.



### *Housing V.S. Farmland*

The annual 9.17% increase in the number of households and the shrinking household sizes speak to an astonishing growth of housing demand and infrastructure development, which inevitably leads to the loss of arable land. According to Wuhan's annual statistic report, 42.45% farmland lost in 2004 went to construction for urban development; 28.53% was restored to forests; 23.05% was converted to other miscellaneous agricultural uses; and 5.97% was converted to orchards, tea planting or mulberry fields.<sup>56</sup>

The Central Government has issued mandates for municipalities to increase the amount of arable land. Such efforts were immediately offset by the overwhelming volume of construction by developers. To the general public, food supply is not an issue as it only seems to increase as the nation becomes wealthier. This is at the expense of soil fertility as chemicals are used to increase production. In general, the housing problem is seen as a far more urgent matter that the market eagerly seeks to accommodate.

### **Urban Development - Superblocks**

The prevalent trend of Chinese real estate developments is to build large scale gated communities. Similar to North American suburban developments, these Chinese developments are favoured by the average citizens for their safety, low traffic volume and exclusiveness. The developers also prefer such a planning strategy as less infrastructure is required and the properties can be managed with lower cost.

While this development type is the most prominent in suburban China due to ease of land acquisition, urban centres have a fair number of large scale gated communities as well. Considering that the streets have traditionally been the dominant form of public space in China, the current real estate development pattern is a huge threat to the preservation of Chinese urban culture. The consolidation of the small blocks and the limited access through the super blocks has greatly reduced the number of streets in all Chinese cities, causing the loss of small businesses and creating usable public spaces. The critique of block sizes leveled against the American cities by Jane Jacobs is now a valuable lesson for the current Chinese urban condition.<sup>57</sup>

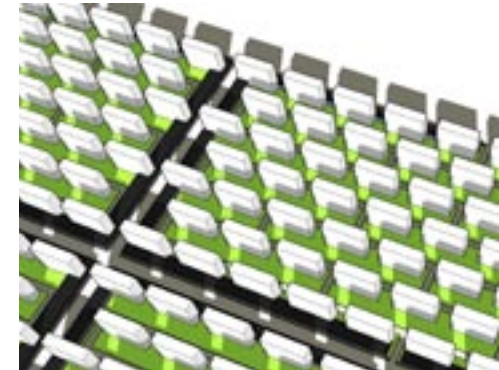
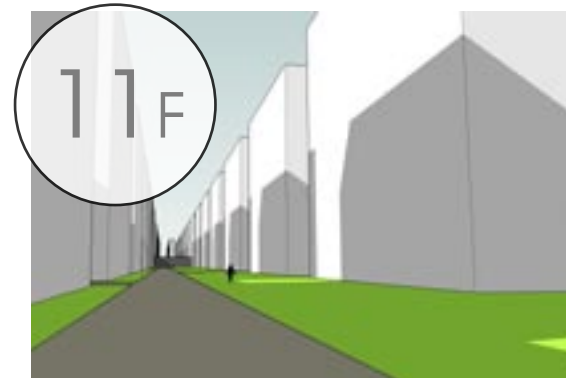
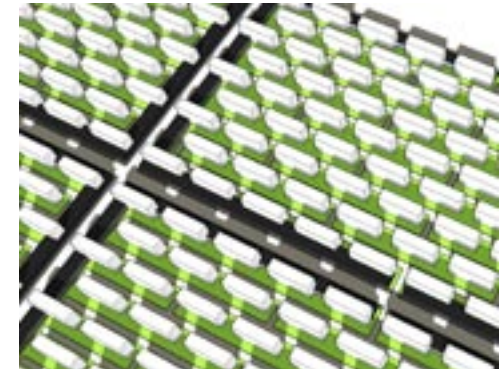
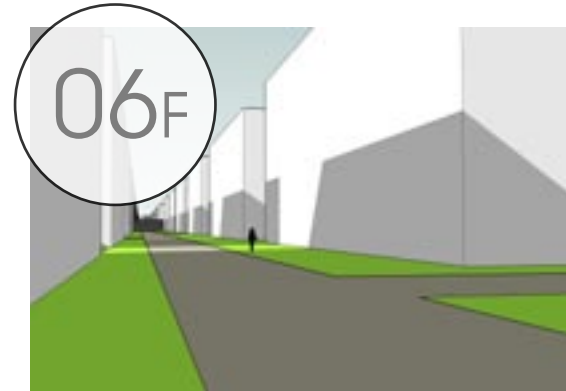
In a mercantile culture where small businesses help sustain many families, the repercussion of such a large scale development pattern has serious effects on the local economy. For a crowded place like China, communities built to encourage car culture exacerbate the already congested traffic conditions and poor air quality.

### Urban Development - Planning by the Book

The design process in China is an exercise of maximizing density and profit while satisfying the planning code.<sup>58</sup> The first key design factor is based on the ratio between the number of storeys to the number of elevators. The general rule is one elevator for buildings over 6 storeys; two elevators for buildings over 11 storeys. The distance between the north and south face of the buildings is based on the height of the building multiplied by a variable factor to a maximum of 40 meters. While buildings can be as tall as desired, they will have to ensure that every window on the surrounding buildings get a minimum of one hour full coverage sunlight on the day of winter solstice. This usually results in a monotonous design with even building heights across the entire block. The monotony of the superblock is exacerbated by the common belief that developers will not be able to sell east-west oriented units, forcing every building to face south. At the base of buildings is a carpet of grass upkeep to pristine condition but infrequently used by the residents. Because the developments are internalized as gated communities, these potential public spaces have no hope of introducing shops and businesses, rendering them wasted land. The shops are only expected to happen around a perimeter podium that also serves as the enclosure of the development. When this happens the podiums usually become unaffordable for small shops and restaurants, leaving only big boxes, brand names and up scale restaurants in the area. If property value were to eventually depreciate, small businesses return to the area but the internal structure of the communities will remain insipid and lifeless as long as it is enclosed. The disappearance of the small streets degrades the spatial, socio-economic and environmental conditions and must be stopped. The situation is further complicated in the case of Wuhan where its many lakes are commoditized as views in these large scale developments.

#### Economy

GDP	24.42 m. USD <sup>58</sup>	(Year 2004)
GDP per Capita	3115.90 USD / capita <sup>59</sup>	(Year 2004)
Avg. Wage	1424.77 USD / capita.year <sup>60</sup> 144.186 USD / capita.month <sup>61</sup>	(Year 2004) (Year 2004)
Avg. Disposable	99.80 USD / capita.month <sup>62</sup>	(Year 2004)
Avg. Living Exp.	81.32 USD / capita.month <sup>63</sup>	(Year 2004)





Block Dimension	240x480m
Perimeter Podium	2 f
Units Each Floor	4
Unit Size	90 m <sup>2</sup>
Distance N-S	16.2 m
Distance E-W	14 m
Buildings	77
Residential Units	1,848
People	5,544
Residential Area	184,800 m <sup>2</sup>
Commercial Area	24,620 m <sup>2</sup>
<b>Total Floor Area</b>	<b>209,420 m<sup>2</sup></b>
<b>FAR</b>	<b>1.82</b>
<b>Person per hectare</b>	<b>481.25/ha</b>



Block Dimension	240x480m
Perimeter Podium	2 f
Units Each Floor	4
Unit Size	90 m <sup>2</sup>
Distance N-S	24.3 m
Distance E-W	14 m
Buildings	60
Residential Units	2,640
People	7,920
Residential Area	264,000 m <sup>2</sup>
Commercial Area	27,714 m <sup>2</sup>
<b>Total Floor Area</b>	<b>291,714 m<sup>2</sup></b>
<b>FAR</b>	<b>2.53</b>
<b>Person per hectare</b>	<b>687.50/ha</b>



Block Dimension	240x480m
Perimeter Podium	2 f
Units per Floor	4
Unit Size	90 m <sup>2</sup>
Distance N-S	40 m
Distance E-W	14 m
Buildings	43
Residential Units	3,784
People	11,352
Residential Area	378,400 m <sup>2</sup>
Commercial Area	32,112 m <sup>2</sup>
<b>Total Floor Area</b>	<b>410,512m<sup>2</sup></b>
<b>FAR</b>	<b>3.56</b>
<b>Person per Hectare</b>	<b>985.42 /ha</b>



- 32 (opposite page) Typical Planning Strategies for Gated Communities at Various Densities.
- 33 (top) Ubiquitous Slogan: "Development is the impeccable reason," a famous quote by Deng Xiao-ping.
- 34 (center) A Business Card Handed Out in the Streets of Wuhan, Advertising Fake ID's and Certificates: The list includes university diploma, driver's licence, Chinese College English Test, accountants certificates, engineers certificates, divorce paper, proof of marital status and etc.
- 35 (btm.) Bamboo Mistresses: only in Wuhan can one see the streets lined up with bamboo beds in the summer. The phenomenon has disappeared since the 80's when air conditioners became widely affordable. Occasionally, they still make an appearance for nostalgic reasons. The photos was taken in the summer of 2007.

### Material Wealth

#### Education

Like in many Asian countries, Chinese parents put all their efforts in their child's education. The pressure to succeed is paramount and demands on children are heavy and sometimes unbearable. The city of Wuhan is among one of the top cities to produce the largest number of top students in China. As a result, some of the best universities and research institutions in the nation are located in the city. The 52 post-secondary institutions in the city are an important source of employment and revenue for the city.

#### Aspirations

The average income per capita remains very low in comparison to that of developed nations and to China's coastal cities. The average citizen has the capacity to purchase items such as cell phones and digital cameras but most never dream of traveling abroad considering their savings will have to be put towards a house someday, especially if they have a son of legal marrying age, as it is common for parents to buy their son an apartment unit when he marries. Many children rely on this tradition for housing, leaving them dependent on parental support. Young couples who attempt to be financially independent are usually left with a mortgage for 20 to 30 years.

Citizens with greater financial freedom pursue a material life inspired by a wealth of western advertising. The negative impact that American styled suburban housing and luxury cars have on the Chinese urban environment is not considered as for many Chinese, including the majority of the intelligentsia, these is a common belief in the superiority of the Western world. Material pursuit is a noble lifestyle, and any possible damage brought on by the creation of wealth is justified. "Development is the impeccable reason," says Deng Xiao-ping.

### Public Space

#### Heating & Cooling

Like most places in Hubei Province, indoor heating is not common though the weather does stay around 0 to -2°C in the winter. On cold days, one can find old ladies spending their afternoons knitting on buses, McDonald's and Kentucky Fried Chicken, since these are some of the few places with indoor heating. Before the arrival of air conditioners in the 1980's, city streets used to be lined with families and their bamboo beds in the summer. These urban phenomena could only be found in the city of Wuhan where extreme heat and cold are a fact of life. As people become wealthier, these endearing street traditions are disappearing.

## Water – Lake Shahu

Avg. Depth	0.5 m <sup>64</sup>
Water Quality	below grade V <sup>65</sup> (Year 2004)
Capacity	1,360,000 m <sup>3</sup> <sup>66</sup> (Year 1980)
Mean Area	4.67 km <sup>2</sup> <sup>67</sup> (Year 1950)
	3.29 km <sup>2</sup> <sup>68</sup> (Year 1980)
	3.86 km <sup>2</sup> <sup>69</sup> (Year 1995)
	0.81 km <sup>2</sup> lost - 17.34% of original

The lake is mostly surrounded by a mixture of old and new apartments and several universities. Access to the lake is extremely limited due to the lack of a continuous ring road around the lake and any promenades leading to it. Both industrial and municipal effluents are discharged into the lakes thereby degrading the water quality to below grade V. This polluted water does not stop seniors from the neighbourhood from fishing and using its water to grow vegetables on the dyke. The lake is divided into two parts: the north is a large lotus field and the south is open water.



36 (left) Key Map of Lake Shahu

37 (spread) Lake Shahu: the dyke separates the lake from the open sewage. The white substance in the image was discharged from the treatment plant nearby.







## Water – Lake Donghu

Avg. Depth	2.8 m <sup>70</sup>
Water Quality	below grade V <sup>71</sup> (Year 2004)
Capacity	9,418,000 m <sup>3</sup> <sup>72</sup> (Year 1995)
Mean Area	34.10 km <sup>2</sup> <sup>73</sup> (Year 1950)
	33.70 km <sup>2</sup> <sup>74</sup> (Year 1980)
	32.98 km <sup>2</sup> <sup>75</sup> (Year 1995)
	1.12 km <sup>2</sup> lost - 3.28% of original

Very little of Lake Donghu has been reclaimed for land development because it has always been one of the main tourists attractions in the city due to its immensity and its proximity to the old city core. Despite this protection, its water quality is still below grade V. Surrounding the lake are apartments, some farmland, various scenic spots and an artificial beach. It is by far the most accessible lake in the city and the locals have always identified its presence as an important identity of Wuhan.



- 38 (left) Key Map of Lake Donghu
- 39 (spread) Lake Donghu: the largest lake within the second ring road. Its large area is divided into several parts by dykes, which form an incredible scenic route across the lake.





## Water – Lake Nanhu

Avg. Depth	1.4 m <sup>76</sup>
Water Quality	below grade V <sup>77</sup> (Year 2004)
Capacity	1,225,000 m <sup>3</sup> <sup>78</sup> (Year 1995)
Mean Area	14.20 km <sup>2</sup> <sup>79</sup> (Year 1950)
	8.00 km <sup>2</sup> <sup>80</sup> (Year 1980)
	8.03 km <sup>2</sup> <sup>81</sup> (Year 1995)
	6.17 km <sup>2</sup> lost - 43.45% of original

Most of Lake Nanhu's edges are lined with gated communities that have privatized the banks. The view onto the lake is limited to a few spots such as the dykes that cut through the lakes for vehicular access. There is access to the surface of the water at these spots but the foul smell from the lake makes it an unpleasant experience.



- 40 (left) Key Map of Lake Nanhu.
- 41 (spread) Lake Nanhu: the so-called Californian style houses and apartments line up at the embankment.





## Water – Lake Moshuihu

Avg. Depth	1.1 m <sup>82</sup>
Water Quality	below grade V <sup>83</sup> (Year 2004)
Capacity	970,000 m <sup>3</sup> <sup>84</sup> (Year 1995)
Mean Area	3.40 km <sup>2</sup> <sup>85</sup> (Year 1950)
	3.40 km <sup>2</sup> <sup>86</sup> (Year 1980)
	2.83 km <sup>2</sup> <sup>87</sup> (Year 1995)
	0.57 km <sup>2</sup> lost - 16.76% of original

The lake is hidden from sight if one does not meander through the villages behind the tall apartment buildings and pervasive car dealers. Once inside, one discovers its beautiful rural scenery, a complete disjunction from the busy streets outside. Located at the least developed city of the trio, Hanyang, Lake Moshuihu is able to keep its agricultural land to this date but it will not be long before real estate developments begin bullying the farmers out of their homes. The large apartment tower looming in the background testifies to this foreseeable future.



42 (left) Key Map of Lake Moshui

43 (spread) Lake Moshuihu: a pig sty sits on the embankment. The pig farmer collects food waste from restaurants and feed them to the pigs after stir frying them. The pig manures are then fed to the fish pond next to it.

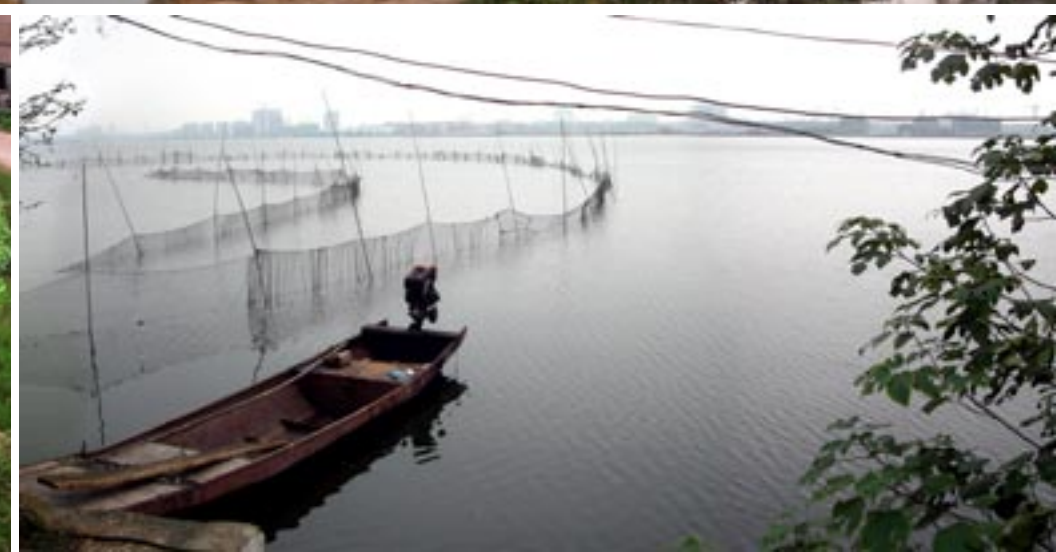














## Character and History

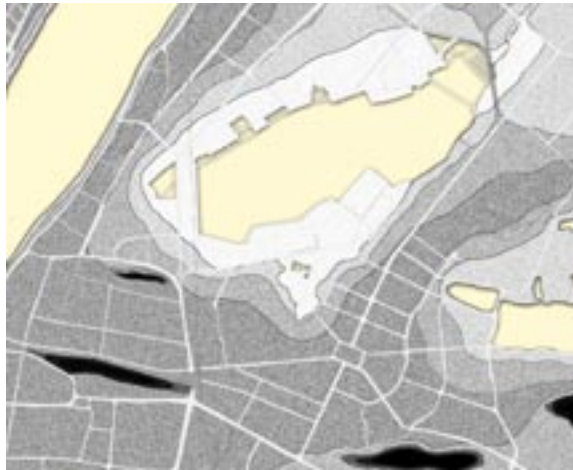
The history of Lake Shahu is a microcosmic image of the hundreds of lakes in the Central Yangtze River Basin undergoing urbanization. It was once part of a larger water system connected to Lake Dong and the Yangtze.<sup>1</sup> Before the fall of the Qing Dynasty (1911 AD), it was the largest lake immediately outside the old Wuchang city wall. To this date, the names of a few places at the south east of the lake, such as the Che Family's Hill (车家岭), the Mouth of the Blue Fish (青鱼嘴), and the Yu Family's Lake (余家湖) still suggest their rural origins. In addition, the street structure of these places still resembles winding village trails. The rapid urbanization since the 80's has completely encapsulated the lake with buildings, hiding the lake behind a forest of concrete slabs. As urbanization intensifies, the lake continues to be devoured by real estate developments and polluted by waste water. The image of a rural lake surrounded by villages, farmland and fishponds and populated by waterbirds and fish has become a forgotten past few care to remember.

02	03	04
05	06	07
	08	
		10

Mosaic of Lake Shahu

- 02 Draining Pump at Lotus Farm: keeps the water level low during harvest season.
- 03 Lotus Farm in the Distance: photo taken from author's rented apartment.
- 04 Opening at Long Wall Surrounding Lake Shahu.
- 05 New Park on West Side Lake Shahu.
- 06 Remains of a Rural Lake Previously Connected to Lake Shahu: area now surrounded by high rise buildings.
- 07 East Rim of Lake Shahu: the area is significantly higher than the rest of the perimeter, creating a sloping terrain through the residential area.
- 08 Vegetable Plots on Sides of a dyke Surrounding Lake Shahu.
- 09 Nets Strung Across Water to Prevent Fish from Escaping: a sluice gates here controls the water level of the lake.
- 10 Farmers Harvesting Lotus Roots from the North Portion of Lake Shahu.





11 Topography Around Lake Shahu.

Water body      Elevation (dark - high)



12 Available Space for Development

New high density development (stable)  
 50'-80's Development (semi-stable)  
 Farms / lakes / hills / villages / old city fabric (fragile)  
 Readily available land for development

13 (left) Satellite Photo of Lake Shahu and Vicinity

## Abiotic, Biotic, Cultural and Energetics Analysis

### Geography

*Origin of Name* Sha (沙) – Sand, Hu (湖) - Lake  
 The Chinese name of Lake Shahu literally means Sand Lake.

*Location* Located within the first ring road in the Wuchang area, Sha Lake is bounded by Youyi Ave. On the west, Xudong Ave. On the north, Zhongbei Rd. On the east and Gongzeng Rd. on the south.

*Area* 4.0 km<sup>2</sup> (Year 2005)<sup>2</sup>

*Depth* Average 0.5 m, deepest 1.1 m – at mean water level<sup>3</sup>

### Geomorphology

The rim of the basin is higher on the east side, forming a platform from which the lake could be surveyed. The east and north bank are almost levelled with the water, providing a more direct access to the lake. Like many lakes of the area, Lake Shahu has a broad coverage but a shallow depth around an average of 0.5 m.

### Water - Pollution

*Waste Water* As of 2007, two point sources remain at Hubei University and San-jiao Road municipal waste discharge point. Both at the north west side of the lake.<sup>4</sup>

*Water Quality* Grade IV<sup>5</sup> (Year 2001)  
 Below Grade V<sup>6</sup> (Year 2005)  
 Ammonia nitrogen, petroleum, total nitrate, total phosphate, COD and BOD substance exceeds Grade II Standard. No heavy metals.

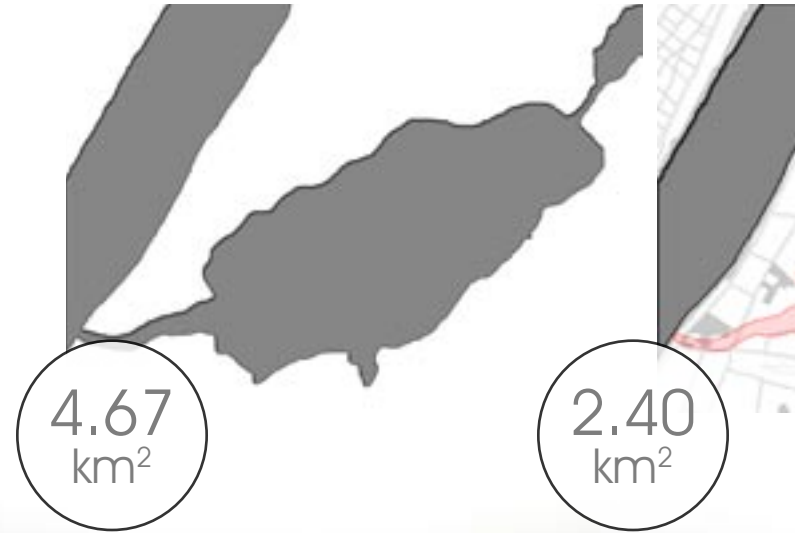
*Water Pollution* Situated at the South East corner of Lake Shahu is one of Wuhan's first water treatment plants. Although the treatment plant went through two expansion phases, its adjacent water still remains heavily polluted. As industrial and municipal waste water are discharged into the lake, the water will be burdened with more pollution. Because of their proximity to the water, many of these high-end developments are advertised to their clients as "ecological dwellings" but continue to discharge their waste into the lake. It is not uncommon that owners near the most polluted portions of the lake feel frustrated with the foul smell during hot seasons.<sup>7</sup>

- 14 (top left) Lake Shahu in Relation to City Core.
- 15 (top second from left) Area of Lake Shahu, circa 1644-1911.
- 16 (top third from left) Area of Lake Shahu, 2005.
- 17 (top right) Area of Lake Shahu planned for 2020.
- Existing Lake Area
  - Area Lost from Previously Recorded
- 18 (below) Landfill at Lake Shahu: background showing new housing for the Yujiahu village entirely built on landfill.

Shahu in relation to city core defined by the ring roads



Shahu Qing Dynasty (1644-1911)



Shahu 2005 (Current)

Shahu 2020 (Wuhan City Planning Guide 1996-2020)



1.25  
km<sup>2</sup>



*Sedimentation of Pollutants*

A total of 800,000 m<sup>3</sup> of contaminated soil will be dug up and treated by year 2020. The average depth of sedimentation is 0.7 m. All sources of waste water are to be connected to the treatment plants by the same date. <sup>7</sup>

*Reconnection*

Aside from the effort to clean up the lakes, the largest restoration work in plan is the project to connect Sha Lake with five other adjacent lakes and re-establish its connection with the Yangtze at the Qingshan Harbour located at the northern tip of Lake Donghu. The six connected lakes will be Lake Shahu, Lake Donghu (东湖), Lake Yandonghu (严东湖), Lake Yanxihu (严西湖), Lake Beihu (北湖) and Lake Yangchunhu (阳春湖). Together they will form a huge network of drainage basins capable of easing flood water and complementing each other's self-cleaning capacity. Their connection with Yangtze will also help restore greater biodiversity to the aquatic ecology and wetlands. <sup>8</sup>

**Water - Land Reclamation**

<i>Chronology of Shahu</i>	4.67 km <sup>2</sup> <sup>9</sup> (Year 1950)
	3.29 km <sup>2</sup> <sup>10</sup> (Year 1980)
	3.86 km <sup>2</sup> <sup>11</sup> (Year 1995)
	2.40 km <sup>2</sup> <sup>12</sup> (Year 2004)
	1.25 km <sup>2</sup> <sup>13</sup> (planned area by Year 2020)

*Qing Dynasty*

According to the book *Shahuzhi* (沙湖志, or *The Book of Sha Lake*) by an official of the late Qing Dynasty (late 19th century), Lake Shahu and Lake Donghu used to be named Small Sha Lake and Large Sha Lake. <sup>14</sup> The two lakes were considered a pair since they were connected through a waterway. The pair also joined the Yangtze at Qingshan Harbour located at the north end of the huge water body. Lake Shahu was also connected to the Yangtze at its west end until a flood wall was built in late Qing Dynasty.

A railway connecting Beijing and Guangdong was built at the end of the Qing Dynasty, cutting through Shahu and dividing it into a small lake named the Inner Sha Lake and a larger lake named Outer Sha Lake. The one commonly referred to as Lake Shahu nowadays is the Outer Sha Lake.

*1950's onward*

Land reclamation from the 1950's to 1970's had reduced the lake from 4.67 km<sup>2</sup> to 3.29 km<sup>2</sup>. The 1990's saw the return of farmland to lake, restoring the lake to 3.86 km<sup>2</sup> by 1995. <sup>15</sup> Sometime during the 1990's, the lake was further divided into two compartments by a dyke that connects the east bank to the west. The area north of the



- Walk around lake
- Entry to lake
- Commerce (weak to strong)

- 19 (left) Accessibility Diagram to Lake Shahu: only three points of entries to lake.
- 20 (right) False Real Estate Advertisement: ad depicting Lake Shahu area as an American city by the water (top) and a primal forest by lake. (bottom)
- 21 (opposite page) No Visible Access to Lake Shahu: photo taken from new apartment in a gated community near Lake Shahu. The main body of the lake is actually separated from an open sewage originating from an water filtration plant.



Current Land Use Around Lake Shahu



- |  |   |  |   |
|--|---|--|---|
| <p><b>22 Residential / Commercial</b></p> <ul style="list-style-type: none"> <li style="width: 25%;">■ gated high rise</li> <li style="width: 25%;">■ gated mid rise</li> <li style="width: 25%;">■ low to mid. apt.</li> <li style="width: 25%;">■ squatters</li> <li style="width: 25%;">□ office</li> <li style="width: 25%;">■ retail</li> <li style="width: 25%;">■ mall</li> <li style="width: 25%;">■ big box store</li> <li style="width: 25%;">■ whole sale</li> <li style="width: 25%;">■ constrct. material</li> <li style="width: 25%;">■ car dealer</li> <li style="width: 25%;">■ recycled mkt.</li> </ul> | <p><b>23 Institution / Administration</b></p> <ul style="list-style-type: none"> <li style="width: 25%;">■ administration</li> <li style="width: 25%;">■ university campus</li> </ul> | <p><b>24 Green and Recreation</b></p> <ul style="list-style-type: none"> <li style="width: 25%;">■ university farm</li> <li style="width: 25%;">■ parks</li> <li style="width: 25%;">■ fishing spots</li> <li style="width: 25%;">■ forests</li> </ul> | <p><b>25 Water Management</b></p> <ul style="list-style-type: none"> <li style="width: 25%;">■ pump station</li> <li style="width: 25%;">■ water treat. plant</li> <li style="width: 25%;">■ open sewage</li> </ul> |
|--|---|--|---|





dyke became an immense lotus field shared by four owners. The field would be filled with water during the summer and spring but its water would be drained out during the harvest seasons.

More landfill took place in the 1990's and continued until 2004 when the mayor issued a crack down on "unapproved" landfills with the establishment of the Wuhan Lake Protection Plan issued in year 2002. By 2004, the lake was measured 2.4 km<sup>2</sup>. The pressure of landfill is largely attributed to Lake Shahu's centrality within the city.

Although the Wuhan Lake Protection Plan<sup>16</sup> forbids further land reclamation, the 1996-2020 Master Plan for Wuhan City<sup>17</sup> indicates a small Sha Lake measured approximately 1.25 km<sup>2</sup>. The protection plan singles out Sha Lake, describing its boundary as "to be defined after the city's evaluation of the land use masterplan." Considering the ambiguity and contradiction of the two sets of municipal documents, one has to wonder what would become of its remaining coverage.

#### **Urban Development - Lakes as Commodity**

A glance over several real estate flyers handed out in the streets of Wuhan shows a recurring theme of beautiful lake scenery as one of the selling points. The advertisements are almost always deceiving since most of the new developments are not situated by the lakes. On the other hand, developments that are actually located by the lakes are depicted in renderings where the surroundings suggest an image of a modern American city set by the water or primal forests.

Besides the strange dislocation of context, advertisements for lake-side developments rarely mention access to the actual water. A walk around several lakes in Wuhan exposes that such estates are usually gated communities built right to the water edge, yet most do not provide public access to the lakes and public space by the lakes. Lake Shahu, for example, has only three obscure points of entry to the lake. The lake, a huge spatial entity in the center of the city is so well concealed behind a concrete forest, most Wuhanese know of its presence but have never encountered it.

What the advertisements reflect is ultimately an pathological obsession with the visual. This common design mentality negates the spatial and ecological dimensions of the lakes, proposing yet

## Fishery - Seasonal Fishing

The municipal government has shut down six of the eight waste water discharge points, leaving Hubei University and Sanjiao Rd. area the only two point sources.<sup>18</sup> Despite this effort, the lake remains heavily polluted. The pollution directly affects the three hundred fishermen living in the Yujiahu village since their income is dependent on seasonal fishing.<sup>19</sup> The bad quality and variety of the harvest allows only a small return and the market is restricted to the local restaurants and markets. The consumption of the polluted has resulted in significant increase in cancer patients and incidents of skin disease.



- 26 (top) Key Map of Fishing Port.
- 27 (left) Algal Bloom Near the Yujiahu Fishing Village at Lake Shahu.
- 28 (spread) Fishermen Setting Out to Work: seasonal fishing spotted right before the high demand arrives for Chinese New Year.





## Agriculture - Vegetable Plots

Be it the little patch of soil next to a wall or the sides of a meandering dyke, small vegetable plots take over any idle soil. These are not grown for commercial purposes as most of the owners of these plots are local seniors passing time. In essence, they are urban public gardens without any deliberate organization. Measured at 1 m x 3 m per plot, most people own 2 to 3 units. The varying blooms of vegetables weave a continuous patch work of greenery along the lake edge. The sight is a truly impressive expression of adaptive culture. However, the practice has its questionable aspects since the vegetables are fed by toxic eutrophic water from the lake. It remains that the phenomenon of public vegetable gardens has the potential to become something sustainable, beautiful and an ingenious expression of the local culture.



29 (top) Key Map of Vegetable Plots.

30 (btm.) Vegetable Plots Carpeting Both Edges of the Dyke.

31 (spread) Two Seniors Scooping Eutrophied Water to Feed Their Vegetables.





## Agriculture - Remains of a Rural Village

On the south side of Lake Shahu there remains a few small lakes that were presumably connected to the large waterbody at one time. Following the lakes, one finds a small village tucked away from the busy metropolis. There are chicken feathers piling up to a small mound on the ground and pigs being herded into their sty. A handful of rural households still exist, some grow vegetables, some raise livestock and some manufacture lime in a pond used for disinfecting new buildings. The villagers appear to be original inhabitants since they speak the local Wuhanese dialect. How the village is still intact is a mystery but it is obvious that it will disappear under the pressure of housing development in the near future.



- 32 (top) Key Map of Hidden Farm.
- 33 (btm.) Remains of a Small Lake: encountered before discovering the hidden village
- 34 (spread) Vegetable Farm: found at the foot of new apartment buildings.





## Agriculture - Lotus Field

The lotus field of Lake Shahu is one of the most breathtaking sight of Wuhan, though as an agricultural practice it is clearly environmentally destructive. In the summer and spring, the isolated lake would be filled with lotus blossoms. In the fall and winter, the plants would wither, turning the once green field into one covered in umber. The dramatic change of landscape is comparable to the changing of leaves in autumn. Unfortunately, the farmers harvesting lotus roots drain the water from the entire lake, leaving no chance of survival for any fish and amphibians. The landscape then becomes a field of standing lotus plants with drooping heads. A few farmers dig into the mud for the lotus roots; another few would truck the harvest to the gathering house with a trolley. Much like the public vegetable gardens, the image of the lotus farm speaks of its immense potential to become a landscape that is productive, sustainable and beautiful all at once.



- 35 (top) Key Map of lotus farm.
- 36 (bim.) Farmers Gathering Their Harvest of Lotus Roots at the Collecting Point Before Sunset.
- 37 (spread) Withered Lotus Plants in a Dried Pond.





## Perimeter Area 1

The west bank is traversed by a railway hidden behind a long stretch of car dealers along the street. The monotonous array of big box warehouses has made the street unbearably grey and empty.



- 38 (top) Key Map of Area 1
- 39 (bim.) Future of Lake Shahu's Water Front: a sign showing the future plan for the west bank to be a huge parking lot for automobile dealers.
- 40 (spread) Monotonous Line of Car Dealers Hiding Lake Shahu from Sight.





## Perimeter Area 2

The north west of Lake Shahu is a campus park for the Hubei University. This is the part of the lake that is more accessible to the public. However, the lack of a promenade leading to the water still makes the lake a hidden secret most people do not know about. The park contains several ponds with Chinese pavilions but they are either dried up or severely eutrophied.



- 41 (top) Key Map of Area 2
- 42 (bim.) One of the Two Remaining Point Sources of Pollution is at Hubei University; note the sluice gate in the picture.
- 43 (spread) Campus Park of Hubei University at North West of Lake Shahu.





### Perimeter Area 3

The north bank is undergoing major construction for a group of high-end housing ranging from twenty-storey apartments to five storey apartment buildings. As a complementary project, a large waterfront public park is also under construction. From the rendering of the development, it seems a that promenade to the water has finally been planned. While the park will be publicly accessible, the residential part will be a typical gated community.



44 (top) Key Map of Area 3

45 (center) An Exaggerated Rendering of the New Development in Lush Greenery: note the circular intersection and its connected promenade.



46 (btm.) New Gated Community: returning to the site after one year, the buildings depicted in the renderings were found partially materialized.

47 (spread) The Water Front Park Under Construction.





## Perimeter Area 4

The rate of residential development for the north east bank is not as intense as the north bank due to the presence of the industrial railway heading towards the Wuhan Heavy Machinery Plant. All this is going to change as Hong Kong real estate tycoon Li Ka-Shing is planning to develop the site of the machinery plant into another commercial hub.<sup>20</sup> Currently, new developments ranging from single family dwellings to high rise apartments are springing up on this side of the lake with absurd designs built right up to the railway.

The open sewage splits up into two branches when it meets the railway. One branch heads westward and becomes invisible at some point. Presumably, it continues traveling in an underground pipe and eventually gets discharged into the Yangtze. The other branch keeps heading north, passing the untreated water from Shahu Water Treatment Plant to the Qingshan Harbour Water Treatment Plant before it gets discharged into Yangtze.



- 48 (top) Key Map of Area 4
- 49 (btm.) Single Family Dwellings Built Right up to the Wall at the Railway; note the person working on a vegetable plot.
- 50 (spread) Open Sewage Splits up Before Passing Under Railway Bridge.







## Perimeter Area 5

The east bank is the most intensely built up part of all sides because of its proximity to the old Wuchang city core and the ring road traversing through it. The site is occupied mostly by old five-storey houses but new high rises are replacing them gradually. There is only one path that leads to the water on this side of the lake, though several meandering paths terminate at platforms overlooking the lake.

A pump station is located on the dyke running along the east bank. It is responsible for pumping the lake water into the open sewage during heavy rains. A ring of fish net strung across bamboo sticks is set up to prevent fish from escaping into the sewage when the sluice gate is opened.



51 (top) Key Map of Area 5

52 (btm.) Five Storey CourtYard Apartments on Site: built in the 70's, the apartments provide gathering space for seniors in this neighbourhood. A game of mah-jong can often be spotted. Public space like this is getting replaced by large and usefulness green space in modern development.

53 (spread) The Pump Station on Dyke with Sluice Gate: excessive water is released into the open sewage to maintain the water level.





## Perimeter Area 6

The south east of the lake is home to the Yujiahu fishing village. There is still a little livestock rearing in the area and commercial fishing still takes place seasonally but its vibrant mercantile streets suggest a rapid change in its economic constitution. Descending down the hill where the former village sits, one comes across a new residential community with uniformly arranged five-storey apartments on pedestals. The development was entirely built upon landfill created sometime around 2002. Instead of providing access to the water, the lake is fenced off by a long running wall at this side of the lake.



- 54 (top) Key Map of Area 6
- 55 (btm.) Wall Surrounding Lake Shahu: the slogan reads, "protect Lake Shahu for the sake of our future generations."
- 56 (spread) Replacement housing for Yujiahu Fishing Village: built on landfill.





