Alternative futures for a floodplain in Nanchang City, China
——Migrating birds' stepping stone, hydrologic retrofit and new urban residences

Table of Contents

Abstract

Landscape changes caused by rapid economic growth and broad scale rural-to-urban migration in China have contributed to significant degradation of natural ecosystems and loss of biodiversity in the past two decades. Nanchang City, the capital of Jiangxi Province in southeastern China, exemplifies the challenges of sustainable natural resource design and management implicit in a fast growing city. The city is situated in the floodplain of Poyang Lake, China’s largest freshwater lake and one that is characterized by a long history of frequent flooding. After the extreme floods in the Poyang Lake Region in 1998, the central Chinese government launched new policies to return reclaimed land to floodplains and the Poyang Lake, aiming to increase the lake size to its level in the 1950’s.The Poyang Lake Region attracts thousands of waterfowl each year including 95% of the world’s Siberian crane population. Due to loss of regional wetland habitat, migrating birds frequently visit green open space in the city. This phenomenon points to the importance of urban ecological design for Nanchang City.

This study investigates the landscape history and the development trajectory of Taohua, a 3,022-acre green field in Nanchang requested for a future urban district. Situated between the Gan River and Xiang Lake, Taohua is one of the two large green fields in the Nanchang urban scope and is protected from floods by levees. The predominance of agriculture and nutrient rich aquaculture precludes the full realization of Taohua’s ecological functions and services despite its undeveloped status. Ecological restoration and improved flood protection have to be considered at the same time because it is essential to the public that the future is safe from flooding Therefore, this thesis utilizes a normative scenario approach to invent and evaluate three plausible and socially and ecologically desirable futures, with the final goal of educating the public and provoking a conversation among stakeholders about what the future landscape *should* be. Three radically different scenarios focus respectively on 1) enhancing stepping stone habitat for migrating birds; 2) reestablishing the hydrological network with improved flood management; 3) accommodating increasing land demand for new residents. All scenario designs draw inspiration from Taohua’s landscape history and are based on explicit ecological studies. Each scenario creates a future with explicit rendered landscape images to facilitate future decision-making. These scenarios demonstrate the way in which normative approaches can clarify and emphasize different ecological and social goals in a complex urban context.

Chapter 1. Introduction

1.1 Urbanization in modern China

China has been the fastest-growing major nation for the past quarter of a century, and has recently become the fourth largest economic power in the world behind the United States, Japan, and Germany. According to China Yearly Macro-Economics Statistics (2007) since its 1978 launch of the economic reforms, the Chinese economy has realized an annual growth rate of 9.37% on average. The population of China also doubled from 0.6 billion in 1953 to 1.29 billion in 2003. The rapid industrialization along with rural-to-urban migration has created a boom in urbanization in China.

In the past two decades, China has been experiencing an unprecedented rural-to-urban migration in human history (Fettig et al. 2006, Chen et al. 2008, Deng et al. 2008). Each year, about 12 million farmers move to cities searching for opportunities. According to the Chinese Ministry of Agriculture, in 2004 there were 150 million farming labors surplus in China (Li 2006). It was expected that the total number of rural-to-urban migrants would have reached 300 million by 2010 (Lague 2003, Fernandez 2007). China will thus build new houses for nearly 400 million new city residents in the coming decades. The equivalent would be rebuilding all the houses in the U.S. in seven years (Fettig et al. 2006).


100 MILLION CHINESE ON THE MOVE

China's 'floating population' challenges the government and stirs resentment, 8A

CHINA
A look inside

By R. Jones, Sinopix

In transit: Migrant workers wait at Zhengzhou railway station to return to their countryside homes to celebrate the lunar new year.

http://www.southwestern.edu/~robertsk/chinamig.html, 2008

Urban areas of developing countries will capture more than 95% of the net increase in the global population. Nearly all the new megacities with a population of 10 million or more are in the developing world (Grimm et al. 2008). Urban sprawl experienced in the developed countries is being repeated in many developing countries (Burgess 2000).

The number of cities in China had increased from 69 in 1947 to 223 in 1980, and today it has tripled to 670 in less than three decades. According to United Nations statistics, China has 15 of the world's 100 fastest-growing cities with a million or more population (Normile 2008). If migrant workers are included, China’s real urban population can reach about half of its total population today. By 2020, the government estimated that this number could increase to 60%.

In China, rapid urbanization has caused severe degradation of natural ecosystems as well as loss of biodiversity. For example, 70% of the water in the Huai River, Hai River and Huang River basins, which supply almost half of China’s population, is polluted (United Nations Development Programme 2006). Forest cover only accounts for 16.5% of the country today. China is listed among the countries with the most threatened birds and mammals (IUCN 2002). Increased coal burning and fossil fuel consumption have contributed to serious air-pollution and public heath issues. For example, total carbon emission from solid-waste treatment increased nearly threefold from 1990 to 2003 in Beijing, the capital of the country (Xiao et al. 2007).

In the early 1990s, the City Planning Act came into effect in China aiming to control urban expansion into the rural area through creation of small satellite cities connecting to the major metropolitan cores with compact transportation corridors. However, these policies soon were overwhelmed by the soaring development pressure.

Facing the condition that China now accounts for half of all new construction in the world (Fernandez 2007), landscape architects and urban planners are challenged by the tension between urgency of protecting the natural ecosystems and the increasing demand for residential and commercial space catalyzed by the booming economy. The expansion is expected to continue in the coming decades. These challenges also offer opportunities for creative and ecologically conscious design solutions.

“With so many cities growing so rapidly, China is already a laboratory for urbanization. Now it is poised to become an experiment in innovative urban planning as well” (Normile 2008). With such a rapid pace of growth, the socioeconomic and ecological rewards from a shift of development trajectory may be evidenced in a relatively short period of time. A transformation from conventional resource-intensive development to sustainable development is desired and the sooner these creative changes for sustainability launch, the more the society and nature will benefit. If we think of fast developing China as an arrow on the string ready to shoot a target, a tiny correction of the aiming direction with relatively little effort will help avoid an undesirable target. Otherwise, much effort will be needed to move to the desirable target once the arrow is released. Like any systems, social-ecological systems have multiple stable states. Some of the changes are irreversible such as species extinction and global warming. We shall not wait until the system has reached a threshold. More strategic approaches with respect to multiple stable states and thresholds will be discussed in the methodology section.

1.2 Site context and history

Nanchang, the capital city of Jiangxi province, is located in southeastern China (Figure 1.1). The city was first established in the lower Gan River delta during the West Han Dynasty, more than 2,200 years ago.

Figure 1.1. Nanchang City, Jiangxi Province in China

Jiangxi province, adjacent to the major economically booming areas in China, including the Pearl River delta to the south and Zhejiang province to the east, was famous for its political history of communism.

The major economic source in Jiangxi is agriculture, with top crops of rice and tea among others. Industries have become increasingly prominent in the economy in the recent years. Frequent flooding in the Poyang Lake Region imposes significant negative impacts on the regional economy. However, the capital city, Nanchang, has experienced a very strong economy and urban population growth in the last two decades (China Census Data 2005).

Earliest historical events of Nanchang in literature:

- 58 AD (the Han Dynasty): The earliest record of a hydrological project in the Poyang Lake Region. Yuzhang town (Today's Nanchang historical district) was built with a manmade lake in town connected directly to the river channel. The lake was designed as a retention pond to temporarily store flood from the river.
- 423 AD (the South Song Dynasty): the retention lake was separated from the major river channel by a controlled gate because of inadequate storage capacity. Over flow frequently occurred during the summer. Since then water was manually carried out during inundations and the gate remained closed during floods.
- 622 AD (the Tang Dynasty): Yuzhang town was renamed Hong City, which literally means City of Flooding in Chinese.
- 675 AD: As the first major construction on an elevated location in the floodplain, historical landmark architecture Teng-Wang Pagoda was built on the east bank of Gan River (Figure 1.2).
- 772 AD, (the Tang Dynasty): the earliest record of severe flooding in Nanchang (Chen et al. 1997)

Figure 1.2. TengWang Pavilion on the east bank of Gan River as a landmark (www.panoramio.com 2007)

1.2.1 Hydrology & land development

Situated 25 miles northeast of Nanchang City, Poyang Lake in Jiangxi province is the largest freshwater lake in China, formed as a fluvial lake around 6000 years ago. Today the Poyang Lake watershed spreads 162,225 km^2 and covers up to 94.04% of the province. The water level and size of Poyang Lake both fluctuate greatly multiple times within a year. During the dry season in the winter, the lake surface shrinks to less than 3,000 km^2 and in the summer months, it can grow up to 4,000 km^2 (Figure 1.3)

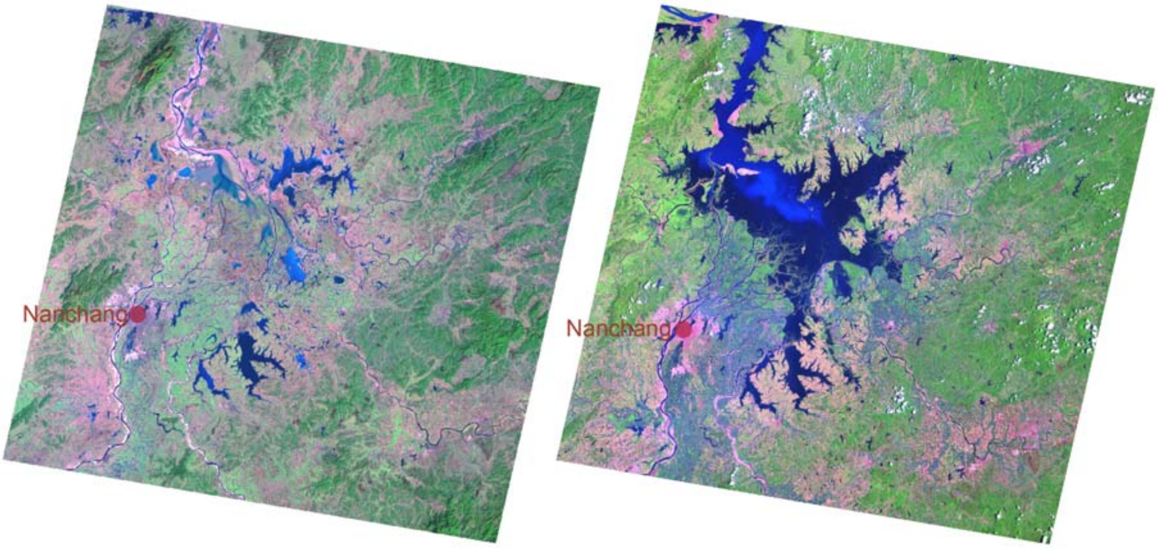


Figure 1.2. Landsat image of Poyang Lake in 2004: left) winter ; right) summer

In Jiangxi province, Gan, Fu, Xin, Rao, and Xiu rivers, often referred as five fingers by the locals, meander through the broad and relatively flat alluvial area into the Poyang Lake from the southwest, south, southeast, east, and west respectively (Figure 1.4). Among them, the Gan River accounts for 55.5% of the total discharge to the lake. It also carries the greatest sediment load. Over the course of history, a large delta plain has formed from the sediment deposited by Gan River on the southwest of the Poyang Lake where Nanchang city sits today. The region immediately surrounding Poyang Lake and along the five rivers are mainly wetlands and floodplains. The mountains are in the west of Nanchang city.

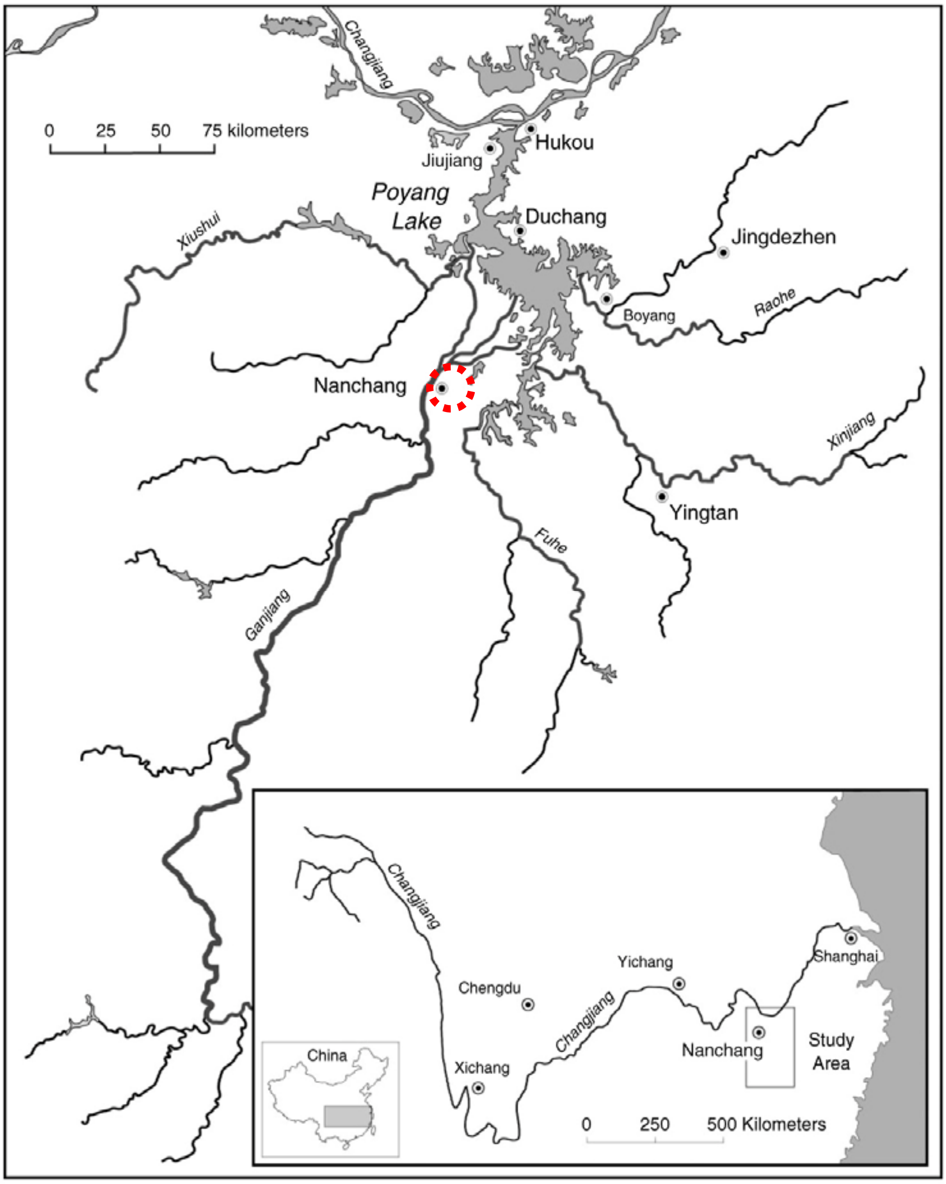


Figure 1.3. Poyang Lake, Yangtze River (Changjiang) and the five Jiangxi rivers (Adapted from Shankman et al 2006)

Poyang Lake receives discharges from these rivers and in the north it drains into Yangtze River, the third longest river in the world. When the peak flows from the five Jiangxi rivers meet the peak flows from Yangtze River, severe floods occur when the water level reaches beyond the Poyang Lake limit. This often results in a back flow from Yangtze River into Poyang Lake. Therefore the five Jiangxi rivers together with Yangtze River determine the water level in Poyang Lake. Back-flow further upstream along the Jiangxi rivers can also cause significant damage to the upstream lowland area.

With a strong belief in technological progress, decision makers of the City of Nanchang once believed that the natural ecosystems could be fully understood and flooding could be successfully controlled. In recent history, the development trend was to construct more hydrologic engineering projects and to reclaim as much land from the floodplain and the lake as possible. However, the reality is that flooding frequency has increased through history.