## Perimeter Area 7

The most dramatic contrast to all the new development is the wasteland on the south bank. A comparison between the 2004 and 2005 tourist map shows a large area non-existent before 2005. Most of the new landfill is covered in rubble and junk except for few places where peasant families managed to gather some soil for growing vegetables and raising a few chickens. A few figures loomed around in the distance with white garbage bags on their shoulders, picking up trash found in the field. The houses are made from make-shift materials and there is clearly no running water in the area. Without a doubt, the residents will one day be evicted when development finally reaches this side of the lake.



- 57 (top) Key Map of Area 7
- 58 (btm.) Scavengers Looking for Recyclable Materials in Waste Pile.
- 59 (spread) Makeshift Shacks by Peasant Families Built on Landfill: one of the three access points to Lake Shahu can be found here.









## **A Few Conclusions**

Lake Shahu is a critical point in the context of this analysis as it embodies a condition of intense urbanization soon to engulf many lakes in the Central Yangtze River Basin. The disappearance of the lake will mean the loss of one of the few reconnection points to Yangtze. Preservation of the lake is critical but flood control and biodiversity alone do not provide enough reason to the Chinese for its preservation and neither does altruism. A set of strategies that will realize the lake's potential as a flood basin, city extension, agricultural ground and healthy ecosystem are necessary to formulating a sustainable future for the lake. Only through transformation can the lake be preserved.



# Case Study



## **Introduction to Case Studies**

The end of the complex system analysis shows the importance of Lake Shahu's transformation into an urbanized zone and a point of reconnection to Yangtze. These two changes will eventually lead to the design of a new urban fabric, streets and public spaces by the water. The following is a list of precedents:

*Fresh Kills Landfill Rehabilitation by Field Operations, James Corner*

*Proposal of City Extension over Tokyo Bay by Kenzo Tange*

*City Streets and Urban Fabric of Wuhan, Venice and Amsterdam*

*Public Space in Chinese Canal Towns*





**Fresh Kills Landfill Rehabilitation**

## Fresh Kills Landfill Rehabilitation - Field Operations, James Corner

Fresh Kills is a former landfill south of New York. It is now being transformed into 2,200 acres of public parkland and natural habitat. The design, by Field Operations, intends to recover the ecosystem and life of the site through a the process of soil rehabilitation, plantation, earth work and programming. James Corner writes:

Understanding Lifescape as process is central to the project, for a site of this scale and complexity can not be “designed” in total, nor constructed overnight. Rather, it must be “grown”, as in seeding, cultivating , propagating and evolving. ... Thus design at Fresh Kills is as much about the design of a method and process of transformation as it is about the design of specific places.<sup>1</sup>

The first stage of the process involves farming the land with “strip cropping”, a technique used in green manure agricultural practice. Three carefully selected crops are seeded each year and rototilled to build up the soil’s organic content. The crops are planted in alternating strips with the even rows left fallow to stabilize slopes while the odd rows are cultivated. Once the soil is recovered, plantation will then begin with the sowing of native grasses. The planting of trees will follow once the meadow is established. The first wave of saplings will be planted in a point-grid with subsequent saplings planted in-between. Afterwards, natural succession will take place, changing the planted site into a natural forest over time. The site also features a mount made of debris of the former World Trade Center, which provides a vista towards lower Manhattan.<sup>2</sup>



02 Strip Cropping to Restore Organic Content in Soil.



03 (top series) Process of Transformation Over 30 Years.

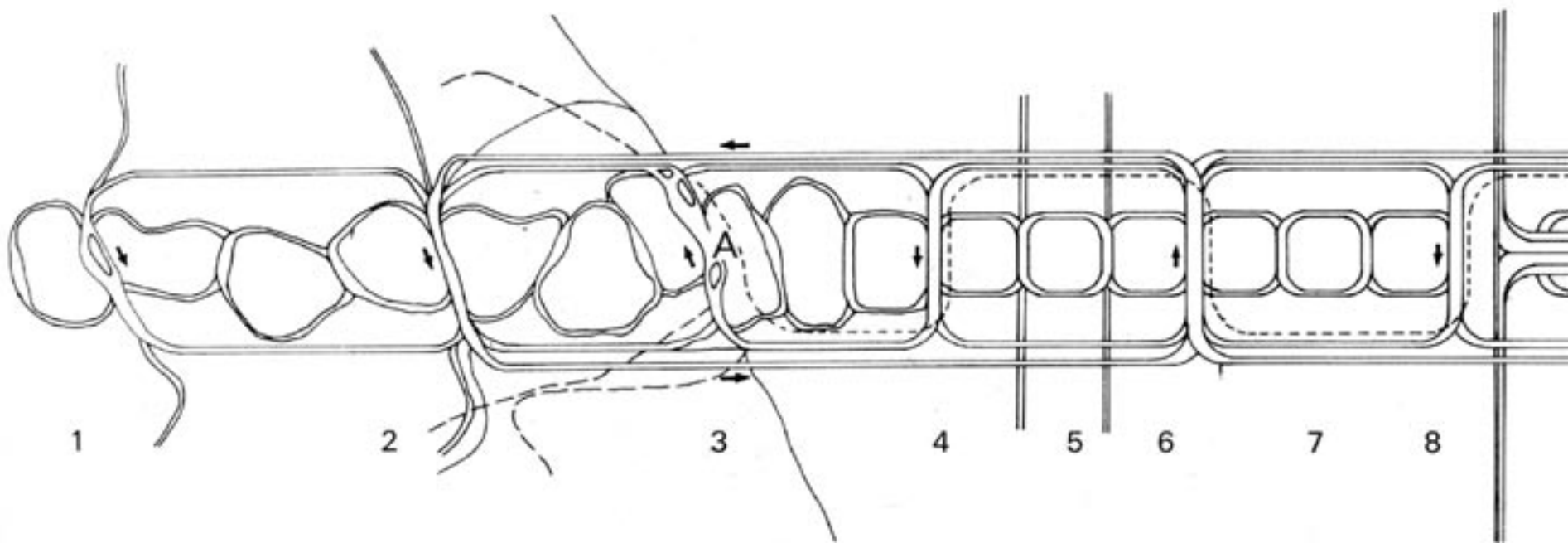
04 (btm.) A Wetland Ecosystem Accessed by Boardwalk in the Future Park.

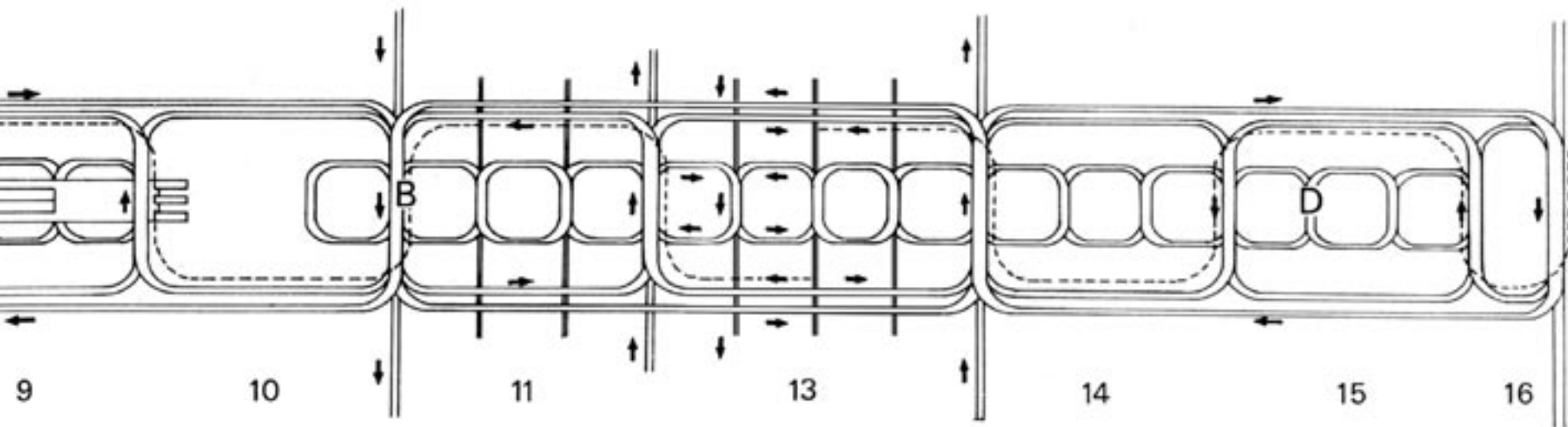




- Low salt marsh
- High salt marsh
- Lowland swamp forest
- Fresh water pond
- Existing woodland
- Turf Moist grassland
- Dry grassland
- Woodland
- Existing woodland
- Programs and places
- Major arterial roads
- West shore expressway service roads
- Proposed loop road
- Primary bike and pedestrian network
- Mountain bike trails
- Secondary bike and pedestrian network
- Garden boardwalks
- Lighting and media screens
- Parking
- Pedestrian entrances
- Major vehicular entrances

05 (left series) Layers of Components for the Construction of the Park  
 06 (right) Overall Plan for the Park Explaining the Variety of Habitats and Activity Space





City Extension Over Tokyo Bay

## City Extension over Tokyo Bay - Kenzo Tange

Tokyo in the 1960's was experiencing tremendous pressure to expand outward, resulting in a collection of bedroom communities in its suburban area rapidly growing concentrically around Tokyo's core. This radial development pattern became increasingly unsustainable as Tokyo's population reached 10,000,000.

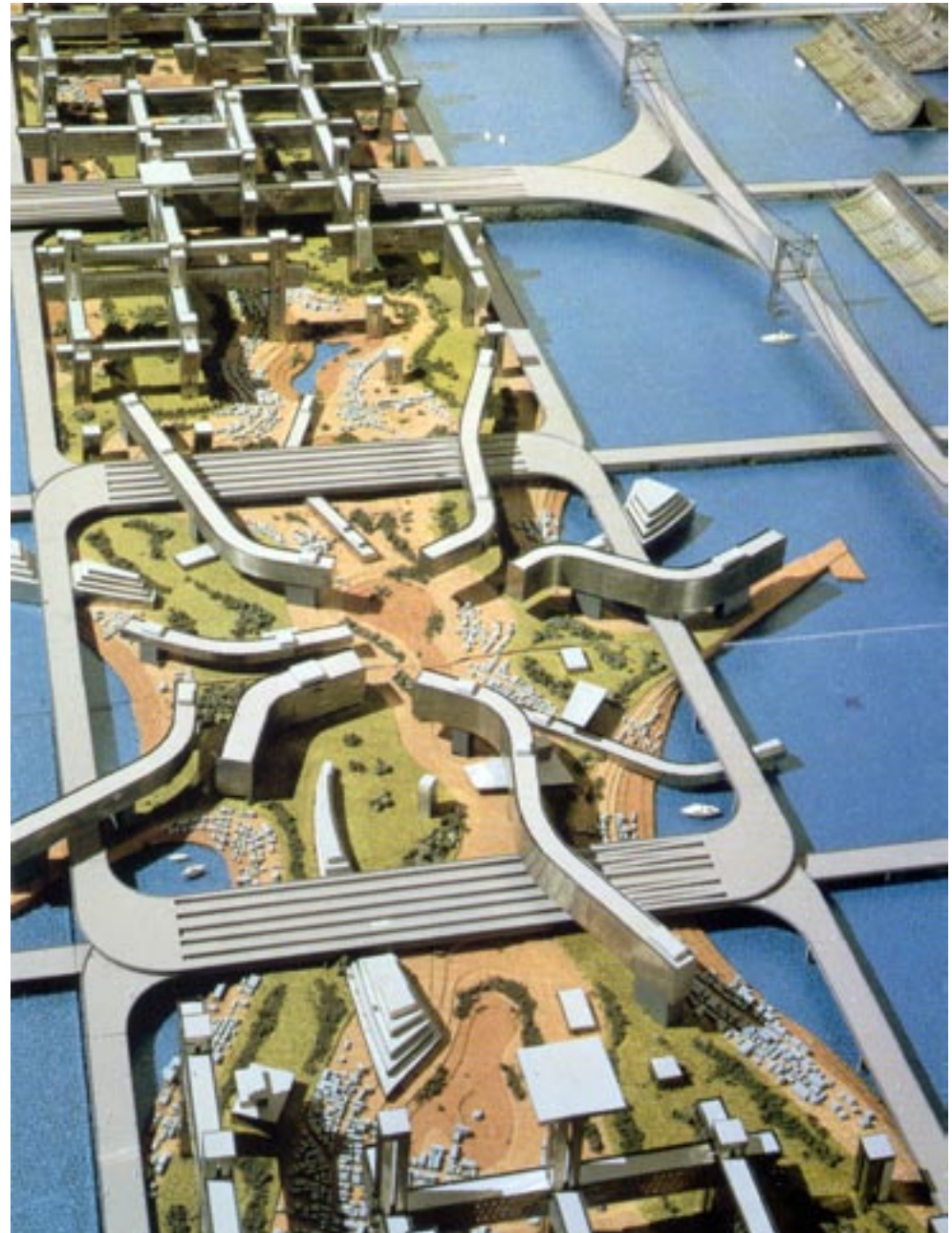
Envisioned as a new model of development for Tokyo, Kenzo Tange proposed a linear city expansion over Tokyo Bay, connecting the city to its neighbouring prefectures and establishing new land for growth. The extension, named Civic Axis, was to house 2,000,000 people and be equipped with all the necessary functions of a city.

The cyclical traffic system of Civic Axis is divided into three levels, offering three rates of travelling speed and artificial ground for parking. It divides the 27 km stretch into nine units, each designated with a single function such as government district, office district and Tokyo Harbour. Large open spaces are to be found under the buildings, creating a continuous park across the bay.

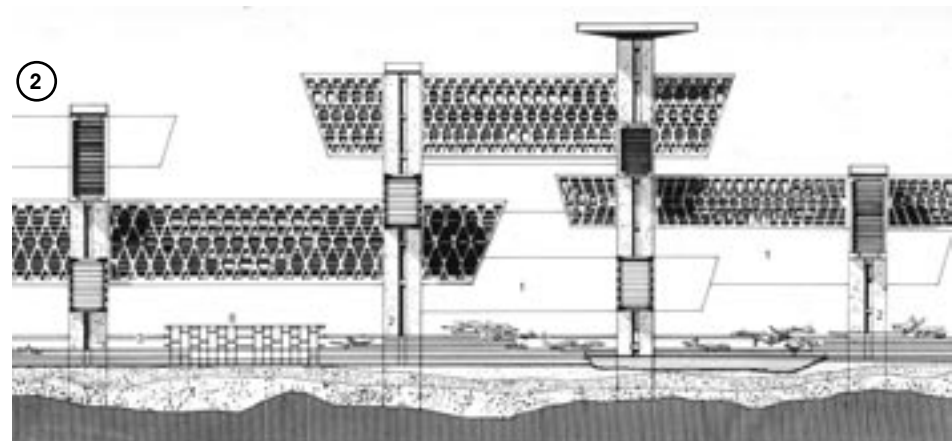
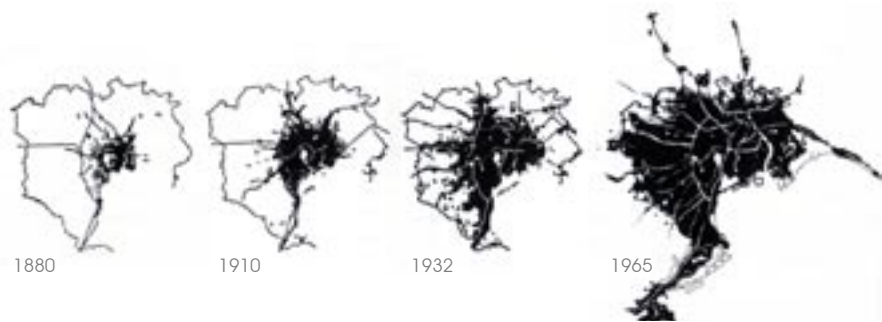
Clusters of low density residential communities are found scattered across the spine but the main residential area is designed on a network of artificial platforms over water branching off from the center. Depicted as triangles in section, the residential structures are fitted with parking, shopping centers, monorail stations, schools and public spaces. Reclaimed land is also proposed to provide space for residential communities.<sup>1</sup>

The proposal sets out to create a linear center to connect existing urban centers. Tange's solution does not include any coherent city fabrics that suggests pedestrian movement, commercial activities, and cultural events. The segregation of commercial, administrative, and residential areas with no consideration to the fluctuation between day and night time population creates a unsustainable situation where there is no cross-exchange. The residential area is connected to the spine only by vehicular access. Even though public transportation is provided, its feasibility is questionable due to the low density in the area.

While the Civic Axis might function as a bridge with hyper fluidity that shortens distances between urban centers, its development as a linear center falls apart as a dis-integrated system. However, Tange's basic strategy of inhabiting an infrastructure is critical for a city of mobility. The separation between urban life and travelling, or places and vehicular conduits, is one of the fundamental obstacles to the idea of integration. The three level / speed communication system of the project begins to speak of the possibility of coexistence between highway, local thoroughfares, streets, alleys and pedestrian walkways. The juxtaposition of life and high speed travelling can form a tighter and more intense network of exchange but a full spectrum of infrastructure inbetween such as a cohesive urban fabric, is needed to exist in order for such a relationship to materialize.



02 Model of Civic Axis: large open space below office buildings and small clusters of low density housing.



03 (top) Radial Development of Tokyo City 1880-1965.  
 04 (center) Section of Triangular Residential Buildings.  
 05 (btm.) Single Function Zones: model showing separation between commercial and residential area.

06 (top) Section of Office Buildings: shafts are connected to the utility lines and the roads.  
 07 (btm.) Over All Plan for the City Extension.





**City Streets and Urban Fabric**

## Urban Fabric and Street - Wuhan

Wuhan has a mixture of different types urban fabric because of the rapidly changing modes of development in the last fifty years. A look at the current fabric reveals four general types: old city fabric formed before the 1950's, communist worker's housing constructed between 1950 to 1980, the mid to high rise development in the 1980's and the high rise gated communities that began appearing since the 1990's.

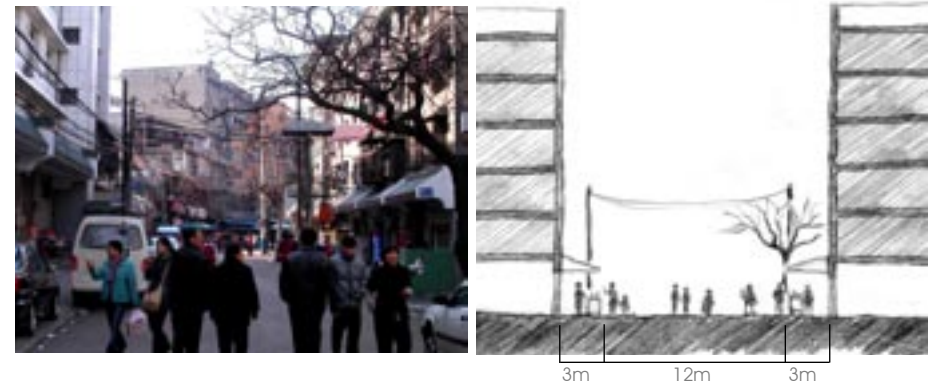
Although few structures from the Qing Dynasty remain, portions of the old city fabric is still intact. They are characterized by the crowded cluster of houses with alleys negotiating through the cracks between buildings. Once permeated with commerce, the alleys have become quiet passages where neighbours gather to socialize.

The worker's housing communities began a planning strategy named *xiaoqu*, which literally means small community. This mode of development forms enclosed neighbourhoods for workers employed at the same factories. The communities usually have few entries and an internalized network of streets and courtyards. Since they are not guarded during the day, traffic through these areas are free for public passage, allowing a few shops to survive on the ground floor. The high rise developments in the 1980's continued this tradition but development eventually evolved into the modern high rise gated communities. This latest iteration relocates most commercial activities to major streets but some medium scale streets in Wuhan still remain intensely commercial. (figure 02-03) The survival of these streets is largely due to the gathering of street vendors and night markets. Some of the medium scale streets are vacant during the day and transformed into markets at night, while others are permanent vendor streets. The small block size, at a rough average of 150 m X 150 m, surrounding them allow for multiple entrances onto the site, making them easily accessible.

## Urban Fabric and Street - Venice and Amsterdam

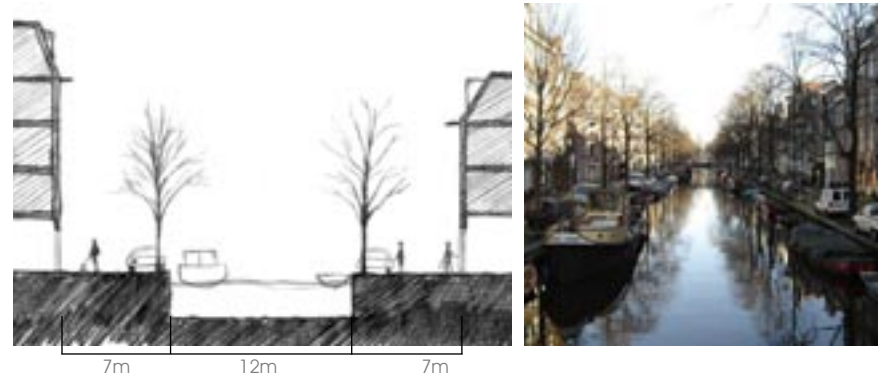
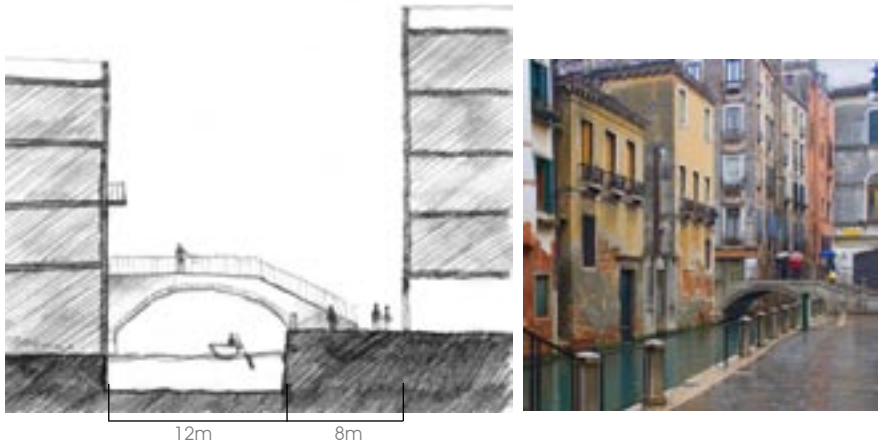
Because of landfill and the floodwall along Yangtze, the city of Wuhan does not possess any streets along its waterbodies. The proposal of a city extension over Lake Shahu will become an opportunity to establish a new relationship between city and water. For this reason, Venice and Amsterdam area valuable precedents.

Both Venice and Amsterdam have extensive networks of canals. The canals define the spatiality of the streets, providing wider spaces in tightly planned cities. In Venice, the canals are randomly situated irregularly shaped, and possess various configuration in relation to streets and buildings, thus making them distinct places that help orient pedestrians in a labyrinthian city. With larger blocks and bridges placed at regular intervals, streets in Amsterdam appear to be more navigate. A structured fabric, however, does not mean monotony for Amsterdam. The various scales of the canals are designed with corresponding street width and building heights, thus giving rise to different street intensities and types of commerce on the embankment. The commonality of the two cities is that they rely on subtle variations in street sections to create different relationships with the water.



- 02 (top left) Ziyou Road: a busy street famous for its street vendors in Wuhan. The fabric of the area is a mixture of old city from Qing Dynasty and developments from the 80's.  
 03 (top right) Section of Ziyou Rd. 1:500.  
 04 (btm.) Urban Fabric of Wuhan 1:1,5000.





05 (top left) Typical Street Section of Venice 1:500.  
 06 (top right) A Street in Venice.  
 07 (btm.) Urban Fabric of Venice 1:1,5000.

08 (top left) Typical Street Section of Amsterdam 1:500.  
 09 (top right) A Street in Amsterdam.  
 10 (btm.) Urban Fabric of Amsterdam 1:1,5000.





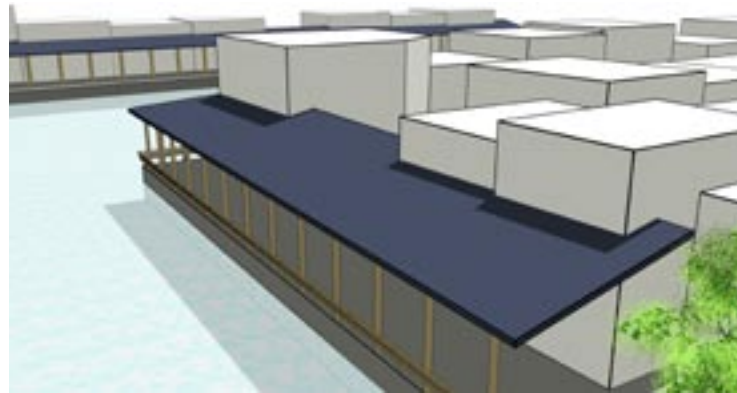
**Public Space in Chinese Canal Towns**

## Public Space in Chinese Canal Towns

Canal towns in south China used to be the mercantile centers for surrounding groups of rural villages. The wealth accumulated in these towns allowed the construction of extensive canal networks which in turn shaped the public space in the towns. The hot and humid climate put an emphasis on the need for shaded public spaces. These spaces include canal streets, bridges, commercial streets, ports, water squares, and ponds, accommodating a range of civic and commercial activities.

### *Arcade by Canal*

Arcades by water are usually a sign of commercial activity. The most common public street furniture is the continuous wooden bench built along the water edge. There are also sets of tables and chairs placed along the water by tea houses and shops. Despite the private ownership of the street furniture, the arcade is always a lively extended living room for the residents.



- 02 (top) Sheltered Street.
- 03 (btm. left) Long Bench Along Water, Zhujiqiao, Jiangsu.
- 04 (btm. right) A Busy Sheltered Street with Commerce. Zhujiqiao, Jiangsu.



### ***Street by Canal***

Unsheltered streets by water are usually flanked by housing. To achieve a balance between shade for the public space and natural light for the houses, various deciduous trees are planted along the canal, sometimes resulting in dense foliage hovering above water. These streets are much quieter since the lack of shelter makes them less conducive to commercial activities. The transition from the busy quarters of the town into this area offers a pleasant sense of relief.

- 05 (left top) Access to the Water by Stair, Zhouzhuang, Suzhou.
- 06 (left btm.) Model Showing a Shaded Street by Canal.
- 07 (right) Dense Foliage Over Canal. Zhujiqiao, Suzhou.



### **Bridge**

The bridges are designed as arches to enable boat passage underneath. Their elevated position also allows for excellent vistas onto the canals. Sheltered bridges are especially useful as they provide extra incentive for lingering.



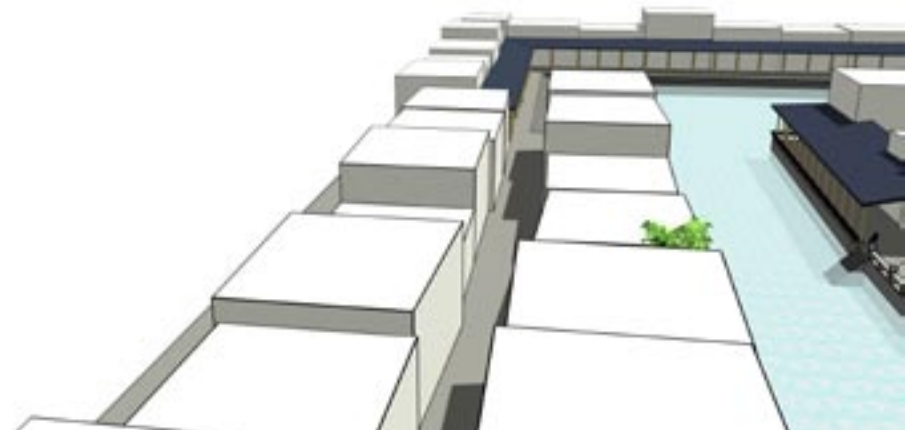
- 08 (left) Model of Bridge Accessed Through an Opening Between Two Buildings.
- 09 (top right) Tourists Linger in the Sheltered Bridge. Zhujiqiao, Jiangsu.
- 10 (btm. right) View from One Bridge to Another. Zhouzhuang, Jiangsu.

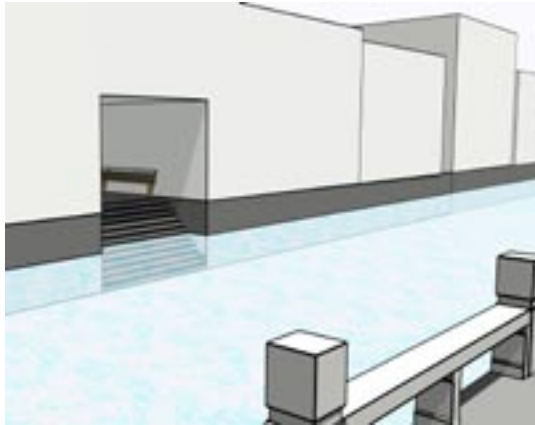


### **Commercial Street**

The typical Chinese canal towns are saturated with commerce but there are usually one or two major commercial streets conveniently located between two major public spaces. The narrow streets are usually enclosed by the shops that line the streets and punctured by occasional openings towards the water. Overhangs from the shops provide adequate shade for the street to be comfortably lit while allowing penetration of light through the slit opening. Although these towns have been artificially preserved as tourist attractions, the intimate scale of these streets still manage to keep alive the everyday interactions of a vibrant community.

- 11 (top) Roofs Parted by a Thin Stripe of Light: the commercial street is comfortably shaded yet surprisingly illuminated. Zhujiqiao, Jiangsu.
- 12 (btm.) Model Showing a Narrow Commercial Street.





**Enclosed Port**

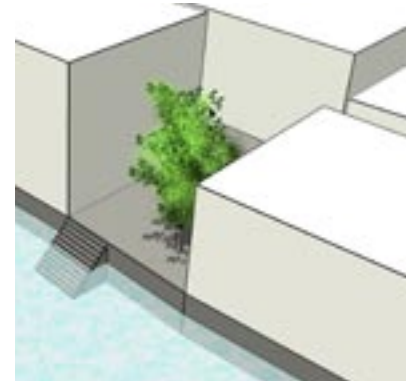
Although this former private port in the canal town Wuzhen has lost its function as a busy transportation hub, it is now one of the favourite spots for the tourists and the residents because of the view and shade it provides.

- 13 (top) A Sheltered Port from Across the Canal.
- 14 (btm.) Tourists Resting in the Darkened Port. Wuzhen, Jiangsu.



**Shaded Port**

Often shaded with a simple tree, the port is no more than several steps leading to the water. It provides access to water for residents who do their laundry in the canal and for children who swim in the water.

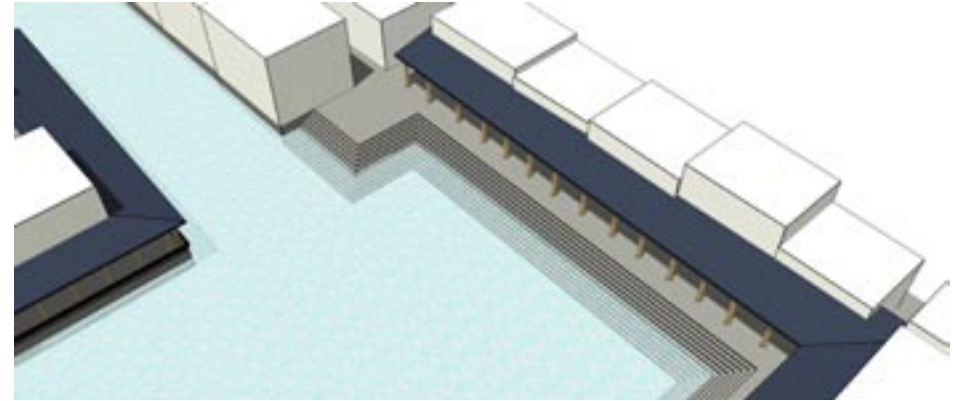


- 15 (top left) Model Showing Shaded Port Between Two Buildings.
- 16 (top right) Shaded Port in Wuzhen, Jiangsu.
- 17 (btm.) Children Swimming in the Water. Zhujiajiao, Jiangsu.



### **Water Square**

The largest public space in the ancient town of Wuzhen is the former public port. Located at the end of the main commercial street, the large open water and its adjacent sheltered space makes it a great spot for cooling off and public gatherings.



18 (top) Model showing water square.

19 (btm. left) Steps Around the Square Provide Seating. Wuzhen, Jiangsu.

20 (btm. right) A Busy Commercial Street End at the Water Square. Wuzhen, Jiangsu.





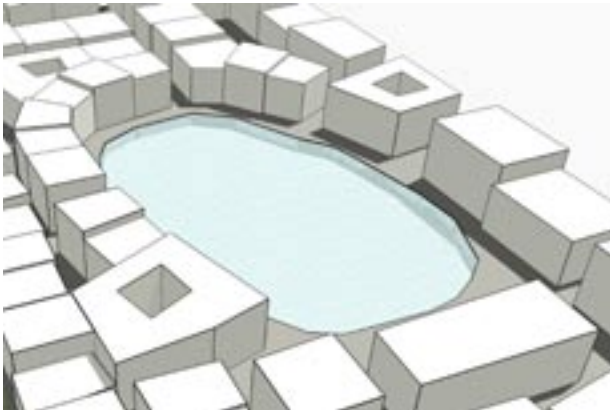
### **Pond**

Ponds are characteristic of v and Hubei province where larger bodies of water are more common. Much like canals, the ponds are often used for laundry and fish gutting. However, unlike the flowing canal water, the stillness of the pond makes it an ideal place for growing lotus. The picture shows the town of Hongcun in Anhui. The pond is the one and only large water body in the ancient town. It is the main public space where everyday labour is carried out as well as the center of all festivals.

21 (top left) Model Showing Pond.

22 (btm. left) Women Doing Laundry by the Pond. Hongcun, Anhui.

23 (btm. right) Lotus Floating in Village Pond. Hongcun, Anhui.





# Design Synthesis

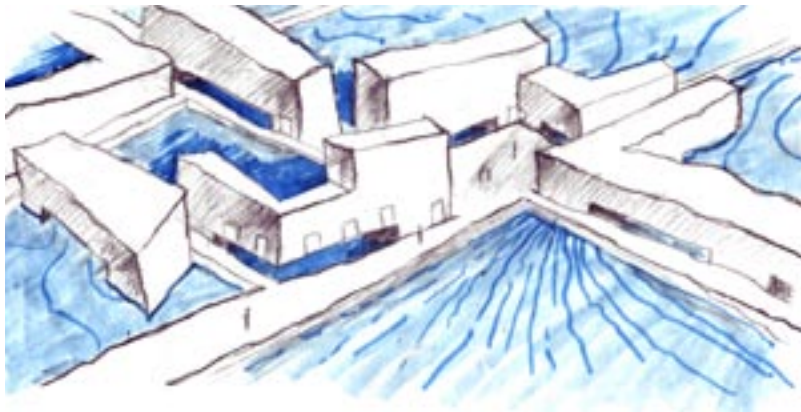
## Introduction to Design Synthesis

The complex system analysis shows Lake Shahu as a microcosmic example of a lake in the Central Yangtze. Problems typical of the lakes in the region are:

1. The input of municipal and industrial waste water and the lakes' disconnection from the Yangtze render the water polluted and stagnant.
2. Lakes disconnected from the Yangtze are not able to accommodate flood water from the river.
3. Gated communities are replacing old apartments along the water. Because of the new construction, the previous urban fabric is destroyed and public spaces are replaced by an inaccessible and unusable landscape. The annihilation of small streets also means the end of small businesses in the area.
5. There are only few hidden points of access to the water, making lakes an exclusive scenic feature for the residents of nearby apartments.
6. Due to development pressure, the lakes are to be infilled.

A set of problems particular to Lake Shahu's situation are:

1. The lake is an obstacle for communication within the city core.
2. A portion of the lake is segregated for rearing lotus plants. The large pond is drained during harvest.
3. Three hundred fishermen are fishing from the polluted lake seasonally. Many of the residents from fishing villages are experiencing health problems from

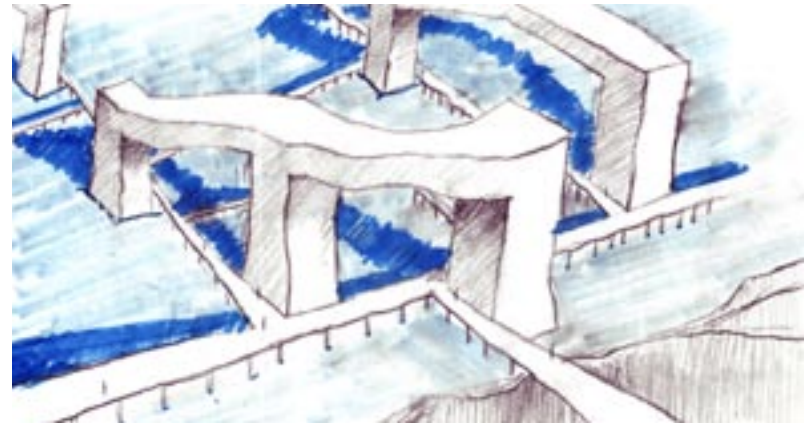


**01** Scheme 1 Dyke City: allows formation of dense city fabric but cuts water body into numerous independent enclosures, cutting off the nutrient and organism exchange between each compartment and disabling the flood retention function of the lake.

consuming polluted water and fish.

4. The south side of the lake is a garbage dump. Many scavengers hover around to find scraps for the recycle market nearby.
5. A rural village exists on the south side of the lake and several small farms can be found around the perimeter of the lake. Their existence is threatened by development.
6. Road side vegetable plots are contributing agricultural run off into the lake.

The most conflicting issues at Lake Shahu are the need for a city extension and the urgency for a flood retention network. Although separate projects can be proposed to mitigate the two problems one by one, the solutions are detrimental to each other. If a city extension is to be constructed by infilling Lake Shahu, then the city wide flood retention will not be possible anymore. The possibility of a flood retention network through the rural areas upstream from Wuhan still presents immense challenges since the lakes in the region have been mostly converted to fish farms. Considering the Central Yangtze has a limited number of places where a large collection of water bodies can potentially form a retention network, every lake, even the ones located in the densest urban centers, has to be considered for its potential. Lake Shahu is in this exact situation where urbanism and flood retention must co-exist. As the complex system analysis demonstrates, the densely populated landscape of China does not allow separate rooms for human activities and natural phenomenon. In this context, the machines of two disparate systems, flood retention and cities, need to be redesigned and forged into one



**02** Scheme 2 Tower City: towers minimize footprint but a traffic grid is still needed to enable circulation. The urban fabric, however, is not supported by store fronts, making them incomplete as functional streets. Compared to the dykes, the raised platform works better with the ecosystem below as it does not divide up the lake into separate compartments.

functional entity. Thus, the approach of the design synthesis is one that advocates a humanistic landscape instead of one that is in favour of complete naturalization.

Several schemes have been entertained for the design of the city extension. They each establish a different relationship with the water. In chronological order of their conception, they are: a city on earth dykes, a city of towers, a floating city and a city on an artificial platform. The city on earth dykes compartmentalizes the water into small pockets, thus dividing the lakes into a collection of small ponds that disables the flood retention network. A city of towers rising from the water does not allow the formation of a dense city fabric, thus depriving the ground of public space and small businesses. The floating city poses serious technical difficulties at the junction between the city extension and the land as its fluctuating elevation makes accessibility impossible at times of high and low water. The artificial platform raised over the water seems the most feasible proposal as it keeps the lake an integral whole, provides a dense city fabric, and joins with the land with a static connection.

#### Proposed Infrastructures

1. Flood Retention Network (reconnection)
2. Flood Berm
3. Land Over Water
4. Park and Public Space
5. Wetland

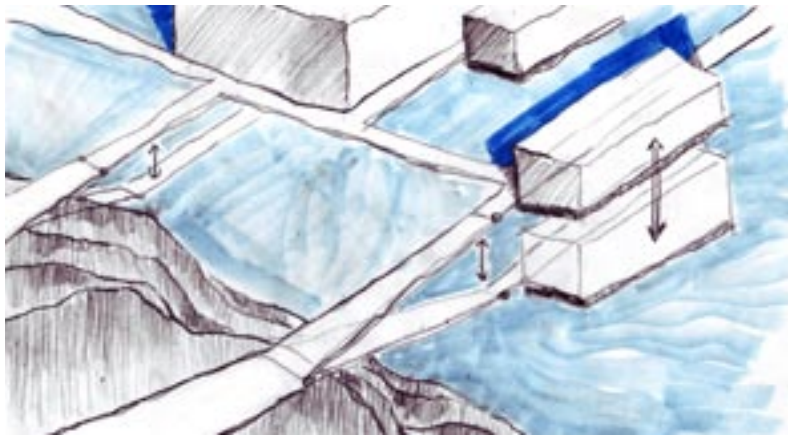
#### Passive

flood + pollution  
flood  
development + communication  
access + activity  
habitat

#### Reorganized Infrastructures

1. Agriculture (lotus farm)
2. Fishery

sustenance of Rural Population  
sustenance of Rural Population



**03** Scheme 3 Floating City: floatation of the block maintains a close proximity to water at all times. The changing to the water level implies a moving junction between the floating platform and the land. The multiple movable joints for the platform has low tolerance for mechanical failure.

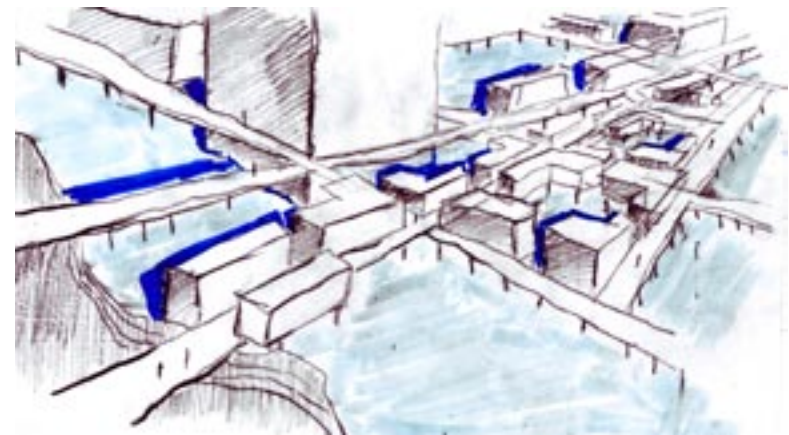
The last scheme of the city extension proposals, named Land Over Water, was eventually chosen for further development. The design of the LOW still involves several issues such as the quantity of shade cast over the water, access to water, the creation of public spaces, strategies to densification and management of waste. The solutions concerning the many aspects of LOW will be incorporated into a larger system of integrated infrastructures that deals all the issues surrounding Lake Shahu.

The approach for the design for a system of an integrated infrastructure stems from the understanding of the dynamic relationships of the various forces in the environment revealed in the complex system analysis. Such an approach refuses the convention of passive problem solving where one issue is addressed by one project at a time. Based on the problems listed, a list of components in the integrated infrastructures can be assembled to generate discussions at this point.

#### Integrated

water transportation + access to water + biodiversity + fishery + agriculture  
development + nutrient for farm + new location for road side vegetable plots + buffers run-off  
nutrient for farm + improve microclimate + ease algal bloom  
education + commerce  
recreation + biodiversity + grey water treatment

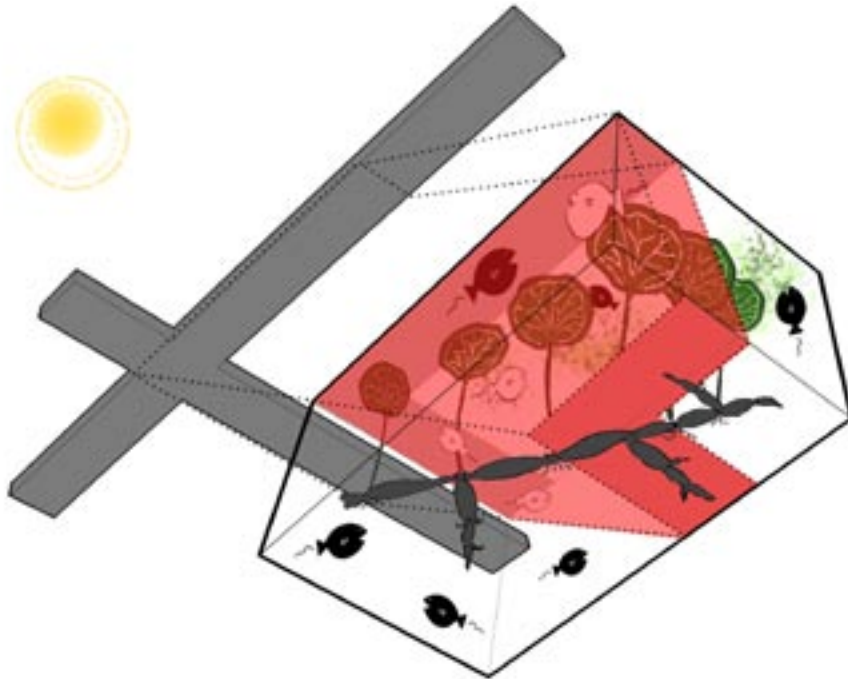
managing the ecosystem + grey water treatment + plants for auxiliary fish feed  
managing the ecosystem



**04** Scheme 4 Land Over Water: a raised platform with towers, mid rise and low rise buildings become a more feasible option as it allows for flood retention to a certain height, maintains the water body as one whole and provides a dense city fabric for urban life.

## Co-dependent Infrastructures

The premise to the design is to establish a sustainable and symbiotic relationship among existing forces and the infrastructure to come. Sustainability does not mean a constant state of equilibrium but a condition of relative stability supported by various measures to keep the balance in check. The proposed infrastructures are assembled as an abstract to demonstrate their potential relationship with the existing elements on site and with each other. A number of possible adverse scenarios that could disturb the balance of the system is discussed here as well as possible measures that can be taken to adjust the condition.



05 Lake Ecosystem and Integrated Infrastructure : supplying local planktivorous fish (illustrated as black fish) such as silver carp and bighead carp will help reduce algal growth.<sup>1</sup> The proposal of a Land Over Water system will reduce sunlight necessary for algae, thus easing the reproduction rate and allowing water plants to thrive. The most important measure taken to rid the lake of eutrophication would be cutting off the source of waste water.

## Proposed Infrastructures

### Flood Berm

- supplies space for development thus connecting existing city fabric to LOW
- allows numerous and frequent access points to the lake
- development on berm provides base density for commerce supporting recreational activities
- development on berm produces grey water for lotus farm and ecosystem
- buffers storm and agricultural run-off with trees on slope
- berm top provides new location for road side vegetable plots, thus reducing nutrient run-off
- provides space and structure for treating contaminated soil from lake bed. Phytoremediation process creates jobs for farmers

#### Caution & Adjustment

- flood tolerant capacity of plants need to be tested before selection. Maximum tolerant duration affects duration of flood retention
- shoreline needs to be reinforced by rip rap or gabion wall
- berm blocks off rain water on city side, requiring extra drainage management and porous surfaces

### Flood Retention Network

- helps relieve Yangtze's flood problem through reconnection and flood retention
- flowing water replenishes fish stock and water.
- provides spawning ground for endangered species such as Chinese sturgeons

#### Caution & Adjustment

- silt from Yangtze will have to be filtered by the flood gate. Reforestation program upstream must be enforced to reduce soil erosion into the water. Possible sedimentation in floodway and the confluence between the canal and Yangtze requires monitoring and removal if necessary
- species indigenous to Yangtze need to be studied for their effect to the existing ecosystem
- water-borne snails from Yangtze carrying schistosomiasis need to be eliminated with the use of iclosamide, acrolein, copper or sulfate<sup>2</sup>

Land Over Water (LOW)	Park	Wetland	Lotus Farm	Fishery
<ul style="list-style-type: none"> <li>allows minimum 50% sunlight for a minimum of 5 hours on winter solstice. Shades lake to reduce humidity content in air<sup>3, 4</sup></li> <li>deters algal growth by reducing excessive light</li> <li>provides efficient communication lines across lake</li> <li>supplies land thus reducing pressure on suburban landfill</li> <li>produces grey water for lotus farm and aquatic system</li> <li>stops landfill thus making flood retention network possible.<sup>5</sup></li> </ul>	<ul style="list-style-type: none"> <li>engenders awareness of sustainability through experiencing a working landscape and aquatic ecosystem</li> <li>transforms lake into activity zone thus extending life onto the lake</li> <li>large open area of the parks signifies presence of lake</li> <li>supports commerce in vicinity</li> <li>defines center of community interaction</li> </ul>	<ul style="list-style-type: none"> <li>provides habitat for a diverse range of migrant birds species and other organisms</li> <li>educates the citizens about the importance of biodiversity</li> <li>absorbs nutrients in grey water thus reducing load on treatment plants</li> <li>increases biodiversity thus supporting a larger fish population for fishery</li> </ul>	<ul style="list-style-type: none"> <li>produces an array of valuable parts such as lotus rhizomes, leaves, seeds, seed head, stamens, petal, whole flowers</li> <li>to be accompanied by water hyacinth, alligator weed, and water cabbage in small areas which can be used as supplementary food sources for fish and pigs</li> </ul>	<ul style="list-style-type: none"> <li>provides fish for local market and export. Fish quality is enhanced by the over all improvement in ecosystem, making them more marketable and profitable</li> <li>transforms fishery into a link in the active management of the ecosystem. Fishermen will monitor the lake along with experts from the National Academy of Science in Wuhan. The change of practice transforms fishery into steady employment akin to aquaculture</li> </ul>
<p>Caution &amp; Adjustment</p> <ul style="list-style-type: none"> <li>reduction of sunlight primarily affects submergent plants and algae. Although the summer should offer 70% to 80% sunlight coverage, in case of too little algae growth, artificial input would be needed to feed planktivorous fish. Bottom feeders and herbivorous fish would have to be supplemented with diced emergent plants, such as water hyacinth, alligator weed or water cabbage, from the lotus farm</li> </ul>	<p>Caution &amp; Adjustment</p> <ul style="list-style-type: none"> <li>garbage management will become a challenging issue for the water body. Numerous garbage cans should be placed near the water. Park management can employ existing scavengers on site as custodians or recycling staff. Garbage receptacles will have to be well designed so as to prevent bird scavenging</li> </ul>	<p>Caution &amp; Adjustment</p> <ul style="list-style-type: none"> <li>fish population might be affected due to introduction of migrant birds. Responsible seasonal fishing will have to take place right before the arrival of migrant birds to secure an amount for the market, while leaving enough for the birds</li> <li>bird feeding would become a problem at the few wetland parks that are accessible. Birds will develop a tendency to stay if enough food is provided for by visitors. Park management will have to monitor the situation</li> </ul>	<p>Caution &amp; Adjustment</p> <ul style="list-style-type: none"> <li>growth of water hyacinth, alligator weed and water cabbage have to be monitored carefully to prevent aggressive take over. If required these plants can be removed, processed and fed to fish<sup>6</sup></li> </ul>	<p>Caution &amp; Adjustment</p> <ul style="list-style-type: none"> <li>increase in bighead and silver carp might lead to increase in aggressive species such as erythroculter mongolicus and erythroculter ilishaeformis. These two species are currently monitored and captured during mating season<sup>7</sup></li> <li>might require additional harvest and distribution of algae, eelweed and processed water hyacinth for bighead, silver and grass carp if natural production becomes inadequate</li> </ul>

## The Collapse of An Aquatic Ecosystem

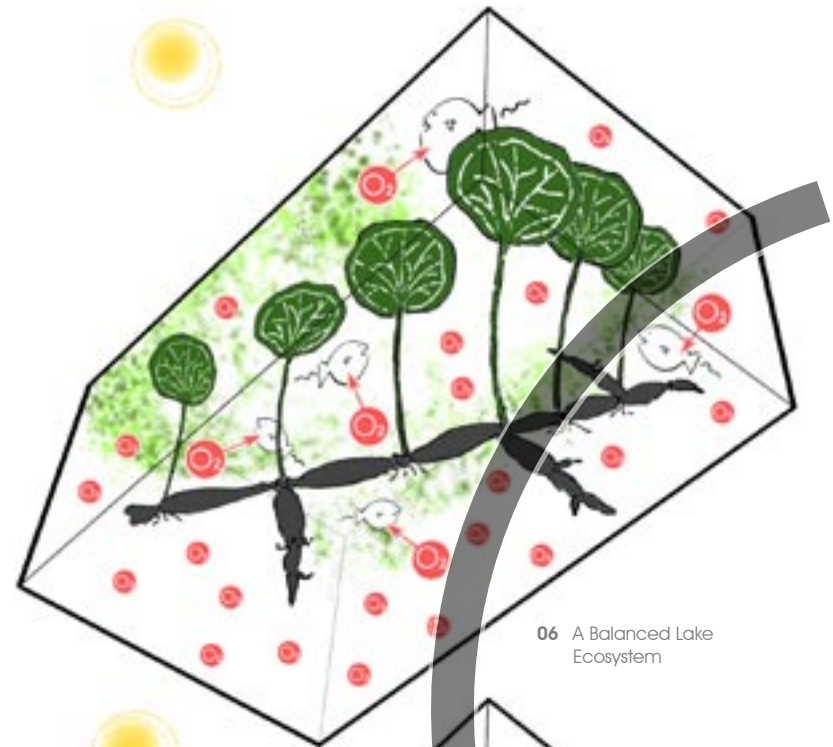
The active management of an ecosystem requires monitoring the conditions of biotic and abiotic elements in order for adjustments to be carried out in time before system collapses. The following illustrates a common scenario leading to a collapse if an ecosystem is left unmanaged.

1.

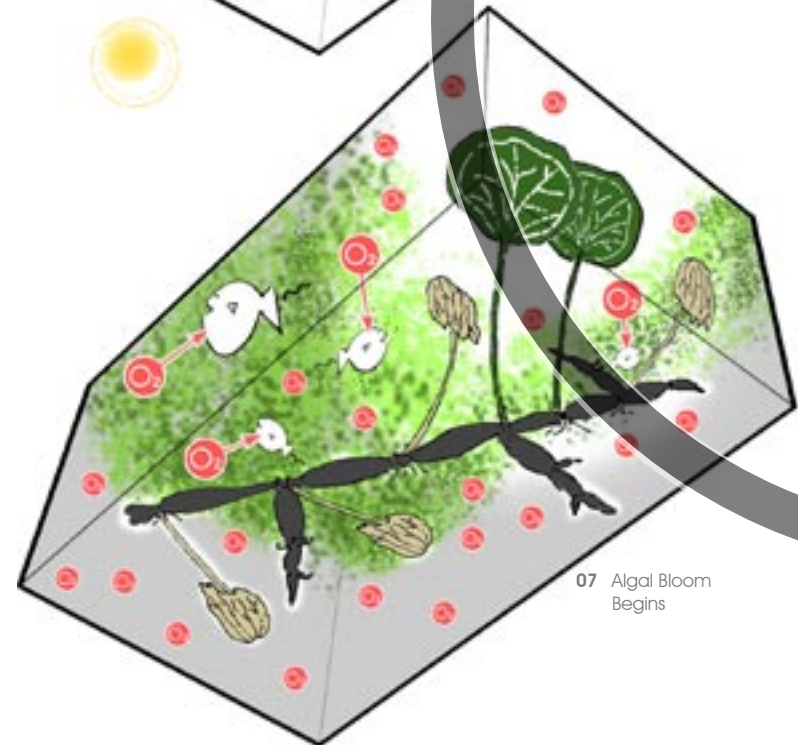
A functioning lake ecosystem should contain various water plants, a healthy population of fish, microbes, zoo planktons, and phytoplanktons, which includes algae. The balance of the ecosystem is often disrupted when algae start to rapidly expand its population due to excessive sunlight and the addition of phosphate and nitrate from waste water.<sup>8</sup>

2.

Stimulated by intense sunlight and rich nutrients from waste water, algae can rapidly reproduce by cell division. The phenomenon is not rare amongst single cell organisms but what is unique to algae is their ability to produce energy necessary for reproduction through photosynthesis. The simple formula of speed and energy efficiency assures their dominance before water plants can grow to competitive quantities. As the expansion continues, algae take over a huge area of the water surface, blocking out sun light for other water plants and causing their eventual death.<sup>9</sup>

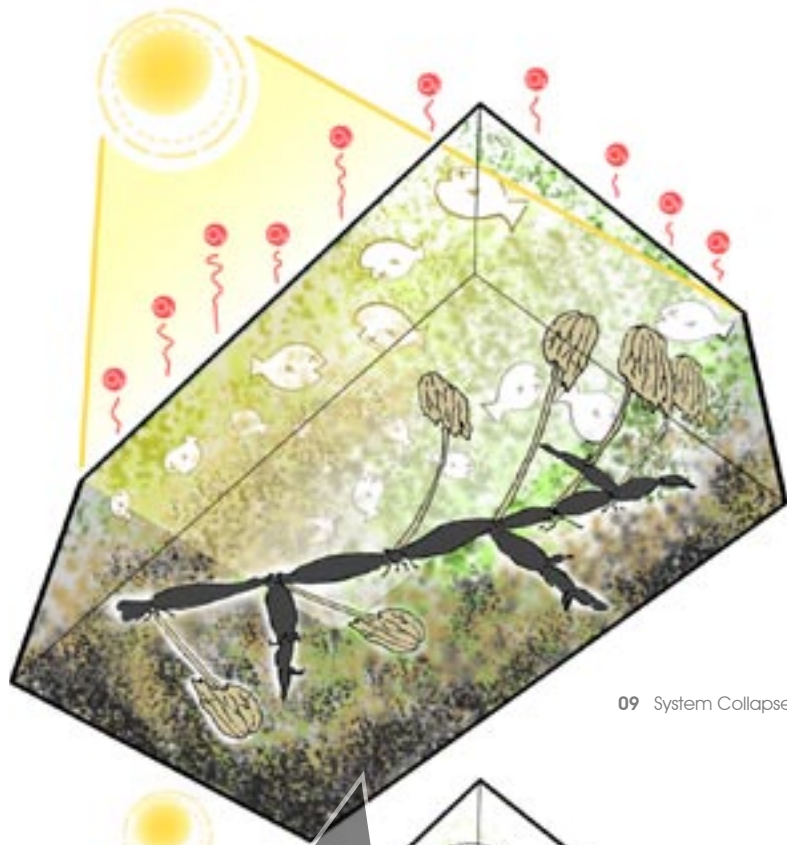


06 A Balanced Lake Ecosystem



07 Algal Bloom Begins





09 System Collapses



08 Massive Algae Decomposition Deprives Oxygen

## 4.

The situation reaches its worst when the temperature of the water rises to its highest under the summer sun. As the temperature rises, oxygen escapes the water, leaving even less dissolved oxygen for the fish. This phenomenon is known as summer fish kill.<sup>11</sup> At this point, the intense sunlight will cause a full algal bloom over the entire water surface, killing off the rest of the surviving water plants. The entire system collapses. A small window for replenishment will occur at the start of winter. When the sun is weaker, the algae will clear off the surface of the water, making it possible for water plants to slowly grow back. However, the system will collapse again the next summer as long as excess phosphates and nitrates are introduced.

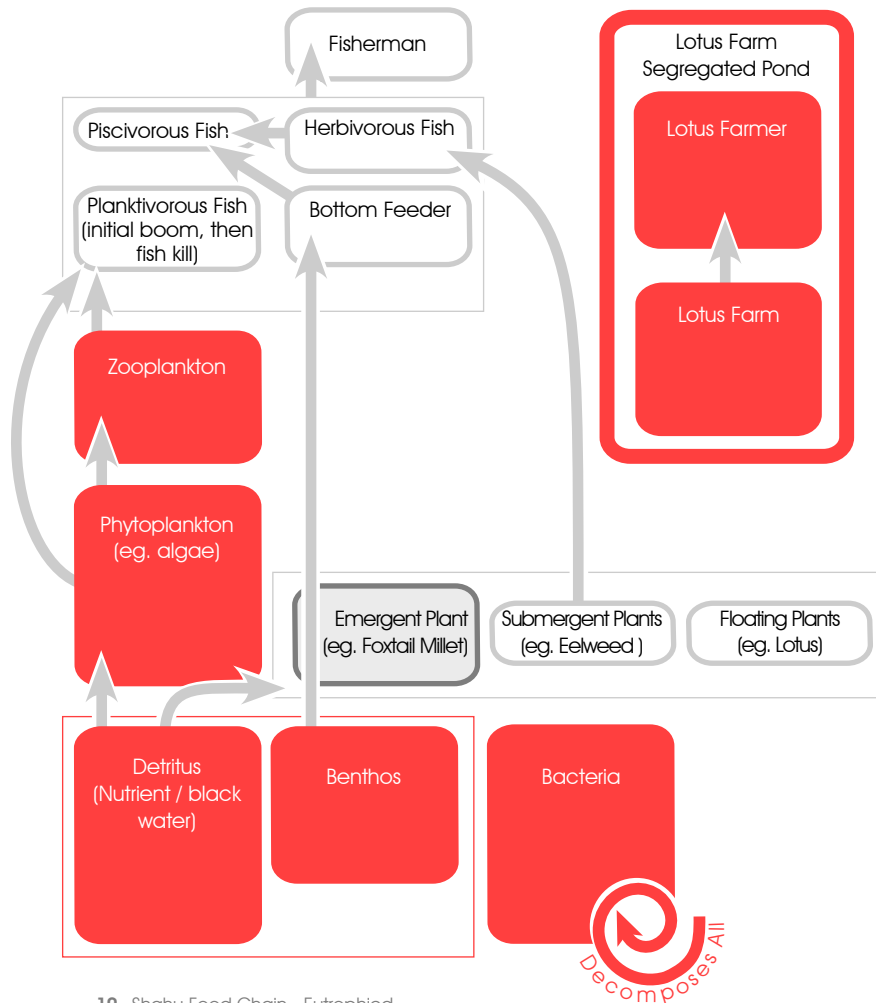
## 3.

The life expectancy for a single cell of algae is one to two days. When dead algae start to decompose at the bottom of the lake, the bacterial population booms, resulting in rapid consumption of the water's scarce dissolved oxygen. The phenomenon leaves fish suffocating. Many fish are forced to the surface of the water where they become easy prey for their predators, but more simply die from the lack of oxygen.<sup>10</sup>

## Managing the Food Chain

Because the changes brought on by the new infrastructures could be unpredictable, the ecosystem of the lake will have to be designed with a flexible coping mechanism that responds to most changes in the food chain.

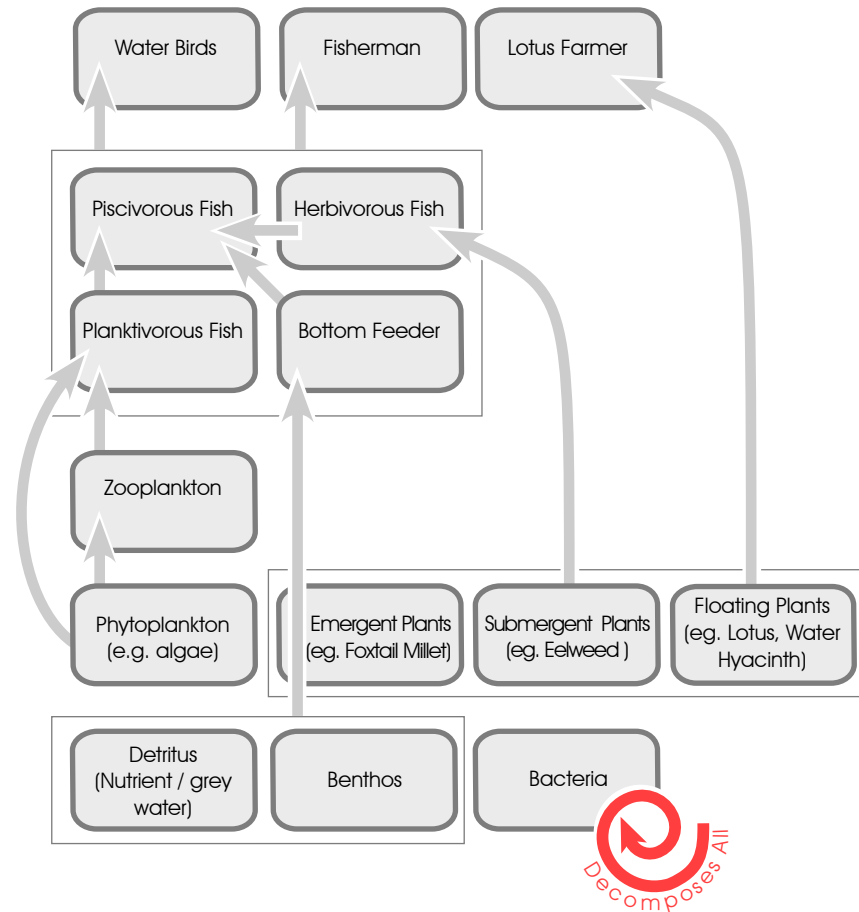
The food chain to the left is Lake Shahu in an eutrophied condition. As illustrated in figure 06-09, the disappearance of dissolved oxygen content eventually leads to summer fish kill. Theoretically, the introduction of the pro-



10 Shahu Food Chain - Eutrophied.

posed infrastructures will bring the ecosystem into a temporary state of equilibrium. This, however, is a very fragile balance. Any of the elements could be affected by change in the other or by unforeseen external forces.

The third food chain illustrates a sample scenario where the Land Over Water system discourages the growth of algae and submergent plants. This might cause the herbivorous and planktivorous fish population to experience some set

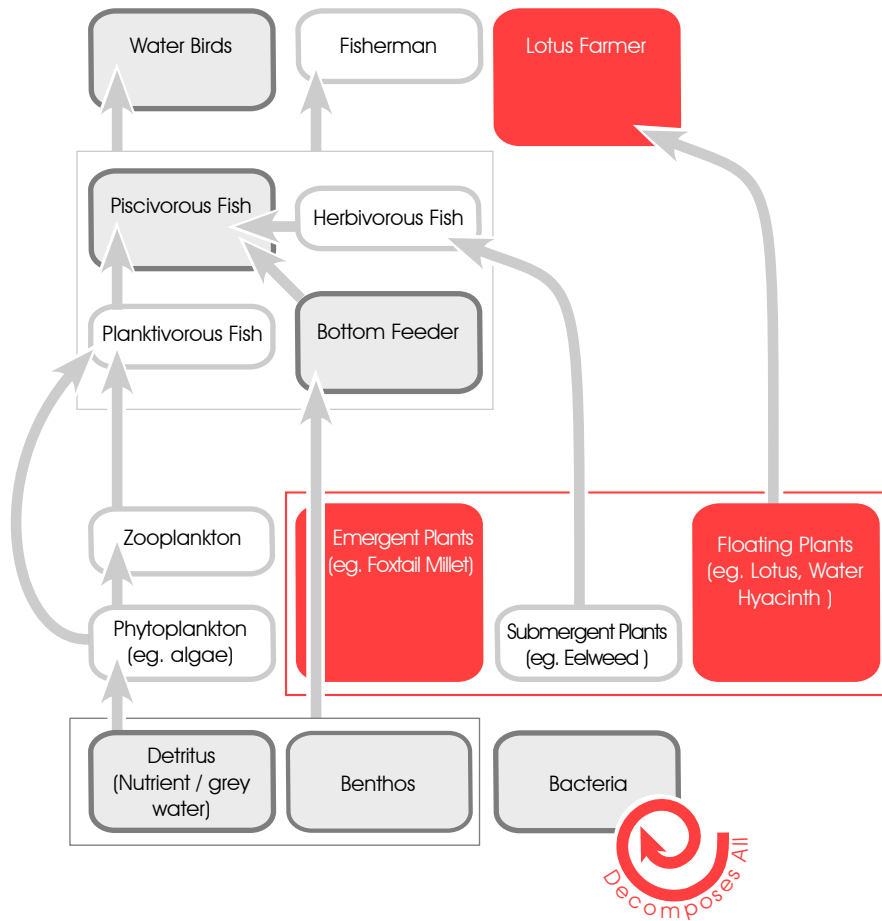


11 Shahu Food Chain - Equilibrium.

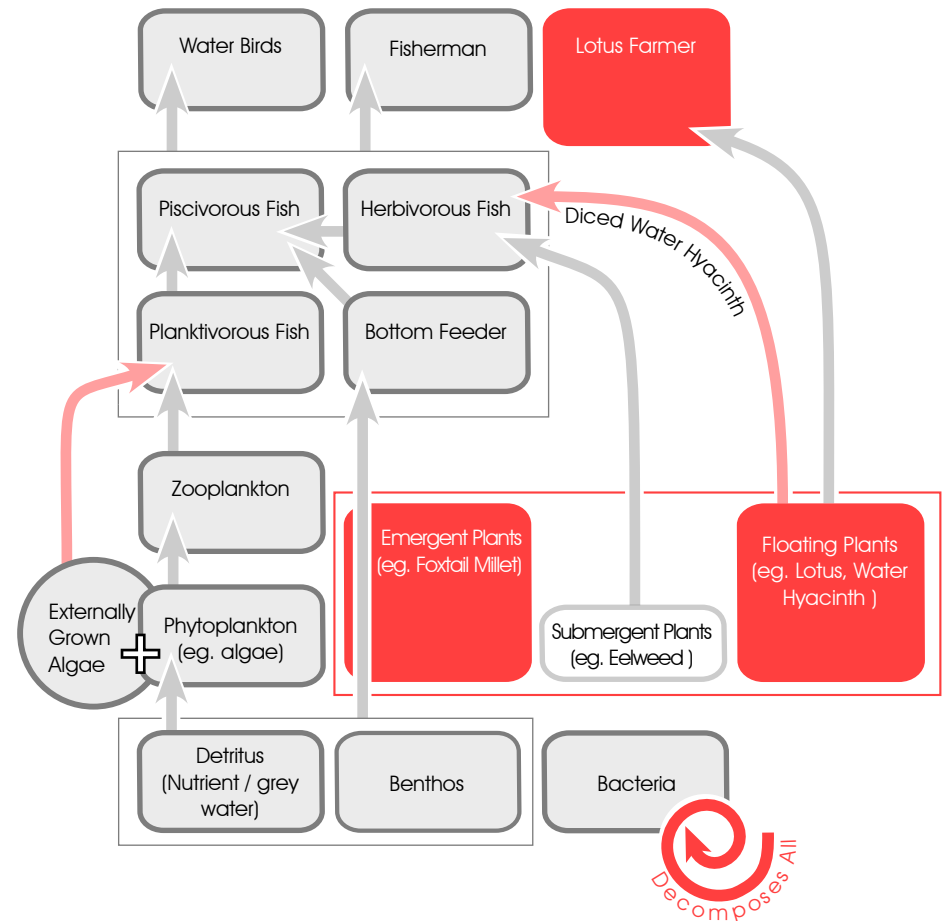
back. Farmers and fishermen will work with the experts from the Department of Aquatic Ecosystem from the National Academy of Science in Wuhan to monitor the lake and make adjustments. The situation can be remedied with the growth of water hyacinth, alligator weed and water cabbage in the lotus farms along shore. These plants are originally indigestible by fish but can be fed to fish once processed into small pieces.<sup>12</sup> As for planktivorous fish, algae can be easily acquired

from the excess found in suburban fish farms or can be easily grown in tanks. The fishermen and farmers in this case, become the stewards of the ecosystem, monitoring and adjusting the ecosystem while making a living.

10-13 Dynamics of Food Chain in Lake Shahu  
 Legend: ■ Surplus   Normal   Diminution ↑ A Feeds B ↑ Supplementary Feed



12 Shahu Food Chain - Reduced Exposure to Sun.



13 Shahu Food Chain - Adjust Input.



## Zooming Out

Among the infrastructures proposed for Lake Shahu, the flood retention has an inherent implication beyond the scale of the particular lake. The network is intended to be a region wide infrastructure, affecting conditions rural to urban. Before going into the details of the integrated infrastructure at Lake Shahu, a return to the regional and city scale is needed to establish a general solution. The following pages will be labelled with a sign indicating its scale in the grand scheme of the proposal.