The lake area was once up to 6000 km2, including most of the area in the Gan, Fu and Xiu river delta today. Through history, natural hydrological evolution and anthropogenic activities have greatly changed the ecosystems and the landscape. With increased soil erosion along the rivers and sediment load into the lake, the lake bed has risen and the water surface area has shrunk (Figure 1.5)(Jiang 2006).

Figure 1.4. Comparison of the size of the Poyang Lake: left) 600's; right) 1970's (Adapted from Jiang 2006)

Today, Poyang Lake and Dongting Lake are the only two large lakes that still maintain free hydrological connections to the main river course of the Yangtze River (Figure 1.). Most of the lakes along the Yangtze River were disconnected from the river by damming or levee construction during the 1950 -1970's (Wang and Liang 2001). Therefore, these two lakes play critical roles in maintaining hydrological connectivity and retaining peak flow from the Yangtze River.

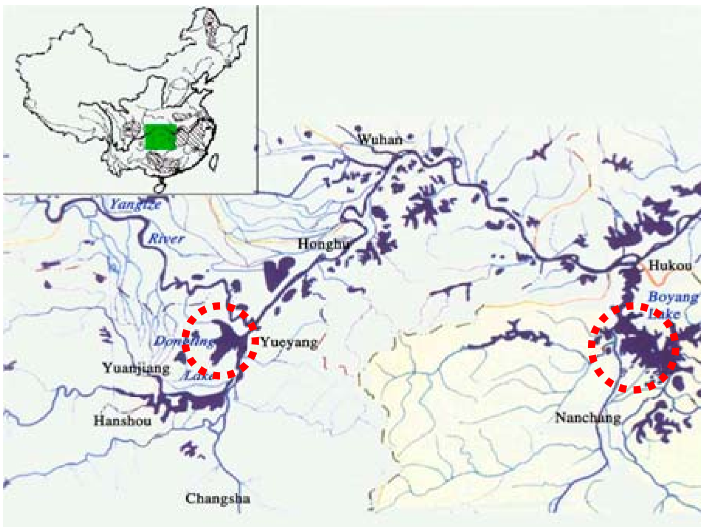


Figure 1.6. Poyang and Dongting are the only two large lakes that are still connected to the main river

course of the Yangtze river

The historic JiuJiang* census indicates that on average flooding happened every ten years from the 12th to 14th century; every four years from 15th to 17th century; and more frequently than every three years since then. In the past few decades with detailed hydrological records from the 1950's, annual severe flood events have increased dramatically. In the Poyang Lake Region, severe flooding was recorded in 1991, 1993, 1994, 1995, 1998, and 1999, at an average interval of 1.7 year. In Nanchang city, the frequency and severity of flooding events have also significantly increased (Figure 1.7)(Figure 1.8)(Figure 1.9), primarily due to levee construction and land reclamation at the periphery of the lake and the rivers.

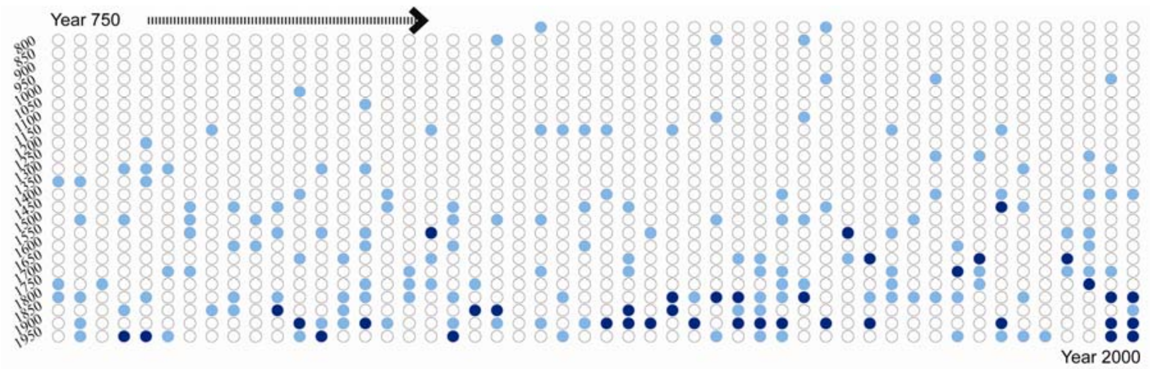


Figure 1.5. Distribution of flood events from 772 to 2000 in Nanchang, China. Each circle represents one year with light blue indicating a recorded flood event and dark blue indicating a severe flood event with broken levees. Each row is 50years.

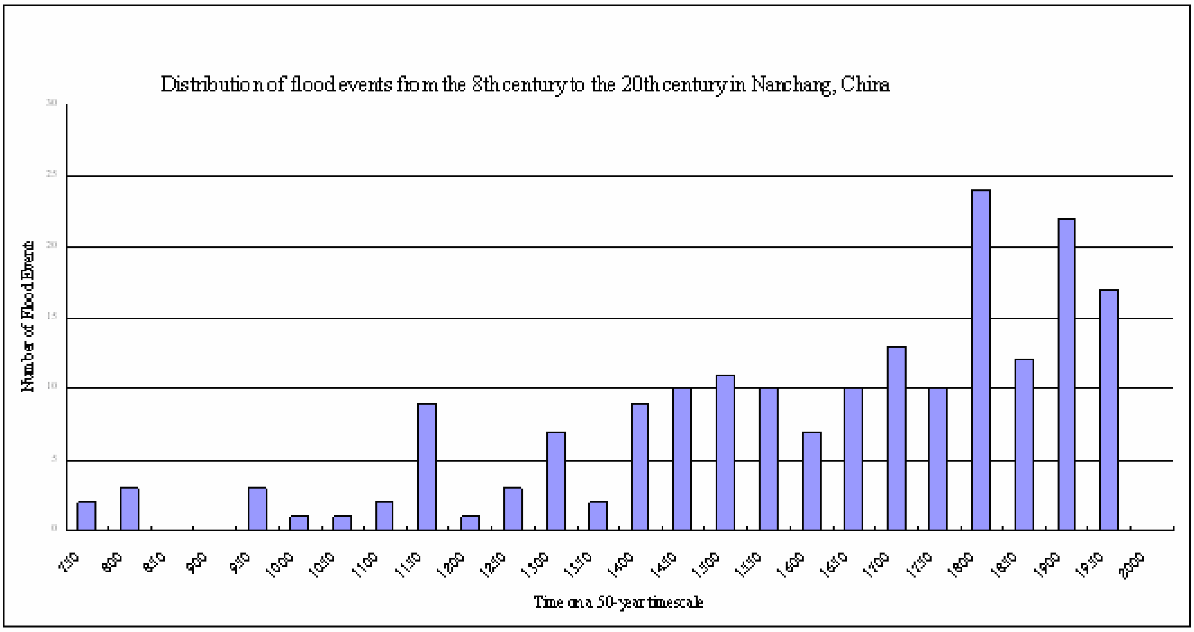


Figure 1.6. Distribution of flood events in Nanchang City, China from 772 to 2000 on a half-century timescale

* Note: JiuJiang is a city 100 km downstream in the Poyang Lake Region

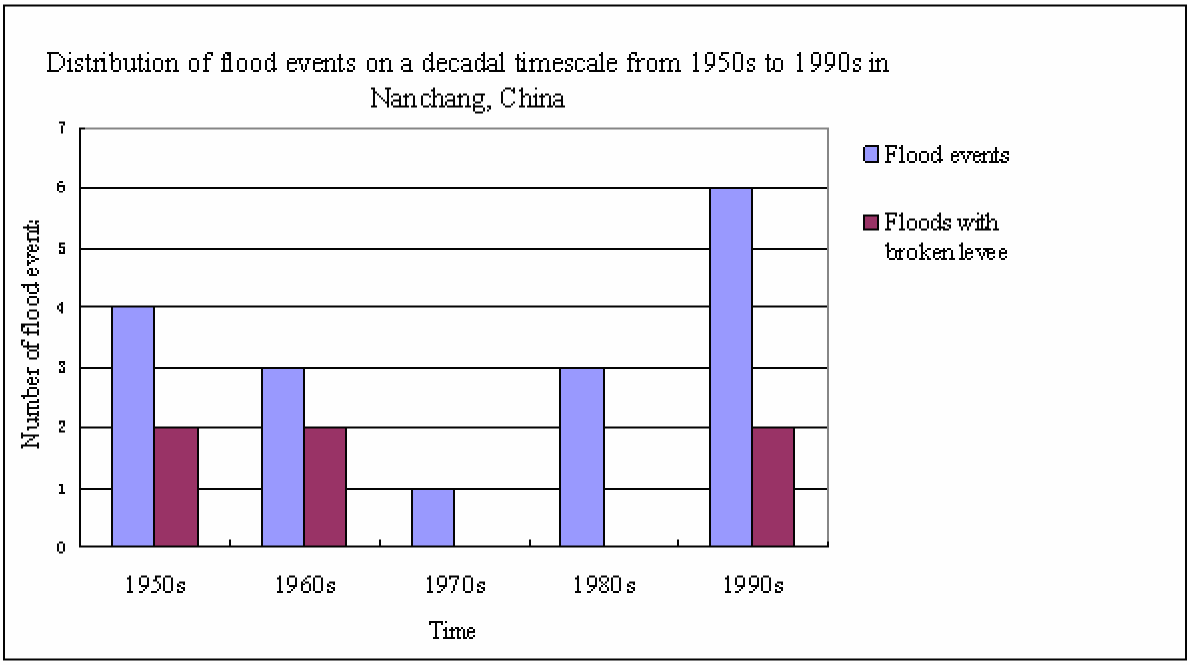


Figure 1.7. Distribution of flood events in Nanchang, China from 1950 to 2000 on a decadal timescale

Most of the land reclaiming activities occurred before the 1980's and since PR China was established in 1949. In the 1950's, 394.9km^2 was reclaimed. The reclaiming activities peaked in the 1960's with 793.4km^2. The trend started falling down in the 1970's with still 211.7km^2 reclaimed. The reclaiming activities have been regulated and controlled since the 1980's with 66.93km^2 converted to agricultural and urban land. From 1954 to 1995, the Poyang Lake surface area was reduced by 1466.93km^2. The volume decreased 8.5 billion m^3 which contributed to a 20% loss of the flood storage and retention capacity (Chen et al. 1997)

The history of levee construction in the Poyang Lake region can be tracked back to the East Han Dynasty more than 1000 years ago. In recent history, extensive levee-building began after the severe flood event in 1954. The levees also caused a 14% increase of sediment discharge from the Jiangxi rivers into Poyang Lake due to denaturalization of the river banks (Shankman and Liang 2003) and caused the lake bed to rise 9cm per decade (Min and Wang 1994).

The extensive levee system protects a large urban and rural population. The length of the levees has grown from 3100 km in 1950 to more than 6400 km today protecting 10000 km^2 of farmland and 10 million people (Chen et al. 1997). The levees today are not only longer but also higher. The annual average maximum stage for Poyang Lake is 19.2 m. Major severe floods occur when the lake stage exceed 20.5 m. The largest floods in the last century were recorded in 1954 and 1998 when the lake stage reached 21.8m and 22.4m respectively. The average level of the annual maximum stage has also increased from 18.5m in the 1950's to 20.4m in the 1990's when the lake stage exceeded 20m four times.

However, constructing levees is not a sustainable way to solve the flooding problem. These levees greatly reduce the floodplain area that would otherwise be available for floodwater storage. As a result, higher and quicker peak flows move from the Jiangxi rivers to the lake, causing high lake stages from late spring to early summer. Due to the land reclamation for high density settlement in the Gan River and Fu River delta region, the levees have been moved closer and closer to the riverbanks and lake shores.

Despite of their immediate effectiveness for preventing floods from spreading out across the floodplain, levees can drive the social-ecological system into a feedback loop. The feedback between the elevated lake stage and demand for higher and stronger levees may contribute to the collapse of the system (Figure 1.10).

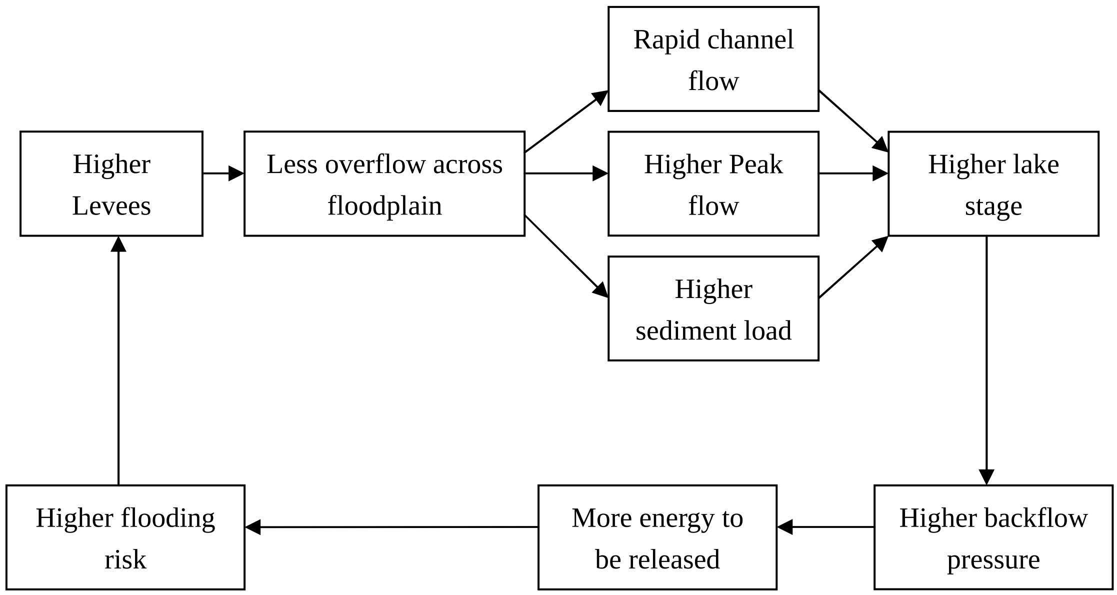


Figure 1.10. Model of positive feedback between lake stage and levee height

The model above might be able to explain why Nanchang has experienced a pattern of increasing flooding frequency despite the fact that more and more effort has been put in levee improvement with new material and technologies. Lessons have been learned from the catastrophic levee failures in 1998. Similar lessons have also been learned in other parts of the world. In the Rhine delta in the Netherlands, the floodplain was regularly flooded due to dike breaches in the near history as the results of a combination of the decreased discharge storage capacity and the relatively poor condition of the river dikes (de Vaate et al. 2006)

In 1998, the flooded area in the Poyang Lake Region was 244 km^2. Ninety-three cities, 1787 towns, and 4.4 million people were affected by the floods. 2.6 million people were relocated during the floods; 313 people were reported dead; and 910,000 rooms were destroyed. The direct economic loss was 4.71 billion US dollars (Ma et al. 2004).

The numerous new dams being constructed along the rivers in the region and the Three-Gorges Dam on the Yangtze River upstream of Poyang Lake may change the peak flow timing and contribute to increased flood risk in the area (Shankman and Liang 2003). The Three-Gorges Dam will potentially cause the peak flow to appear earlier in summer months (Liu and Wu 1999) when it is more likely to meet the Jiangxi rivers' discharge peaks. This will slow down the discharge from the five Jiangxi rivers into the Poyang Lake. In the worst case, raised lake stage will cause water to back flow into the five rivers and create severe floods in the upstream floodplains with dense settlement.

In the record of the past few decades, all of the severe floods in the Poyang Lake region occurred during or in the months following El Niño events (Shankman et al. 2006). The Poyang Lake region is where warm and moist air confronts cooler air. This climate pattern forms frequent spring and summer storms. Big storms are among the major contributors to inundation and flooding in the region. The frequency of El Niño has increased during the past few decades. With global climate change, the effects of El Niño will more likely to have stronger impacts on this region although the direct link between El Niño and flooding pattern in the Poyang Lake Region has not yet been studied.