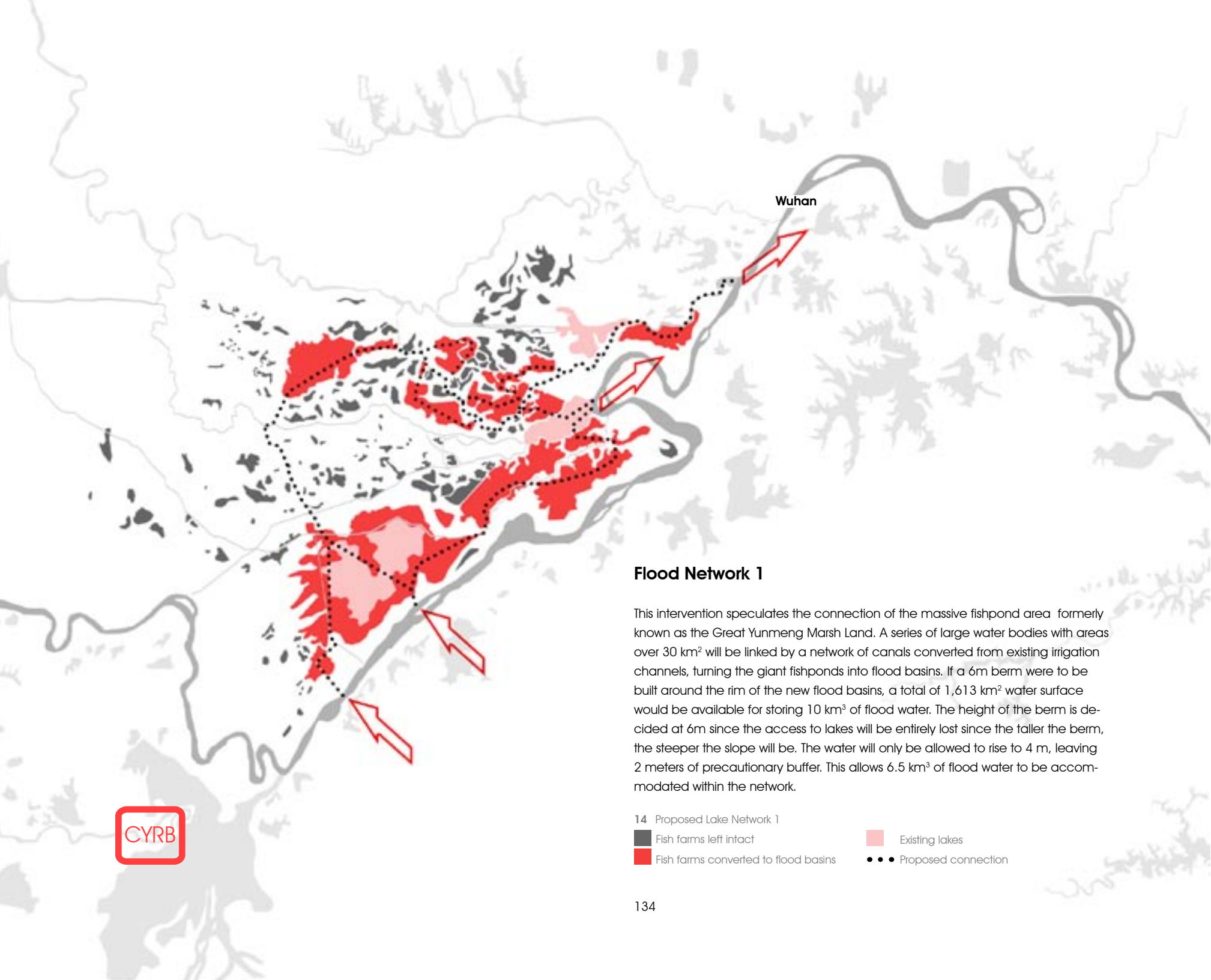
Central Yangtze  
River Basin



City of Wuhan



Lake Shahu



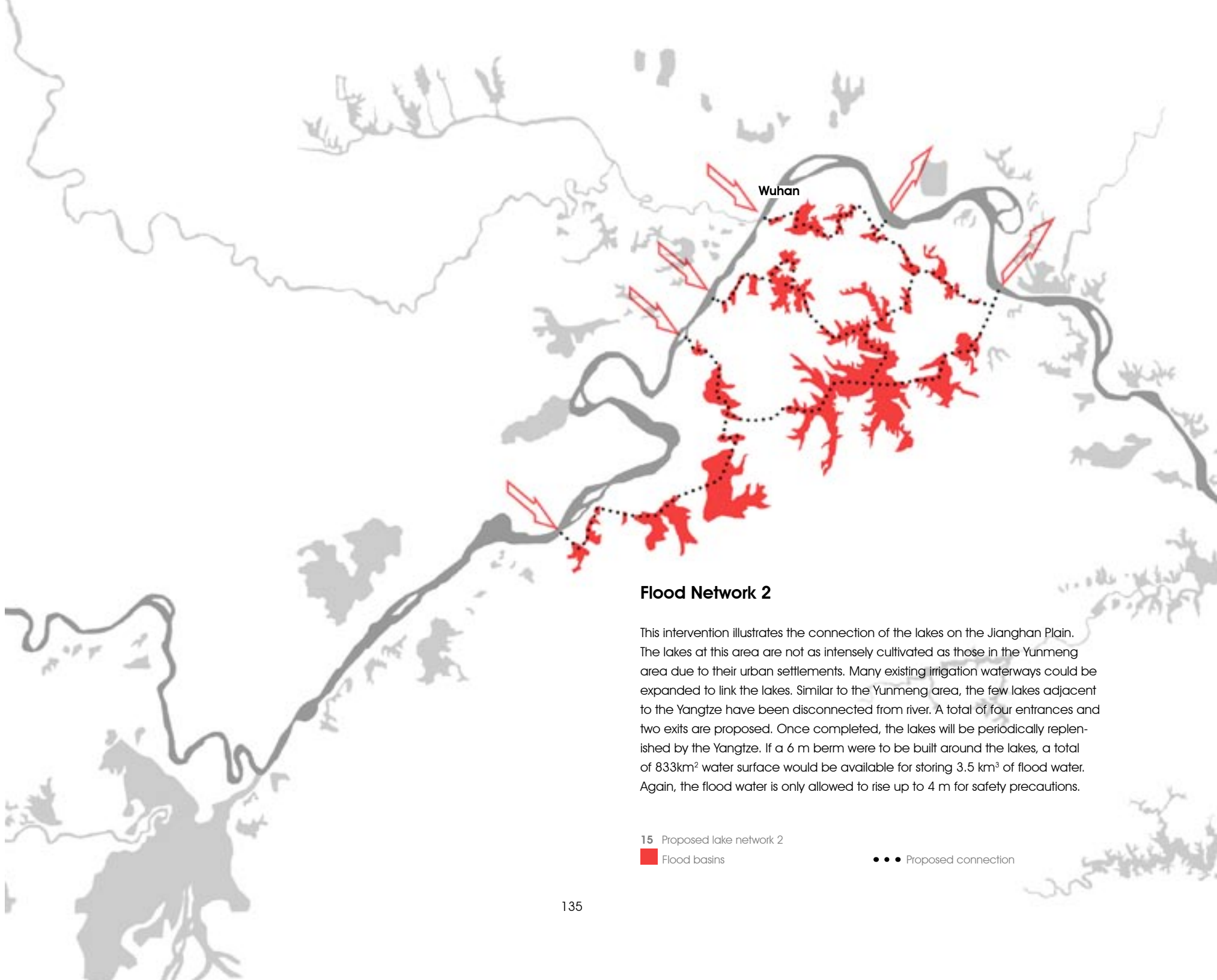
Wuhan

### Flood Network 1

This intervention speculates the connection of the massive fishpond area formerly known as the Great Yunmeng Marsh Land. A series of large water bodies with areas over 30 km<sup>2</sup> will be linked by a network of canals converted from existing irrigation channels, turning the giant fishponds into flood basins. If a 6m berm were to be built around the rim of the new flood basins, a total of 1,613 km<sup>2</sup> water surface would be available for storing 10 km<sup>3</sup> of flood water. The height of the berm is decided at 6m since the access to lakes will be entirely lost since the taller the berm, the steeper the slope will be. The water will only be allowed to rise to 4 m, leaving 2 meters of precautionary buffer. This allows 6.5 km<sup>3</sup> of flood water to be accommodated within the network.



- 14 Proposed Lake Network 1
- Fish farms left intact
- Existing lakes
- Fish farms converted to flood basins
- Proposed connection



### Flood Network 2

This intervention illustrates the connection of the lakes on the Jiangnan Plain. The lakes at this area are not as intensely cultivated as those in the Yunmeng area due to their urban settlements. Many existing irrigation waterways could be expanded to link the lakes. Similar to the Yunmeng area, the few lakes adjacent to the Yangtze have been disconnected from river. A total of four entrances and two exits are proposed. Once completed, the lakes will be periodically replenished by the Yangtze. If a 6 m berm were to be built around the lakes, a total of 833km<sup>2</sup> water surface would be available for storing 3.5 km<sup>3</sup> of flood water. Again, the flood water is only allowed to rise up to 4 m for safety precautions.

15 Proposed lake network 2

■ Flood basins

●●● Proposed connection

## Implications of a Large Scale Network

While reconnecting the lakes in the Yunmeng and Jiangnan region to the Yangtze River helps resolve the issue of flood retention, it is not sufficient. An additional  $8 \text{ km}^3$  of water still has to be displaced. This is however, beyond the capacity of the two proposed networks.

Several complications arise with such massive infrastructural changes. The construction of a continuous flood berm surrounding the lakes will become necessary. To minimize site clearance and population relocation, the berm will have to be built on infill on the lakes. A certain amount of land reclamation is necessary but should be minimized. In situations where the berm traverses through rural lands with few people, site clearance will become permissible, provided that appropriate compensation be made. Before the construction of the berm, future land use should be schematically designed so as to integrate the berm with its context.

The change in lake level will become an issue once reconnected. The lake beds generally sit higher than that of Yangtze's and the average water height of the Yangtze is often lower than that of the lakes. This creates a backwash problem during Yangtze's low water seasons. Devices such as dams with sluice gates should be constructed at the entry and exit points of the reconnection path in order to regulate the water height. The dams will also ensure the water level of the lakes do not exceed the design limits. The reconnection project utilizes the original natural path of Yangtze for flood retention, however, it is not a total restoration to its unregulated natural flow as such lack of control is not an option for the millions of residents nearby.

The proposed solution is a large scale engineering piece that rivals the scale of the Three Gorges Dam but, unlike the Three Gorges, the reconnection aims to restore part of the Yangtze River Basin's natural function instead of transforming it for other uses. It will not only maintain but also improve the ecosystem by promoting the circulation of the water. The overall network will be managed at several entry and exit points, thereby eliminating the risk of a system managed by a single mechanical entity. Necessary site clearance will be minimized and land will be restored once the flood berm is constructed. The precautionary comparison to the Three Gorges Dam project illuminates the vastly different nature of the reconnection project. Although challenging, the studies show that it is nonetheless feasible and sustainable.





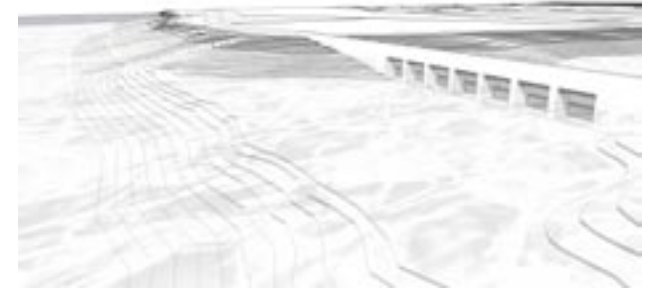


## Reconnection at the City of Wuhan

The reconnection scheme for the city of Wuhan requires management of the seasonal water level and control for extreme water levels. To help accomplish this, a dam crossing over the reconnection canal must be constructed. Sluice gates will be built into the dam. The gates will open and close to regulate the water level of the lakes according to the various scenarios as illustrated in figure 24 - 26.<sup>13</sup>

Minimizing the disruption of the urban population is the deciding factor when siting the reconnection canals. The connection between the Yangtze River and Lake Shahu is sited on land currently occupied by warehouses or land currently unoccupied. All the other connections between lakes are sited on rural areas where population density is low.

The canal and dam will only work when a continuous barrier is constructed around the lakes. The barrier will be in the form of a berm whose soil will come directly from the excavated lake bed. For the construction of the flood berm, some amount of lake infill will be necessary around populated lake shores as illustrated in figure 21. However, the majority of the lakes, including the east side of Lake Donghu and the entire rim of Lake Yanxihu and Lake Yandonghu, are still primarily occupied by farmlands and fishponds. Eventually, the berm will either become land for housing or agriculture.



17 Proposed Sluice Gate at the Connection Between Lake Shahu and Yangtze.



Scale 1:1,000

18 Before Construction of the Flood Wall Along Yangtze: settlement around the lakes was only possible above flood.



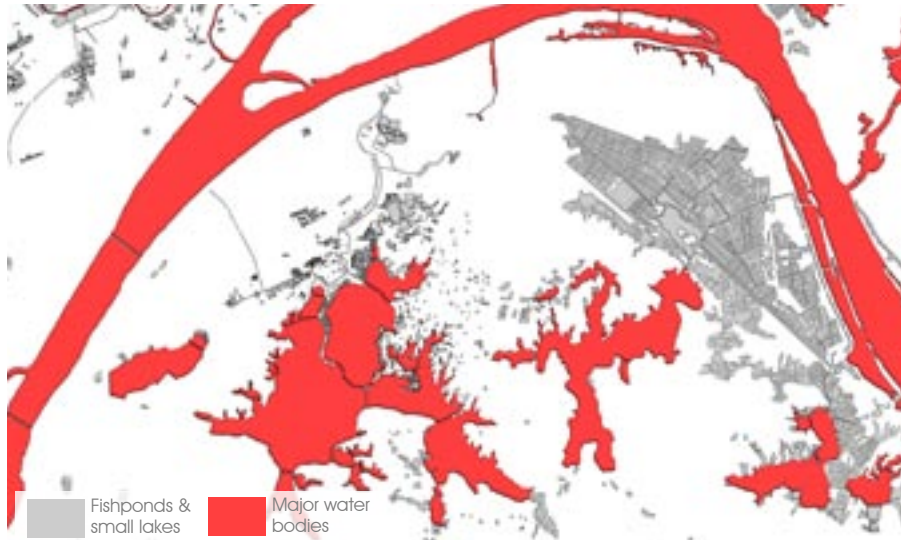
19 After the Construction of the Flood Wall Along Yangtze: land reclamation around the lake began.



20 The Proposed Reconnection with Yangtze: enables the retention of flood but inundate settlements.

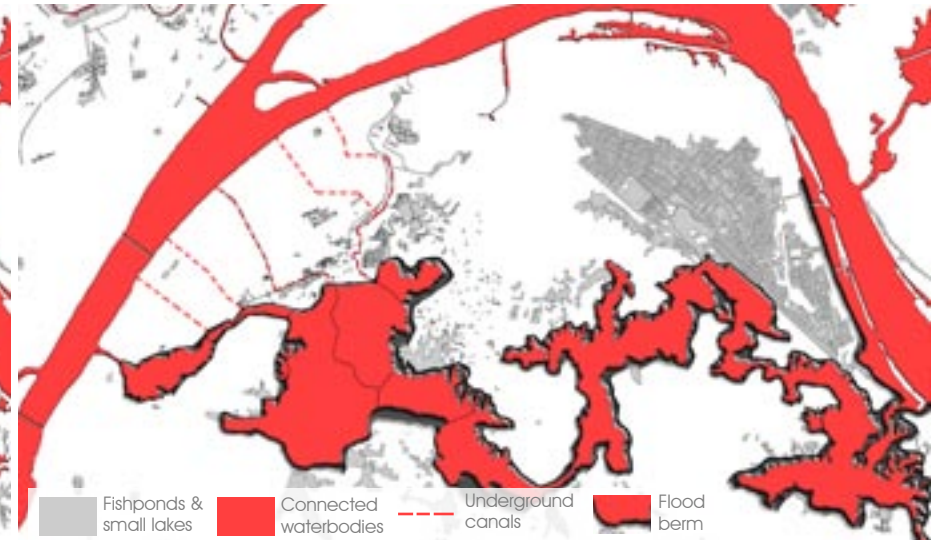


21 New Flood Berm: to be constructed so that all settlements will be protected during flood.

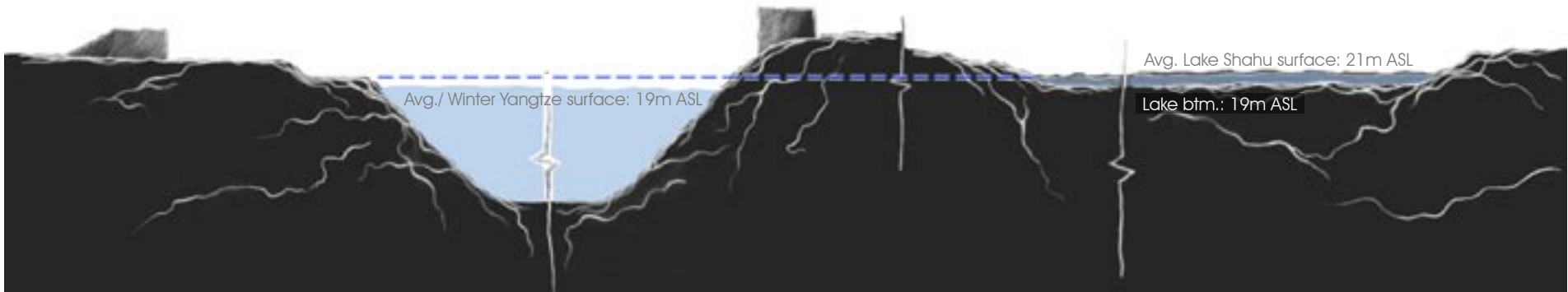


Scale 1:100,000

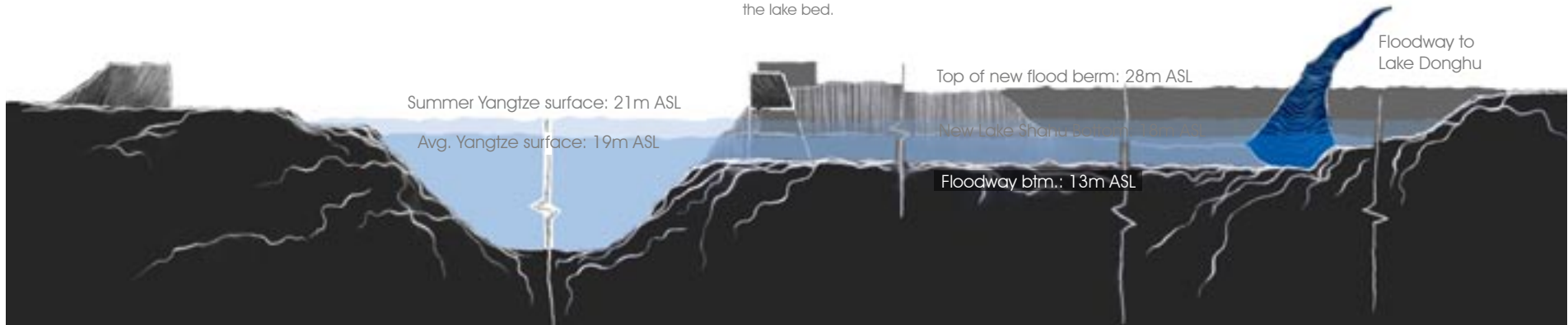
22 Disconnected Lakes: the four large lakes are disconnected from each other. Although they do serve as storm water retention ponds, they do not help alleviate the flood volume from the Yangtze.



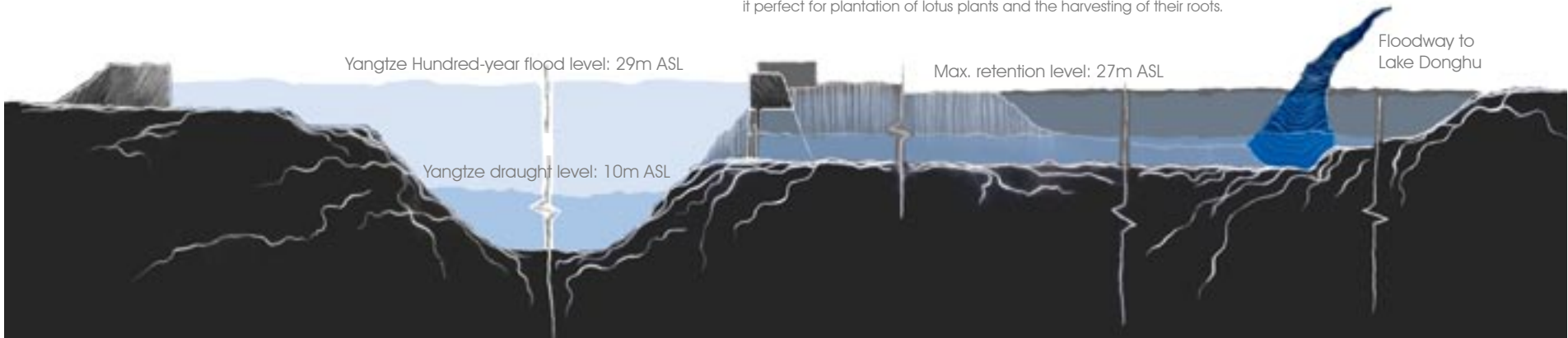
23 New Flood Network: proposal shows reconnection of the lakes and the construction of a continuous flood berm around them to form a flood retention network. Influx is controlled by one major canal and five additional underground lines.



**24** Water Level Before Reconnection: The bottom of lake Shahu and the average Yangtze water surface are about the same level. This means the reconnection between the two entities will turn the entire lake into a wetland during winter and deprive many aquatic organisms of their habitats. Therefore, the reconnection will required 2 m of excavation of the lake bed.



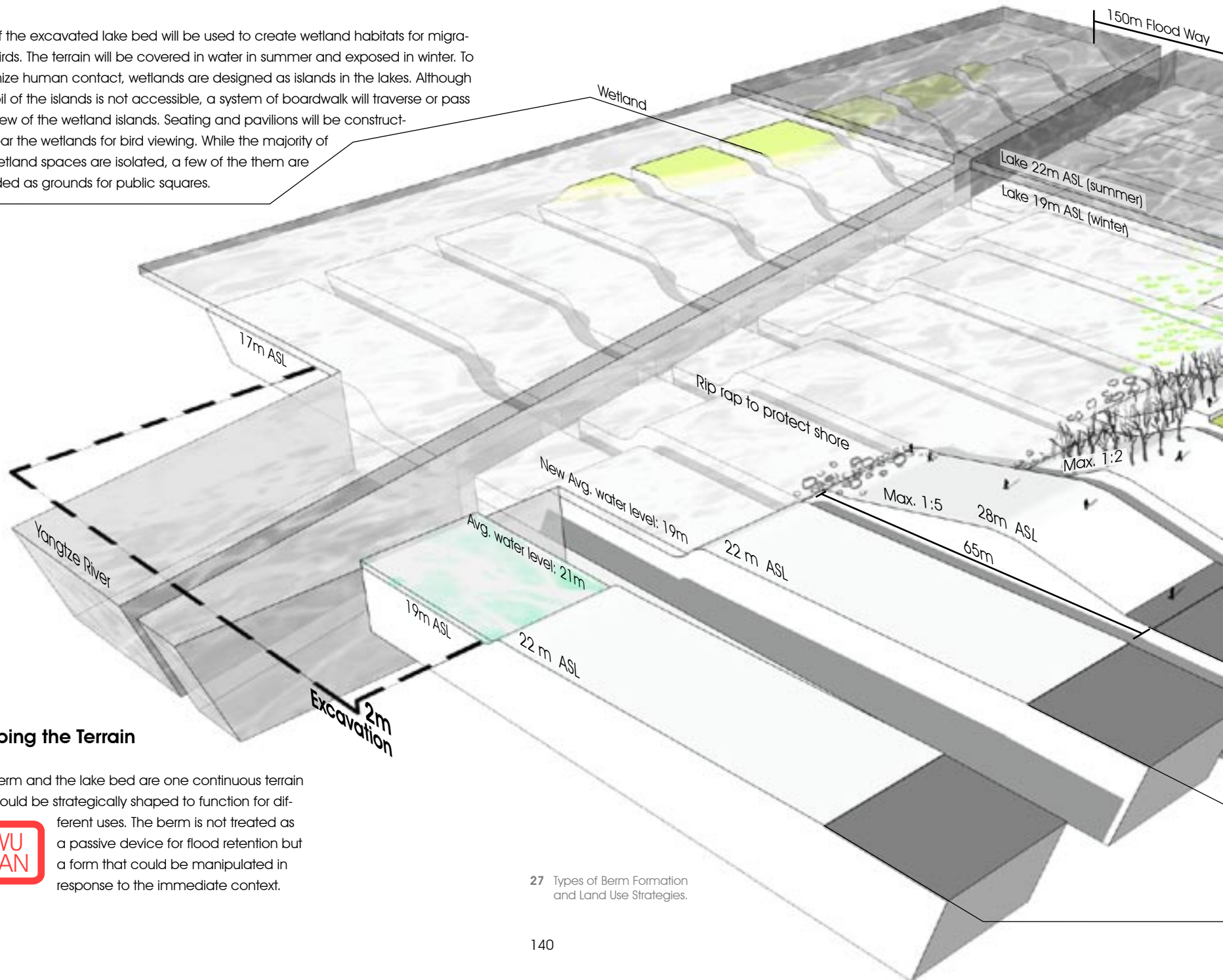
**25** Seasonal Water Levels: The seasonal water level will be regulated by the sluice gate so that the lake level will remain at 21m during summer and 19m during winter. This expose the shallower areas at the rim of the lakes during winter, making it perfect for plantation of lotus plants and the harvesting of their roots.



**26** Extreme Water Levels: During the most severe draught, the Yangtze drops to 10M ASL. The sluice gate then will have to be closed in order to retain the lake water. On the other hand, the gates will be opened to retain the water from Yangtze during flood. The influx will be maintained so that the maximum flood level within the lakes will not exceed 27m ASL.



Part of the excavated lake bed will be used to create wetland habitats for migratory birds. The terrain will be covered in water in summer and exposed in winter. To minimize human contact, wetlands are designed as islands in the lakes. Although the soil of the islands is not accessible, a system of boardwalk will traverse or pass by a few of the wetland islands. Seating and pavilions will be constructed near the wetlands for bird viewing. While the majority of the wetland spaces are isolated, a few of them are intended as grounds for public squares.

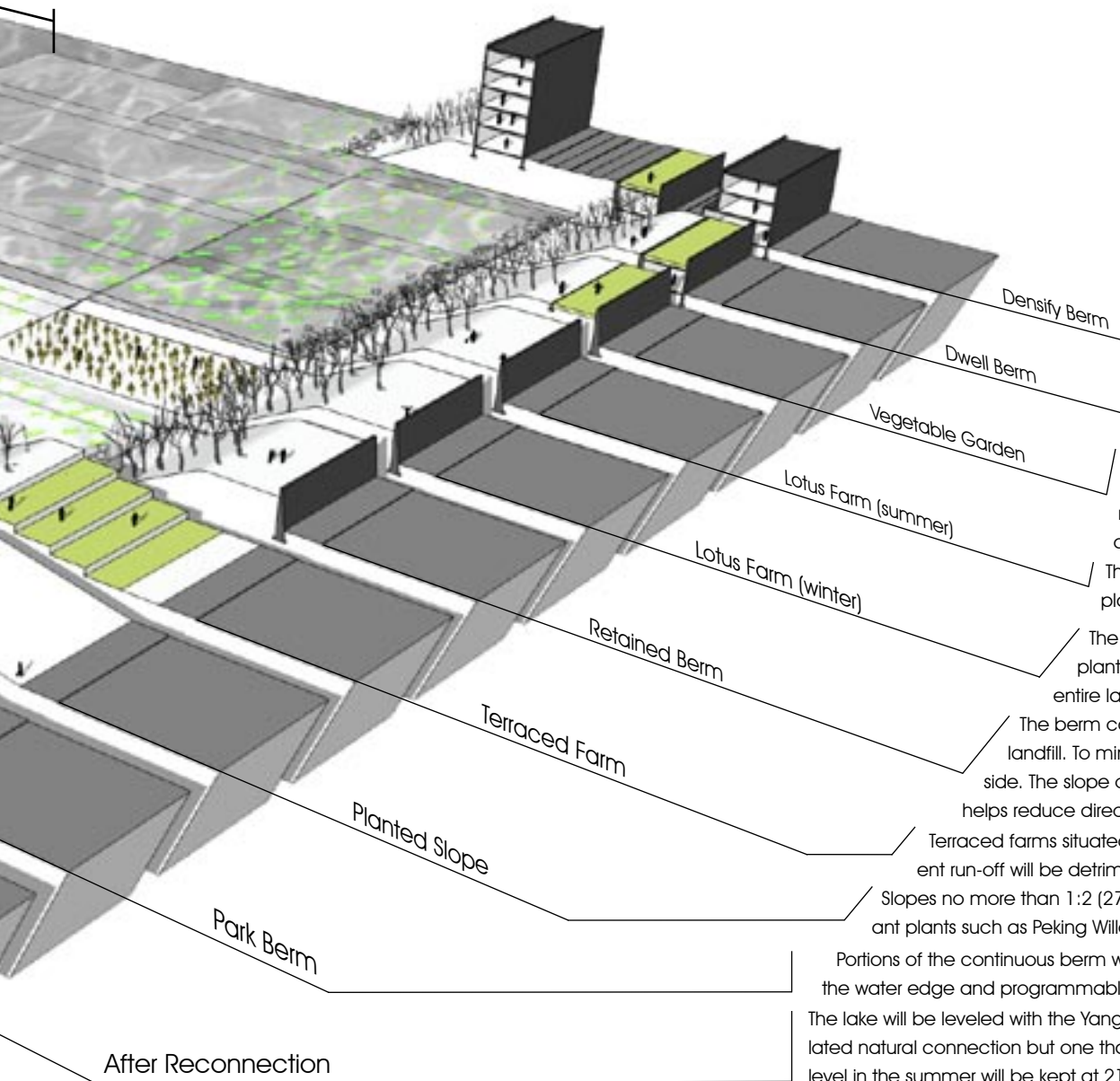


### Shaping the Terrain

The berm and the lake bed are one continuous terrain that could be strategically shaped to function for different uses. The berm is not treated as a passive device for flood retention but a form that could be manipulated in response to the immediate context.



27 Types of Berm Formation and Land Use Strategies.



To design the berm as an uninhabited strip of park land without housing is wasteful space planning considering the housing pressure in the city. It is also vital that the city fabric be extended to the edge of the lake so that the activities at the lakes could be supported by the amenities at its perimeter. Access to the lake is most effective when the berm is imprinted with an urban fabric made of small blocks as it encourages the establishment of commerce and public life.

Space can be reclaimed from the berm to create habitable volumes. Its unfavorable day lighting condition suggests it be used for commercial rather than residential.

The old vegetable plots along the lake edges, as wonderful as they are, contributes agricultural run-off to the lake. The plots can be relocated to the top of the berm and the run-off can be buffered with a planted slope.

The lake bed by the foot of the berm is deep enough so that lotus plants can be cultivated in the summer.

The land is shaped so that the water level will retreat to expose the lotus plants in winter. This enables the harvest of lotus roots without dredging the entire lake as it is currently practiced.

The berm can take up a large amount of space and intrude upon the lake as landfill. To minimize infill, the berm often has to be retained by a wall on the city side. The slope on the lake side is not to be retained by walls since the planted slope helps reduce direct storm water run-off into the lakes.

Terraced farms situated in the rural areas should not be placed on the lake side since nutrient run-off will be detrimental to the lake ecology.

Slopes no more than 1:2 (27°) are designed to buffer nutrient and storm water run-off. Flood tolerant plants such as Peking Willow and Bishop Wood will be the primary vegetation types planted.

Portions of the continuous berm will become park land. Gentle slopes (1:5) will provide easy access to the water edge and programmable space.

The lake will be leveled with the Yangtze once reconnection is completed. This does not mean an unregulated natural connection but one that could be managed by a series of sluice gates if necessary. The lake level in the summer will be kept at 21 m ASL so to ensure accessibility to the water edges and to provide appropriate water depth for lotus plants growing around the rim of the lakes. Lake water is allowed to rise above 21 m ASL only when flood diversion is needed.

Lakes are isolated entities regulated by small sluice gates to control water height. Land around the lakes are occupied by residential buildings built close to the water level.

## Transformation - Current Condition

The lake is now surrounded by residential areas of different densities as well as open land. In order to minimize the disruption to the population during the construction of the flood network, the path of the new canals will avoid high density zones. Present site conditions along the reconnection path are:

1. Fourth Cotton Factory of Wuhan
2. Land cleared for development
3. Car dealer parking lot
4. Lotus pond
5. Gated high rise development
6. Land cleared for development

Of the six areas, area 5 contains residential development. The estimated population to be relocated for this segment of the canal is 2,000 people. The land between area 6 and Lake Donghu used to be the old waterway connection between Lake Shahu and Lake Donghu. The waterway was converted into fish farms decades ago but it stands as empty landfill now.



### Transformation - Phase 1 (completed by year 4, duration 3 years)

The first phase begins with excavation of the floodway. A temporary earth dam will be built to enclose the floodway while excavating. Before draining of the enclosure, fish from the future floodway will be captured and released into the adjacent open water. The excavation will head towards the direction of the Yangtze and Lake Donghu.

The top 60 cm of the excavated soil will be transported off site for treatments, the remainder will be piled up against a continuous retaining structure to form the flood berm. Temporary dykes constructed from the excavated soil will provide surface for soil transportation. The dykes are in the form of small peninsulas that also help store soil during transportation.

When excavation of phase one is complete, the floodway will be reintroduced with water plants and microorganisms from Lake Donghu in order to speed up its rejuvenation process.



## Transformation - Phase 2 (completed by year 5, duration 1 year)

Excavation for the rest of the flood plain proceeds around temporary transportation dykes. Before excavating each area, fish will be captured and released into the new floodway.

Excavated soil will be used to construct the berm. Until portions of the berm reach desired height and contaminated soil can be piled onto the top for treatment, the dirty soil will remain in temporary storage on site. Contaminated mud will first

be mixed with green manure to increase rigidity then it will be shaped into raised beds, a common gardening technique used to form uncompacted soil beds with increased aeration and nutrient flow.<sup>14</sup> Local farmers then will be hired to phytoremediate the soil by planting vegetables. The increased aeration in loose soil will speed up the aerobic process in the treatment and the vegetables will help extract toxins and excess nutrients.<sup>15</sup>



30 Raised Bed Vegetable Plots at the Top of the Berm.



31 Transformation Phase 2



### Transformation - Phase 3 (completed by year 15, duration 10 year)

Excavation continues around the remaining temporary dykes, following a similar process to phase 2. When the berm is completed, a ten-year waiting period is necessary before any development can take place on the berm, to allow the soil to settle and be treated. In the mean time, the slope of the berm will be planted with saplings of flood tolerant plants.

The produce from the raised bed vegetables plots will become marketable when treatment is completed. The farmers will continue to cultivate the land in the ten year period.

Once the shallow water areas around the shore can support water plants and other organisms, lotus farms will be allowed these places. Development

around the retaining structure can take place at the completion of the berm.

At the end of the 15th year, the flood gate at the confluence of the Yangtze River and Lake Shahu will also be finished. Some of the temporary transportation dykes will be left behind as permanent wetlands.



## Transformation - Phase 4 (completed by year 20, duration 5 years)

Fifteen years after the initiation of the landscape transformation, the soil will be treated and settled. The city extension over the lake can now begin.

The city extension will begin on the berm. This lays down an urban fabric which will eventually connect with the Land Over Water project. In the mean time, the construction of new bridges connecting existing

roads on opposite sides of the shore will begin to define the spatiality of the extension. Design and planning process of Land Over Water begins.

The farmers treating the soil will now have the option to work in the lotus farms or as fishermen. The ecosystem of the lake will depend on the active management by the farmers and fishermen. The only

vegetable plots remained will be the top of the retaining structure. They will be planted and cared for by residents in the area who desire gardening space.



### Transformation - Phase 5 (completed by year 25, duration 5 years)

As the design details for Land Over Water units are finished, the first wave of LOW construction will begin. The construction begins along the main lines, expanding outwards from the shore. Upon completion of each LOW unit, construction of buildings on each unit may commence.



## Transformation - Phase 6 (completed by year 30, duration 5 years)

Construction of Land Over Water units continues and merge with each other from different directions. This stage reveals strategically placed open areas for wetlands, ferry routes, and floodway.



**Transformation - Phase 7 (completed by year 35, duration 5 years )**

The Land Over Water network will be completed at the end of this phase. The image is only a schematic representation of LOW. A detailed design of thirty two LOW units will demonstrate strategic openings in relation to building height which are not represented below.

Construction of the boardwalk system will begin with the completion of LOW since the path of the

boardwalk will have to negotiated between the structures of LOW. Stair cases that connect LOW to the boardwalk will be strategically located to allow access to water and points of passage for boats.

**Detailed Study Area**

The process of transformation shows a general strategy for the development of the berm and LOW. Details of the various infrastructural components were developed for the south side of the lake.



## Infrastructural Components

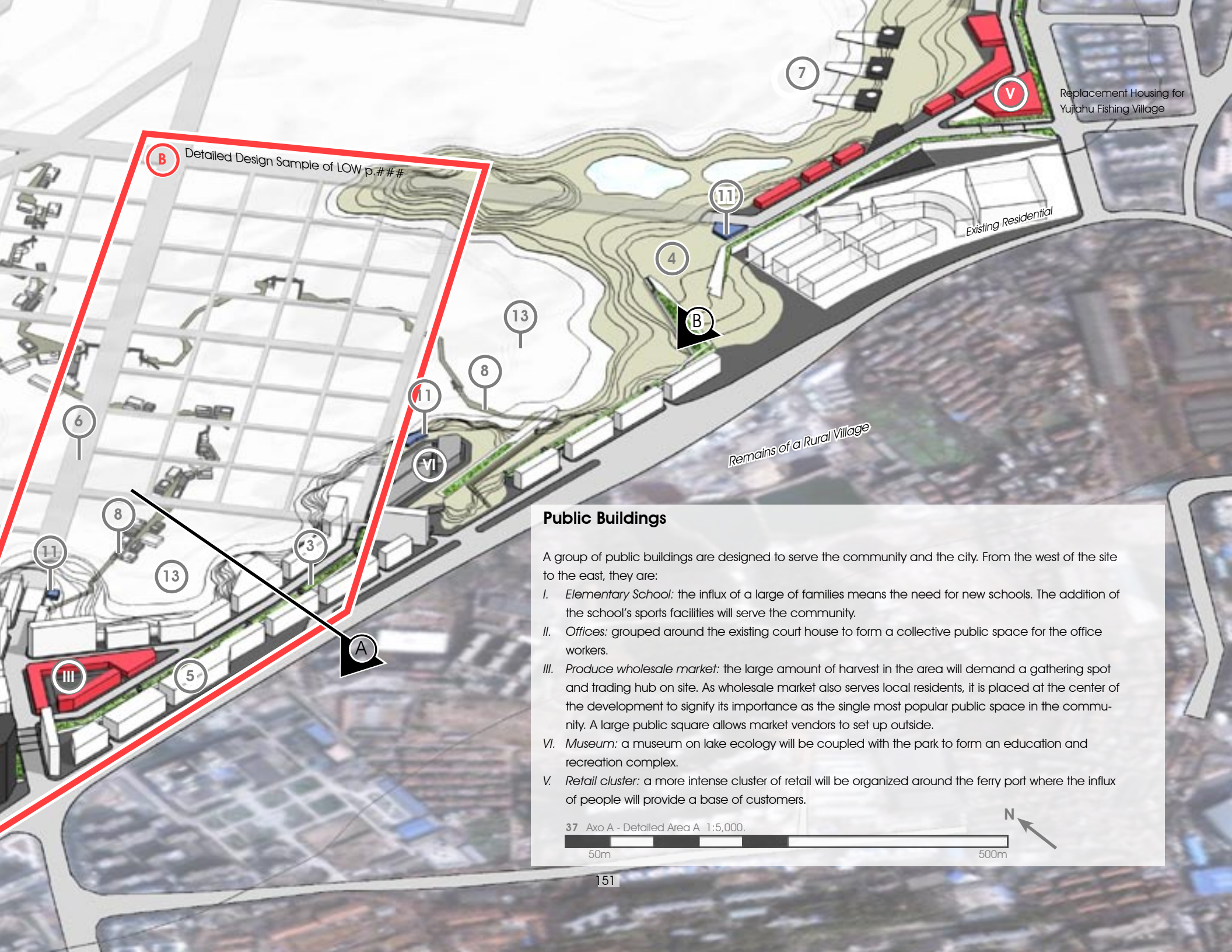
The South side of the lake was developed to illustrate detailed planning of the berm. Infrastructural components included are:

1. *Flood Berm*: the top of the berm is 6 m above the shoreline. It will be constructed from excavated soil of the lake bed and future canal paths. The structure slopes towards the lake but is retained on the city side.
2. *Retaining Bar*: the retaining structure contains a continuous inhabitable volume for commercial or residential use. Numerous and frequent stairs along the retaining bar will provide access over the berm.
3. *Vegetable Plots on Retaining Bar*: these vegetable plots will serve as a reminder of the phytoremediation raised beds. They public gardens for residents in the area rather than commercial agricultural grounds.
4. *Park*: makes the presence of the lake known as well as provides access to the lake. By juxtaposing a recreational area against lotus farms and wetlands, the public will become more aware of the workings of the environment.
5. *Development on and around berm*: creates a continuous urban fabric that eventually extends to LOW. It also provides grounds for larger institutions, cultural facilities, wholesale markets and office towers that required larger land area.
6. *Land Over Water (LOW)*: extension of the city that serves as traffic network and inhabitable land at the same time. The structure shades the lake below to improve humidity content in micro climate and deters algal growth by reducing excessive sunlight.
7. *Ferry Ports*: needed to transport people between opposites sides of the shore. They will form a ferry network across all lakes in Wuchang, relieving communication and transportation pressure in parts of the city.
8. *Boardwalk* : floating structures that traverse the lake surface. A commercial path sets out near the produce wholesale market and a recreational path sets out from the park. The two paths converge at the wetland and diverge onto paths that lead to the shore across. Staircases from the boardwalk to LOW will become points of passage for fishing and recreational boats.
9. *Wetland*: is created from the remains of the temporary transportation dykes constructed during excavation work. The wetlands are islands in the lake. Two large ones will become accessible via the boardwalk system while the remainder will be undisturbed sanctuaries for migrant birds and other wildlife.