After the extreme floods in 1998, the central Chinese government announced new policies responding to the vulnerability of the local ecosystems with the goal of increasing the lake size back to its level in the 1950's. The new policies applied two different strategies to completely or seasonally return the reclaimed land back to the floodplains or the lake (Jiang 2006). Depending on its location and adjacency to the water body, the land was categorized with different restoration strategies. Other practices include planting trees on the mountain, returning highland crop land to forest, and removing part of the levee to store floodwater. The focus of the new policy was to relocate the residents in the floodplain where there had been frequent flooding to the higher area and to restore the floodplains' ecological functions.

However, a recent study indicated that overall reclamation of wetland for urban use is still dominant in the Poyang Lake Region, especially in the lower elevation area that is close to water bodies (Jiang et al. 2008) (Figure 1.11). The elevation of the project site ranges from 17m to 23m, corresponding to the peak transition from wetland to urban land use that is illustrated in figure 1.11.

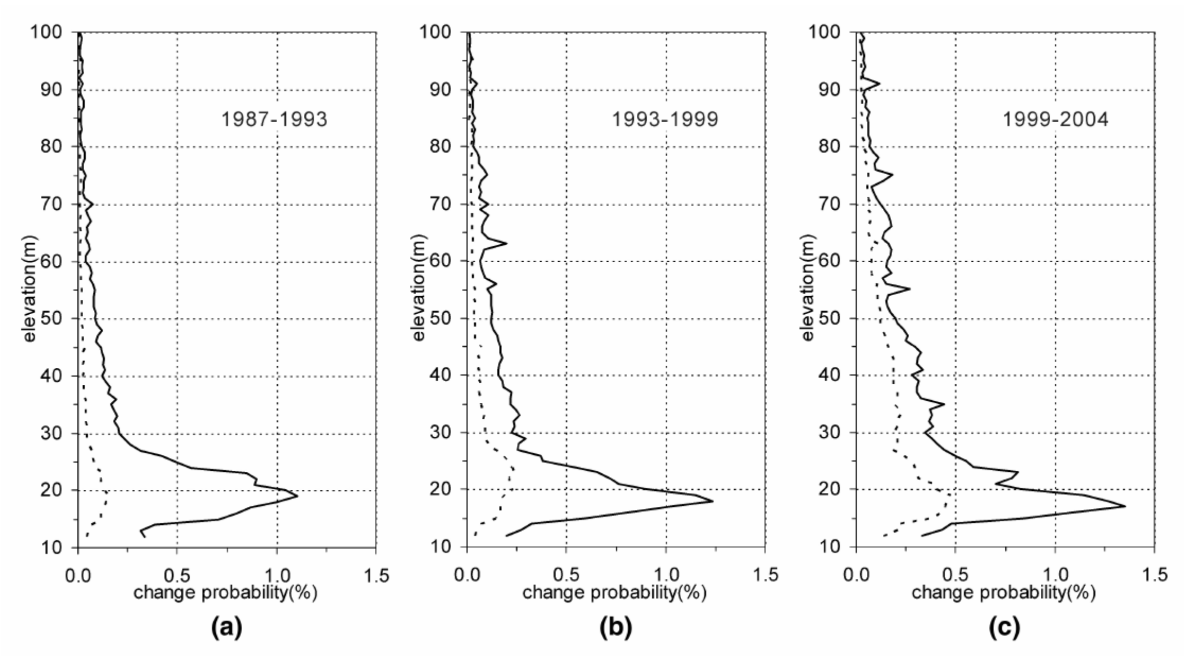


Figure 1.81. Land use change probabilities between wetland and urban area in the Poyang Lake Region (solid lines indicate wetland to urban; dashed lines indicate urban to wetland) (Adapted from Jiang et al, in press).

1.2.2 Biodiversity

The extensive wetlands around Poyang Lake provide valuable ecological functions and services. Besides being a buffer zone for flooding, they also provide habitat for numerous wild birds, of which 13 are listed for international protection. Every year Poyang Lake attracts thousands of waterfowl. It is a world famous wintering ground for a number of world-endangered bird species including about 3,000 Siberian Crane, *Grus leucogeranus*, 95% of its world population. Other rare and endangered species include Swan Goose *Anser cygnoide*, over 5,000 recorded once recently, Oriental White Stork *Ciconia boyciana*, and White-naped Crane *Grus vipio*.

In August, 1992, China signed the *Convention on Wetlands of International Importance especially as Waterfowl Habitat (Known as Ramsar Convention)*[†]**.** The Poyang Lake Region was among the first key wetland preserve areas in China, and is on the list of wetlands of

[†] The Convention on Wetlands, signed in Ramsar, Iran, in 1971, is an intergovernmental treaty which provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are presently 158 Contracting Parties to the Convention, with 1721 wetland sites, totaling 159 million hectares, designated for inclusion in the Ramsar List of Wetlands of International Importance.

International Importance in the Ramsar Convention. China has increased its nature reserve area to about 13% of the nation's area in the last 20 years, and is aiming to reach 15% by 2010 and 20% by 2050 (Liu et al. 2003).

The majority of the bird species in this region live in marshes, wet grassland and alluvial floodplains with shallow water. Vegetation composition in the floodplains varies with water level through the year. During low water level seasons from fall to winter, massive wetlands emerge with *Podostemaceae* and *Phragmites* plants. When water level rises to merge the wetland from spring to late summer, growth of this plant community is replaced by a community dominated by *Potamogeton malaianus*, *Vallisneria asiatica* and *Hydrilla verticillata*. This alternating vegetation composition pattern provides ideal habitats for migrating waterfowl in the winter when vegetation with emerging wetland and underwater organisms provide both living refugee and food sources to the birds. Roots of *Vallisneria asiatica, Acorus calamus,* and *Cates sp.* were found to be the main food for the swan gooses and the leaves of *Carex sp.* was the main food source for white-fronted (Chen et al. 1997).

Fish and small aquatic invertebrates are important food sources for the water birds too. For aquatic wildlife, it is essential to ensure free passage in river systems to allow the natural migration of fish and all other aquatic organisms (Weyand et al. 2005) Dam and levee construction has contributed to the loss of these habitats. Hydraulic connectivity is critical in maintaining aquatic biodiversity (Zhu and Zhang 1997). Therefore, hydraulic connectivity will enhance aquatic biodiversity and benefit migrating birds in an indirect way. For habitat aspect in this thesis, I focus on seasonal wetland types that are preferable to migrating birds directly.

The rapid wetland reclamation in the Poyang Lake Region has a significant impact on migrating birds since it is the migrating destination for many species. For instance, Siberian cranes migrate between lower Indigirka River in Russia and the Poyang Lake in China each year (figure 1.12). A study monitoring the migrating Siberian cranes for two years observed that the segment traveling time is relatively longer in China than in Russia due to degradation of wetland habitats in China (Kanai et al. 2002). This study also concludes that the wetlands currently protected within the Poyang Lake Nature Reserve are insufficient to provide wintering habitat for the cranes throughout each winter because 50% of the monitored samples were located outside of the nature reserve in 1996.

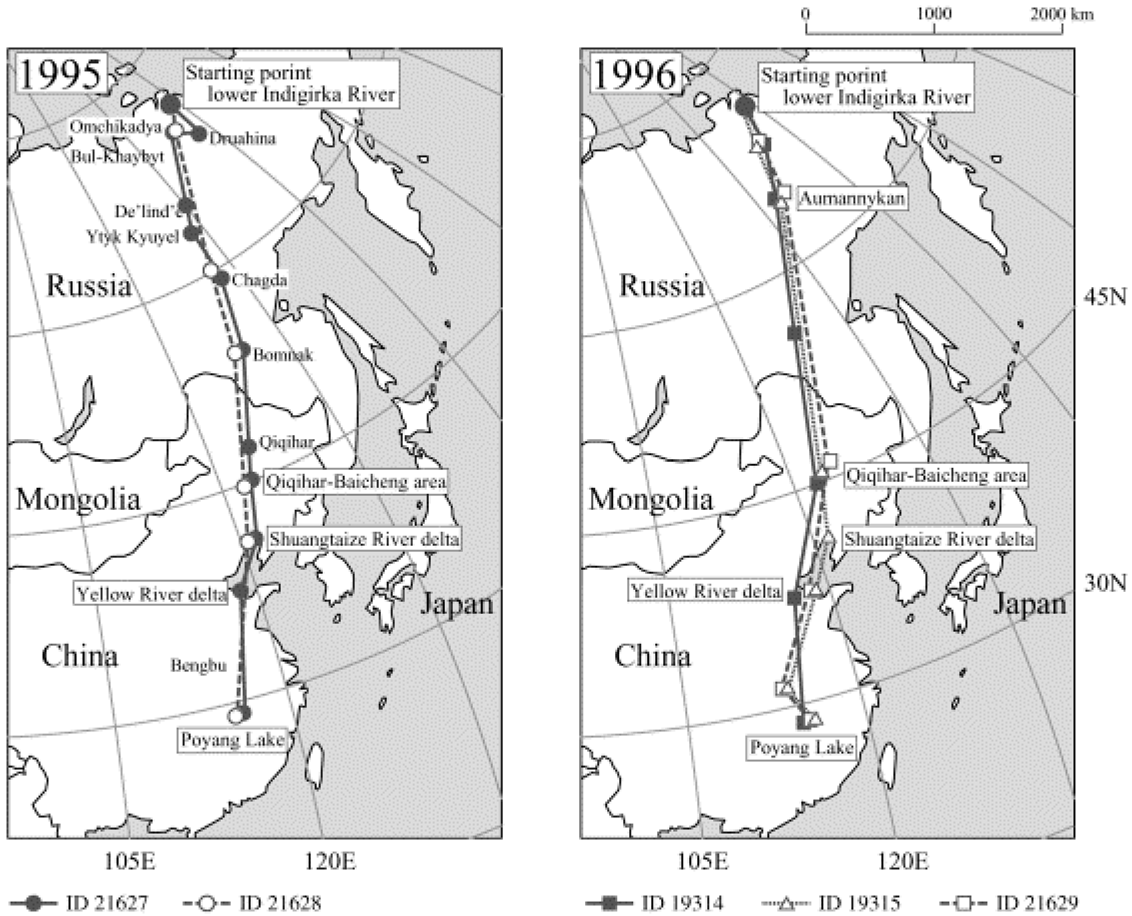


Figure 92. Migrating routes of Siberian cranes tracked from northeastern Siberian in 1995 and 1996 (Adapted from Kanai et al. 2002)

Land-use practices are a major cause of the decline in biodiversity in recent decades (Soule 1991). Loss of habitats in the Poyang Lake Region has caused frequent visits of wild birds to Nanchang. The most common birds that have appeared in the green space within the city include: *Egretta intermedia intermedia* (intermediate egret), *Egretta garzetta* (little egret) *Nycticorax nycticorax* (black-crowned night heron) (Summer migrating birds, come in April and May, and leave to the south in Oct), *Ardeola bacchus* **(**Chinese Pond-Heron), *Bubulcus ibis* (Cattle Egret), *Anser. albifrons* (white-fronted goose).

The renowned bird watching garden, Tian Xiang Garden (Figure 1.13), was originally planned as a plant nursery in the city. The nursery was soon overwhelmed by the number of birds that were attracted by the dense vegetation and the small lake. The nursery was then converted to a bird park. Each year, over a thousand birds visit the garden and some become inhabitants here. It is truly an amazing phenomenon that thousands of wild birds live in a small park surrounded by dense urban development. One of the reasons for this is the rapid loss of wetlands and other habitats in the Poyang Lake Region. Exhausted birds were searching for 'stepping stones' (VanDijk et al. 1995, Forman 1995 , Cals et al. 1998, Nienhuis et al. 2002) after their long trips.

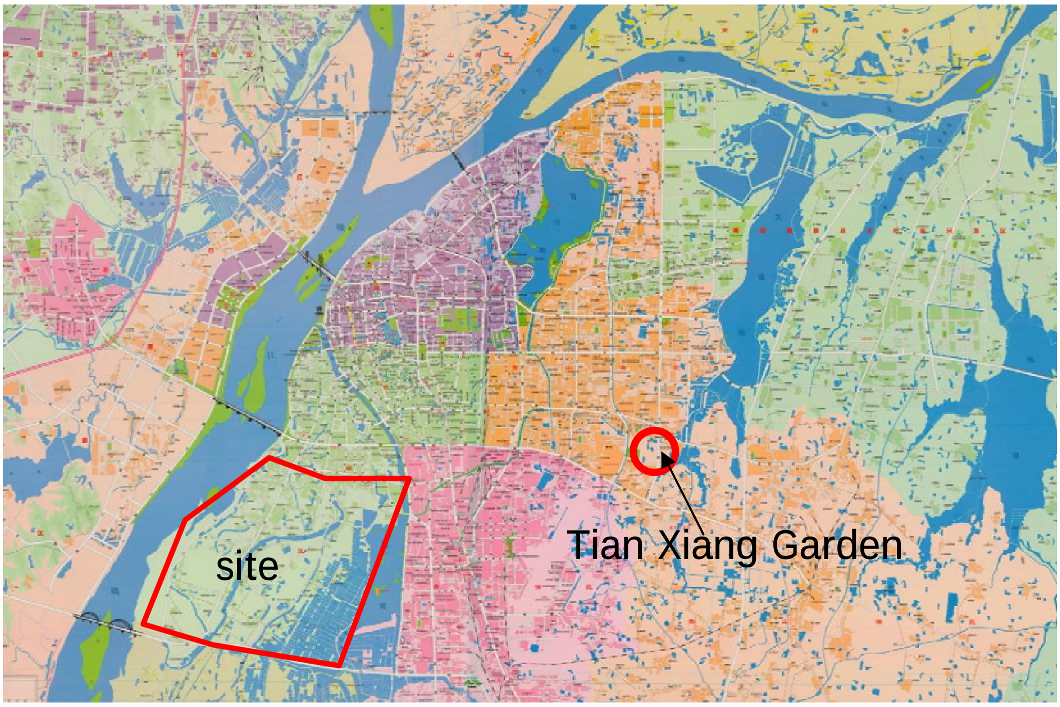


Figure 1.13. Tian Xiang Garden and the project in Nanchang City, China

Tianxiang Garden in Nanchang, China (Photos taken by Tao Zhang in summer 2007)

1.2.3 Site history:

Taohua district in Nanchang, a 3,022 acre site situated between the Gan River and Xiang Lake (figure 1.14), is on the southwest side of the city adjacent to the urban core and the historical district of the city. Taohua is one of the two large green fields in the Nanchang urban scope and is protected by levees from floods.