SHA  
HU

A

Existing Municipal  
Court



**B** Detailed Design Sample of LOW p.###

Replacement Housing for Yujiahu Fishing Village

Existing Residential

Remains of a Rural Village

### Public Buildings

A group of public buildings are designed to serve the community and the city. From the west of the site to the east, they are:

- I. *Elementary School*: the influx of a large of families means the need for new schools. The addition of the school's sports facilities will serve the community.
- II. *Offices*: grouped around the existing court house to form a collective public space for the office workers.
- III. *Produce wholesale market*: the large amount of harvest in the area will demand a gathering spot and trading hub on site. As wholesale market also serves local residents, it is placed at the center of the development to signify its importance as the single most popular public space in the community. A large public square allows market vendors to set up outside.
- VI. *Museum*: a museum on lake ecology will be coupled with the park to form an education and recreation complex.
- V. *Retail cluster*: a more intense cluster of retail will be organized around the ferry port where the influx of people will provide a base of customers.

37 Axo A - Detailed Area A 1:5,000.

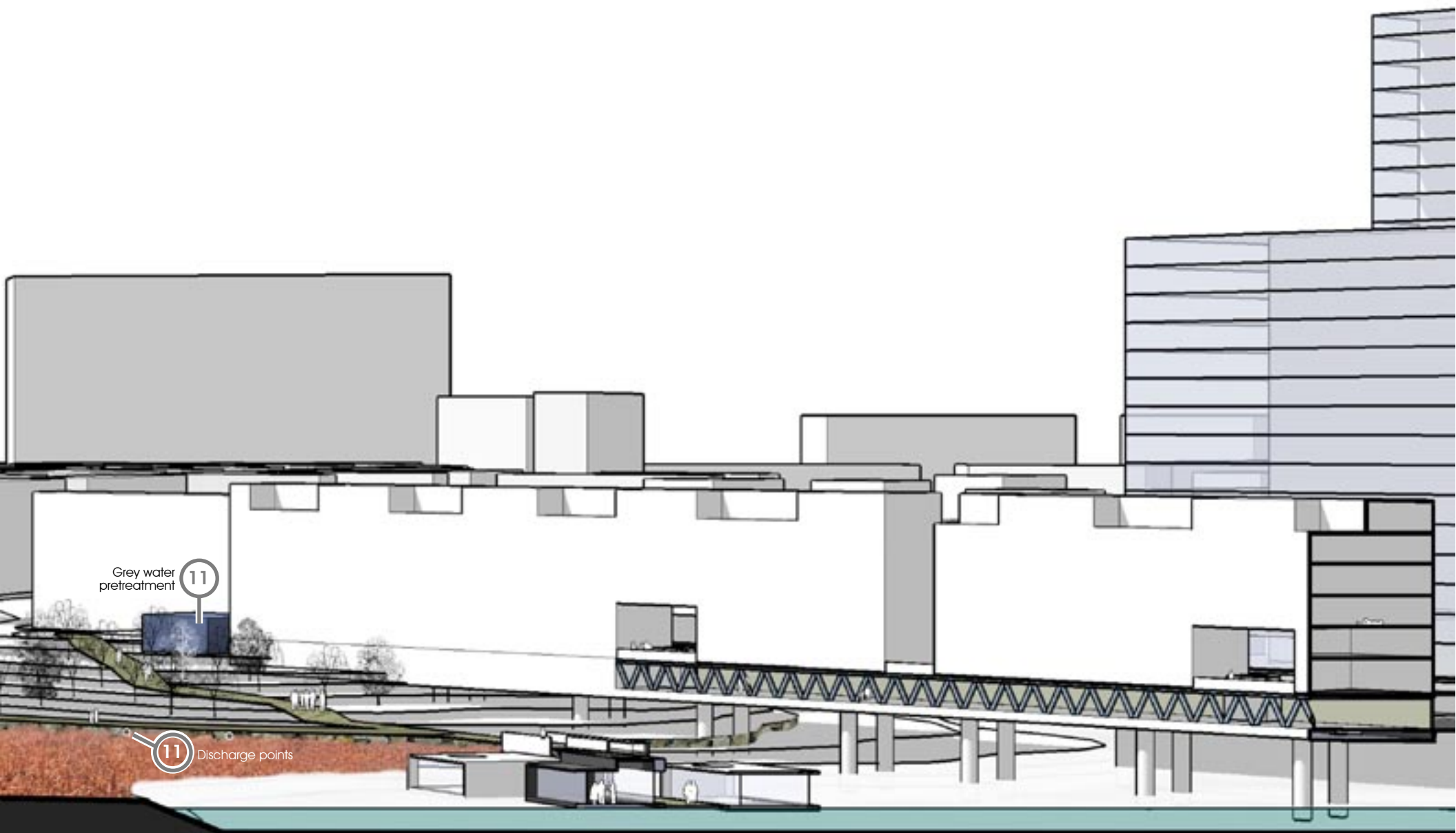


## Infrastructural Components - Continued

10. *Planted Slope*: buffers run off from the berm. Flood tolerant vegetation is selected to accommodate the lake's function as a flood retention pond for the Yangtze.
11. *Grey Water System*: separated from the conduits of storm water and black water. The conduits will run underground and under the road ways of LOW. The conduits will eventually lead to small filtration facilities around the lotus farms to remove grease and other waste before discharging into the lake.
12. *Lotus Farm*: organized as individual entities enclosed in inlets. The farms will feed from the grey water of the surrounding neighbourhoods. The bottom of the farms are higher than the rest of the lake so that natural drainage will occur in the winter, exposing the land for harvesting.
13. *Green Roofs*: retain water thus reducing direct run-off into the lake.

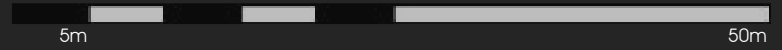






Grey water pretreatment 11

11 Discharge points



## Density, Housing Type and Public Space of Sample Berm Development

Residential development on the berm consists mostly of six-storey apartments ten meter deep. Because these buildings do not have to be serviced by elevators, a two-unit-per-floor-per-staircase structure is designed to eliminate corridors, thus encouraging cross ventilation in a hot and humid climate. This strategy was common in South China but the modern demand for high rise apartments and the proliferation of air conditioners makes it a rare design feature in the present-day housing market.

High rise buildings are placed at the corner of blocks, taking advantage of the width of the adjacent roads which can accommodate longer shadow. A few eleven storey building can be placed close to the edge of the slope but they should not

cast long shadows onto the lotus farms below. Two twenty-two storey apartments are planned for the site. They are placed at the bottom of the berm and on the west side so as to avoid blocking off desirable east and south light for the other apartments.





The volume in the retaining bar has a higher ceiling but less natural illumination and ventilation due to its abutment to the berm. This particular condition makes them more suitable for commercial use.

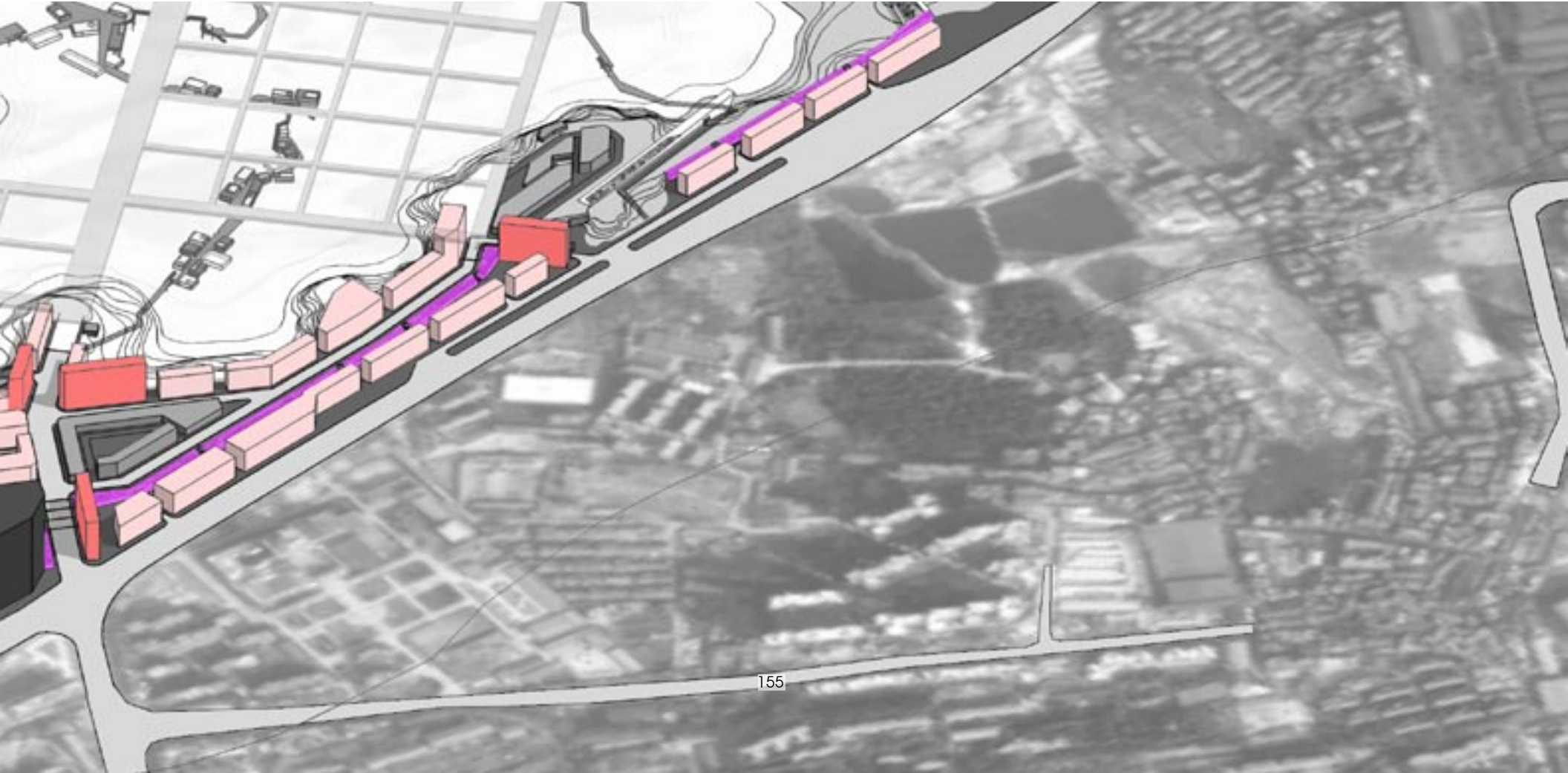
Small public spaces can be found between the buildings. These seemingly insignificant spaces are seen as social spaces for senior citizens and children.

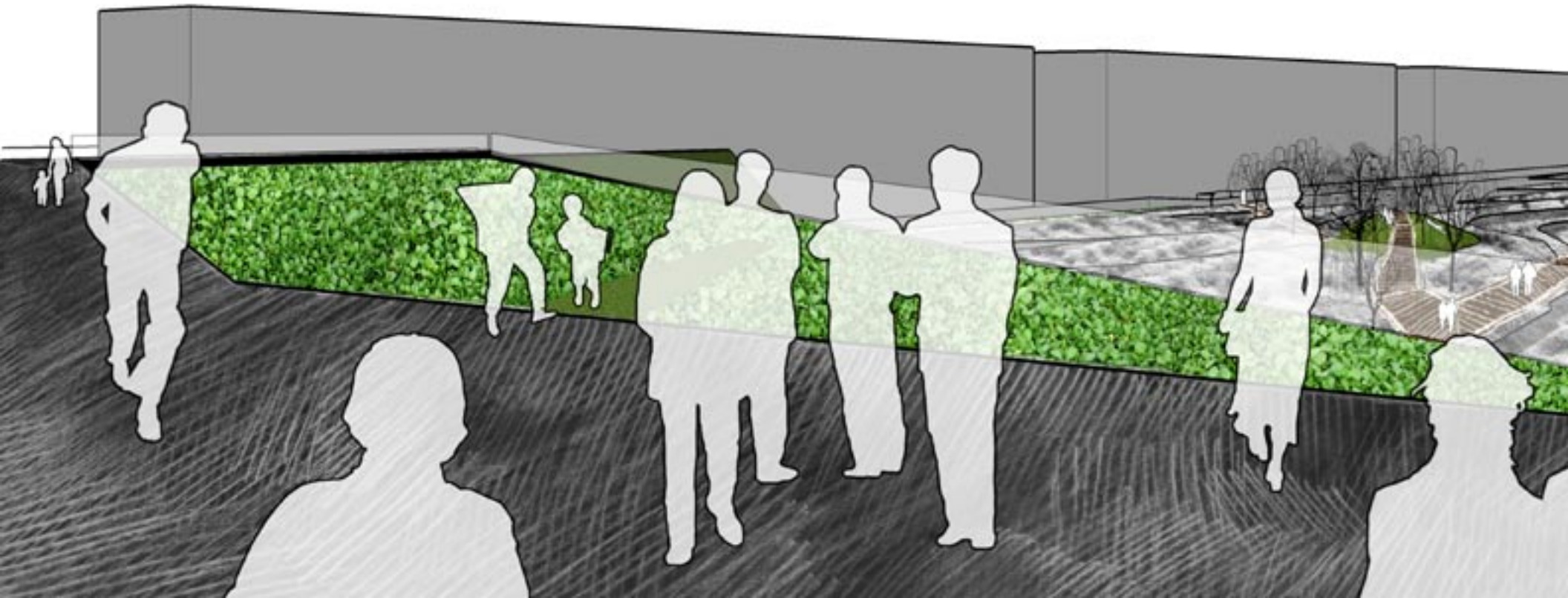


Activities such as mahjong and card games could be accommodated on these corners. Street vendors can also be established in the crevices between buildings. In addition to the small spaces, the courtyard buildings at the center of the development also provide pockets of medium size public spaces for gathering.

Density of Berm Development

	Retaining Bar	33,509 m <sup>2</sup> x 1F = 33,509 m <sup>2</sup>	<b>Total Floor</b>	<b>459,485 m<sup>2</sup></b>
	6 storey	44,602 m <sup>2</sup> x 6F = 267,612 m <sup>2</sup>	<b>Site Area (not including roads)</b>	<b>152,019m<sup>2</sup></b>
	11 storey	9,147 m <sup>2</sup> x 11F = 100,617 m <sup>2</sup>	<b>Estimated Families</b>	<b>4,594</b>
	22 storey	3,309 m <sup>2</sup> x 22F = 72,798 m <sup>2</sup>	<b>Estimated Population</b>	<b>13,782</b>
			<b>FAR</b>	<b>3.02</b>





## Plant Selection

There are three important plant selection criteria for the sloped side of the berm and the park: soil retention capacity, water retention capacity and tolerance to flood.

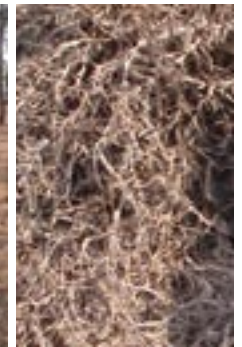
The ground will be covered with "Pangen grass", an indigenous species often used to retain water and soil due to its tangled stem and complex root structure. It appears in small clusters of dunes all year round. Its resilience to trampling, horizontal growing pattern and dryness also make it an idea plant for activity areas.

□

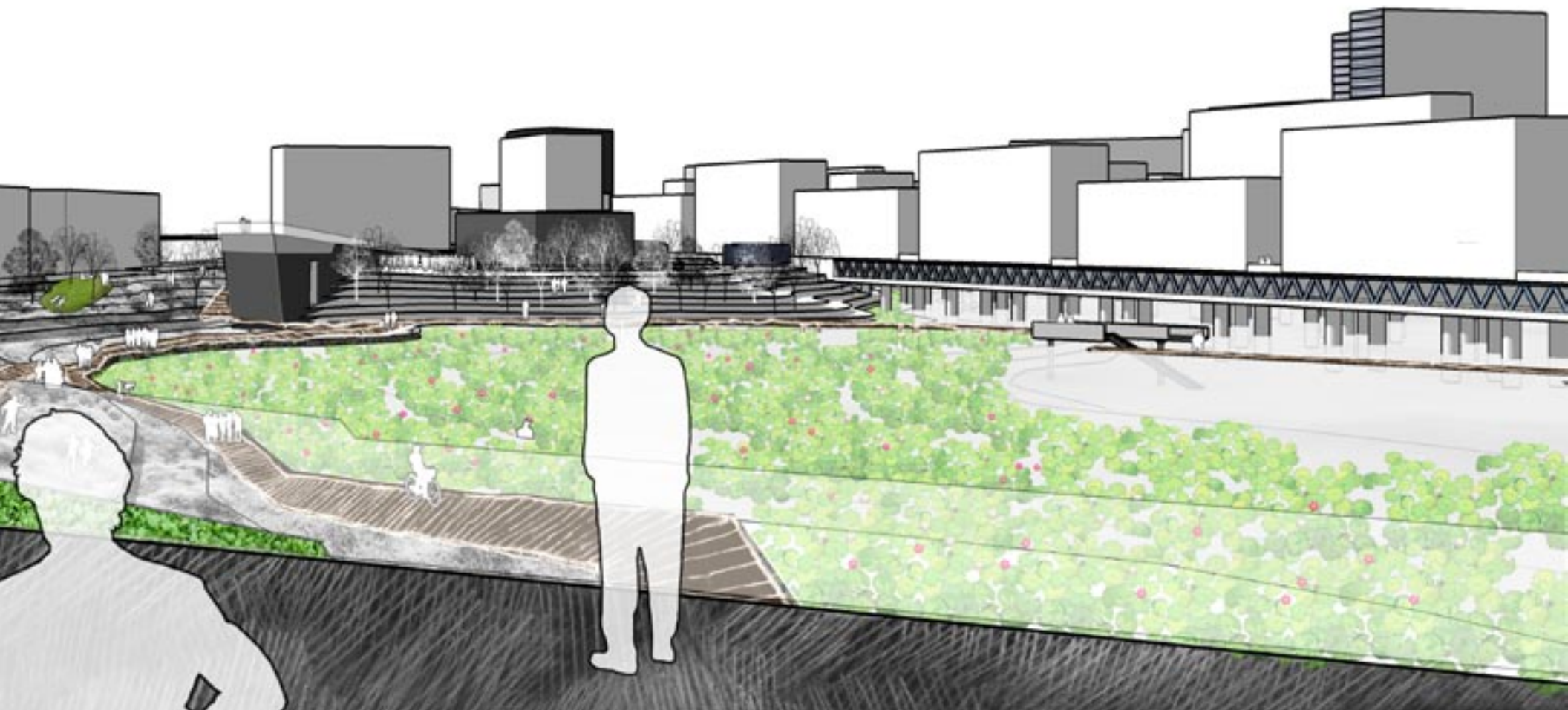
the Yangtze. Their exceptional resistance to flood water has proven them the most resilient species in the basin.<sup>16</sup> Variations in crown density across the selection ensures different degrees of shade and activities taking place under the trees. Plants such as the pond cypress and Peking willow can survive standing in permanent water. Along with the trees and grass, a variety of local vegetables will also be cultivated at the top of the retaining bar.



41 Pangen Grass 盘根草



42 Pangen Grass Detail



40 Perspective B - Park



43 Pond Cypress 池杉  
(*Taxodium ascendens*)



44 Peking Willow 水柳  
(*salix babylonica*)



45 Chinese Wingnut 枫杨  
(*Pterocarya stenoptera*)



46 Oriental Plane 悬铃木  
(*Platanus orientalis*)



47 Chinese Tallow 乌桕  
(*Sapium sebiferum*)



48 Bishop Wood 重阳木  
(*Bischofia javanica*)



49 Hibiscus 木槿  
(*Hibiscus syriacus*)

## General Planning Strategy for LOW

Controlling the amount of shade on water surface is the main concern for the design of LOW. The ecosystem below relies on sunlight to sustain itself but the city extension needs to meet a sustainable density. Quantifiable criteria for sun exposure and density dictates the design of LOW.

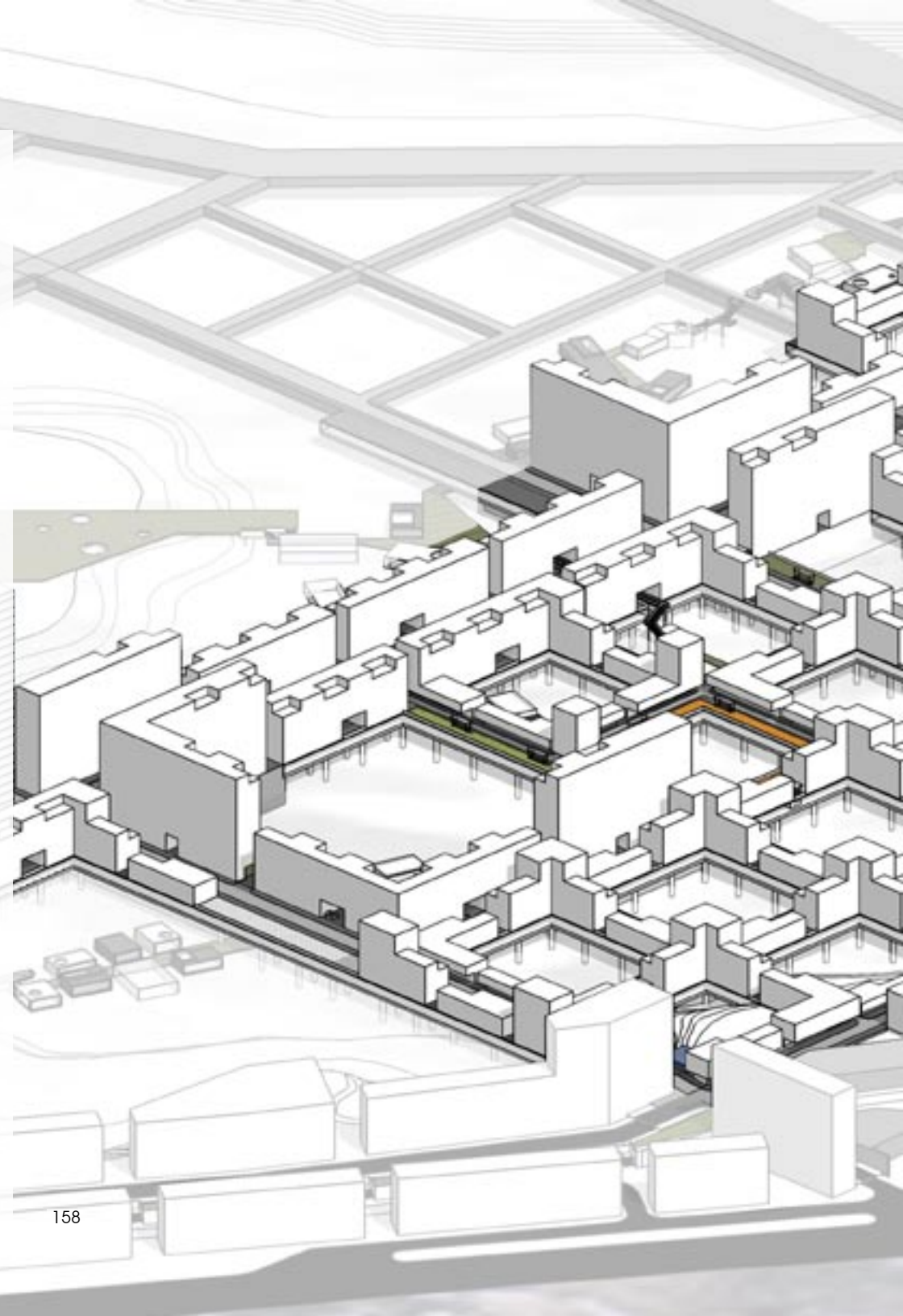
A common technique used in pond gardening practices is to shade up to 70% of the water's surface in order to deter algae growth and give other water plants a chance to mature. This leaves a minimum 30% exposure for five hours a day but a safer approach would be 50% water surface exposed to sunlight for five hours a day. The benchmark for minimum sunlight reflects the condition of winter solstice. For the rest of the year, sun exposure should be significantly higher.<sup>17, 18</sup>

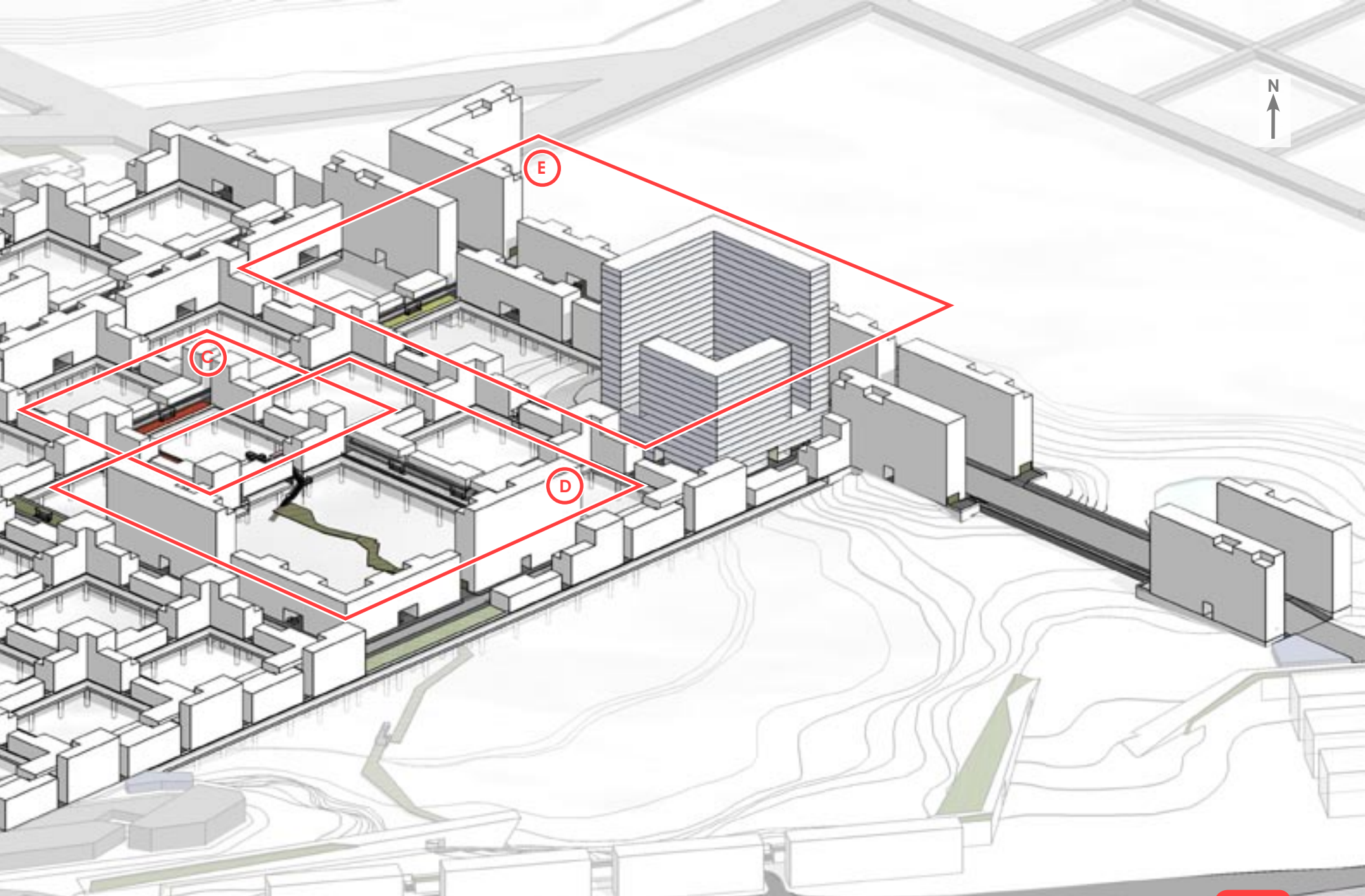
The base of FAR issued by the City of Wuhan is 1.5. Typical developments in downtown Wuhan ranges from 2.0 to 3.0 while the densest parts of Wuhan can reach a FAR of 6.5. FAR 1.5 is just dense enough for Wuhan to support its population but slightly below the standard. The development of LOW will attempt to reach the minimum sustainable density for Wuhan while meeting the shade restrictions.<sup>19, 20</sup>

To meet the density and sunlight criteria, designing the dimension for each opening of the LOW is critical. If the openings are too large, the city fabric will not support pedestrian traffic and density; if too small, the shadow will smother the ecosystem below. A mixture of different opening sizes corresponding to different building height and densities will become a critical tool with which both sun exposure and density can be controlled at the same time.

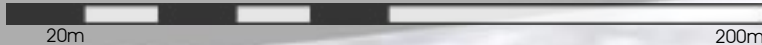
The first strategy is to orient the entire LOW system to be on an 45° angle with respect to due north in order to shorten the shadow length at the extremes of the five hour cycle between ten o'clock AM and three o'clock PM. The smallest feasible base of LOW (Area C), at 60m x 60m, can cast 20% shade within the block, leaving 30% for one to four storey low rise buildings. A medium block size (Area D) four times as big as Area C will be able to host a combination of six-storey mid rise buildings and eleven-storey high rises, resulting in minimum 40% exposure. The sunlight criteria for the medium block is relaxed because the large block size creates more open water. High rise buildings are problematic because they require five times the opening size of the smallest block, significantly reducing the density of the urban fabric. In this scenario, high rise blocks (Area E) can only take advantage of open areas adjacent to ferry route, the floodway, and wetland parks, casting the extremes of their shadow, onto an opening two times its size on one side and the open lake surface on the other.

The strategy establishes a predominantly low density urban fabric with frequent intersections. A substantial portion of the density is distributed around larger open water where construction is prohibited and along major roads whose dimension allow larger coverage of shade. Public spaces of various sizes will be distributed around the development, accommodating the daily and the festive above the water and along the water.





50 Axo - sample LOW development 1:2,000.



## Small Block

Three types of modules have been designed for the small LOW blocks. The three modules are configured primarily to accommodate small public squares of different orientations. The modules will be combined in a wide range of permutations capable of addressing different scales of water courtyards. These public squares will be scattered around the LOW development, creating urban living rooms around water courtyards.

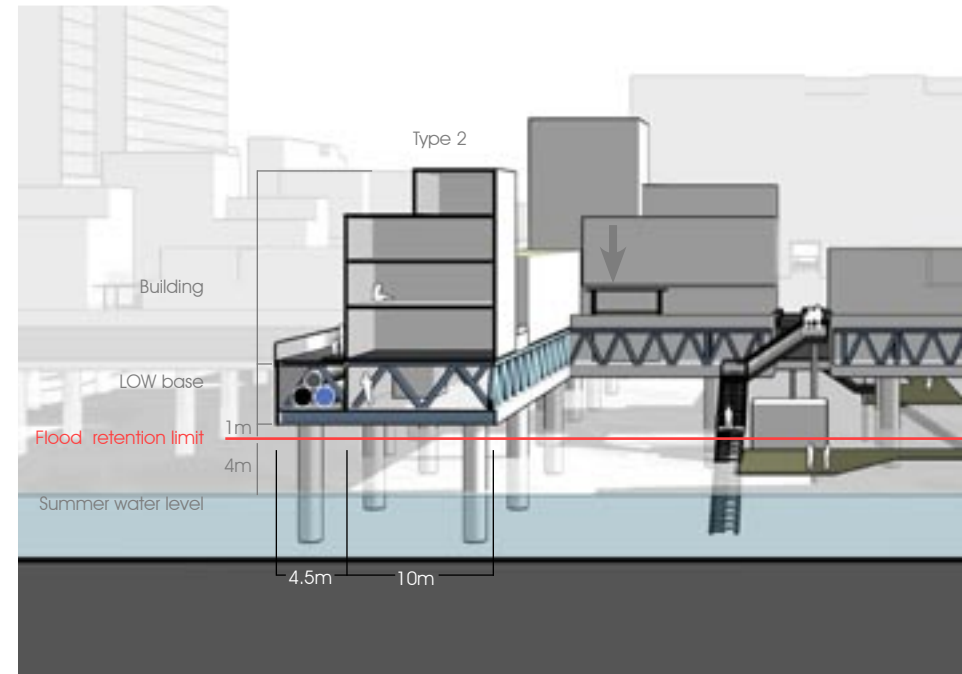
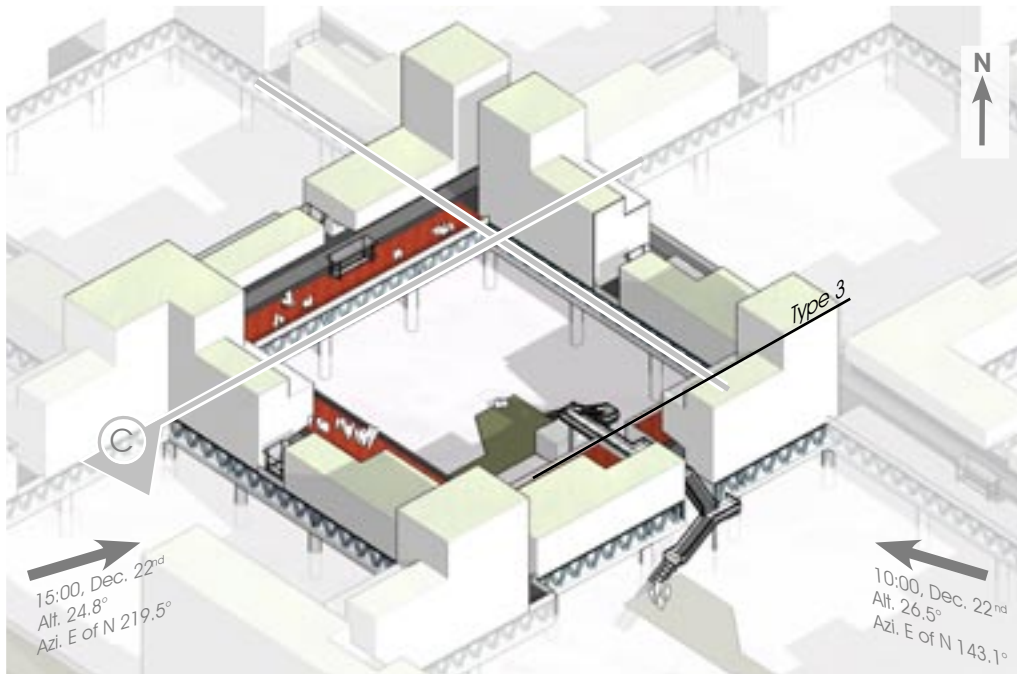
The general strategy for reducing shade on water is to concentrate density at the north corner of each block because this allows part of the long shadow to fall onto the LOW instead. Portions of the top floors are set back to reduce shadow and form balconies at the same time. The boardwalk also traverses through areas of shade so as not to further reduce sun exposure for water plants.

Flexibility is key to the design of LOW's habitable space. Because the base has a continuous configuration, it is more likely to be appropriated for office or institutional use. However, enclosed staircases spaced apart at fire escape distances are designed in the base, so that the circular volume can be divided up into individual

family units if necessary. Although the base is permanent, the buildings above are intended to be flexible and replaceable. This would be made possible by light weight construction. The entire system is predicated on a series of optimized conditions that are sensitively maintained and thoroughly studied before any change is to occur.

The residential units range from 5.5m deep to 10m deep, adopting the two units-per-flood-per-staircase strategy to utilize cross ventilation. The average unit size is 90 to 100 m<sup>2</sup>, a size based on the 30m<sup>2</sup>/capita put forth as the sustainable standard by the Central Government.