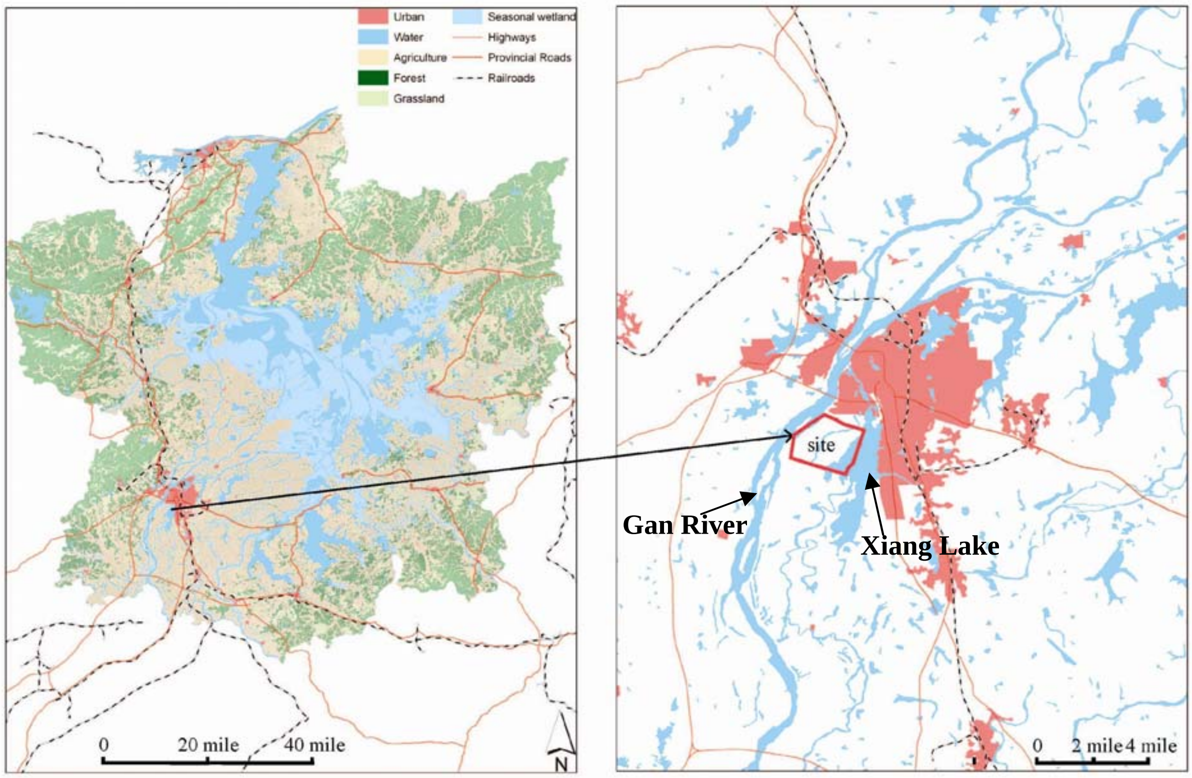


Figure 1.14. Poyang Lake Region and the study area in Nanchang City, China

Located in the lower Gan River delta (figure1.15), the site evolved from a series of fluvial sediment islands over thousands of years. The earliest map of the site dates back to the Ming Dynasty between 1400 and 1500 when the Gan River channel was significantly wider and today's Xiang Lake was still part of the river course (figure1.16). Until the Qing Dynasty in the 18th century, the site was isolated from the historic Nanchang City by the river although the upper stream islands had grown significantly (figure 1.17). Interestingly, these islands' names are still being used today for the local villages and neighborhoods, which offer extremely helpful clues when comparing the historical maps from different eras and the existing land use.

In the early 20th century, the site evolved into a continuous piece with extensive stream networks and wetlands across the area (figure1.18). Xiang Lake did not exist until the 1950's when a brick plant on the east side of the study area was abandoned and the clay excavation site was converted into a lake (personal conversation with Qian Wei, a Nanchang resident, in summer 2007). In the 1970's, extensive fish farms were built around the lake and the stream's hydrological connections were impeded by roads and fish farms.

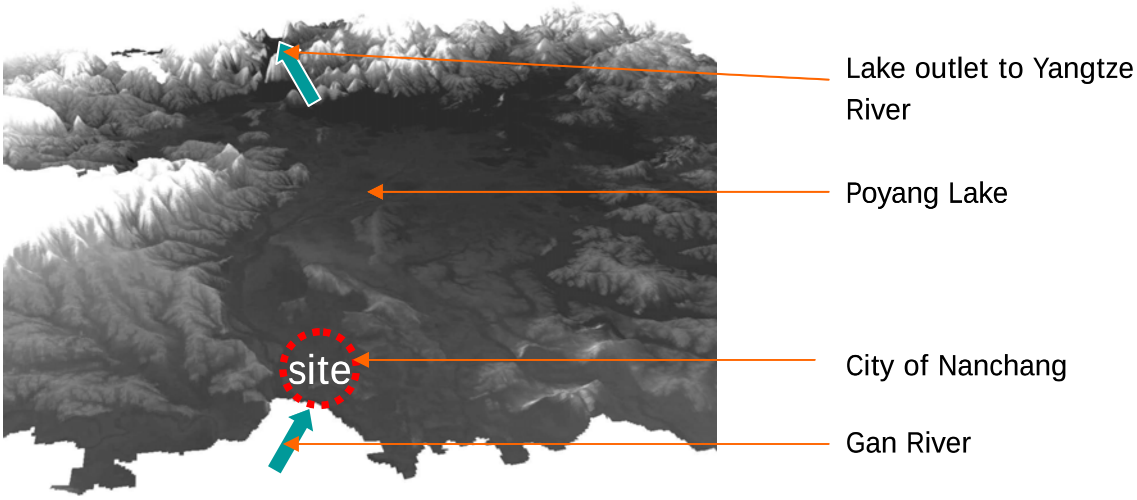


Figure 1.15. Study area in the Poyang Lake Region (DEM is vertically exaggerated for illustration)

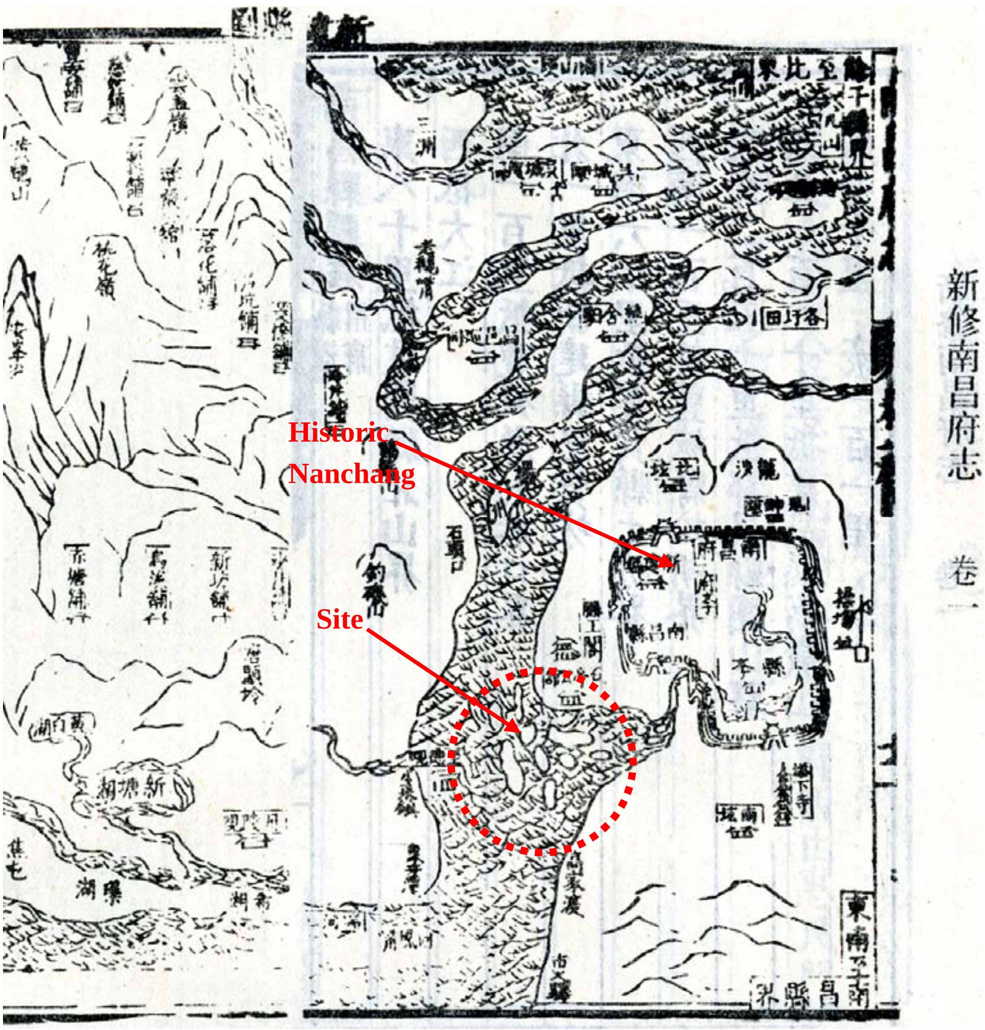


Figure 1.16. Poyang Lake Region and City of Nanchang City in the Ming Dynasty (1386-1644)

Figure 1.17. Poyang Lake Region and City of Nanchang City in the Qing Dynasty (1856)

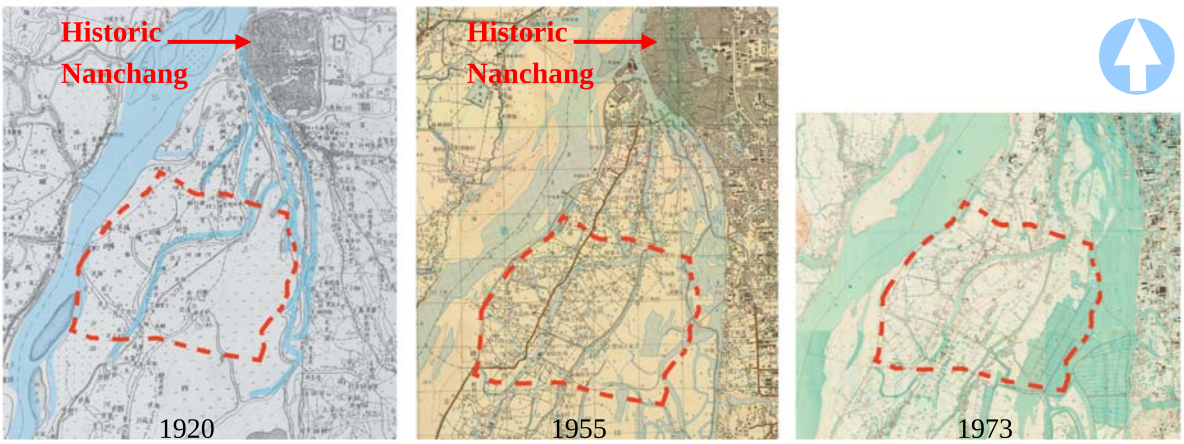


Figure 1.18. Study area in Nanchang City, China. From left to right: 1920, 1955, and 1973.

Today, 72% of the land use in the study area is agriculture, mainly vegetable farms and fish farms, followed by roads and levees (figure 1.19). Due to its adjacency to the center of the city, the study area is facing high development pressure and land demand from multiple sectors. A comparison between the site and an area of midtown Manhattan in New York City with comparable size was made to illustrate the scale of the project and potential urbanization outcome (figure1.20)

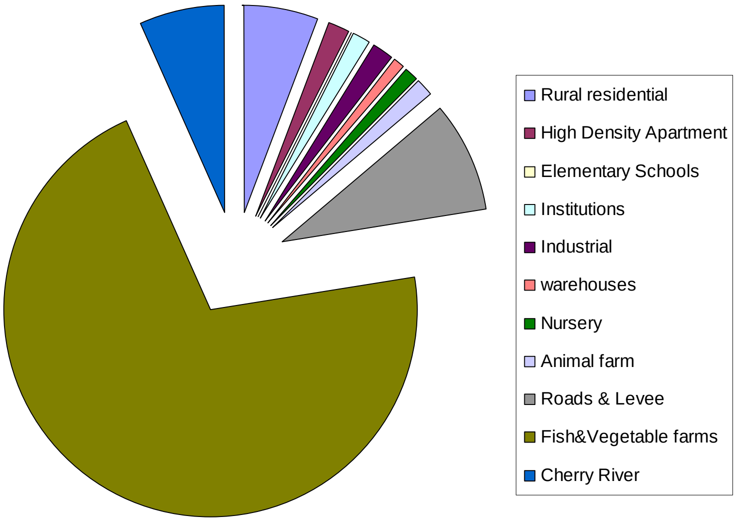
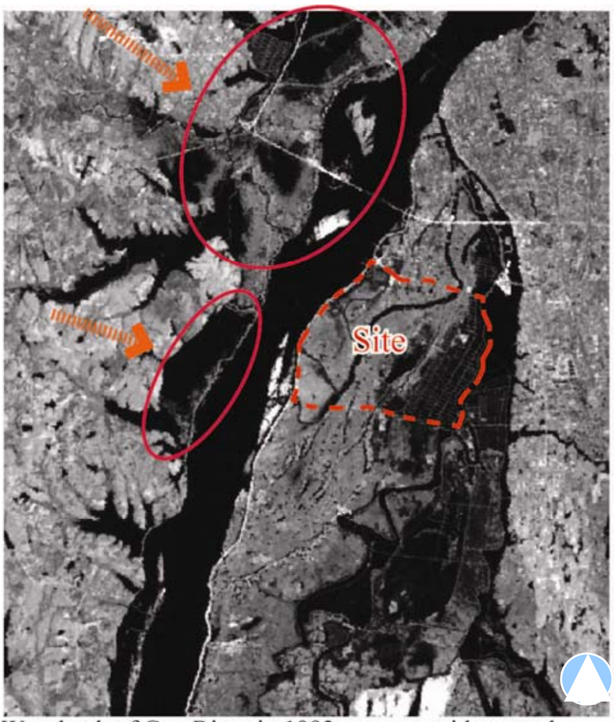


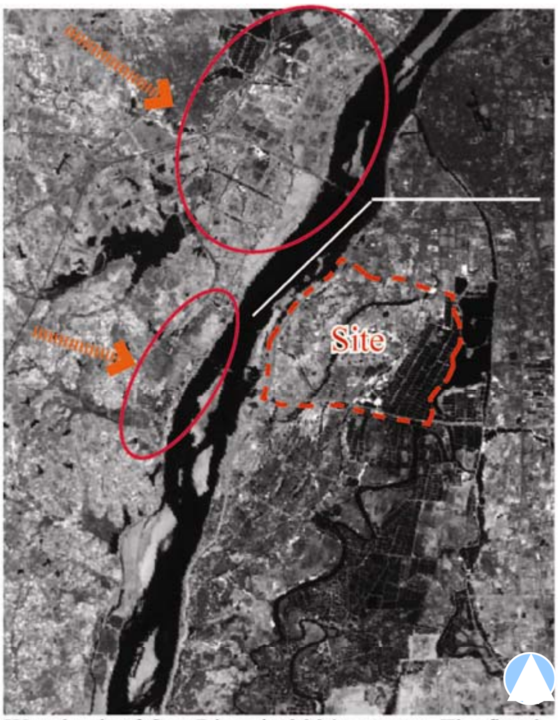
Figure 1.19. Existing landuse in the study area

Figure 1.20. Scale comparison of the study area and Midtown Manhattan in New York City

Despite its adjacent location to the center of the city, the study has been restricted from development for the last two decades to encourage development on the west bank of the Gan River. Satellite images taken in 1993 and 2004 illustrated the massive development on the west bank where floodplains could store floods as recently as summer 1993 (figure 1.21). New development and levees have occupied the floodplain and made the river channel increasingly narrow. As a result, during the raining season the east bank including the study area has increased flooding risk.



West bank of Gan River in 1993 summer with natural floodplain



West bank of Gan River in 2004 summer. The flood-plains had been developed.

Figure 1.21. Development on the west bank is posing increased flooding risk to the city.

At the same time, development pressure has been approaching from the east side of the Nanchang City metropolitan area in the last two decades. Landcover changes from 1987 to 2004 clearly demonstrate the pace and the scale of urbanization in Nanchang City. With increasing land demand to accommodate economic growth and new residents, the city has finally identified the study site for a new urban district that is aimed to provide homes to 200,000 or more new residents.

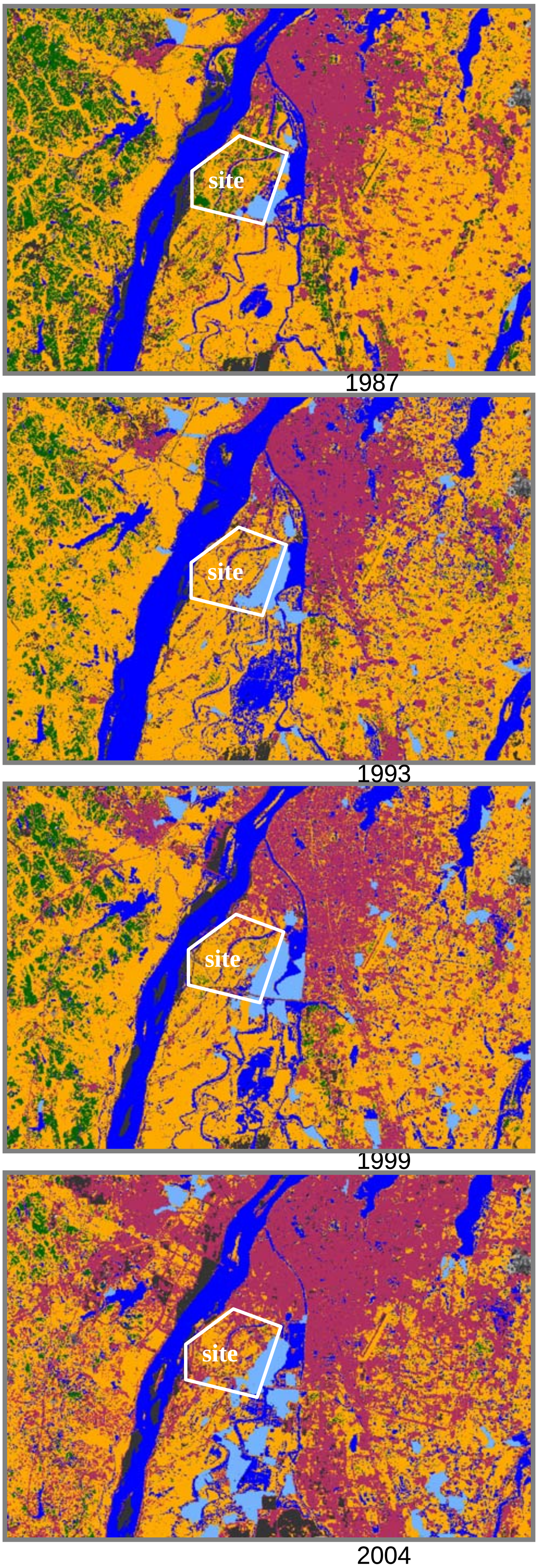


Figure 1.22. Landuse change in Nanchang

1.3 Resilience of ecologically sensitive areas

While the site has been identified for development, this thesis project inquires about what kind of development is appropriate for ecologically conscious floodplain management strategies in rapidly urbanizing areas in China. This study is intended as a pilot project to promote public awareness of floodplain ecosystems and provoke conversations among designers, the public and the other stakeholders about new development in these ecologically sensitive areas. Ultimately, the effects of preserved and restored ecological functions could extend from local to regional scales in the Yangtze River basin.

Resilience measures the capacity of a system to absorb disturbance and reorganize itself through changes and still retain essentially the same structure, function, identity, and feedbacks (Walker et al. 2004). These changes can occur at sub-scales while the mechanisms and functions at the focal level are maintained. An analogy is that in a well vegetated park, due to certain oak diseases a few oak trees may be replaced by maple or hickory trees without changing the overall characteristics of the park, although the microclimate is changed where the oak trees used to be. However, the system will be fundamentally altered when the whole woodland is replaced by a concrete plaza. This example may help us consider the way we manage floodplains. Dense urban development on wetlands in a floodplain ecosystem is similar to replacing woodlands with a concrete plaza in a park.

Ecological resilience reflects the degree of a disturbance that an ecosystem can absorb before it changes its processes, structures and functions (Holling 1996). It seems neither feasible nor realistic to restore floodplain ecosystems in the project site to a natural state without human impacts due to its adjacency to the urban center. A system can have multiple stable states. By designing and managing the floodplains in an ecologically conscious manner, we can help prevent the ecosystem from crossing into an undesirable regime or help bring the system back into a desirable state (Walker et al. 2004) to avoid loss of resilience at larger and social-economical catastrophic scales.

In order to accommodate more urban residents, the current common practice is to avoid the threshold of catastrophic flooding by enhancing levees and building up river banks. Although this might postpone the disaster, it could eventually drive the system closer to the catastrophic threshold. When changes to the ecosystem are inevitable given the decision to develop, efforts should be devoted to making a desirable future with the transformation of the landscape.

Transformability is the ‘capacity to create a fundamentally new stable system when ecological, economic, or social (including political) conditions make the existing system untenable’ (Walker et al. 2004). If poorly planned urbanization is making the ecosystems untenable, landscape architects should try to mitigate this trend by transforming any potentially urbanized area into more ecologically beneficial systems through design strategies. There are many examples of social ecological systems that have crossed the threshold and are unable to be transformed, i.e. salinized agricultural systems, desertification and collapsed fisheries. The goal of this project is to promote plausible and desirable transformation before the system reaches the threshold.

1.4 Floodplain management and river rehabilitation

More than 1,000 years ago people in the Poyang Lake Region started to invade fertile floodplains by reclaiming wetlands for agriculture, followed by urban and industrial uses. More and more evidence suggests that river floodplains are among the most endangered ecosystems worldwide due to extensive human settlement near the water (Olson and Dinerstein 1998, Buijse et al. 2002, Abell et al. 2007, Zhu et al. 2007). In the United States, only 10% of the former floodplains are in a near natural state and in Western Europe, 85-94% of the floodplains were reclaimed in the Rhine River watershed (Jungwirth et al. 2002). In the Poyang Lake Region, this reclamation of wetlands for agricultural and urban landuse is still continuing. Most of the recent river-floodplain restoration and rehabilitation projects have focused on aquatic habitats. Only a few include the floodplain and riparian zone (Buijse et al. 2002).

Urban river restorations are often approached on an ad hoc basis rather than a holistic preventative planning (Clarke et al. 2003), i.e. Los Angeles River, SuZhou River in Shanghai. Similar to the criticism of conventional medicine practice, a holistic preventative approach should be emphasized to promote a long term healthy life for human beings and for natural ecosystems. This idea was deeply appreciated in classic Chinese philosophy. However the belief has faded out as economic growth becomes society’s major focus, particularly after the nation went through a hundred years of poverty and frequent wars.

In the summer of 1993 about 70% of levees along the Mississippi River in the upper Midwest U.S. failed, causing great damage to both farmland and urban areas. The report of the Interagency Floodplain Management Review Committee was the outcome of the effort to reassess the floodplain management policies in the U.S.(Tobin 1995). Levees are a relatively easy and quick solution to flooding, similar to ingesting pain killers for aches and pains. They are effective, cheap and easy to use. But the ‘aches and pains’ still exist, even if we do not physically conceive them. Levees can exacerbate flooding in other places along the river too because the built-up pressure seeks any possible opening, and weak levees may be where breaks occur.

Fixing broken levees is far from the right solution because of fundamental environmental problems. River restoration will only be sustainable if it is undertaken within a process-driven and strategic framework (Clarke et al. 2003). Building the levee further inland from the river bank should be more desirable because this will leave more room for flood discharge during flood events. The Water Framework Directive of the European Union (Naveh 1994) recommends widening rivers or re-allocating flood levees to allow river braiding or meandering. This approach not only restores riparian floodplains but also re-establish a wide array of in-stream and riparian habitats like riffles, pools, gravel bars, etc. (Rohde et al.

2006).

In the last few decades, different strategies have been explored in Europe for floodplain restoration including channel widening, man-made secondary channels and flood levee re-allocation (Simons et al. 2001, Nienhuis et al. 2002, Rohde et al. 2006). Creating new secondary channels helps restore riverine habitat diversity and heterogeneity, and hence biodiversity (Nienhuis et al. 2002). Some other widely practiced sustainable development strategies in Europe include: excavation and widening of the accreted floodplains to enhance the water retaining volume and recreate the original, irregular geo-morphological pattern for habitat diversity; restore the naturally meandering form of deepened straightened channel; excavate oxbow lakes; and convert fertilized arable agricultural fields to floodplain grassland for a reduction of the nutrient leaching from farmland and the urban landuse (Harper et al. 1995, De Waal et al. 1998, Nienhuis et al. 2002).

Natural Safety Through Flow Retention, published in 1999 in the Netherlands (SBB and W.W.F. 1999) advocates a so-called sponge function of the floodplains which delays and retains discharge during flooding seasons and reduces desiccation during low flow periods. 16 approaches were proposed including setting back major embankments, lowering or removing groynes and minor embankments, and extracting deposited sediments from floodplains (Middlekoop and Van Haselen 1999). In this project, I have identified and chosen six of them (figure1.23). Similarly, five types of ecological restoration strategies for river floodplains were recommended (Brookes et al. 1996): (I) restoration of riparian strips, (II) restoration of small but ecologically valuable patches, (III) less intensive restoration of larger floodplain areas, (IV) restoration of the original hydrograph, and (V) relaxing constraints on lateral river channel migrations so that natural processes recreate a mixture of floodplain features.

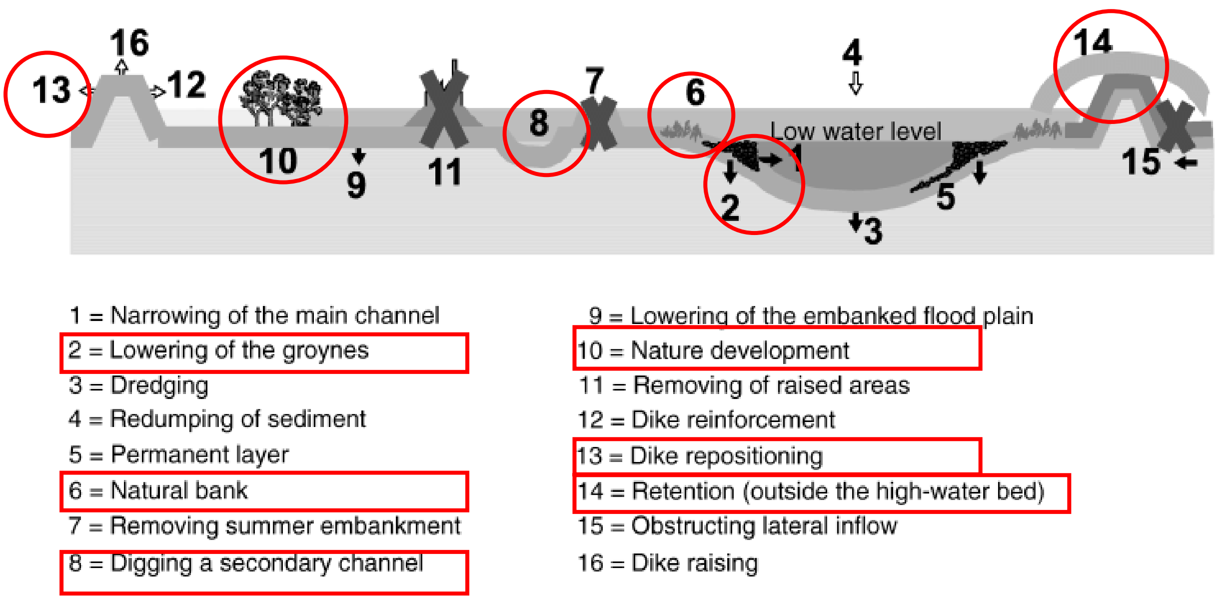


Figure 1.23. River rehabilitation strategies (Adapted from Middlekoop and Van Haselen 1999)

In rapidly growing Chinese urban areas with dense settlement, security from flooding is the primary socioeconomic expectation from the public with respect to floodplain restoration and wildlife habitat protection. Rehabilitation must consider flood protection when focusing on improving the ecological state because the public will support the project only if they can assure that they are safe from floods. Will the restoration effort reduce the risk of potential flooding damage is the question that I was asked repeatedly in Nanchang. Therefore ecological restoration and improved flood protection have to be considered at the same time to be accepted by the public.

Historically, there were numerous channels connected to the main river channel meandering around the sandbars and extensive islands. These hydromorphological conditions provide substantial space for the water surface to expand and contract when water level fluctuates. The river floodplain and secondary tributaries in a natural condition play important roles to retain overflow. The hydrological connectivity also contributes to the rich habitat types for aquatic organism and water birds. However, for most of the rivers around the world where people settle, this hydraulic pattern has been fundamentally replaced by seepage inflow in isolated water bodies. This is especially true for the extensive lakes along the Yangtze River where the natural connections were broken by human impacts (figure 1.6). There have been inspiring cases where different strategies were applied for river-floodplain restoration. For example 13% of the 10-year-flood area was restored to be frequently inundated by active overflow, backwater flooding, and seepage inflow along the Danube River in Austria using the riverine landscape in 1812 as a reference (Hohensinner et al. 2004).

The ‘space for the river’ policy (V&W 1998) in the Netherlands has restricted any expansion of development within the frequently flooded area and proposed to create inland retention basins and inundation fields for high river discharges. This can be difficult in the Poyang Lake Region because centuries ago people have reclaimed, cultivated and settled in these floodplains. Fortunately, the new policy resulting from the extreme floods in 1998 strongly supports these strategies, i.e. setting aside arable lands in the floodplain; reforestation on uplands, and returning reclaimed agricultural land to wetlands. However, due to strong land demand around the urban center in Nanchang, the project site is to be developed despite its location in a floodplain.

A landscape design competition winning report ‘Black Stork’ in the Netherlands in 1987 (De Bruin 1987) became the conceptual basis for many restoration projects along Dutch rivers. It was an important step from nature conservation and protection to ecological river rehabilitation in Europe (Cals et al. 1998). ‘Black Stork’ emphasizes the interaction between the highly productive floodplains and the running river flow that can provide important interrelated habitats including breeding and nursery for many migrating water birds.

For centuries, floodplain and wetlands have been treated as wasteland in China. Pilot projects are needed in China to showcase these practice strategies and to educate the public to deeply understand floodplain ecosystems. In the Netherlands, the public has shown increasing interests in river rehabilitation with thousands of people visiting the Rhine River restoration site each year (Cals et al. 1998). In Nanchang, the local communities are very concerned with their environment. My conversations with residents on the study site in summer 2007 indicated that the local government and the community were aware of the ecological sensitivity of the site and were eager to improve the ecological functions of the region. However, the residents also expressed their concerns that they had inadequate knowledge to be involved in the decision-making processes. This project can potentially be a model for adoption in the broader region in the lower Yangtze River basin in China.

A floodplain design precedent:

Located in a floodplain, Dongtan Eco-city in municipal Shanghai to be completed in 2020 is planned be the world's first "carbon neutral" city that hosts a dense urban population and well preserved wildlife habitats (Figure)(Figure 1.25) (Normile 2008). Similar to the project site in Nanchang, Dongtan is located in a tidal flat that provides extensive habitat for migrating birds and is challenged by the increasing development pressure from the metropolitan Shanghai. Dongtan Eco-city aims to reconcile the conflict between wetland preservation and development pressure with economic growth.

Figure 1.24. Eco-wonder. Shanghai hopes its Dongtan Eco-city will be the world's first carbon-neutral urban development (Adapted from Normile 2008).

Figure 1.25. Dongtan Eco-city in Shanghai plans to protect a waterfowl refuge in a tidal mud flat (Adapted from Normile 2008)

Chapter 2 Design methodology

2.1 Normative scenario design

2.1.1 Normative scenarios approach

Normative landscape scenarios generate futures that *should* be (Ahern 2001, Wachs 2001, Nassauer and Corry 2004). Normative scenarios initiate hypotheses about landscape functions based on scientific knowledge to invent and evaluate landscape patterns that have certain ecological, economic, or cultural effects (Peterson et al. 2003, Nassauer and Corry 2004, Santelmann et al. 2004). In this thesis, 'scenario' refers to the alternative paths or assumptions driven by the explicit policy goals that will contribute to different desirable outcomes in the future. The explicit representation of the land use pattern with these desirable ecological and socioeconomic effects are referred as 'futures'. 'Design' refers to the explicit and critical decisions based on scientific studies that are represented in the alternative futures. Normative scenarios are meant to educate and anticipate future choices. Scenario design can be a powerful tool to envision plausible transformations, and to provoke a discussion about what should be, what is plausible, what is desirable, and to help stakeholders in the processes of social decision making.