Total Floor Area	8,374.7m <sup>2</sup>
Site area w/o water court	3,861m <sup>2</sup> - Far 2.17
Site area w/ water court	5,960m <sup>2</sup> - Far 1.41
Estimated population	83 families, 249 people



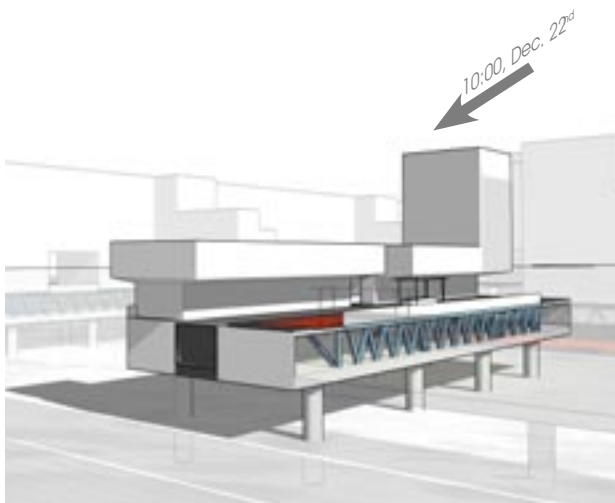
51 Axo Small Block 1:1,000.



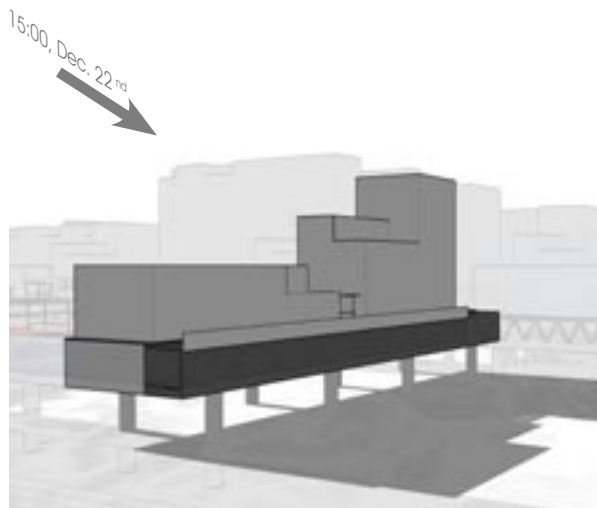
55 Sectional Perspective C - Small Block 1:500.







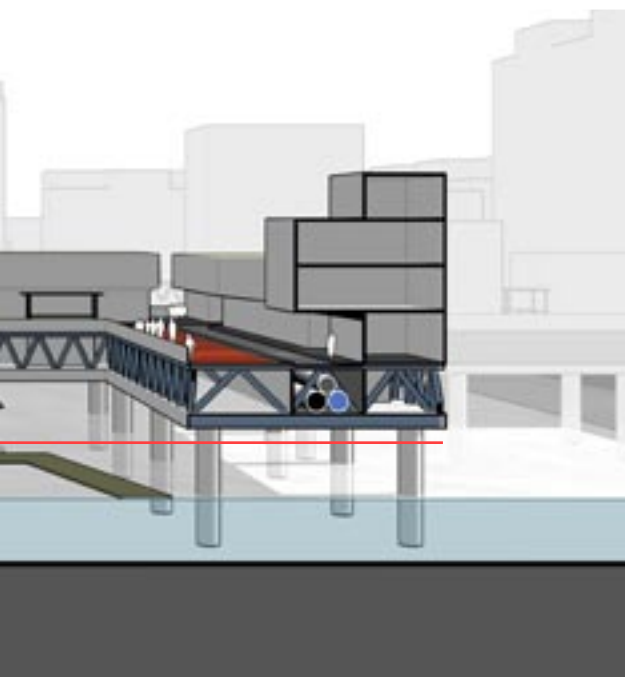
**52** Small Block Type 1: Public square and street on south side, 5.5m building depth on ground, 10m deep above, six- storeys at corner, 7m deep base unit on south side, 5.5m deep base unit on north side, conduit core at center. 2,037m<sup>2</sup> floor area, houses roughly 20 families or 60 people.



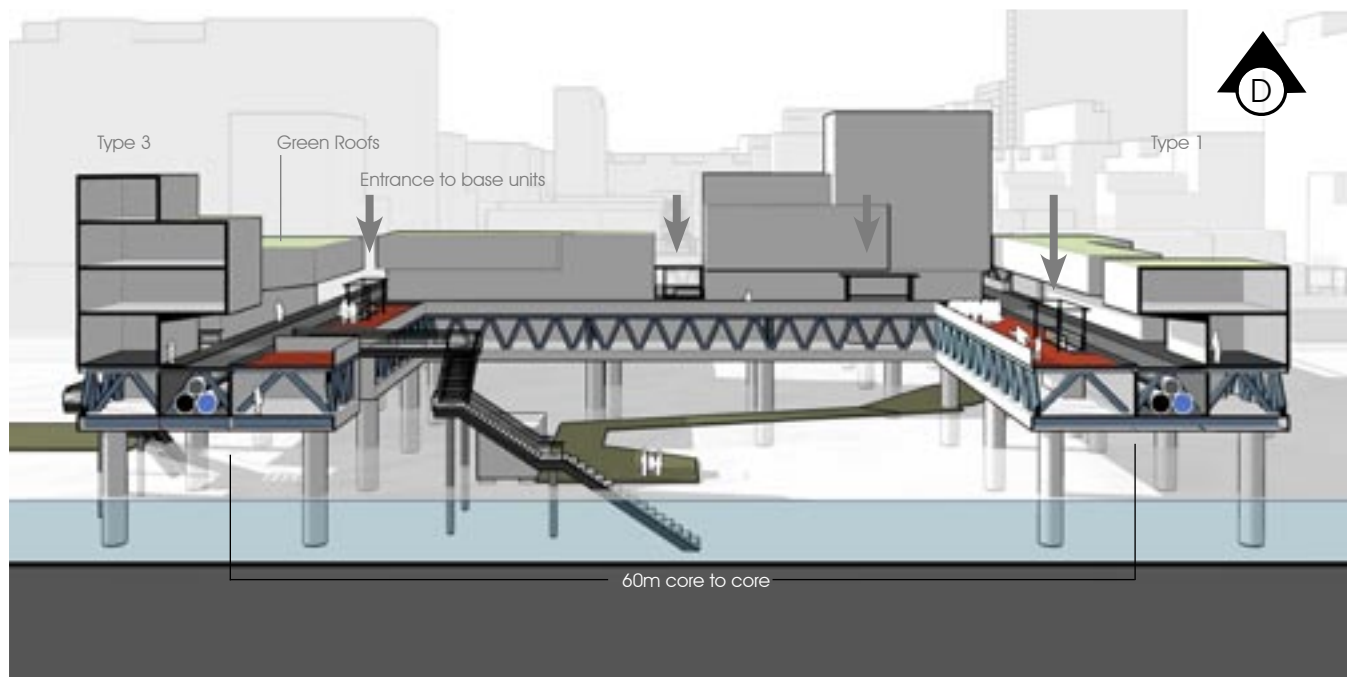
**53** Small Block Type 2: No public square, street on north side, 10m building depth, six-storeys at corner, top floors stepped back to reduce shadow, 10m deep base unit on south side, conduit core on north side. 2133.2m<sup>2</sup> floor area, roughly 21 families or 63 people.



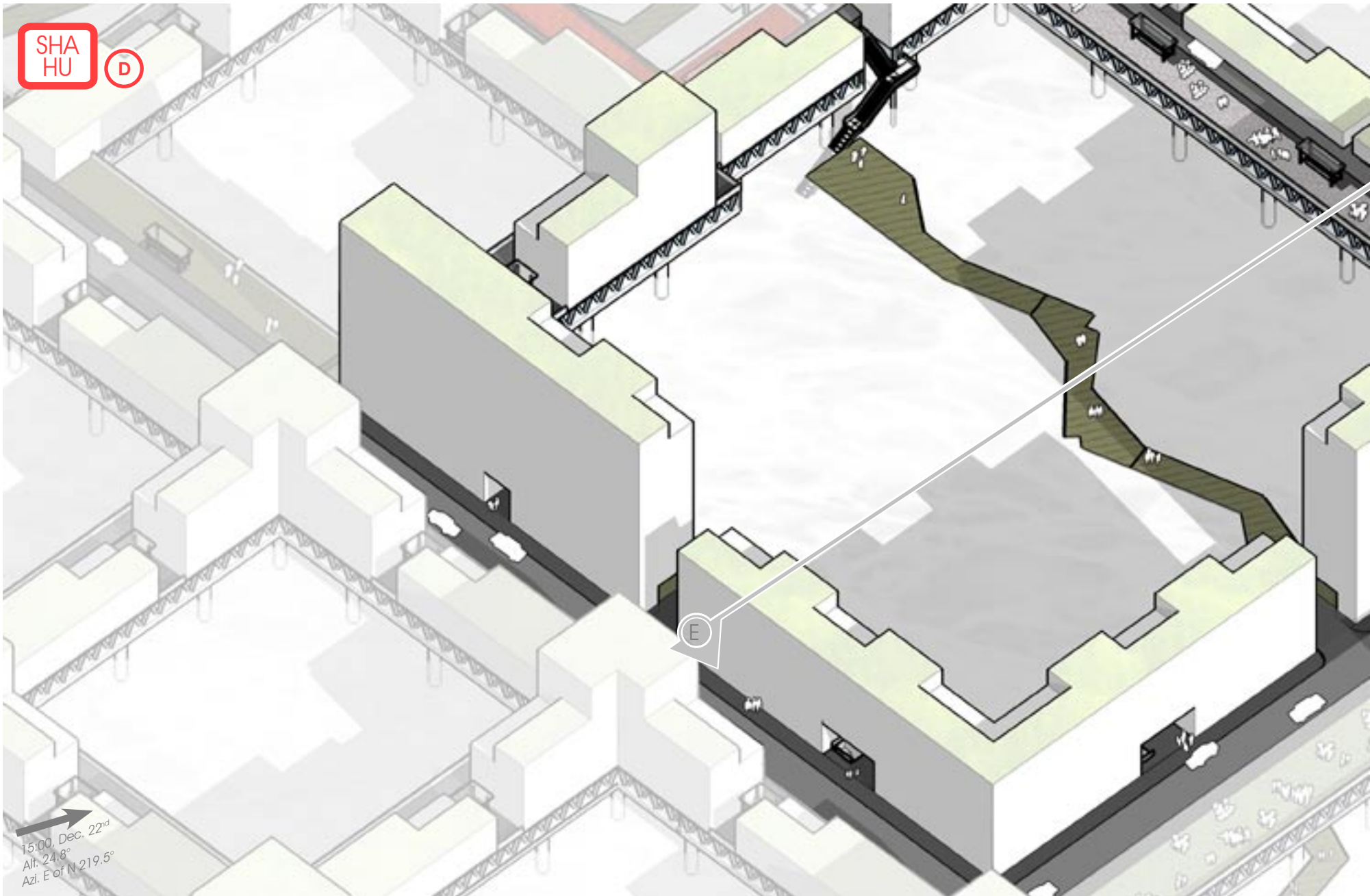
**54** Small Block Type 3: Public space and street on north side, six-storey at corner, top floor stepped back to reduce shadow, 7m deep base unit on north side, 5.5m deep base unit on south side, conduit core at center. Staircase to boardwalk is a atypical condition. 2056.2m<sup>2</sup> floor area, roughly 20 families or 60 people.



50m

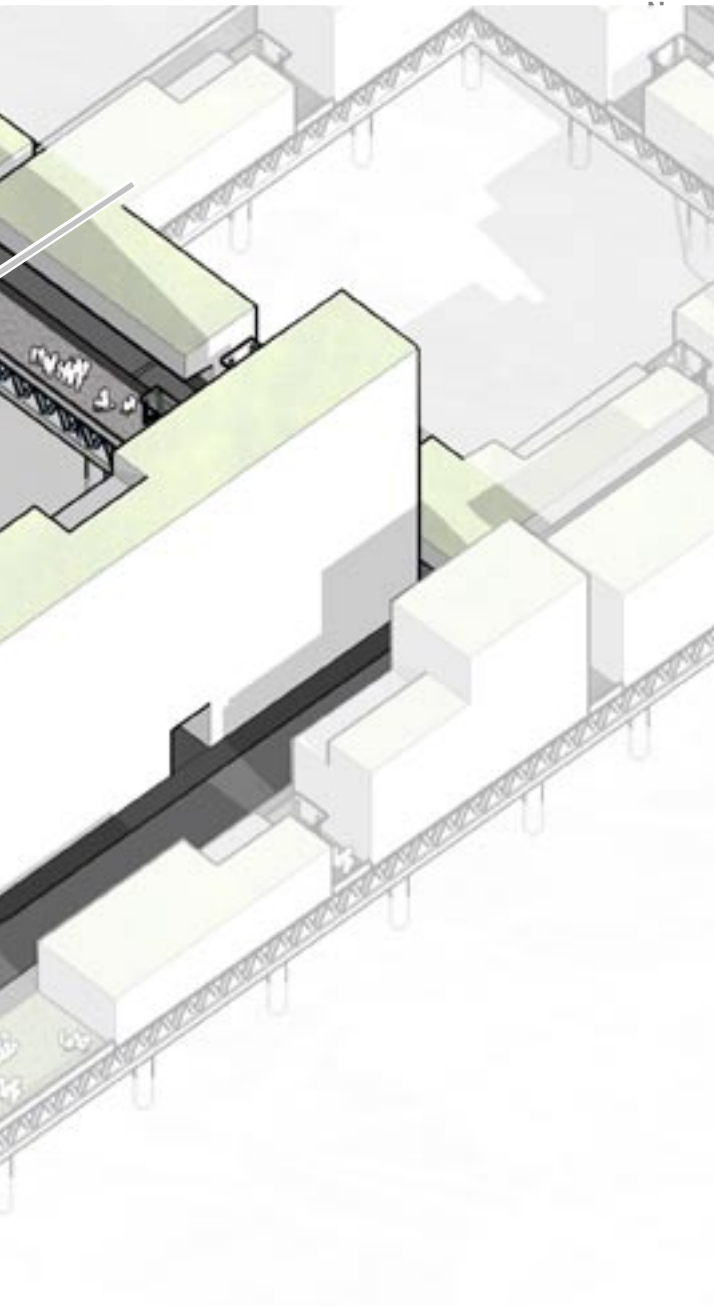


**56** Sectional Perspective D - Small Block 1:500.



57 Axo Medium Block 1:1,000.





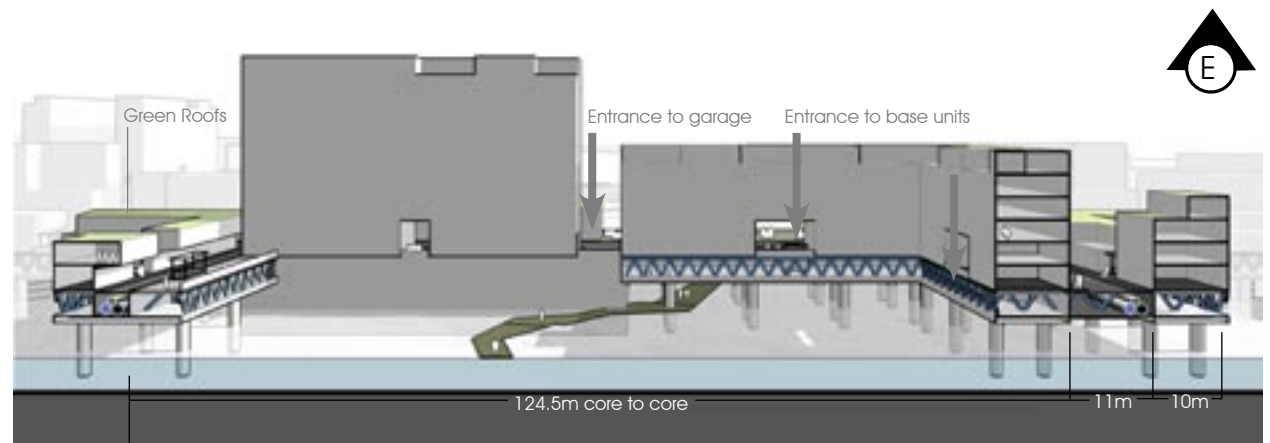
## Medium Block

At four times the size of the small block, the medium block creates an immense urban room for the community. The public square at the medium blocks will be sitting adjacent to a large open space, establishing the square to be the center of the neighborhood. The distinct spatiality of the medium blocks also helps orient residents and visitors in the neighborhood and creates a sense of discovery traversing through the site both above and below.

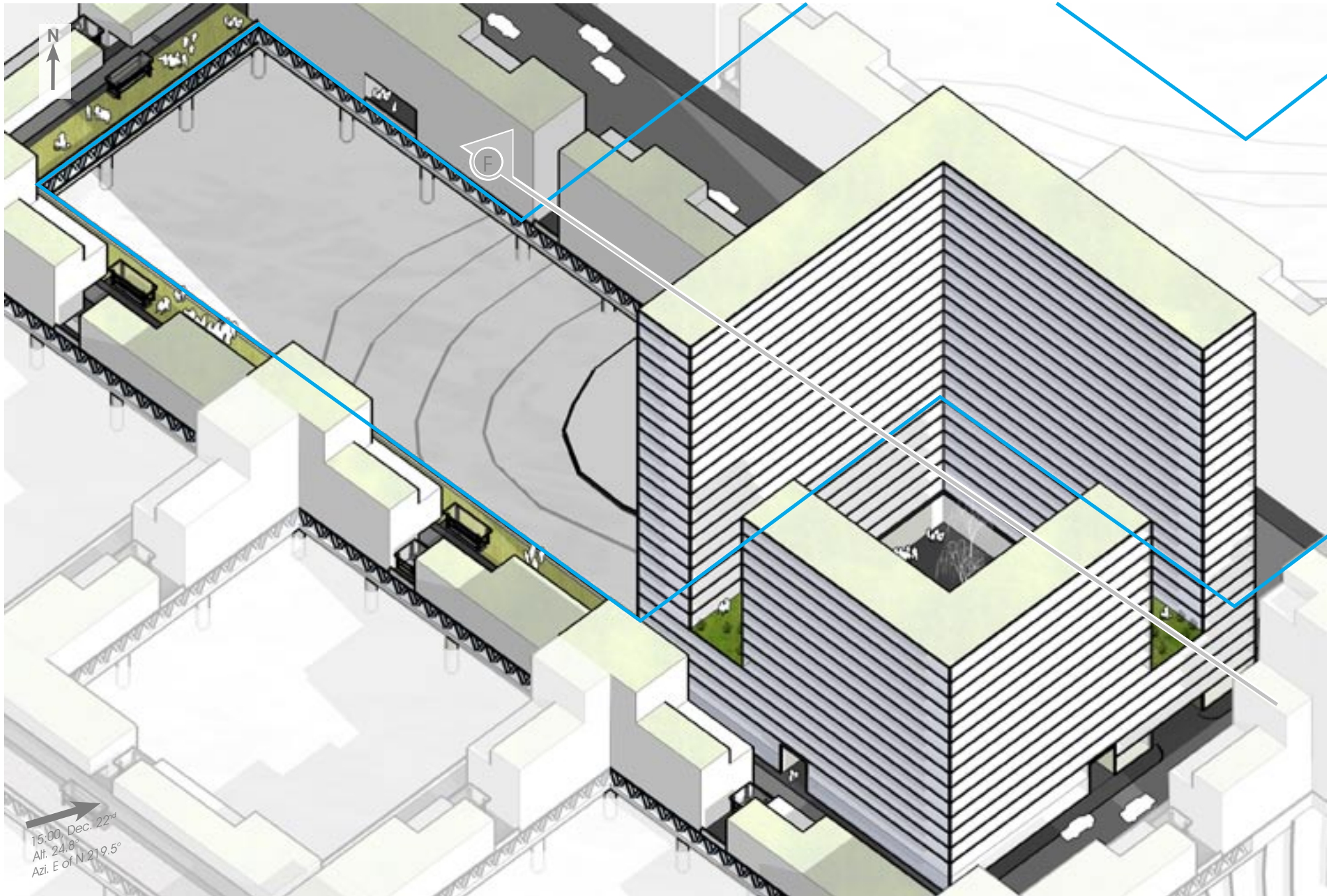
Because of the large open water, shade coverage for the medium block is relaxed to 60%. This allows eleven and six storey apartments to surround the south east and south west side of the opening. These taller buildings will be accompanied by wider roads in order to create more pleasant street sections.

Only two medium blocks are allowed to occur in one development area unit made of approximately thirty-two small openings. The limit is to ensure that development primarily consists of small blocks. The function of the medium block is to provide spatial diversity and focal points in the neighborhood while the small blocks weave a tight urban fabric to sustain small businesses and street life. The mixture of the types is the basis for creating a functioning and agreeable neighborhood.

Total Floor Area	29,890.5 m <sup>2</sup>
Parking	3,870 m <sup>2</sup> (180 spots)
Site area w/o water court	7,745m <sup>2</sup> - Far 3.86
Site area w/ water court	20,588m <sup>2</sup> - Far 1.45
Estimated population	290 families, 890 people



58 Sectional Perspective E - Medium Block 1:1,000.



59 Axo High Rise Block 1:1,000.



## High Rise Block

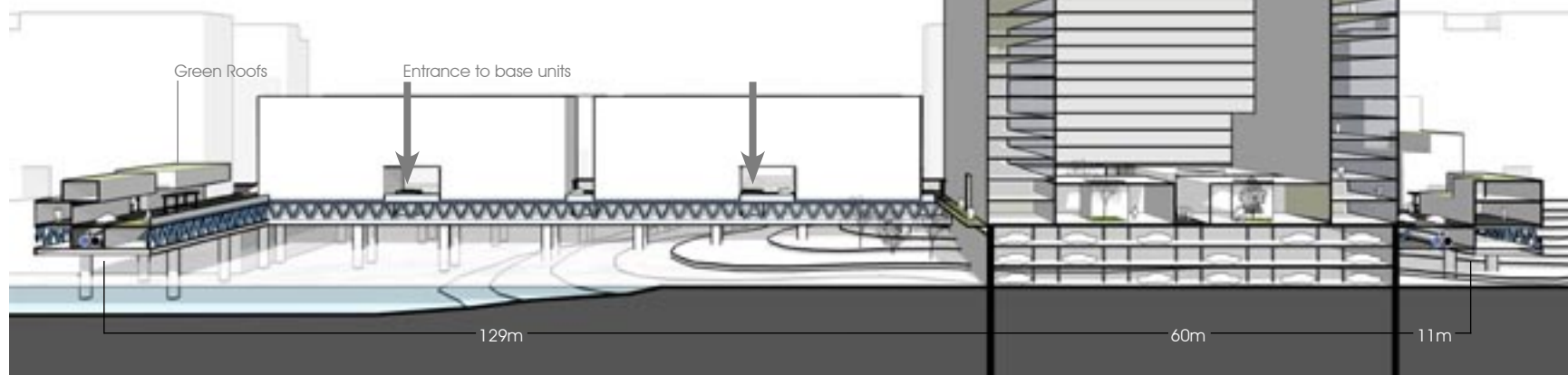
With twenty-two and fifteen storey high rise buildings, the block formation is to function as the density carriers of LOW. To stay within the shadow coverage limit, the opening area for high rise blocks can go up to five unit blocks if situated at the center of a development area unit. The blue lines in the illustration indicates this opening requirement. For this reason, high rise blocks are designed only along the floodway, ferry routes and large openings preserved for wetland parks. The example on the left shows an opening at the size of two unit blocks. The specific condition in the image is the 10:00 AM shadow on the winter solstice. The water in the opening (north west of building) will be in full sun exposure by noon and the open water used as the ferry route (north east of building) will be in shade in the afternoon. The calculation of shade is done by dividing the longest shaded area of the day by an area of five unit blocks. This yields roughly 30% exposure at the extremes of winter solstice - a limit suggested by pond gardening practices. For this reason, the location of high rise blocks has to be very carefully considered. In a sample development neighborhood made of thirty blocks, a maximum of one high rise block can exist along one large open water area. No more than two high rise blocks can occur in one development neighborhood made of thirty-two unit blocks. In addition, these blocks have to take place along major roads in order to avoid oppressive street sections.

The base of the building features a courtyard 20m by 20m. The rest of the base area is to become office or retail spaces. The courtyard does not cover the entire base as typical high rise developments in China have proven over sized open spaces as unfriendly and unusable. A functioning courtyard at the neighborhood scale should suggest intimacy and openness at the same time. This formation also extends the street

through the site, making it a continuous part of the urban fabric.

Besides its role as density carrier, the high rise blocks can also set up the most commercially intense public spaces in the neighborhood at night because of its illumination in the dark. (p.174) This allows another level of public life to unfold on site, transforming a residential neighborhood into a city destination.

Total Floor Area	59,393 m <sup>2</sup>
Parking	3,600 m <sup>2</sup> (168 spots)
Site area w/o water court	11,910 m <sup>2</sup> - FAR 4.99
Site area w/ water court	20,588 m <sup>2</sup> - FAR 3.46
Estimated population	593 families, 1779 people



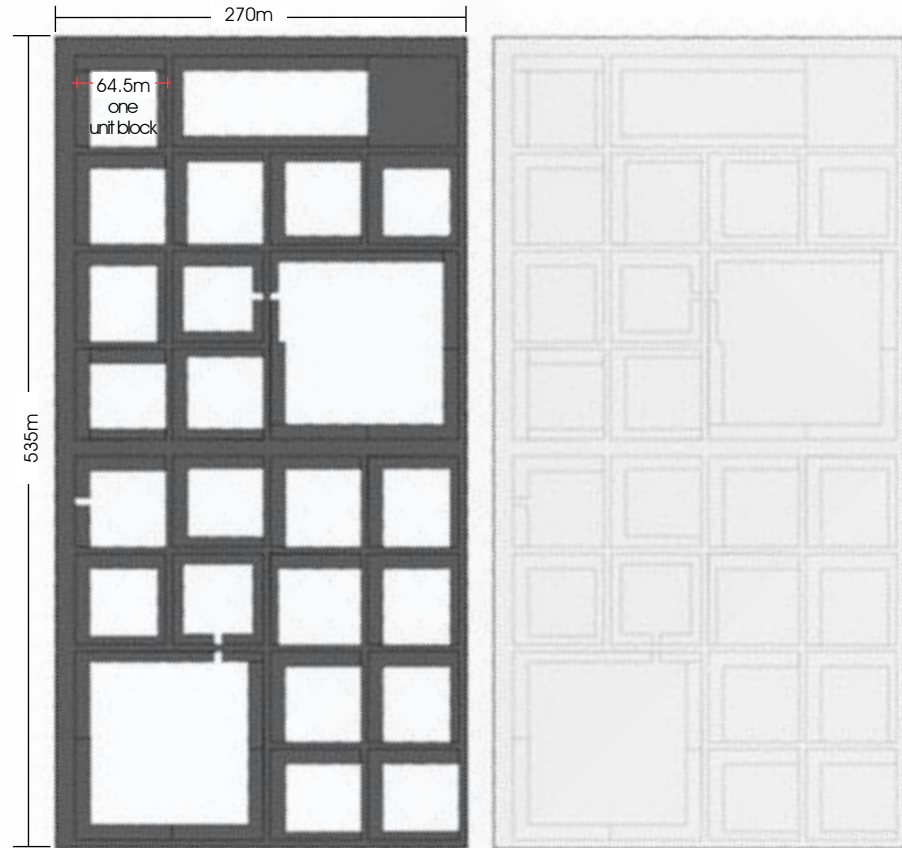
60 Sectional Perspective F - High Rise Block 1:1,000.

## Density of Sample LOW Area

The density calculation of LOW is not as straightforward as the development on the berm because the volumes of the buildings are not direct extrusions of a footprint. The illustrations on the left break down the building volume into storey numbers, reflecting a general distribution of various densities.

The sample area is 270m x 535m, which is close to the area of a typical city block in wuhan (240m x 480m). A quick comparison shows that the FAR of the sample LOW area (1.54) is slightly below the uniform six-floor gated community laid out on page 54 but slightly higher than the regulated minimum FAR of 1.5.<sup>21</sup> Even with stringent shadow restrictions, the development still manages to achieve substantial density. The strategy implemented is to locate the density carried by mid rise buildings, which would have been realized on the landfill occupying the water courts, to concentrated high rise blocks. This leaves most of the buildings surrounding small water courts in the range of one to four storeys.

The dimension of the small block (64.5m x 64.5m) is determined by shade limits as well as the requirements for a dense urban fabric. The dominance of the small block ensures frequent intersections, promoting easy circulation and sustainability of commerce. The strategy gathers enough population on concentrated points and ensures that substantial street frontage is present to support the necessary commercial activities for the community.



### Over All Sample Area

Total Small Blocks	32
Rough Total Floor	227,417 m <sup>2</sup>
Opening through Buildings.	-3,500 m <sup>2</sup>
<b>Final Total Floor</b>	<b>223,917 m<sup>2</sup></b>
Estimated Families	2,274
Estimated Population	6,822
FAR (w/o water court)	3.25
FAR (w/ water court)	1.54
Landfill due to high rise	5.4%

### Projected Count - Entire LOW

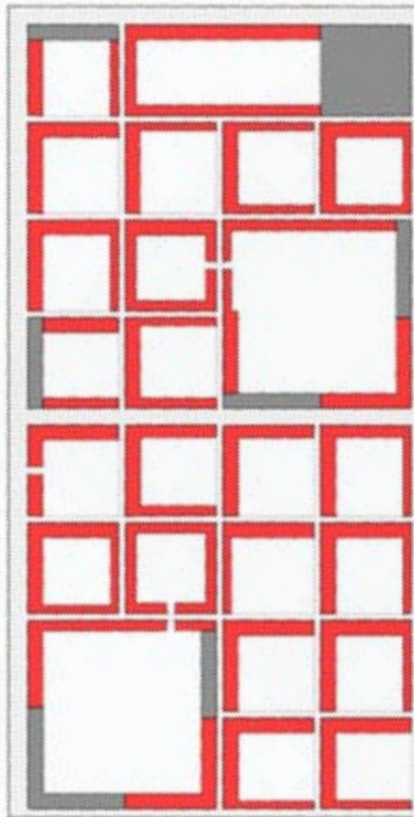
Total Small Blocks	340
Rough Total Floor	2,416,306 m <sup>2</sup>
Opening through Buildings.	-37,187.5 m <sup>2</sup>
<b>Final Total Floor</b>	<b>2,379,118.5 m<sup>2</sup></b>
Estimated Families	24,163
Estimated Population	72,489

### 61 Site Area (w/o Water Courtyard)

Site Area	68,965 m <sup>2</sup>
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### 62 Site Area (w/ Water Courtyard)

Site Area	145,524 m <sup>2</sup>
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63 Base Units & Parking Basement

<span style="color: red;">■</span> Base	33,509 m <sup>2</sup> x 1F = 33,509 m <sup>2</sup>
<span style="color: grey;">■</span> Parking	7,875 m <sup>2</sup> x 3F = 23,625 m <sup>2</sup>

**Subtotal** 57,134 m<sup>2</sup>



64 Low Rise (1-3 Storey)

<span style="color: lightgrey;">■</span> 1 Storey	5,656 m <sup>2</sup> x 1 = 5,656 m <sup>2</sup>
<span style="color: pink;">■</span> 2 Storey	10,879 m <sup>2</sup> x 2 = 21,758 m <sup>2</sup>
<span style="color: red;">■</span> 3 Storey	2,246 m <sup>2</sup> x 3 = 6,738 m <sup>2</sup>

**Subtotal** 34,152 m<sup>2</sup>



65 Multi Rise (4-6 Storey)

<span style="color: lightgrey;">■</span> 4 Storey	2,390 m <sup>2</sup> x 4F = 9,560 m <sup>2</sup>
<span style="color: pink;">■</span> 5 Storey	1,802 m <sup>2</sup> x 5F = 9,010 m <sup>2</sup>
<span style="color: red;">■</span> 6 Storey	6,701 m <sup>2</sup> x 6F = 40,206 m <sup>2</sup>

**Subtotal** 58,776 m<sup>2</sup>



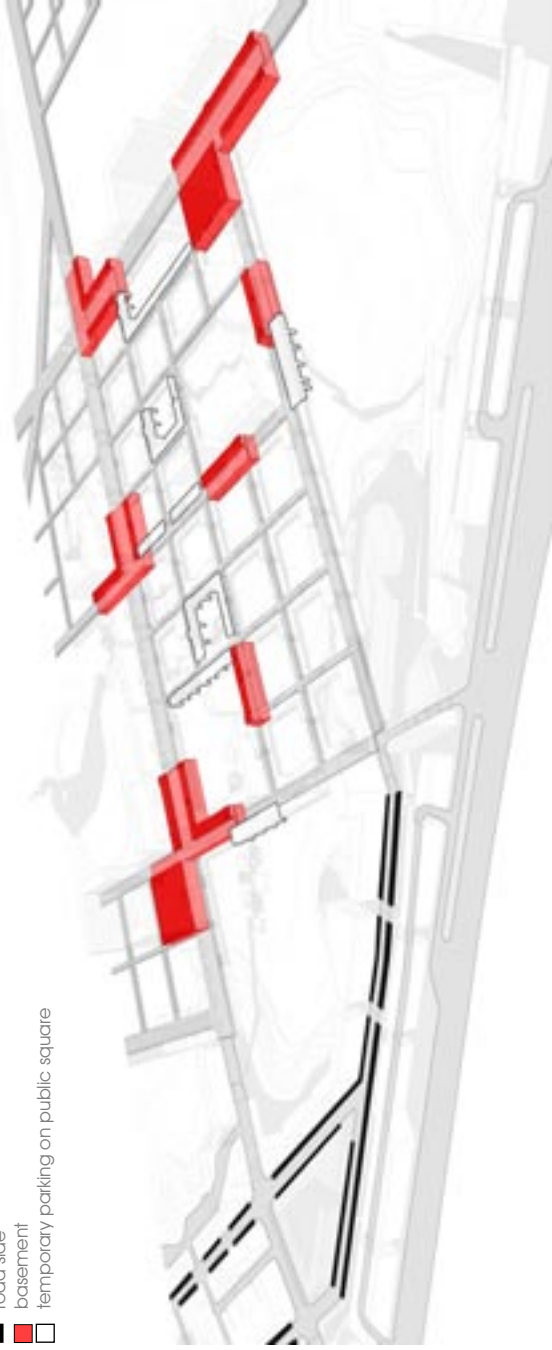
66 High Rise (10-22 Storey)

<span style="color: lightgrey;">■</span> 10 Storey	535 m <sup>2</sup> x 10F = 5,350 m <sup>2</sup>
<span style="color: pink;">■</span> 11 Storey	3,425 m <sup>2</sup> x 11F = 37,675 m <sup>2</sup>
<span style="color: red;">■</span> 15 Storey	690 m <sup>2</sup> x 15F = 10,350 m <sup>2</sup>
<span style="color: black;">■</span> 22 Storey	1,090 m <sup>2</sup> x 22F = 23,980 m <sup>2</sup>

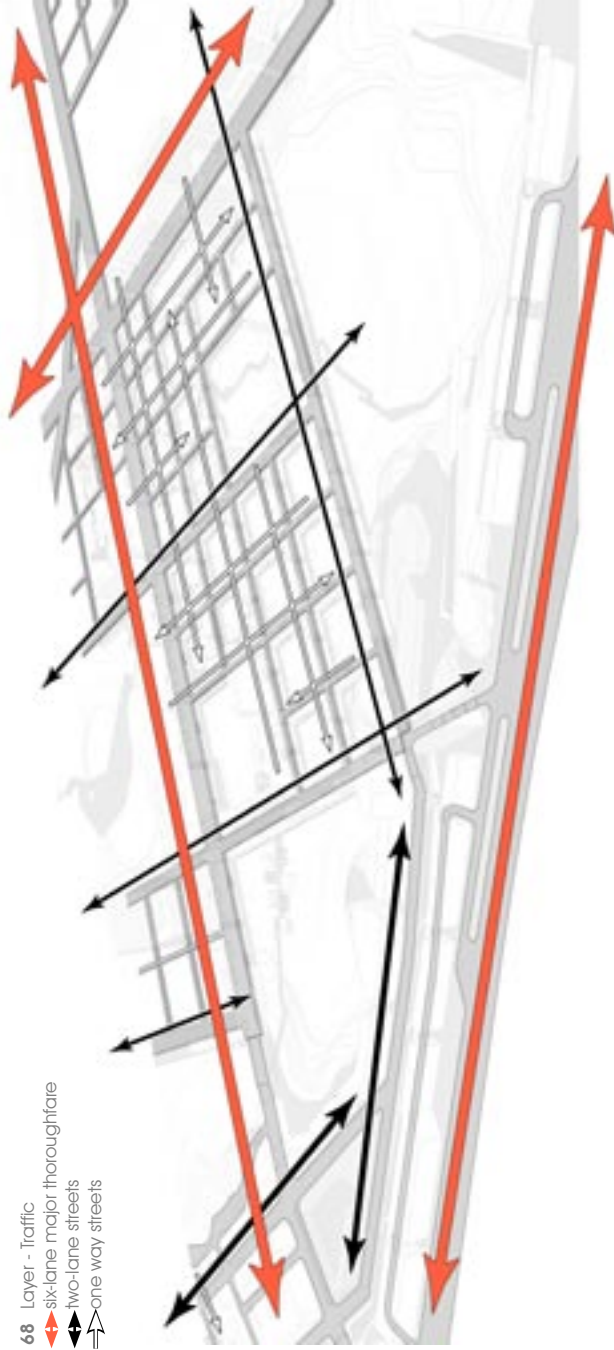
**Subtotal** 77,355 m<sup>2</sup>

## Layers

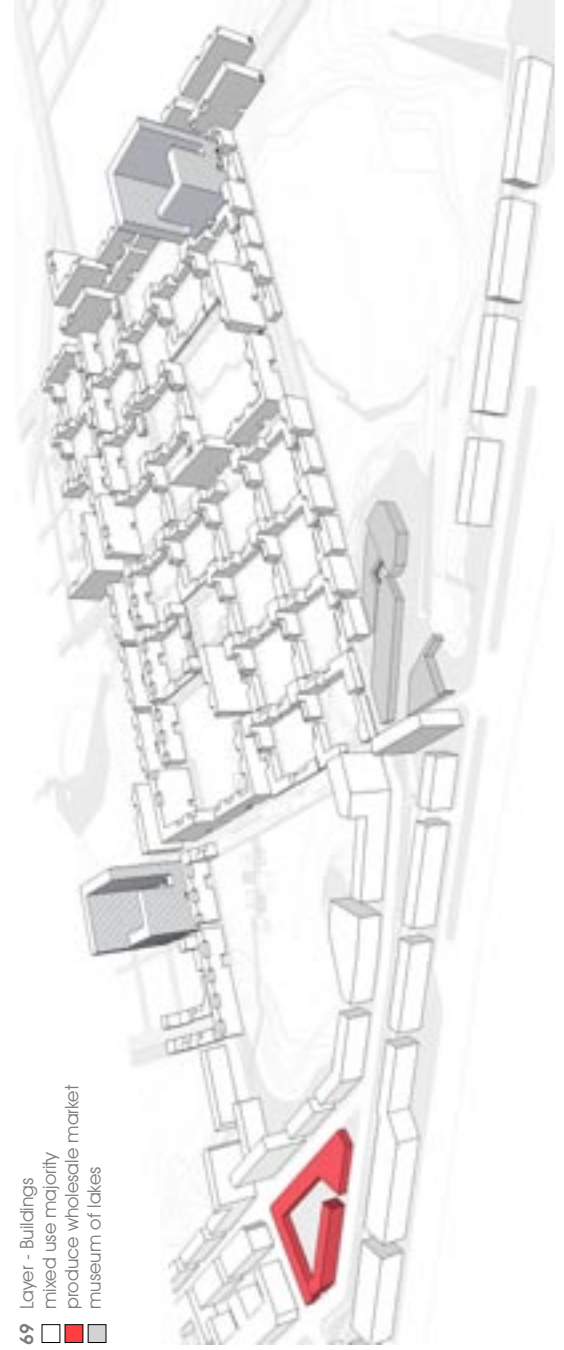
- 67 Layer - Parking  
 - road side  
 - basement  
 - temporary parking on public square