Although the citizen-driven approach produces alternative futures that typically have the advantages of integral citizen involvement, greater political plausibility and increased likelihood of institutional acceptance [in the States], it was not used in this study because the goal of this thesis is to invent ecologically desirable landscapes that might not be imaginable to the stakeholders. The scientific knowledge about the floodplain ecosystems and the policy changes are the fundamental drivers of the scenarios. There is a lack of this knowledge of ecosystems among the stakeholders in Nanchang. Normative scenarios apply a top-down approach with prescribed landscape goals that can potentially produce larger number of scenarios to be further tested and evaluated. Proposed landscape characteristics (hypotheses) can be iteratively revised through design decisions and land use allocation models when the expected integrated landscape patterns are not achieved.

2.1.2 Scenario assumptions

This project is aimed to invent alternative futures for Taohua district in Nanchang City in year 2038, 30 years from the present. 30-year-period was chosen because most of the public infrastructure can be completed and start influencing the emergent landscape in the first 15 years. The strong economic growth and the rapid urbanization trend in China make it difficult to propose a future landscape over a longer term. Development in the major Chinese cities like Shanghai and Shenzhen has exhibited dramatic changes in the last 30 years since the launch of the economic reform in 1978.

The normative futures are required to accommodate 200,000 or more residents including the 20,000 existing residents that currently settle in the project site. Roughly half of the existing residents serve in the local farms and the other half find employment in the service and warehouse businesses in the commercial area adjacent to the project site on the North.

All three scenarios assume:

- The economy in the Poyang Lake Region will continue to be strong.
- The rural-to-urban migration will be at today's scale.
- No major industry will be settled upstream in the Gan River Basin. Therefore, water flowing through the site is assumed to be clean and the wetlands along the water bodies are suitable for wildlife habitat.
- The wetlands across the Gan River on the west bank will not be developed. Hence the potential exists to connect the habitats on both sides of the Gan River.
- The connected river channel outside of the study area will also be restored if the proportion within the site is restored.

2.1.3 Conceptual workflow of scenario development

Three alternative scenarios or policy goals are: 1) enhancing stepping stone habitat for migrating birds; 2) reconnecting hydrological network and flood control; 3) accommodating increasing land demand for new residents. Built upon the analysis of the historical and current landscape, the planning rules and design decisions were applied to invent one landscape future for each alternative scenario. Each future was then tested against predefined social and ecological goals.

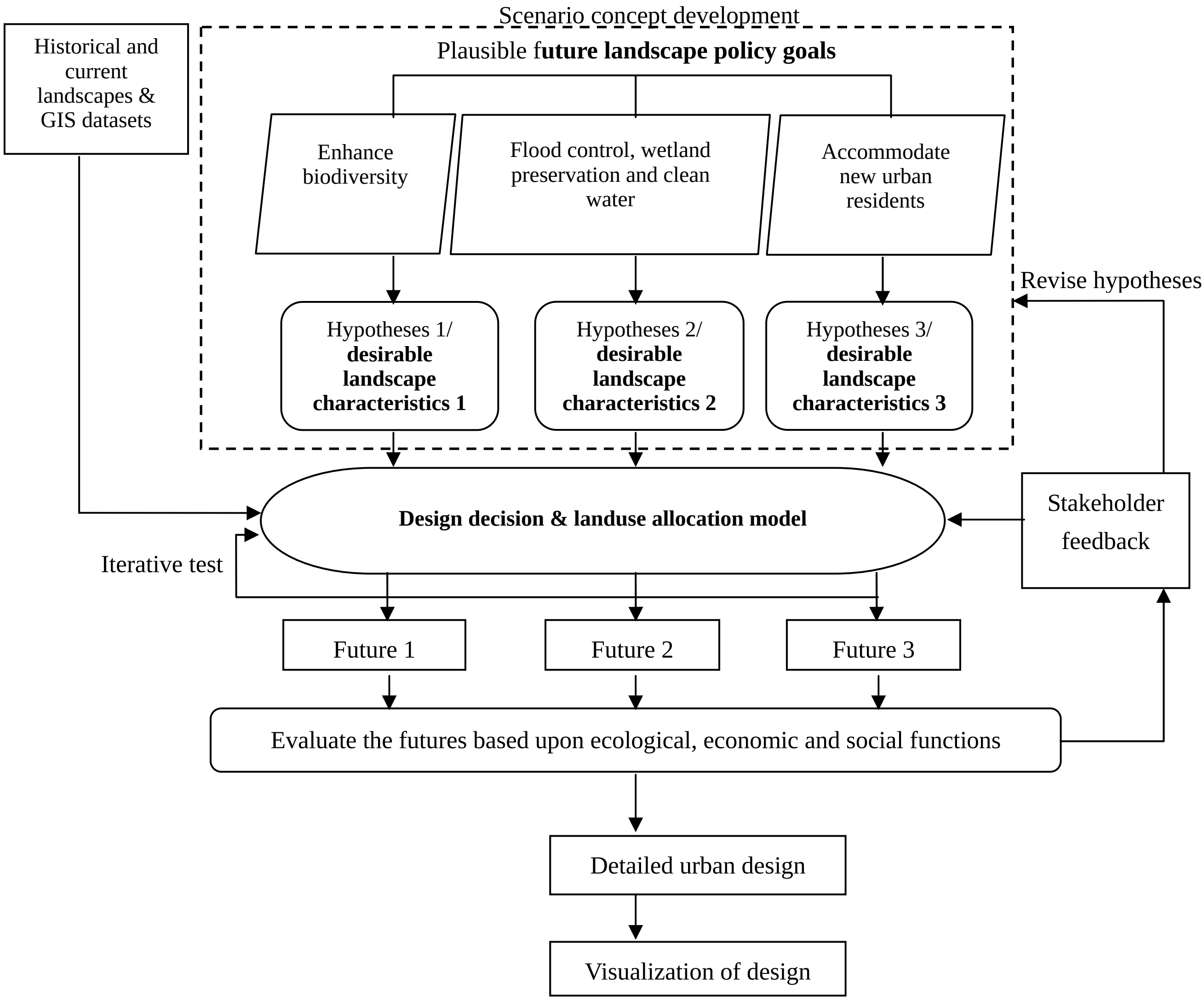


Figure 2.1. Conceptual workflow of scenario development

2.2 Interviews and data collecting

To gain a better understanding of the local ecosystems, the rich landscape history and the public expectation about the new Taohua district I conducted interviews with the local government planning office, the developer, geographers, ecologists at Jiangxi Normal University, and local residents on the streets on a week day and a weekend day. In total, I interviewed about 35 people. The interviews focused on what typologies and major functions of the new development were expected. The questions briefly described the development policy goals and the landscape characteristics associated with the three scenarios and asked for comments and thoughts.

Most of the interviewees showed great interests in sustainable and ecological development, although some of them have never been exposed to any explicit examples of ecological design. The expectations about the new district include: clean water and public access to these water bodies; public green spaces and parks with diverse wildlife in the city; reliable public transportation and convenient parking. The biggest hurdle for environmental protection and river restoration, according to the local residents, is the lack of investment or concern from the government. This points to the importance of educating the stakeholders especially the policy makers about alternative ecologically and socially desirable futures. Alternative futures will be presented to the city and the public to illustrate the explicit policy goals for each scenario.

Census data were obtained from the China Data Center at the University of Michigan. GIS data were from the China Data Center and the Environmental Spatial Analysis lab at School of Natural Resources & Environment at the University of Michigan. These GIS data include: Digital Elevation Model (DEM) for the Poyang Lake Region, landcover and landuse data from 1987 to 2004, vector data for transportation and rivers, and the remote sensing images of the region from 1987 to 2004.

Much valuable information was obtained as local knowledge from personal conversations with the local residents and from historical documents found at Jiangxi Normal University and the Asian library at the University of Michigan. In particular, the Nanchang Fuzhi series documents from 1400 to 1980 were extremely informative and helpful.

Chapter 3 Alternative futures and design

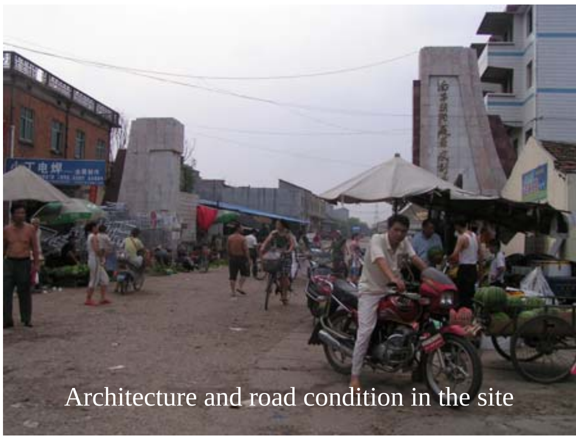
3.1 Site Analysis

The project site, Taohua district, is one of the two large reserved green fields within the Nanchang urban scope (figure 3.1). The other green field, the Yangzi district, located on the North of the city, is currently serving municipal Nanchang as the base for local vegetables and other fresh produce. The City of Nanchang is promoting its rich and unique ecological values to become an “ecological city”. Ecological and sustainable are the terms that frequently appear in the public media. Therefore, whether the future for Taohua district is ecological and sustainable is critical to Nanchang.

The predominance of agriculture and nutrient rich aquaculture precludes the full realization of Taohua’s ecological functions and services despite its undeveloped status.. Most of the wetlands have been converted to rice paddy or fish farms due to their adjacency to natural water bodies. Nutrient wastes from these practices are discharged into the nearby rivers and lakes without treatment.

There is a long history of fish farming in the Poyang Lake Region. The main environmental problems associated with fish farming are nutrient and organic matter discharge and weir construction that impedes free aquatic migrating passage. The extensive aquaculture practices on the West and South side of Xiang Lake were constructed in the 1950’s on the rice field and wetlands along the lake shore. They have significant impacts on the water quality in the lake. The inlet and outlet of Xiang Lake are controlled by five water gates (figure 3.1), which artificially limit exchange of the lake water with the river and the streams. The natural water bodies are prone to eutrophication.

Most residential buildings on site were constructed along the Taohua River that flows through the center of the site. Most of these single family farm houses were constructed in the 1980’s in a manner without any evidences of strategic planning. Almost all the roads in the study area are severely deteriorating, which has caused certain areas to be unreachable by public services such as garbage collecting. Unsurprisingly, I saw many illegal dumps of residential wastes during my visit to the site in July of 2007.


Architecture and road condition in the site


Road deterioration in the site


Eutrophication of the water body


Levee, looking from the site towards Gan River


Illegal trash dump in the site


New development & Ferris wheel on the west bank of Gan River, looking from the site


Major road on top of the levee


Fish farms and a duck farm

Photos taken by Tao Zhang in summer 2007

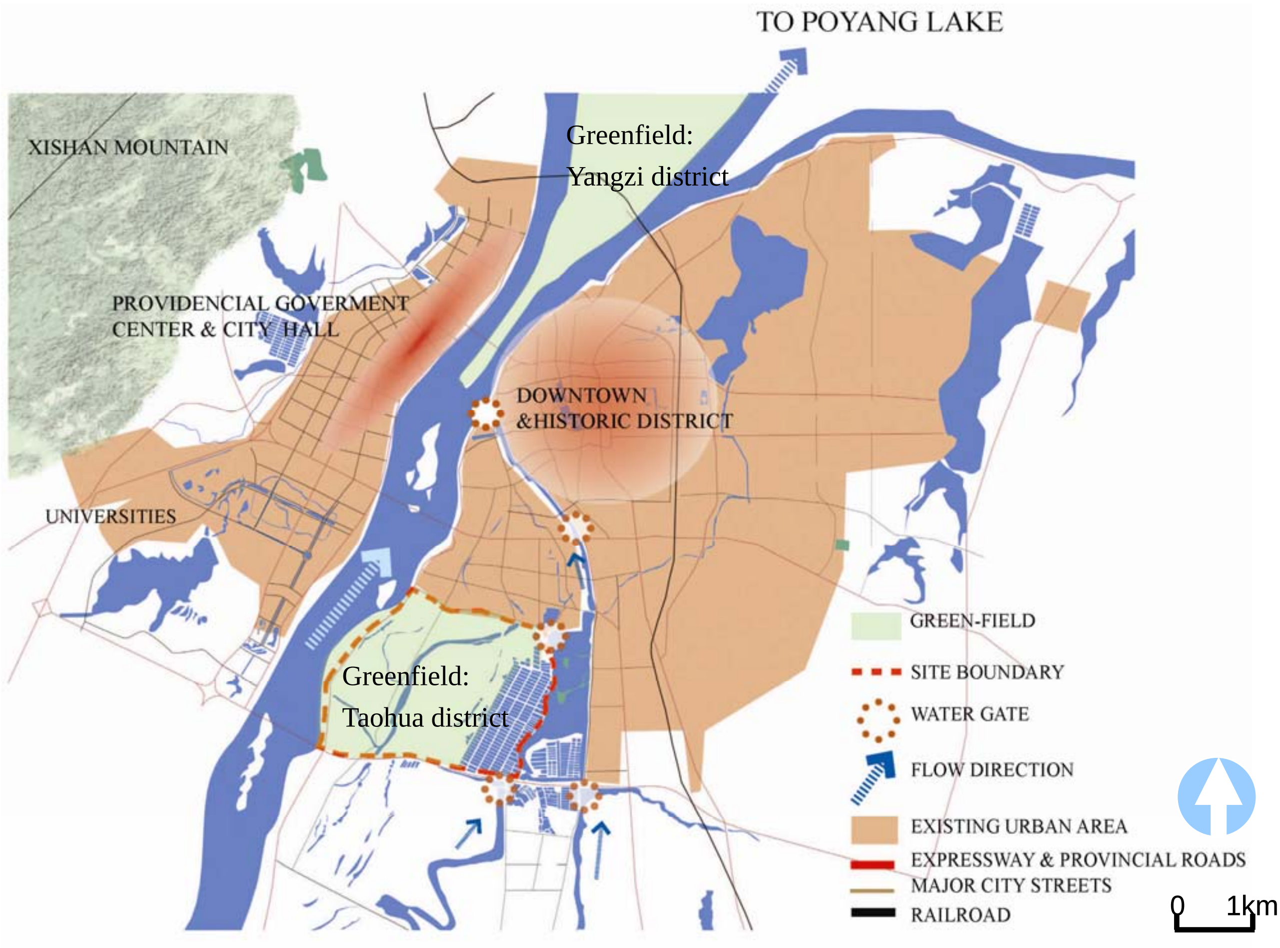


Figure 3.1. Context analysis of the project site

Xishang Mountain sitting on the west side of the city, together with the parks and lakes on the west bank of the Gan River are currently isolated from the east bank by the new development along the Gan River. Great potential exists to establish a green network throughout the city by connecting the highland habitat and the wetlands along the river network. The project site can potentially function as a stepping stone to connect the scattered green spaces on both sides of the Gan River (figure 3.2). Thus it is possible to create a pattern with compact urban districts enclosed by an extensive green network supported by the Xishang Mountain and the restored river riparian zones.

The historical nursery within the project site was abandoned in the 1950's and today it is the only area in the district that has mature woodland and closed canopy (figure 3.2). It is an important terrestrial habitat in the City of Nanchang and may greatly enhance habitat diversity in the future.