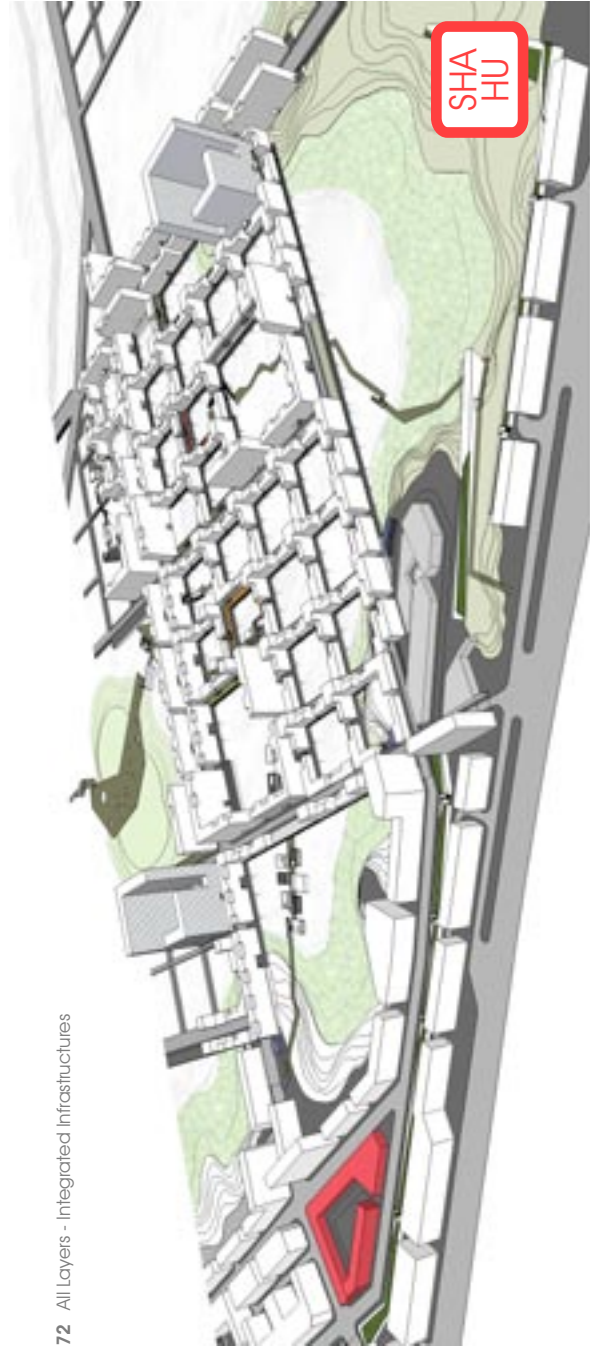
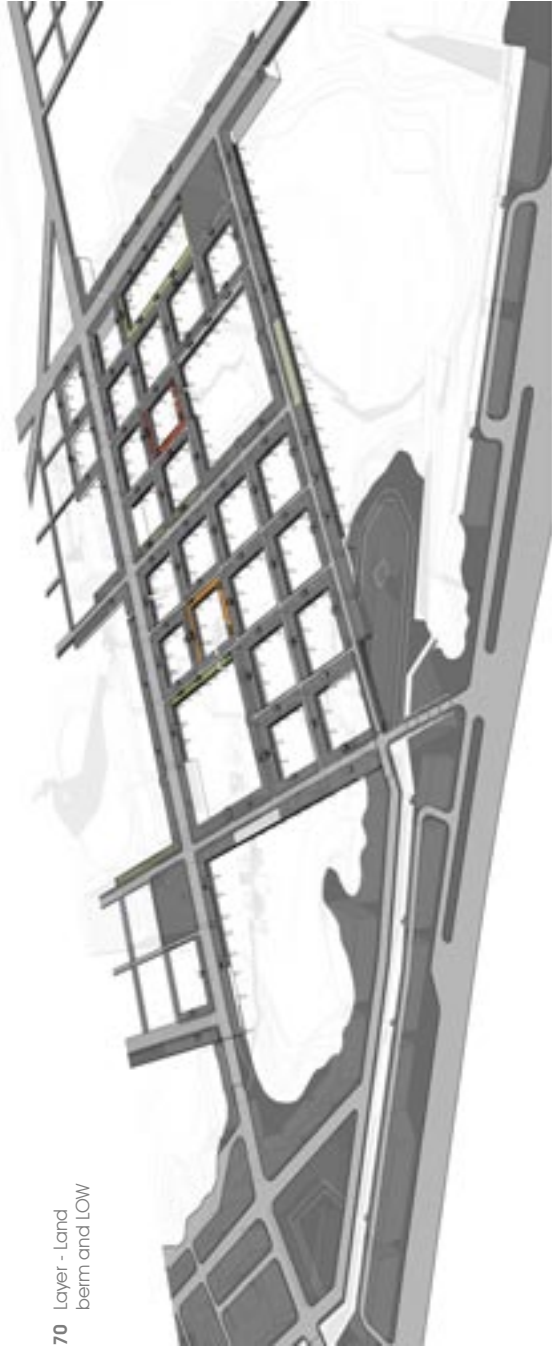
- 68 Layer - Traffic  
 - six-lane major thoroughfare  
 - two-lane streets  
 - one way streets



- 69 Layer - Buildings  
 - mixed use majority  
 - produce wholesale market  
 - museum of lakes



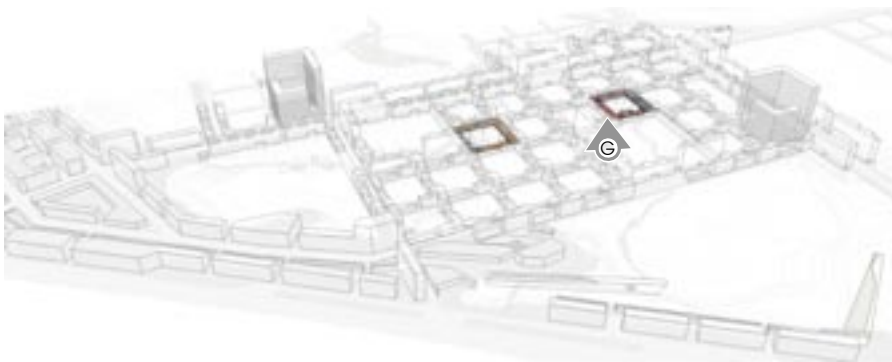




## Public Space - Ring Square

With its sense of enclosure and shaded space, the ring squares will become the outdoor living rooms for residents, making them perfect spots for senior citizens to enjoy a game of mahjong or chess in the shade.

The distinct paving texture and colour will define the square's character and help orient pedestrians. To clarify the boardwalk access within the LOW system, staircases are usually placed in these squares, making them intersections between pedestrian traffic above and below. As the urban living room for the neighborhood and resting points along the boardwalk system, the ring squares are attractive spots for produce and street food vendors to set up after the nearby community markets close in the afternoon.



73 Key Map of Perspective G.

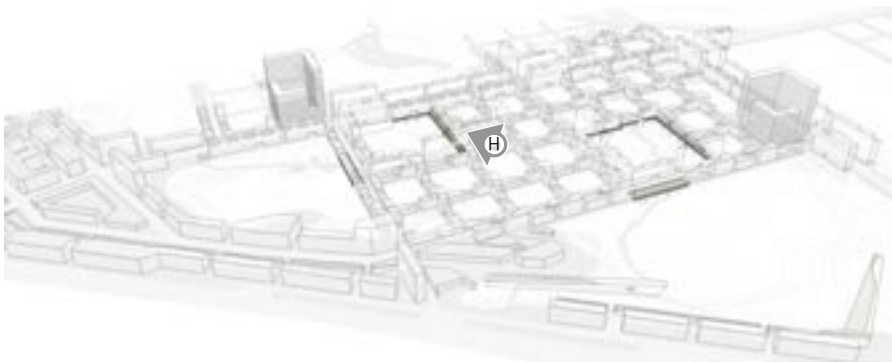


74 Perspective G - Ring Square.

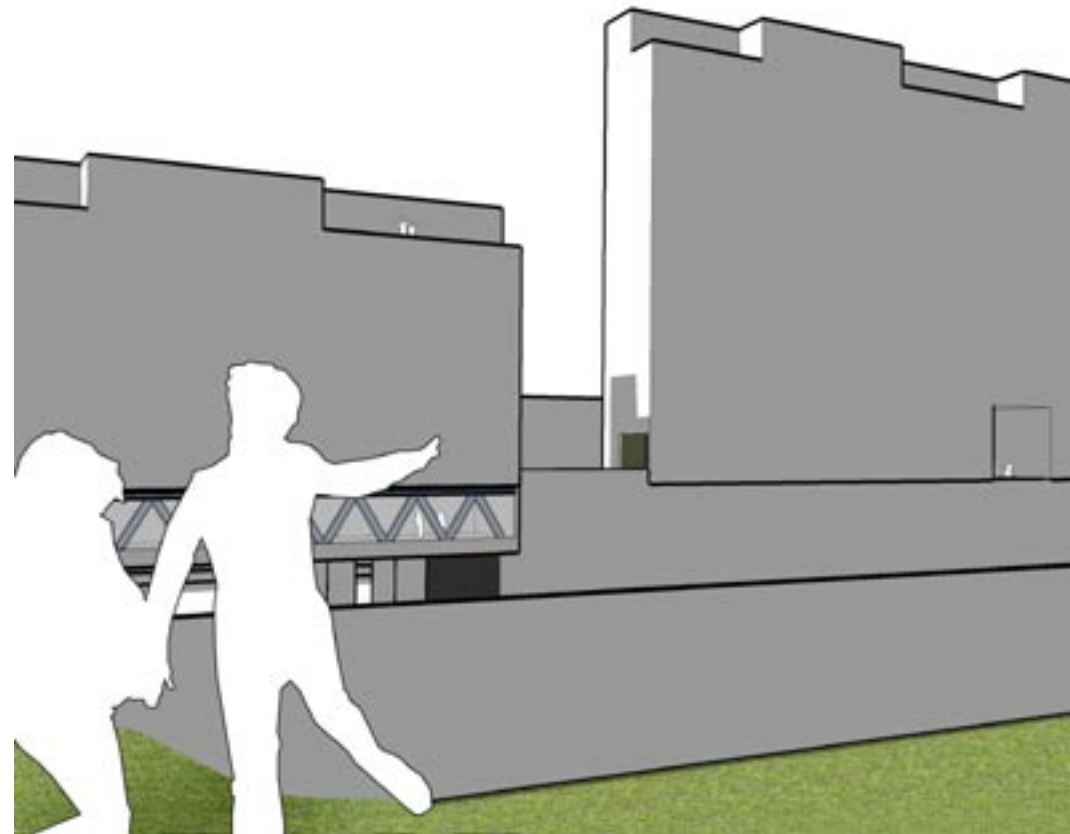


## Public Space - Long Square

Long squares are located right by the large open water of the medium blocks or by lotus farms. They are located to the south side of the buildings to allow for exposure to the sun, making them more suitable spaces for exercise and strolling. In contrast to the ring squares, long squares are understood as neighborhood parks. Some of the squares will be paved in various sizes of pebbles to create foot massage paths commonly found in Chinese parks. The others will be designed as softscapes of grass dunes and meadows. Staircases to the boardwalk are also located in the square.



75 Key Map of Perspective H.

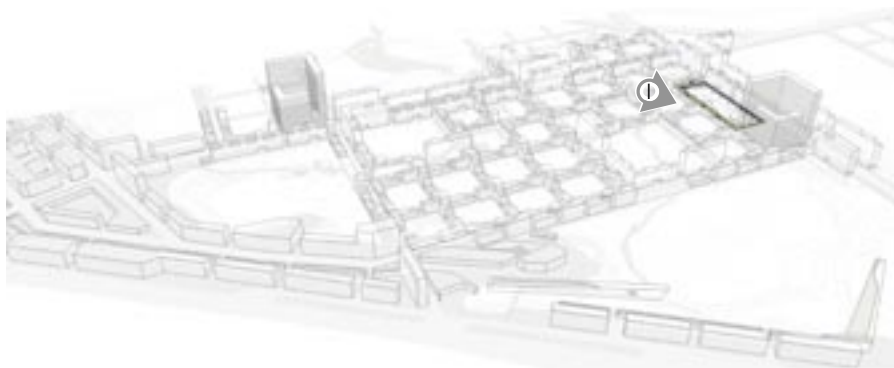


76 Perspective H - Long Square.

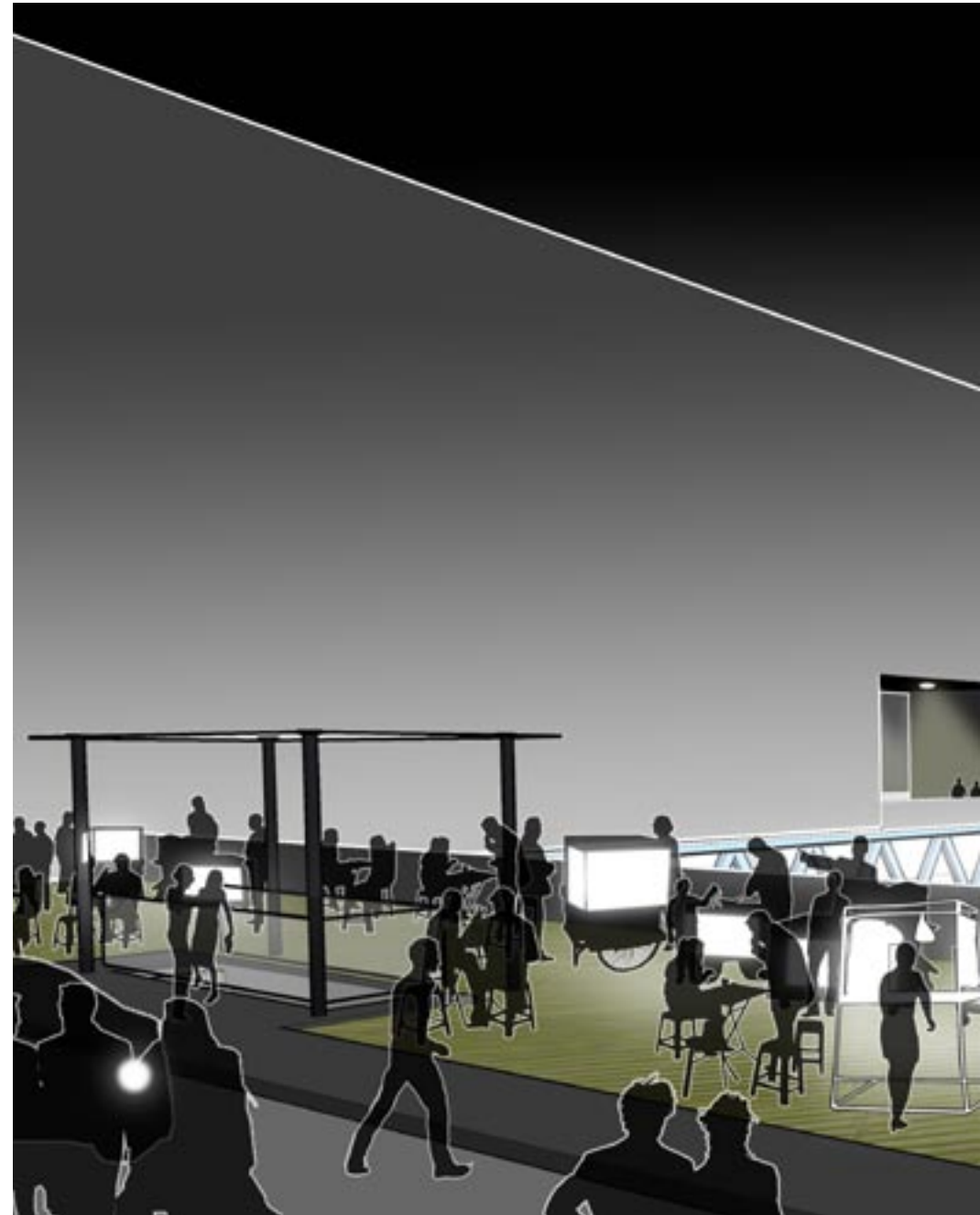


## Public Space - Tower Square

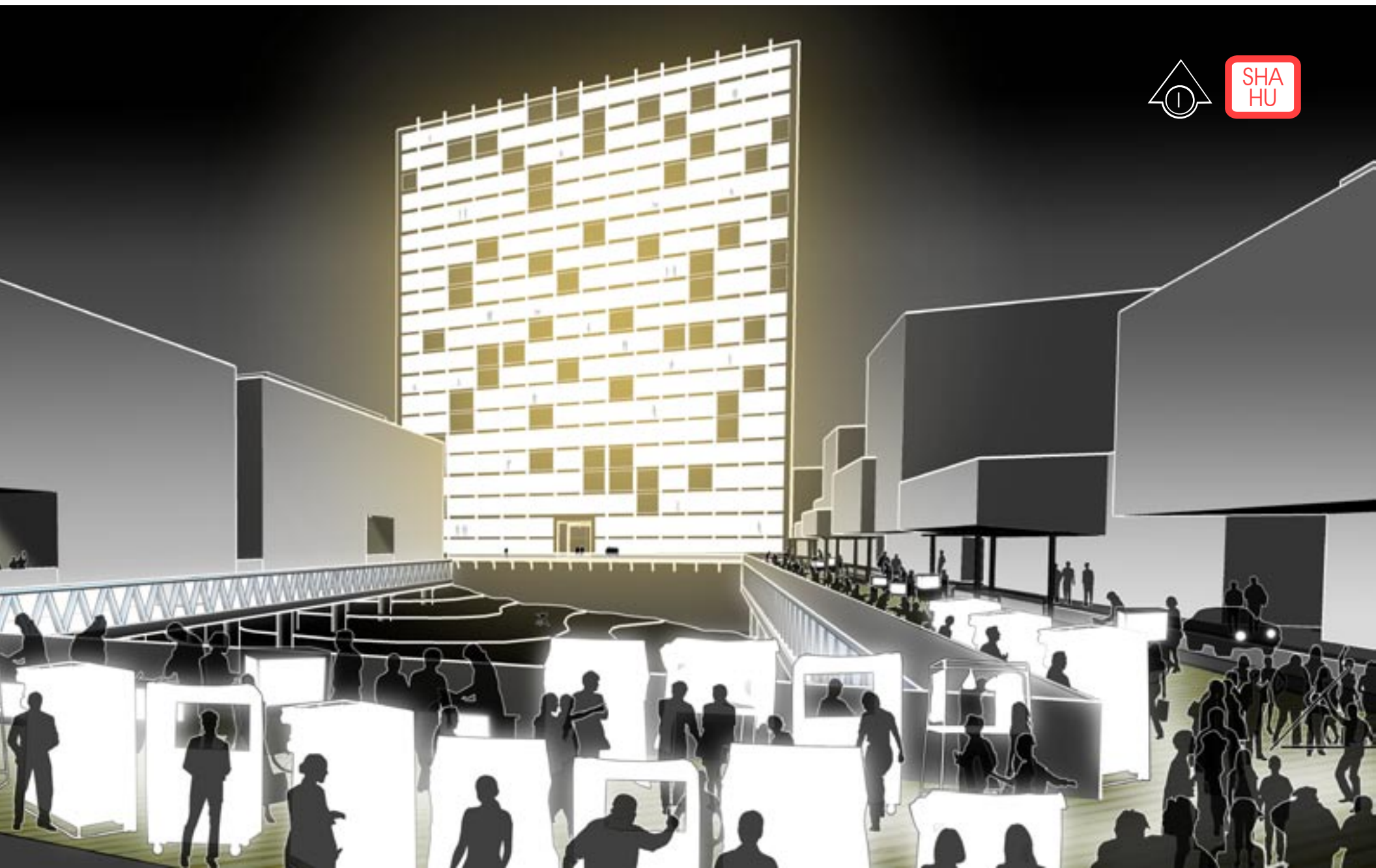
Public squares in high rise blocks are more axial in form due to the prominence of the building height. The tall building establishes a dramatic backdrop for the square and contributes to an atmosphere conducive to bustling commercial activities. During the day, the squares will house the neighborhood food market, while at night, under the illumination of the apartment tower, they will be transformed into night markets. These squares will be littered along the floodway wherever high rise blocks can be established, forming a network of markets across the site.



77 Key Map of Perspective I.



78 Perspective I - Tower Square.

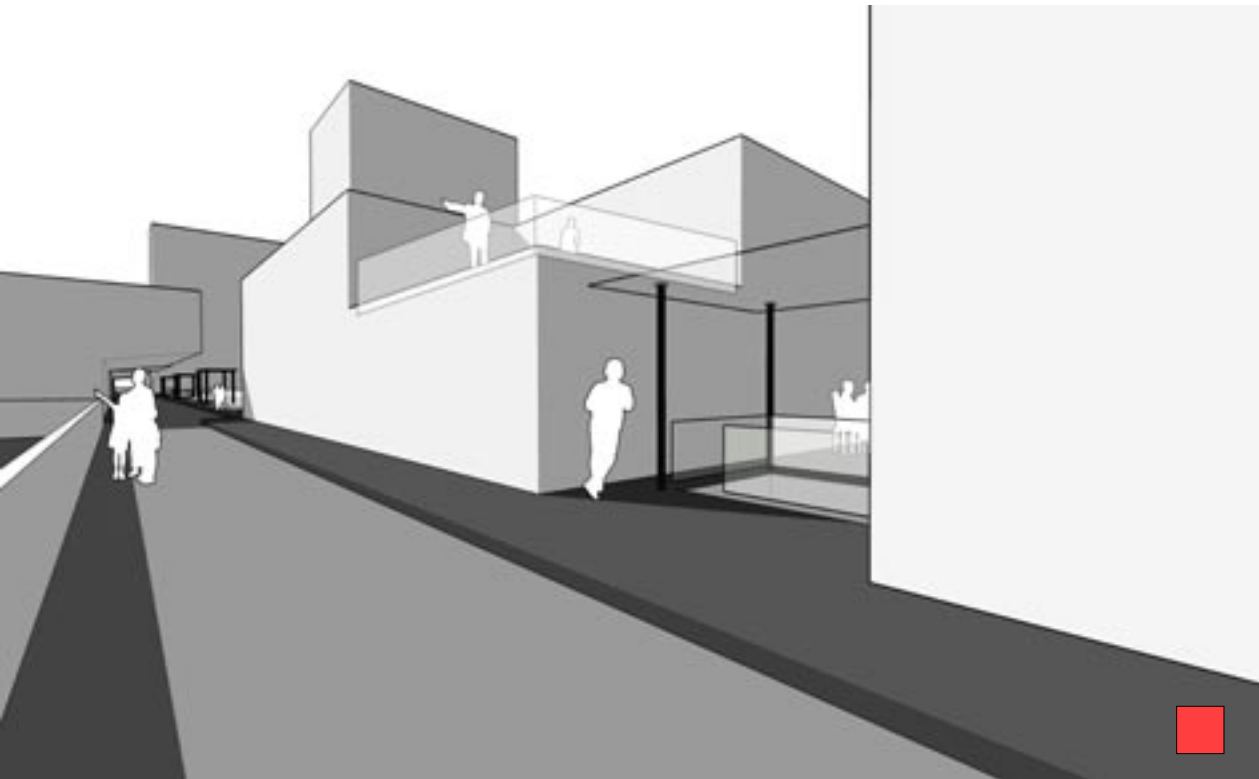


## Public Space - Small Public Spaces

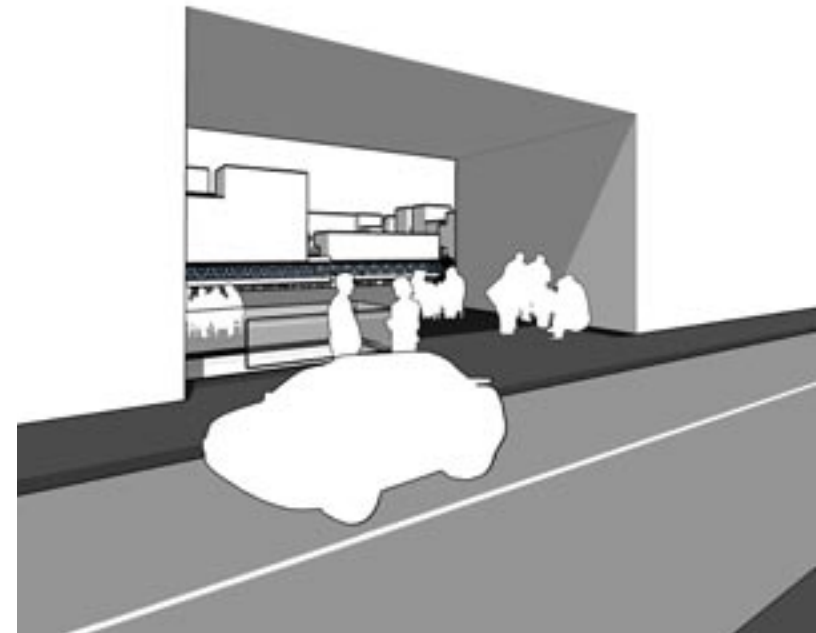
In Wuhan, many small corners and sidewalks are found occupied by seniors playing chess or random street vendors selling a variety of snacks. Although not intentionally designed to be used, these small spaces are important to the life of the city. The larger squares found on LOW serve to anchor the public life while the small public spaces help encourage more spontaneous and random activities.

The design of LOW and the development on the berm incorporates three types of small public spaces around the neighborhood to ensure the continuation of this unique urban life. Spaces between buildings (type 1) are ideal pockets for spontaneous usage as they give onto the water courtyards. At five meters wide, these spaces are often too small for larger gatherings but are sufficient for casual meetings or a small mahjong or dining table. In most cases these spaces will be appropriated for personal use by the residents in the immediate units because they are semi-en-

closed by the access staircase to the base units. Sheltered small spaces (type 2) found underneath buildings allow three to four small groups of people to gather. This size makes the spaces harder to claim as personal property, thus welcoming people from all around the neighborhood. Courtyards (type 3) are installed with small exercise equipment commonly found in parks. They encourage larger groups of gatherings and operate at a similar level of intensity as the ring squares and long squares. The courtyards for the high rise buildings on LOW are also surrounded by retail or office spaces, turning them into spaces that serve commercial functions as well as civic.

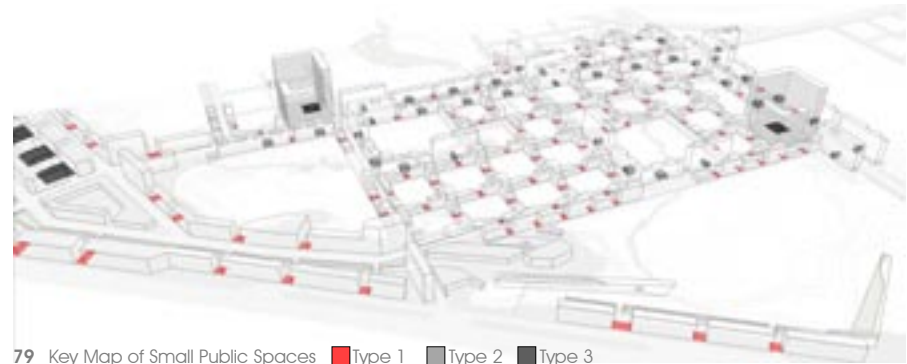


80 Small Public Space - Type 1.

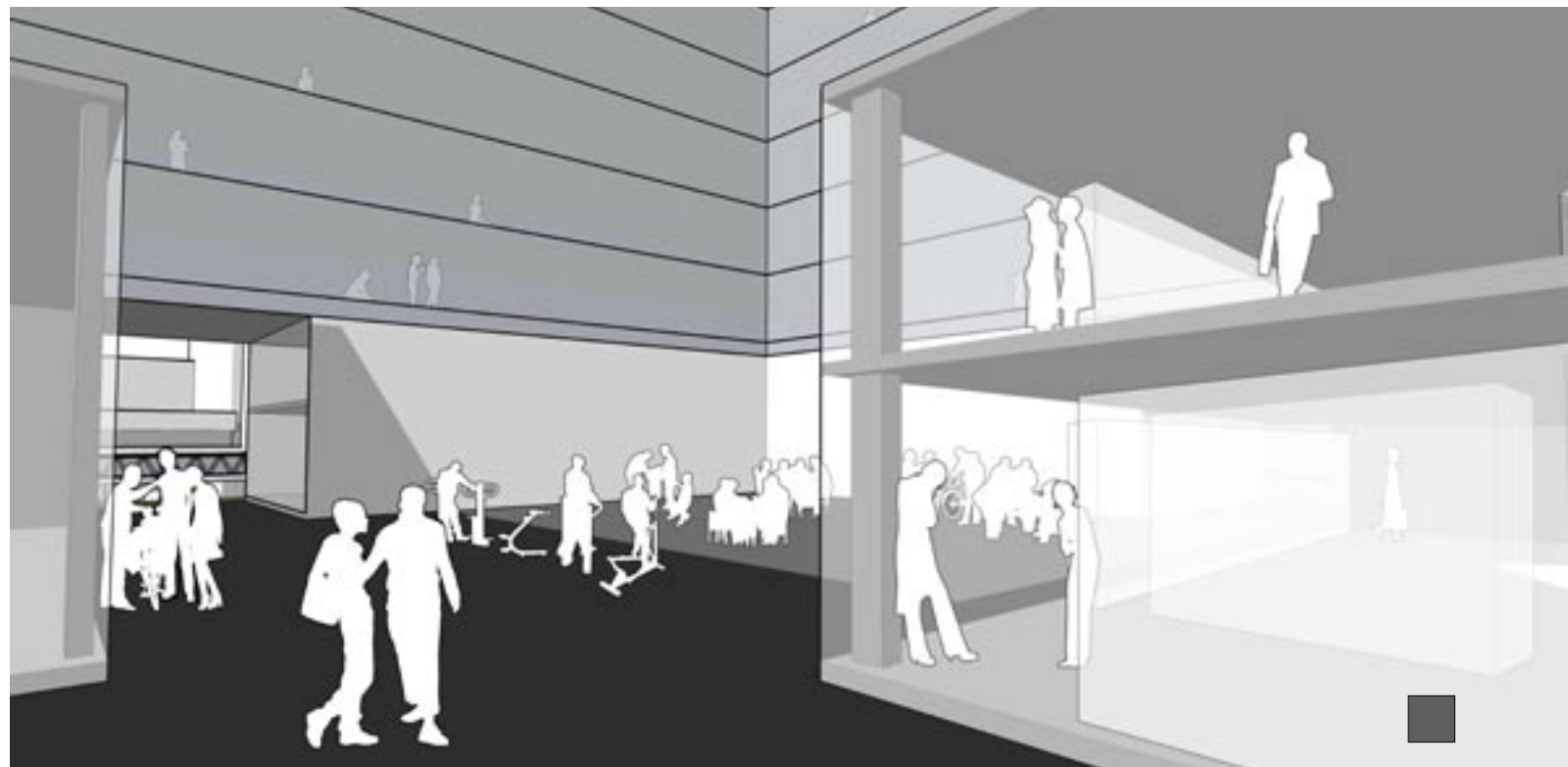
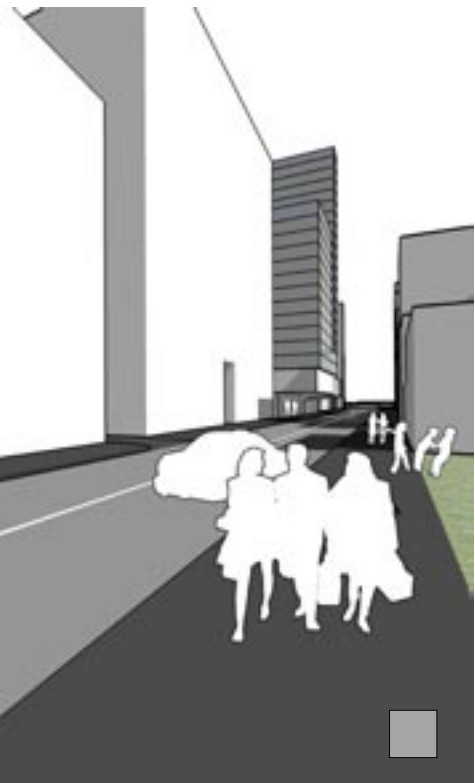


81 Small Public Space - Type 2.





79 Key Map of Small Public Spaces ■ Type 1 ■ Type 2 ■ Type 3



82 Small Public Space - Type 3.

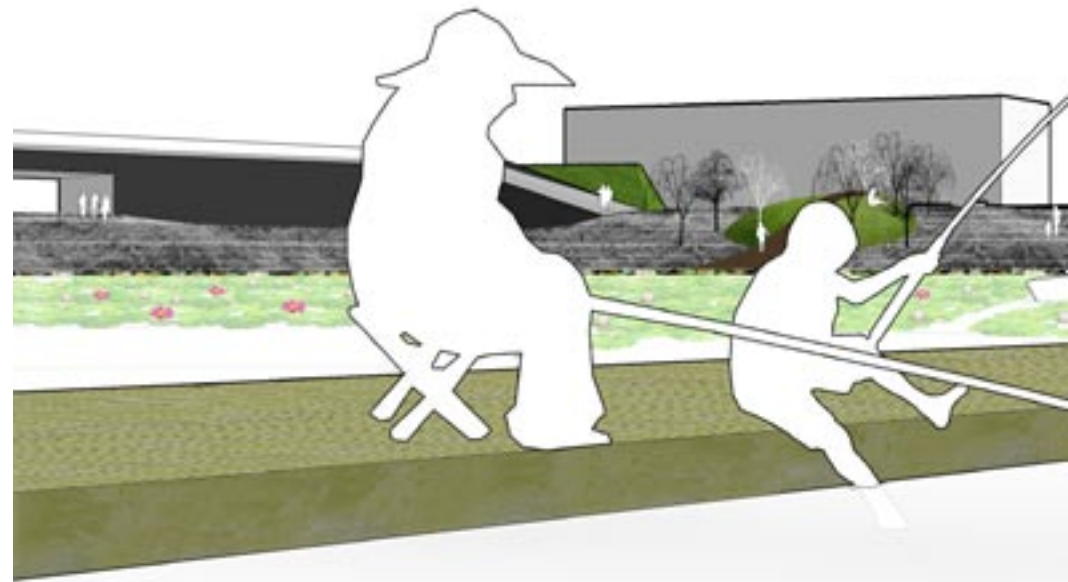
## Public Space - Recreational Boardwalk

The recreational boardwalk is one of the two routes that permit access to water. Contrary to its commercial counterpart, the recreational route is kept unobstructed for activities such as fishing, jogging, swimming or simply dipping one's feet in the water. The path also offers views of lotus farms as it reaches across the lotus field from above.