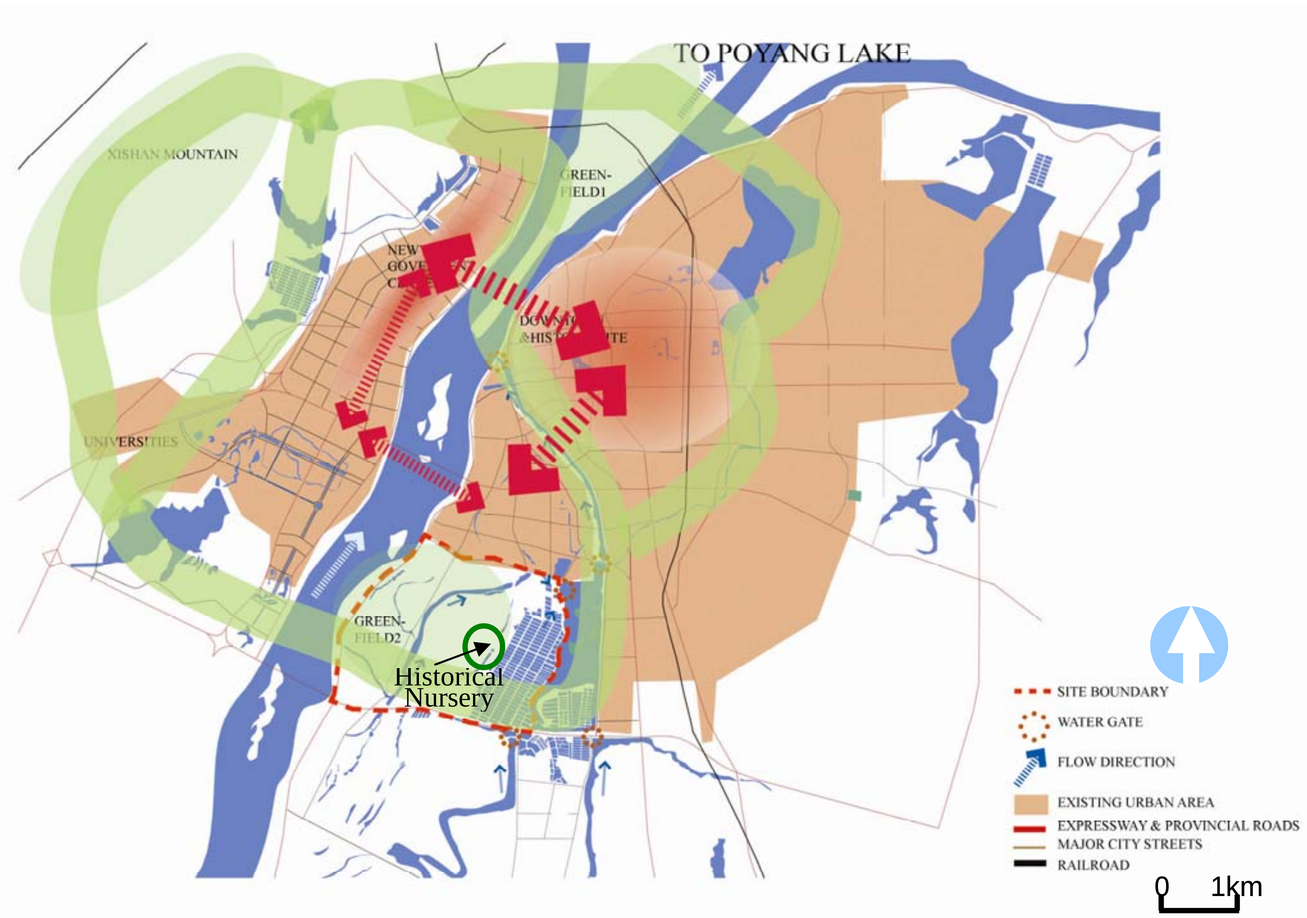


Figure 3.2. Potential green network throughout City of Nanchang

3.2 Scenarios

Built upon the analysis of the existing site context and the study of the landscape history of the region, three alternative scenarios were created with the goals discussed in the previous chapter. Three alternative futures are the outcomes of these scenarios, and their desired ecological and social effects are explicitly described and illustrated in the following sections.

3.2.1 Scenario Ⅰ: Enhancing biodiversity

Land-use practices are a major cause for the decline in biodiversity in recent decades (Soule 1991). The overall object of this scenario is to emphasize the potential habitat value that the site can provide for wildlife, in particular migrating birds that have frequently visited the green space in the urban area due to habitat degradation in the Poyang Lake Region.

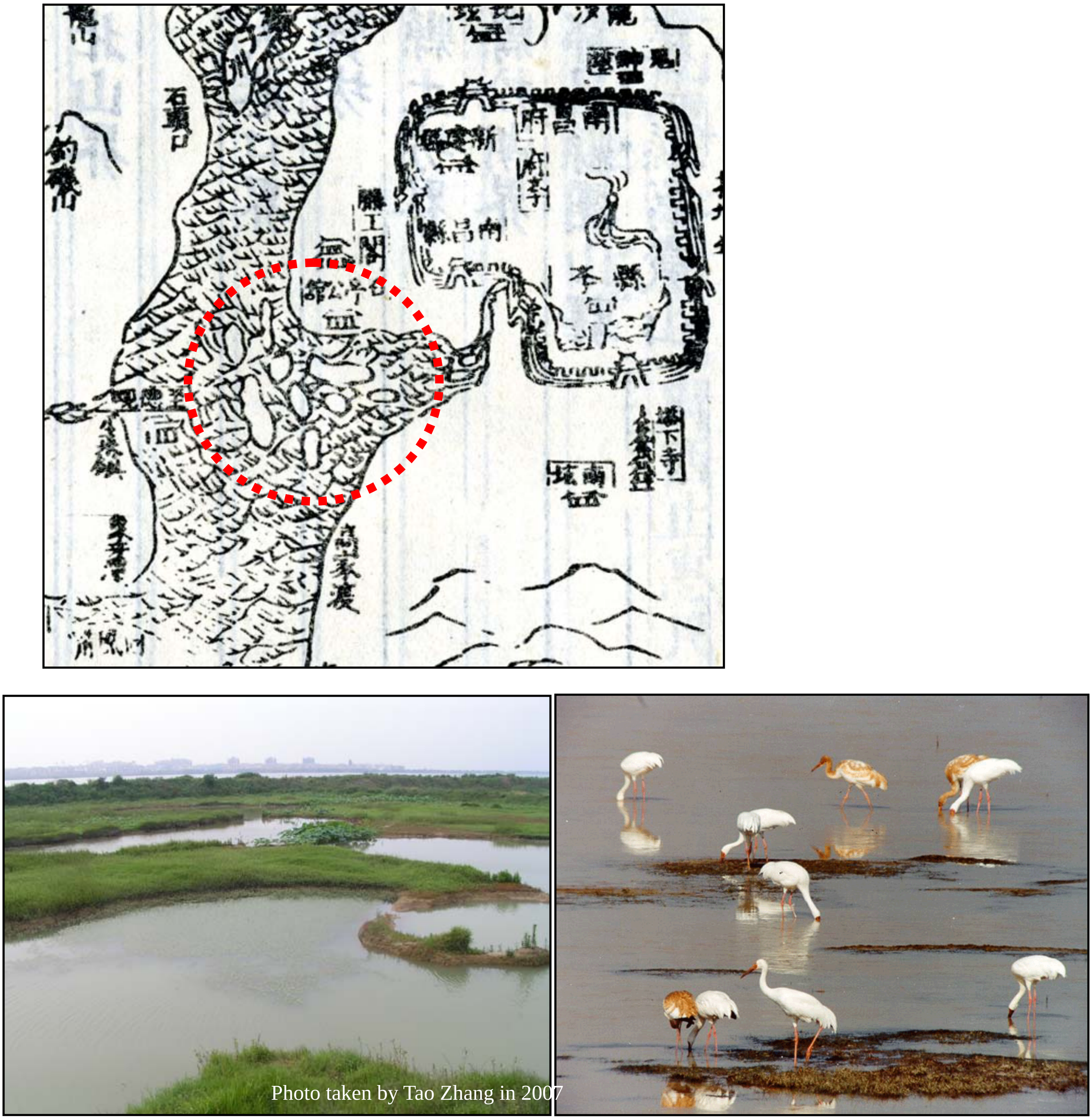


Figure 3.3. Historical landscape and existing habitat types in the Poyang Lake Region

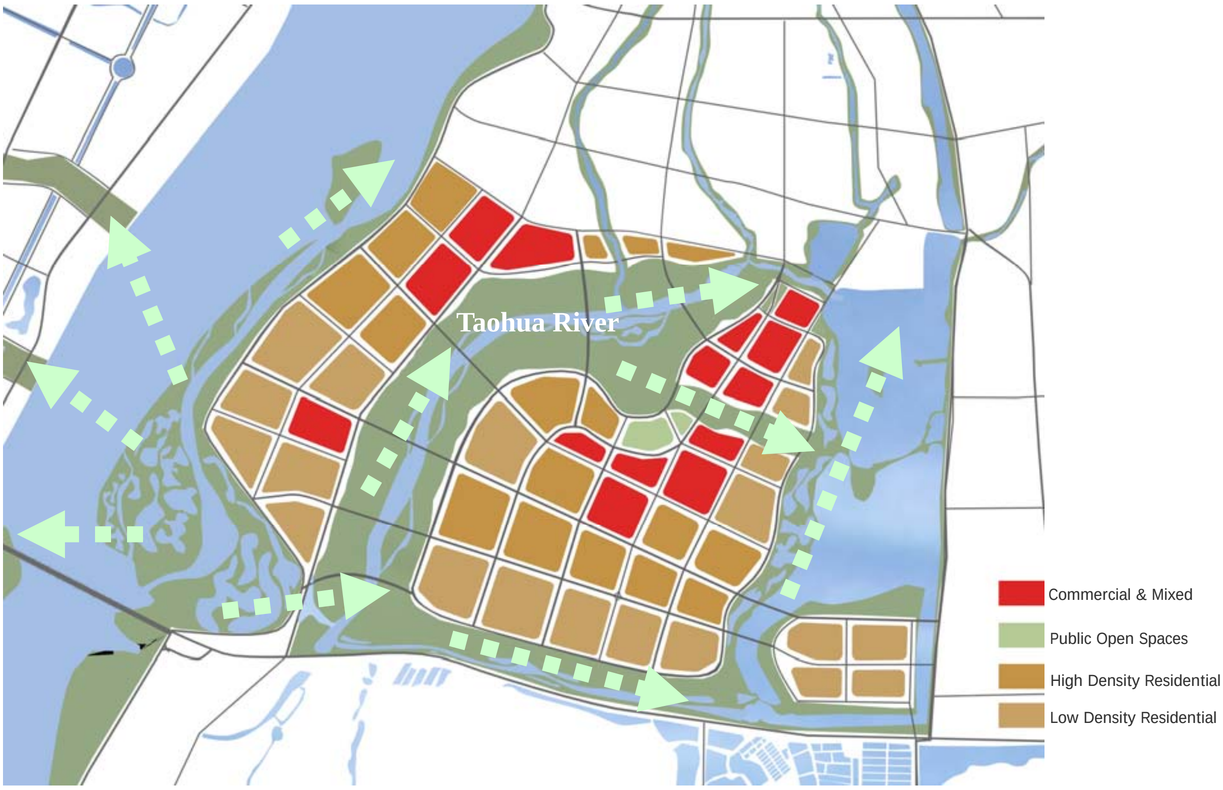


Figure 3.4. Landuse plan diagram for the landscape future for the Biodiversity scenario

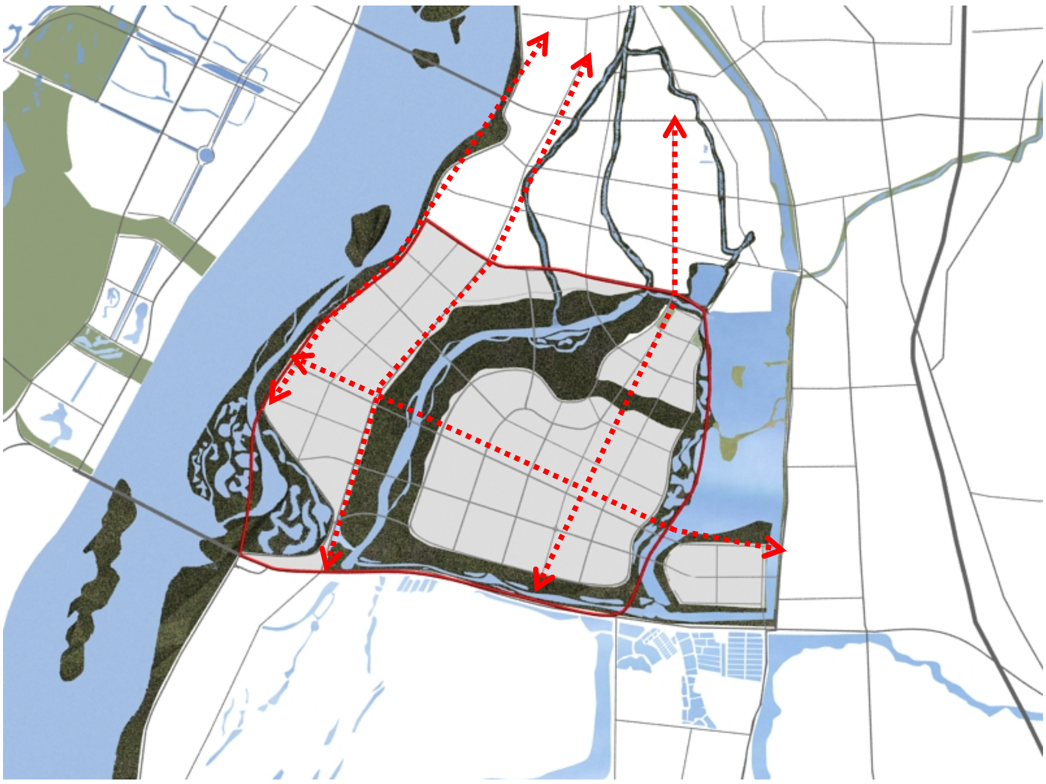


Figure 3.5. Transportation and major recreational green spaces in the landscape future for the Biodiversity scenario.

The following design characteristics quantitatively describe the landscape future and its contribution to desired ecological and social effects. They may be used to facilitate policy making.

Important Design Characteristics of the Biodiversity Future:

	Habitat			
Type	Wetland & riparian zone	Terrestrial	Urban green space	water surface
Area / acre	994	92	144	444

Development			
Residential			Commercial & mixed use
1319 acres	105,520 homes	316,560 residents	271 acres

- The Biodiversity future contains 92 acres of terrestrial habitat in the nursery woodland park area, 994 acres of wetland and riparian habitat, total 144 acres of urban green space in the neighborhoods and 444 acres of water surface. Total 1,319 acres of residential construction will accommodate 105,520 new homes and 316,560 new residents (based on an average four floor residential building and an average family size of three). Commercial and mixed use will occupy 271 acres.

- The design draws inspiration from the landscape's history, and the existing habitats in the site that are frequently visited by the birds (figure 3.3).

- The proposed transportation grid system connects the project site to the existing street grids in Nanchang. The major east-west roads are perpendicular to the rivers and the proposed green space. Two major north-south streets and the new levee road connect the site to the historical district and the center of the city on the north. The grid system has a clear boundary on the south defined by a wetland buffer where further connection to the south is limited.

- The constructed stream channel with 300-meter wetland buffer along the south boundary of the site is intended to define a future development boundary to prevent the city from sprawling further into the upstream floodplain where the rice fields can still support higher level of biodiversity than urban development.

- The future relocates the south portion of the levee in the project site for reinstatement of floodplain habitats that are protected by the existing levee. A secondary channel and seasonal wetland habitats with shallow water along the Gan River are proposed, which will provide a stepping stone for wildlife to travel between the wetland and highland habitat on the west bank of the Gan River and other proposed habitat throughout the city.

- The future restores and creates minimum 300-meter riparian buffers on both sides of the Gaohua River flowing through the site. This decision was based on the habitat patch size for the species that have frequently visited the bird watching garden Tianxiang Garden. *Egretta intermedia intermedia* (intermediate egret) was chosen as the key species to determine the habitat characteristics and patch size. 300 meter wide flooded rice strips has been reported be preferable to egret species and the core habitat should be at least 100 meters from the habitat edges (Maeda 2005).

- The proposed habitat will also provide a continuous recreational green space network to Nanchang for bird watching and public accessibility to rivers and streams.

- This future strengthens habitat connectivity through daylighting the river corridors on the north of the project site in order to establish a broad green network that weaves through the entire city.

- Commercial development will be concentrated along the major north-south roads that connect the new district to the existing urban core.