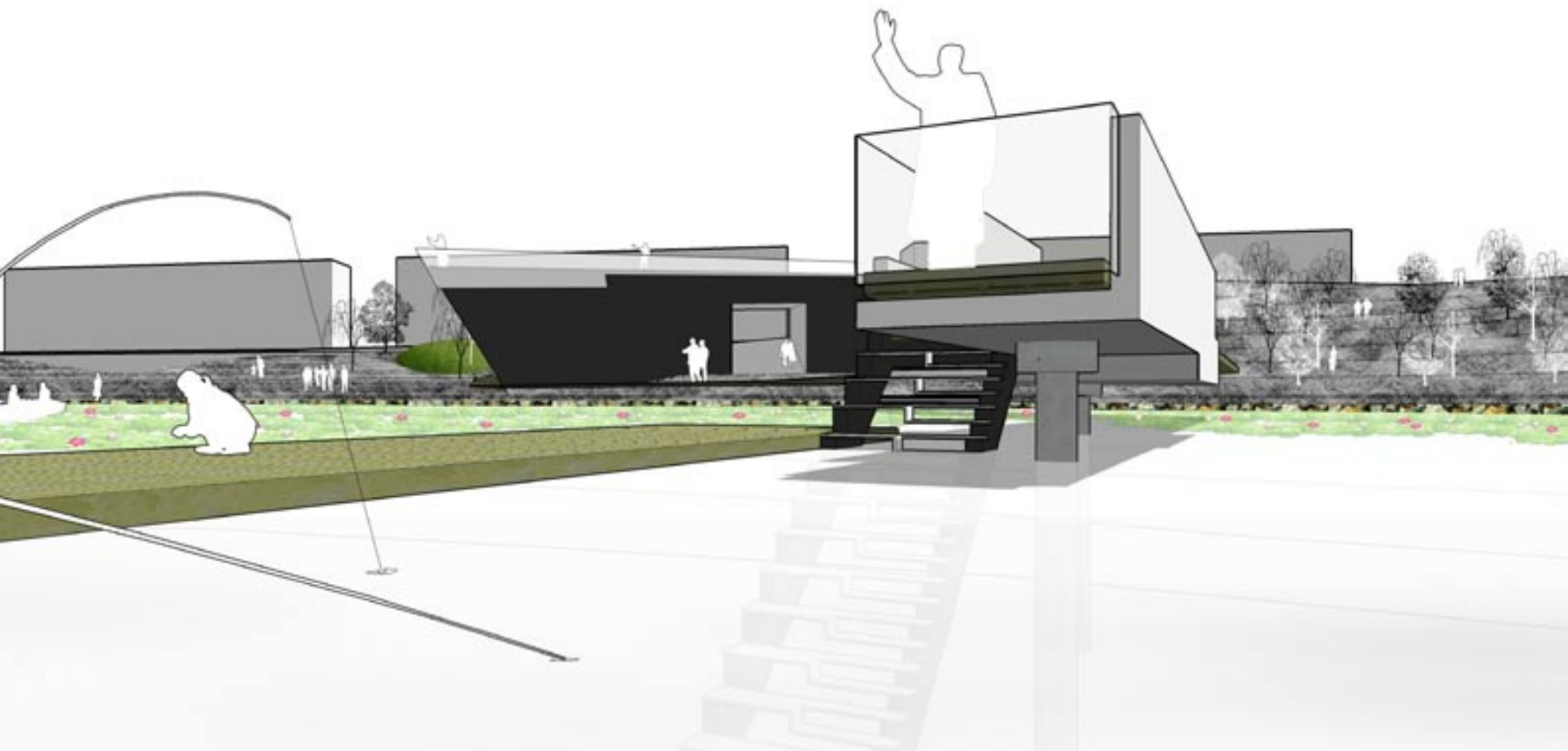
The boardwalk can be divided into two structural parts. The first part is on stilts, sitting one meter above the summer water level. It is an extension of a foot path at the shore of the lake. The second part of the boardwalk is the floating dock moored to the bottom of the lake. The structure rises and falls with the change of water level, making the water accessible at most times except during flood retention. A staircase with wide treads is designed to make the trip from the raised boardwalk to the floating dock easier.



83 Key Map of Perspective J.

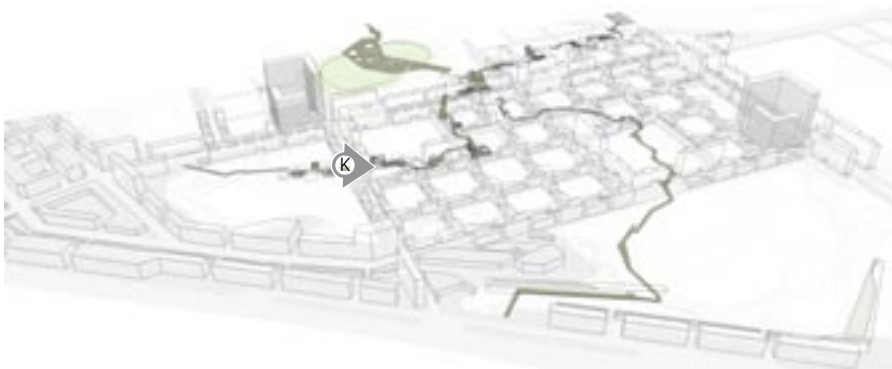


84 Perspective J - Recreational Boardwalk.



## Public Space - Commercial Boardwalk

Floating boutiques, restaurants, bars, and street vendors light up the commercial part of the boardwalk like lanterns on water. The floating structures activate the boardwalk into a busy entertainment district. Together with the night markets on LOW, the boardwalk forms a continuous flow of night life across the site.



85 Key Map of Perspective K.

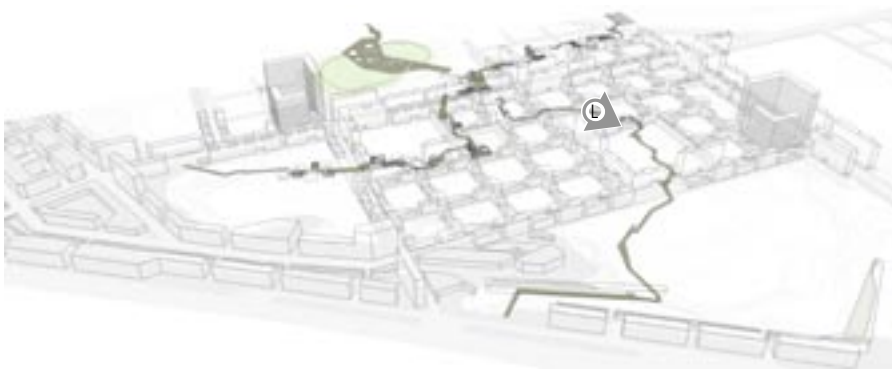


86 Perspective K - Commercial Boardwalk.

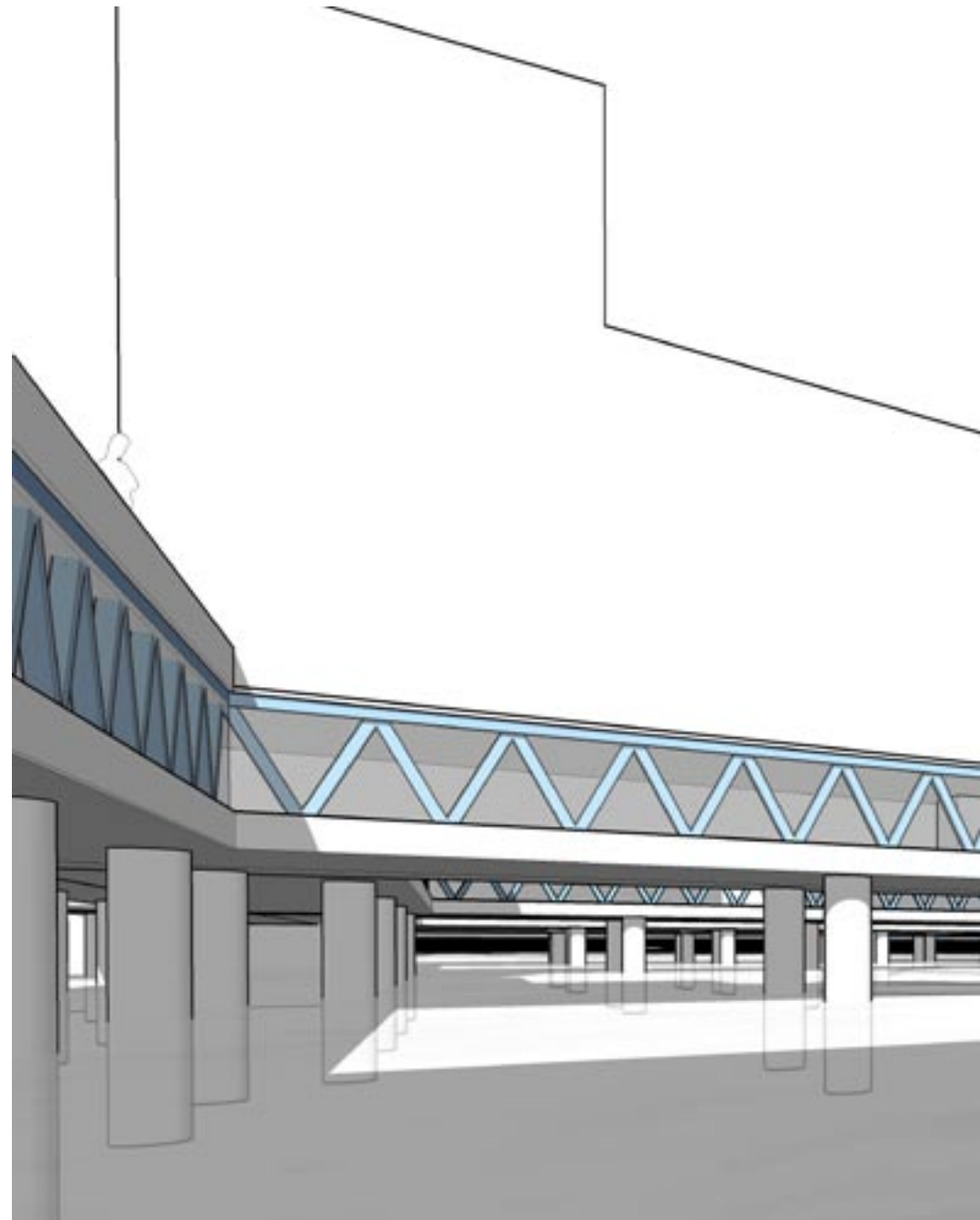


## Public Space - Connection to LOW

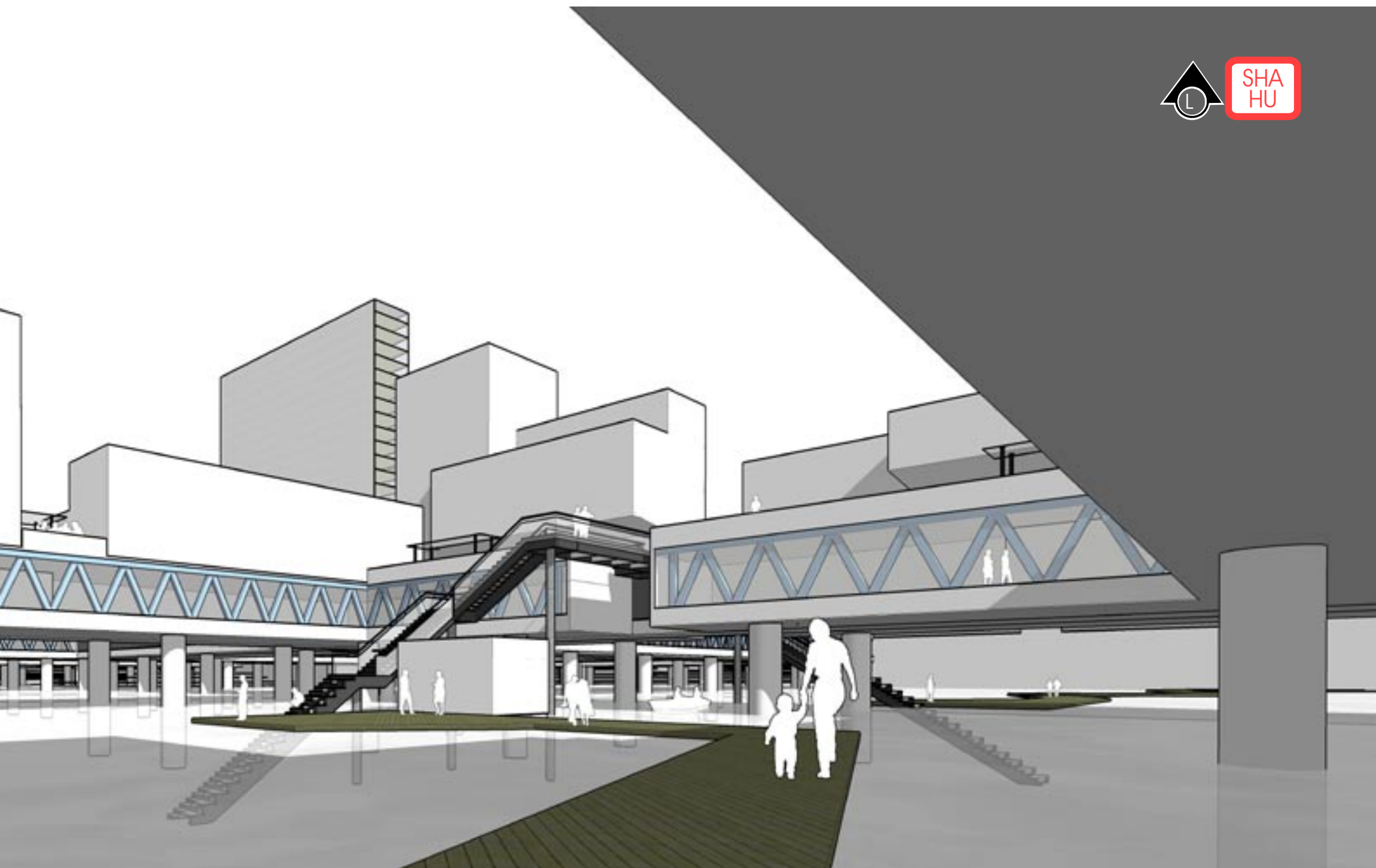
The boardwalk is connected to LOW by staircases that arch over the water similar to ancient bridges in Chinese canal towns. These points of connection also become the points of passage for boats traveling around the boardwalk.



87 Key Map of Perspective L.

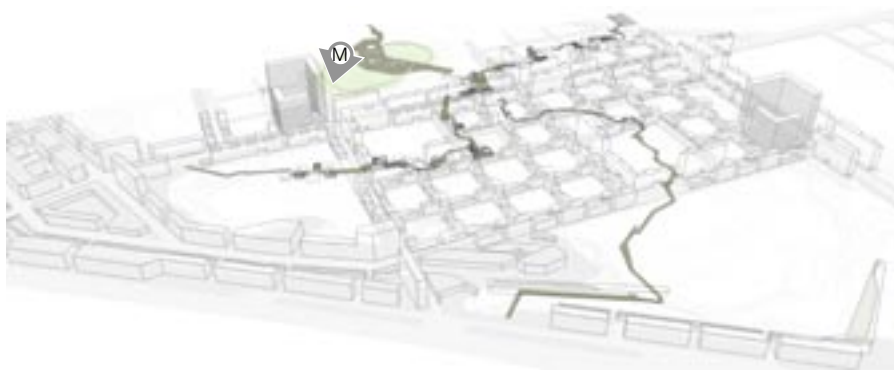


88 Perspective L - Connection to LOW.



## Public Space - Wetland Park

The two routes of boardwalk converge at the wetland park, bringing the people on the two paths onto a common place. The park is valuable because it is the only neighborhood space large enough to hold public events and large gatherings. It is ideal for bird watching enthusiasts and exercise groups. Although the wetland itself is off limits for ecological reasons, the display of a wetland ecosystem enveloped by the city is the most effective way to educating the public about the importance of our relationship to nature.

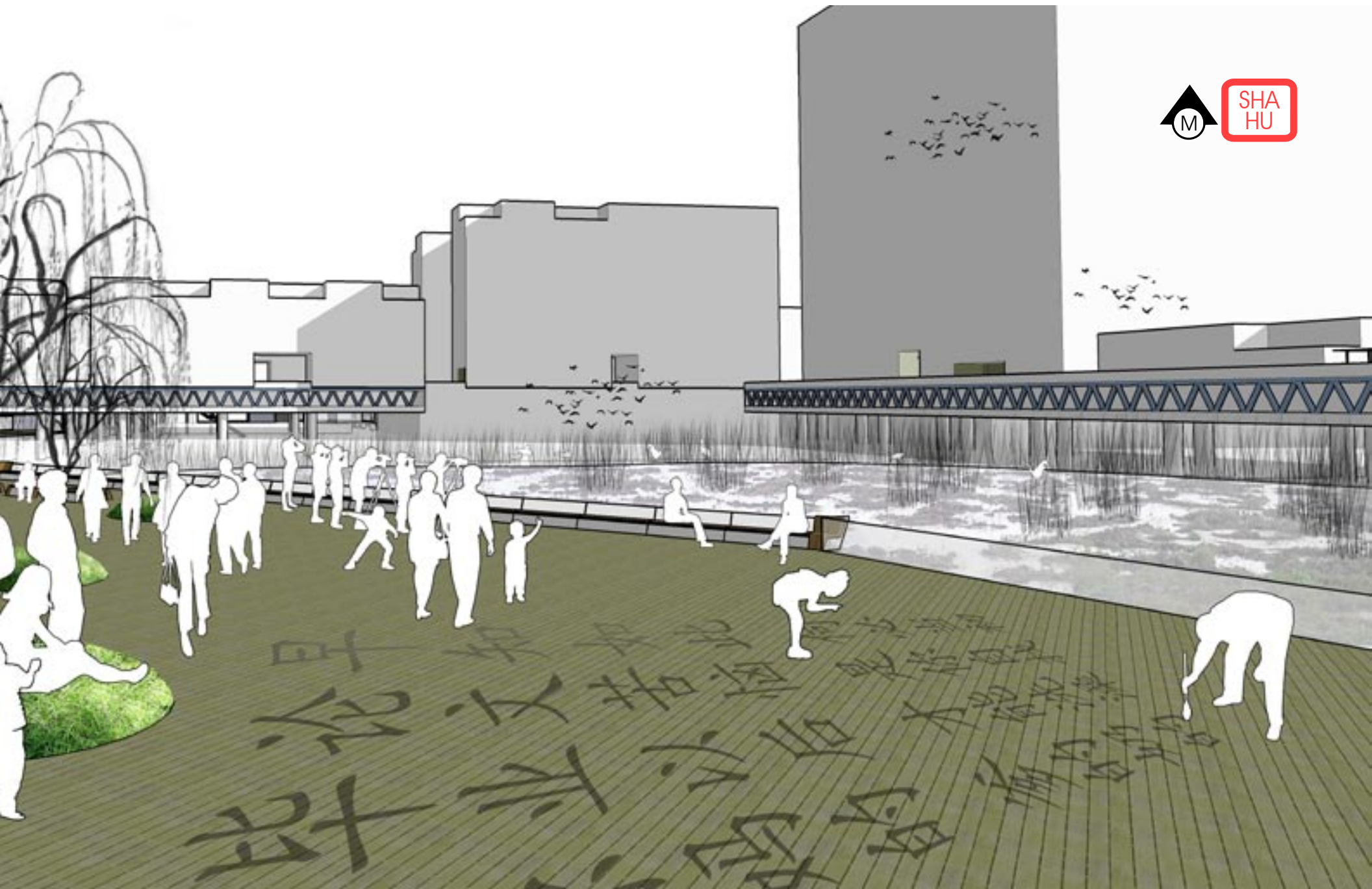


89 Key Map of Perspective M.



90 Perspective M - Wetland Park.







# Conclusion

## Evaluating and Projecting the Future of a Changing Environment

Many of the initial design proposals for this thesis were attempts to resolve the issues surrounding Lake Shahu as separate and isolated projects. The final proposal is based on a process of constant evaluation and projection of Lake Shahu's future. Eventually, the thesis' critical process was driven by the James Corner's idea of Landscape Urbanism which advocates the design of symbiotic relationships and transformative processes. The various issues that surround Lake Shahu, such as inadequate flood retention, pressure from urban development, communication, agriculture, and fishery problems, and maintaining a sustainable ecosystem, are commonly perceived as separate problems but the complex system analysis and a broad ecosystem approach reveals previously unconsidered layers of relationship between them, suggesting the possibility for an assemblage of symbiotic relationships that a design process could engage with better results. The thesis demonstrates this approach by designing a system of integrated infrastructures where the individual components help resolve their immediate issues as well as lending their instrumentality to other parallel and seemingly unrelated concerns.

The flood retention problem for the Yangtze is dealt with by the proposal of a reconnection canal, which is expected to evolve into a project that regulates water levels for the lotus farms in Lake Shahu. The new intervention also creates a city wide network for water transit, replenishes the lake water periodically, renews fish stock and increases biodiversity to strengthen the ecosystem's capacity to handle fluctuations in the food chain. As a component of the flood retention scheme, the flood berm increases the flood retention capacity of the lakes by creating an extruded buffer. The creation of the flood berm also provides land for urban development, forming an urban fabric that connects to the future extension of the Land Over Water project and establish accessibility to Lake Shahu. The Land Over Water (LOW) project addresses the issue of communication and transit within the city core as well as the pressure for urban expansion onto Lake Shahu. Designed to allow the penetration of sunlight to sustain the aquatic ecosystem, the structure of LOW also cuts back the excessive sunlight that encourages algal bloom and high humidity content in the microclimate. Grey water collected from LOW and the development on the berm are discharged into the lotus farms, feeding the crops with nutrients while utilizing their treatment capacity to relieve the burden on the local water treatment plants. The urban fabric of both LOW and the berm development is designed with small blocks and scattered public spaces to accommodate various kinds of social and commercial activities on site, creating a functioning neighborhood with a definite sense of

place.

Agriculture around Lake Shahu can first be used to treat the contaminated soil on site by raised bed phytoremediation. The ten years planned for the settlement and treatment of the soil will provide farmers employment opportunities, allowing them to gradually adapt to urbanization. Farmers who wish to continue working in the field can later become lotus farmers or fishermen. They will be educated with the skills and knowledge to manage the lake's ecosystem, transforming the practice of agriculture and fishery into active management. The presence of agriculture in the city also serves an educational purpose, informing the urban citizens of the food production process in relation to nature and well as altering the preconceived divide between the urban and rural environment.

As the build-out of the design is finalized, the initial critical process of evaluation and design projection should be re-initiated in order to incorporate some further insights that were unforeseen in the design process. The knowledge accumulated from the initial complex ecosystem analysis can serve as a base for this critical operation, anticipating the processes of transformation past the completion of the infrastructures and beyond their local effects.

The illustration of the flood retention capacity shows that the two proposed flood retention networks can only accommodate  $10\text{km}^3$  out of the  $18\text{km}^3$  that are not yet accounted for in the current flood diversion scheme of the Yangtze. The construction of the berm has to take vehicular and pedestrian accessibility into account if it is to stage a vibrant urban life and strengthen the role of the lakes as a destination in the city. With a 6 m tall berm, staircases and vehicular ramps with a 1 to 10 ratio can be designed with economy. In this proposal, urbanism is not to be sacrificed for the sake of flood retention. The remaining  $8\text{km}^3$  of flood water will be accommodated somewhere else in the Central Yangtze. Given the circumstances, the Jingjiang flood plain, which has now been settled upon, will have to be redesigned as a place for both flood retention and urban development. Restoration on the surface area of Lake Dongting and the possibility of a flood berm enveloping the area will also have to be considered.

Although the reconnection with the Yangtze will bring about many positive changes to the lake ecosystems, the problem of sedimentation will emerge as a potential threat at the confluence between the reconnection canal and Yangtze as silt entering the floodgate might eventually accumulate to block water passage. Periodic maintenance is needed to keep the system working but a comprehensive study before the construction of the floodgate would be advised. The study should analyze the change in the long-term hydraulic pattern at the

confluence, outlining the effect of sedimentation in relation to water flow and riverbed. The most crucial solution to the problem of sedimentation, however, is the reforestation of the banks at the upper Yangtze. The problem of soil erosion on the steep hills of upper Yangtze is directly linked to poverty and unsustainable practices of agriculture. A complex system analysis of the area will reveal the same pattern of intricacies shown in this thesis. Thus it is proposed that a similar approach of integrated infrastructures be designed for the area.

The rural population around Lake Shahu is an indispensable asset to the transformation of Lake Shahu as they provide labor for the construction of the berm as well as to the treatment of its soil. Their role as cultivators and managers of the farm and ecosystem in the future is also critical to the sustainability of the lake. 75% of China's population is rural. As Wuhan continues to urbanize, however, the rural population from around Wuhan and adjacent provinces will decline no matter how large the profit generated from the practice of agriculture is. Although the development on the berm can accommodate the existing rural population on site, the new wave of migration into the city will entail the construction of new communities in the vicinity. Further studies speculating the influx of a rural population will have to be prepared before development around the lake saturates.

Perhaps the most controversial proposal of the integrated infrastructures is the Land Over Water (LOW) project. The two most critical aspects of LOW that need further study are the effects of shade in relation to the sustainability of the aquatic ecosystem and the hydraulic behavior of the lake in relation to the supporting structures of LOW. Although empirical evidence from pond gardening suggests the positive effects of moderate shading, the ecosystem of Lake Shahu could still react differently due to unforeseen peculiarities of the system. Similarly, while under typical conditions the water flow around LOW's structure is expected to be relatively tame because it is controlled by floodgates, in times of flood, however, the increase of velocity and water depth could cause scouring around columns supporting the artificial platform. The twenty years leading up to the construction of LOW is of great importance since an isolated area of Lake Shahu could be dedicated to a long term study of a sample LOW section, providing scientific data for evaluating the future of Lake Shahu's ecosystem and hydraulic behavior. The thesis recognizes the potential risks involved in the construction of LOW but sees it as an important alternative that deserves exploration and study.

The centralized one-party political system of China is what enabled the construction of the Three Gorges Dam. So, the realization of this ambitious transformation at Lake Shahu is only possible under such a powerful political system. The Land

Over Water project, an unconventional design for the creation of artificial land, especially requires the political power of the Chinese Central Government in order that the legal issues of land ownership be controlled. The project, however, does not advocate the construction of a monotonous mega-structure uniformly designed and rigidly planned. The Land Over Water structure essentially is a surface on which responsible architecture can be extruded. Thus the planning of LOW is to ensure a variety of public spaces instead of a variety of building form.

The generic buildings illustrated in the design synthesis are only notional representations of massing in response to density and shade requirements. The architecture of the new city extension is expected to be a diverse, and somewhat eclectic collection of disparate styles as the small block structure of LOW and the berm allows the land to be divided amongst multiple developers catering to a variety of buyers. The Land Over Water system, though a modernist structure, is an entity neutral to architectural styling as the role of 'land' in a city functions only when it reserves judgment on aesthetics.

The evaluation shows Lake Shahu to be an adaptable urban, rural and natural environment. It also shows several aspects of the project that require further study for validation. An extended study on the upper Yangtze is also recommended since the root of Yangtze's flood and sedimentation problem lies in the region's poor economy. As the transformation continues, so does the relationship between people and the environment strengthen. Adaptation by active management, however, still has its limits as subtle phenomena and long term change can still escape observation. As management fails, large scale transformation is necessary at times. The intention of the design synthesis is to instigate a process of positive change and devise a system that is adaptable to change.

The sustainability of the environment requires a continuous study to reveal the changing relationships in the complex system. Only under constant observation, can active management and transformation be effective. The goal of transformation is to create a sustainable system with a long healthy life and the capacity for certain adaptation, rather than a static utopia. The critical pragmatism spoken of in the introduction is thus predicated on better informed decisions rather than perfectly informed ones. The longevity of China's current prosperity depends on a renewed understanding of its own environment and the shift of its focus from the present to the future.



# Appendix

## **Environmental Quality Standards for Surface Water in China**

<i>Grade I</i>	Standard expected of headwater and natural preservation areas
<i>Grade II</i>	Standard expected of water source intended for drinking, habitat for rare species, spawning ground for aquatic creatures, and fish nurseries
<i>Grade III</i>	Standard expected of water source intended for drinking, winter habitats for aquatic creatures, return routes for migratory fishes, aquacultural use and swimming
<i>Grade IV</i>	Standard expected of industrial use and recreational use with no direct contact to water
<i>Grade V</i>	Standard expected of agricultural use and scenic areas <sup>1</sup>



### **Ambient Air Quality Standards in China**

<i>Grade I</i>	Standard expected of natural preservation areas and scenic site
<i>Grade II</i>	Standard expected of residential areas, mixed use areas, cultural areas, common industrial areas and rural areas
<i>Grade III</i>	Standard expected of special industrial areas <sup>2</sup>

## Lotus

*Binomial Name* Nelumbo nucifera <sup>3</sup>

*Planting Season* Mid April to early May <sup>4</sup>

*Harvesting Season* Beginning in summer and fall, lasting up to 9 months.<sup>5</sup>

*Growing Conditions* Shallow still water no more than 1.2 m deep  
 Ample sunlight, stable water level  
 Soil rich in organic content  
 More than 20 cm of mud on top  
 3,000-5,000 kg / acre of grass to be mixed in with soil  
 1500-2000 kg / acre of organic fertilizer  
 Plow for 20 to 30 cm <sup>6</sup>



01 Lotus Plant Structure



02 Part - Rhizomes  
 Use - Soup, Stirfry, Desert



03 Part - Seeds  
 Use - Desert Ingredient



04 Part - Seed Head  
 Use - Dry Flower Decoration



05 Part - Stamens Petal  
 Use - Tea Garnish & Dessert  
 Whole Flower Religious Ceremony



06 Part - Leaves  
 Use - Wrapper for Rice Cakes



07 Lotus Root Soup



08 Lotus Seed Dessert



09 Sticky Rice Cake Wrapped in Lotus Leaves



10 Moon Cake with Lotus Seed Paste

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## Endnotes - Images

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- 37 Lake Shahu: photo by author.
- 38 Key Map of Lake Donghu: map by author.

39 Lake Donghu: photo by author.

40 Key Map of Nanhu: map by author.

41 Lake Nanhu: photo by author.

42 Key Map of Lake Moshuihu: map by author.

43 Lake Moshuihu: photo by author.

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01 Key Map of Lake Shahu: map by author.

02 Draining Pump at Lotus Farm: photo by author.

03 Lotus Farm in the Distance: photo by author.

04 Opening at Long Wall Surrounding Lake Shahu: photo by author.

05 New Park on West Side Lake Shahu: photo by author.

06 Remains of a Rural Lake Previously Connected to Lake Shahu: photo by author.

07 East Rim of Lake Shahu: photo by author.

08 Vegetable Plots on Sides of a dyke Surrounding Lake Shahu: photo by author.

09 Nets Strung Across Water to Prevent Fish from Escaping: photo by author.

10 Farmers Harvesting Lotus Roots from the North Portion of Lake Shahu: photo by author.

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21 No Visible Access to Lake Shahu: photo by author.

22 Current Land Use Around Lake Shahu – Residential / Commercial: map by author.

23 Current Land Use Around Lake Shahu – Institution / Administration: map by author.

24 Current Land Use Around Lake Shahu – Green and Recreation: map by author.

25 Current Land Use Around Lake Shahu – Water Management: map by author.

26 Key Map of Fishing Port: map by author.

27 Algal Bloom Near the Yujiahu Fishing Village at Lake Shahu: photo by author.

28 Fishermen Setting Out to Work: photo by author.

29 Key Map of Vegetable Plots: map by author.

30 Vegetable Plots Carpeting Both Edges of the Dyke: photo by author.

31 Two Seniors Scooping Eutrophied Water to Feed Their Vegetables: photo by author.

- 32 Key Map of Hidden Farm: map by author.
- 33 Remains of a Small Lake: photo by author.
- 34 Vegetable Farm: photo by author.
- 35 Key Map of lotus farm: map by author.
- 36 Farmers Gathering Their Harvest of Lotus Roots at the Collecting Point Before Sunset: photo by author.
- 37 Withered Lotus Plants in a Dried Pond: photo by author.
- 38 Key Map of Area 1: map by author.
- 39 Future of Lake Shahu's Water Front: photo by author.
- 40 Monotonous Line of Car Dealers Hiding Lake Shahu from Sight: photo by author.
- 41 Key Map of Area 2: map by author.
- 42 One of the Two Remaining Point Sources of Pollution is at Hubei University: photo by author.
- 43 Campus Park of Hubei University at North West of Lake Shahu: photo by author.
- 44 Key Map of Area 3: map by author.
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- 47 The Water Front Park Under Construction: photo by author.
- 48 Key Map of Area 4: map by author.
- 49 Single Family Dwellings Built Right up to the Wall at the Railway: photo by author.
- 50 Open Sewage Splits up Before Passing Under Railway Bridge: photo by author.
- 51 Key Map of Area 5: map by author.

- 52 Five Storey Courtyard Apartments on Site: photo by author.
- 53 The Pump Station on Dyke with Sluice Gate: photo by author.
- 54 Key Map of Area 6: map by author.
- 55 Wall Surrounding Lake Shahu: photo by author.
- 56 Replacement housing for Yujiahu Fishing village: photo by author.
- 57 Key Map of Area 7: map by author.
- 58 Scavengers Looking for Recyclable Materials in Waste Pile: photo by author.
- 59 Makeshift Shacks by Peasant Families Built on Landfill: photo by author.

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- 02 Ziyou Road: photo by author.
- 03 Section of Ziyou Rd. 1:500: drawing by author.
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- 03 Long Bench Along Water, Zhujiajiao, Jiangsu: photo by author.
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- 07 Dense Foliage Over Canal. Zhujiajiao, Suzhou: photo by author.
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- 09 Tourists Linger in the Sheltered Bridge. Zhujiajiao, Jiangsu; photo by author.
- 10 View from One Bridge to Another. Zhouzhuang, Jiangsu: photo by author.
- 11 Roofs Parted by a Thin Stripe of Light: photo by author.
- 12 Model Showing a Narrow Commercial Street: illustration by author.
- 13 A Sheltered Port from Across the Canal: illustration by author.
- 14 Tourists Resting in the Darkened Port. Wuzhen, Jiangsu: photo by author.
- 15 Model Showing Shaded Port Between Two Buildings: illustration by author.
- 16 Shaded Port in Wuzhen, Jiangsu: photo by author.
- 17 Children Swimming in the Water. Zhujiajiao, Jiangsu: photo by author.



- 18 Model showing water square: illustration by author.
- 19 Steps Around the Square Provide Seating. Wuzhen, Jiangsu: illustration by author.
- 20 A Busy Commercial Street End at the Water Square. Wuzhen, Jiangsu: photo by author.
- 21 Model Showing Pond: illustration by author.
- 22 Women Doing Laundry by the Pond. Hongcun, Anhui: photo by author.
- 23 Lotus Floating in Village Pond. Hongcun, Anhui: photo by author.

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- 01 Scheme 1 Dyke City: drawing by author.
- 02 Scheme 2 Tower City: drawing by author.
- 03 Scheme 3 Floating City: drawing by author.
- 04 Scheme 4 Land Over Water: drawing by author.
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- 06 A Balanced Lake Ecosystem: illustration by author.
- 07 Algal Bloom Begins: illustration by author.
- 08 Massive Algae Decomposition Deprives Oxygen: illustration by author.
- 09 System Collapses: illustration by author.
- 10 Shahu Food Chain – Eutrophified: illustration by author.
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- 12 Shahu Food Chain - Reduced Exposure to Sun: illustration by author.
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- 17 Proposed Sluice Gate at the Connection Between Lake Shahu and Yangtze: illustration by author.
- 18 Before Construction of the Flood Wall Along Yangtze: illustration by author.
- 19 After the Construction of the Flood Wall Along Yangtze: illustration by author.
- 20 The Proposed Reconnection with Yangtze: illustration by author.
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- 22 Disconnected Lakes: illustration by author.
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- 24 Water Level Before Reconnection: illustration by author.
- 25 Seasonal water levels: illustration by author.
- 26 Extreme water levels: illustration by author.
- 27 Types of Berm Formation and Land Use Strategies: illustration by author.
- 28 Current State of Lake Shahu: illustration by author.
- 29 Transformation Phase 1: illustration by author.
- 30 Raised Bed Vegetable Plots at the Top of the Berm: illustration by author.
- 31 Transformation Phase 2: illustration by author.
- 32 Transformation Phase 3: illustration by author.
- 33 Transformation Phase 4: illustration by author.
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- 35 Transformation Phase 6: illustration by author.
- 36 Transformation Phase 7: illustration by author.

- 37 Axo A - Detailed Area A 1:5,000: Illustration by author.
- 38 Section A - Flood Berm and LOW 1:500: illustration by author.
- 39 Axo - Density Distribution for Sample Development on Berm 1:5,000: illustration by author.
- 40 Perspective B – Park: illustration by author.
- 41 Pangen Grass 盘根草: photo by author.
- 42 Pangen Grass Detail: photo by author.
- 43 Pond Cypress 池杉 (*Taxodium ascendens*): drawing by author.
- 44 Peking Willow 水柳 (*salix babylonica*): drawing by author.
- 45 Chinese Wingnut 枫杨 (*Pterocarya stenoptera*): drawing by author.
- 46 Oriental Plane 悬铃木 (*Platanus orientalis*): drawing by author.
- 47 Chinese Tallow 乌桕 (*Sapium sebiferum*): drawing by author.
- 48 Bishop Wood 重阳木 (*Bischofia javanica*): drawing by author.
- 49 Hibiscus 木槿 (*Hibiscus syriacus*): drawing by author.
- 50 Axo - sample LOW development 1:2,000: illustration by author.
- 51 Axo small block 1:1,000: illustration by author.
- 52 Small Block Type 1: illustration by author.
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- 54 Small Block Type 3: illustration by author.
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- 56 Sectional Perspective D - Small Block 1:500: illustration by author.
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- 58 Sectional Perspective E - Medium Block 1:1,000.: illustration by author.
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- 75 Key Map of Perspective H: illustration by author.
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- 78 Perspective I - Tower Square: illustration by author.
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- 85 Key Map of Perspective K: illustration by author.
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- 87 Key Map of Perspective L: illustration by author.
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## Appendix

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