- There are three major vehicular pathways across the Taohua riparian buffer zones that connect the commercial and residential development on both sides of the river.

- The mature vegetation and the historic nursery site are reserved for an urban park that is extended to the east and connected to the wetland park on the Xiang Lake shore.

- A provincial sports center is proposed near the center of the district where the woodland park is located. This decision intends to minimize the direct interaction between the new urban center and the green way to Xiang Lake on the east.

- Extensive fish farms are removed, and wetland habitats are proposed along Xiang Lake. This strategy can not only clean urban runoff from future development, it can also restore wetlands that were reclaimed by the aquaculture activities in the 1970’s.

- Sediment excavation for the proposed seasonal wetland and secondary channels will be used as construction material for the new levee.

- Building height ranges from 3-story to 35-story based on architectural precedents that already exist in Nanchang and nearby regions including Shanghai.

- The dominant form of the new habitat is water patches embedded in a terrestrial landscape matrix (different from landscape patches in a water matrix in the Hydrology scenario).

Figure 3.6. Visualization of the landcape futures for the Biodiversity scenario

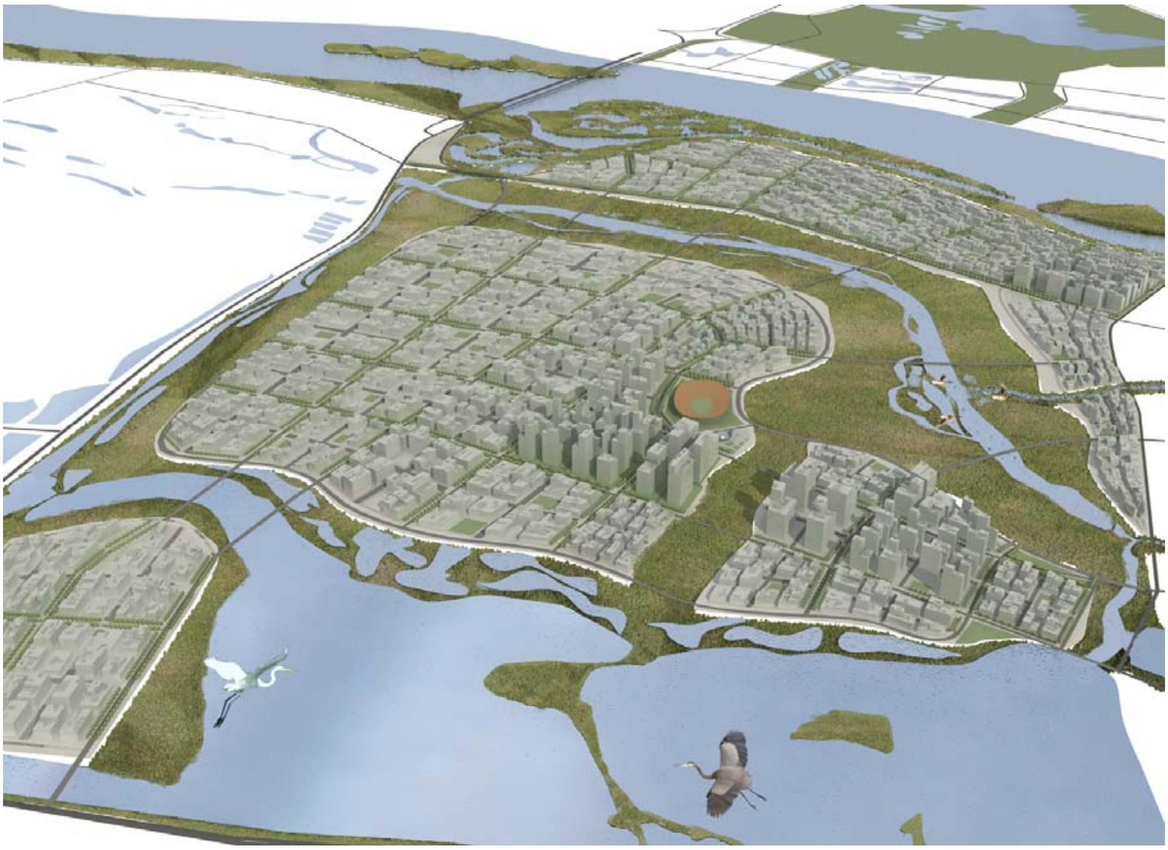


Figure 3.7. Visualization of the Biodiversity scenario (view from the Xiang Lake looking west)

Figure 3.8. Visualization of the Biodiversity scenario (view from the Gan River looking northeast)

3.2.2 Scenario Ⅱ: Reconnecting the hydrological network

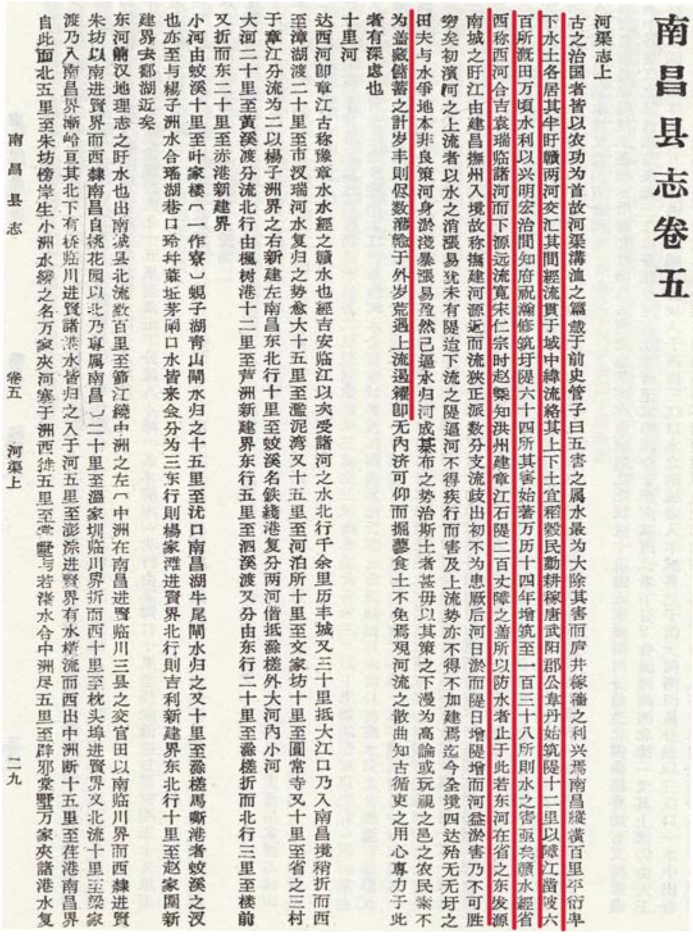

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Figure 3.9. left: Yu the Great http://www.international.ucla.edu/china/events/showevent.asp?eventid=1857 right: historic document in 1800s (Chen et al 1997)

Yu the Great, born in the 21st century BC, is worshiped in China for teaching people flood control techniques. He is believed to be the first person in ancient China who recognized and respected the natural hydrological mechanisms. In many versions of the flood mythology, Yu the Great proposed to make ways for floods instead of blocking or damming water.

"*Fighting with water for land is not a good strategy after all. There are no places left here (in Jiangxi province) that are not relying on the protection of levees. This situation needs to be changed. We shall be cautious about the possible flooding disasters in the future*". I discovered this quote in a Nanchang local event document from the Ming Dynasty in the 1800s (Nanchang Xian Zhi 1800s). It is amazing to see that the anonymous scholar who wrote this document anticipated the increased risk of disastrous floods. However, the mechanisms of the nature have long been disrespected in the Poyang Lake Region. It was not until 1998 when 2.6 million people were relocated and 313 people were killed by the floods that the Chinese government released the new regulation of returning lands to the lake.

The objective of this scenario is to re-establish the broken hydrological connectivity among the lake, the rivers and the streams for two purposes: 1) flexible space for flooding and inundation; 2) clean water source for the city. With riparian zone restoration, the benefit of this proposed scenario will also include: public green spaces; enhanced interaction between the citizens and the water bodies; environmental stewardship and appreciation of the city’s hydrological history.

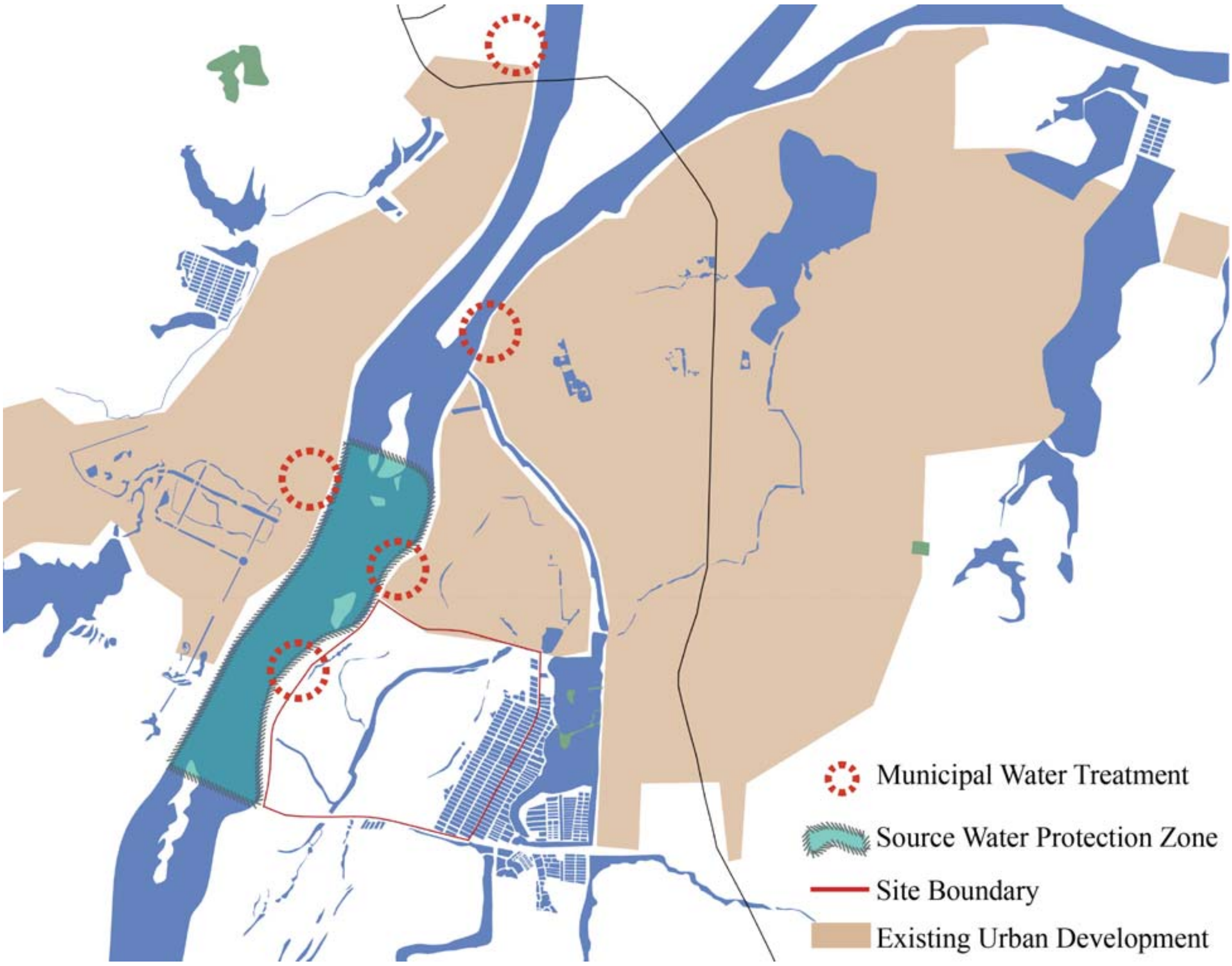


Figure 3.10. Municipal water protection zone and water treatment plants in Nanchang, China

Figure 3.11. Design inspiration and land use plan for the Hydrology scenario

Figure 3.12. Transportation and major recreational green spaces in the Hydrology scenario.

Important Design Characteristics of the Hydrology Future:

	Habitat			
Type	Wetland & riparian zone	Terrestrial	Urban green space	water surface
Area / acre	681	364	79	527

Development			
Residential			Commercial & mixed use
1110 acres	88,800 homes	266,400 residents	269 acres

- The Hydrology future contains 364 acres of terrestrial habitat mainly on the elevated islands in the Gan River and the woodland park, 681 acres of wetland and riparian habitat, and 527 acres of water surface. Urban green space accounts for 79 acres. Total 1,110 acres of residential development will be able to accommodate 88,800 new homes and 266,400 new residents (based on an average four floor residential building and an average family size of three). 269 acres of commercial and mixed use development will provide jobs and public services to the new Taohua district.

- This future will restore and reconnect the stream channels that have been segmented by the residential construction or agriculture and aquaculture facilities.

- The entire segment of the levee in the project site is relocated to create a public green space that is intentionally allowed to be flooded during different flooding events. This will increase flood detaining capacity and mitigate the effects of narrowed Gan River channel due to the development on the west bank (figure 1.21).

- The design draws inspiration from the land evolution history of the site to retrofit the hydrological connectivity in the Gan River channel. The future imitates the island pattern in the Gan river delta in the 1800's by creating multiple secondary channels outside of the proposed levee to widen the water pathway and enhance flood water detention capacity (figure 3.11). Frequent flooding and sediment deposition were the major drivers that shaped these islands before they evolved to a continuous floodplain as being seen today. Land use on these island patches is planned based on flooding events (figure 3.11). Roughly the lower two thirds of the islands are designed to be flooded frequently. The top third of these islands are elevated by the sediments excavated from the secondary channels and are safe from 100 year flood events. Along the Tauhua River inside of the levee, historical streams are restored and connected to the major river channels. The overall form is water as a matrix and islands as patches, different from the Biodiversity scenario as discussed above.

- The proposed islands will become the largest park space for Nanchang that provides education opportunities for the residents to learn about flooding and appreciate floodplain ecosystems. A provincial sports center and other recreational facilities will be located along the existing levee on one of the islands that are proposed along the riverfront. Belle Isle in the Detroit River, the largest island park in the U.S, can be a good precedent of the development typology for these proposed islands. The island park was designed by Frederick Law Olmsted in the 1880's and remains a popular recreational destination.

- Sediment excavation for the proposed seasonal wetland and secondary channels will be used as construction material for the new levee (figure 3.13).

- Major commercial development will be concentrated around the central woodland park in the district where five river channels converge at the historic nursery site. Another commercial center is at the Gan River front on the northwest corner of the site where it is connected to the existing commercial development outside of the site.

- Major transportation corridors are designed around the restored river network, rather than a regular grid system. A ring road circulates around the compact commercial area near the woodland park.

- Aquatic habitat value is improved by enhancing free aquatic migrating passage for fish and other aquatic organisms.

- The mature vegetation and the historic nursery site are reserved for an urban park that is connected to the entire stream network in the site.

- Fish farms are removed to alleviate the nutrient load to the water bodies. The wetland restoration is proposed along the Xiang Lake shore to retain and clean urban surface runoff from new development.

- Building height ranges from 3-story to 35-story based on the architecture precedents that already exist in Nanchang and nearby regions including Shanghai.

- To absorb and infiltrate rain water efficiently, green building technologies such as green roof and green façade are recommended for architecture that is not adjacent to the natural water bodies to minimize the amount of surface runoff and hydrological pressure on the 'downstream' area (figure 3.14). Combined with other stormwater treatment strategies at site level, such as bioswales, permeable surface and rainwater barrels, these green technologies can effectively reduce urban surface run off and postpone river peak flow after raining. In the downstream areas that are adjacent to the water bodies, such as the commercial center in the north part of the project site, due to the relatively high amount of water, rain water and surface runoff will be collected and conducted efficiently through bioswales and pipes to the detention area and riparian zone for infiltration before reaching these water bodies. Some successful green building precedents include Fukuoka City in Japan, Chicago in the U.S. and Singapore city in Singapore etc.

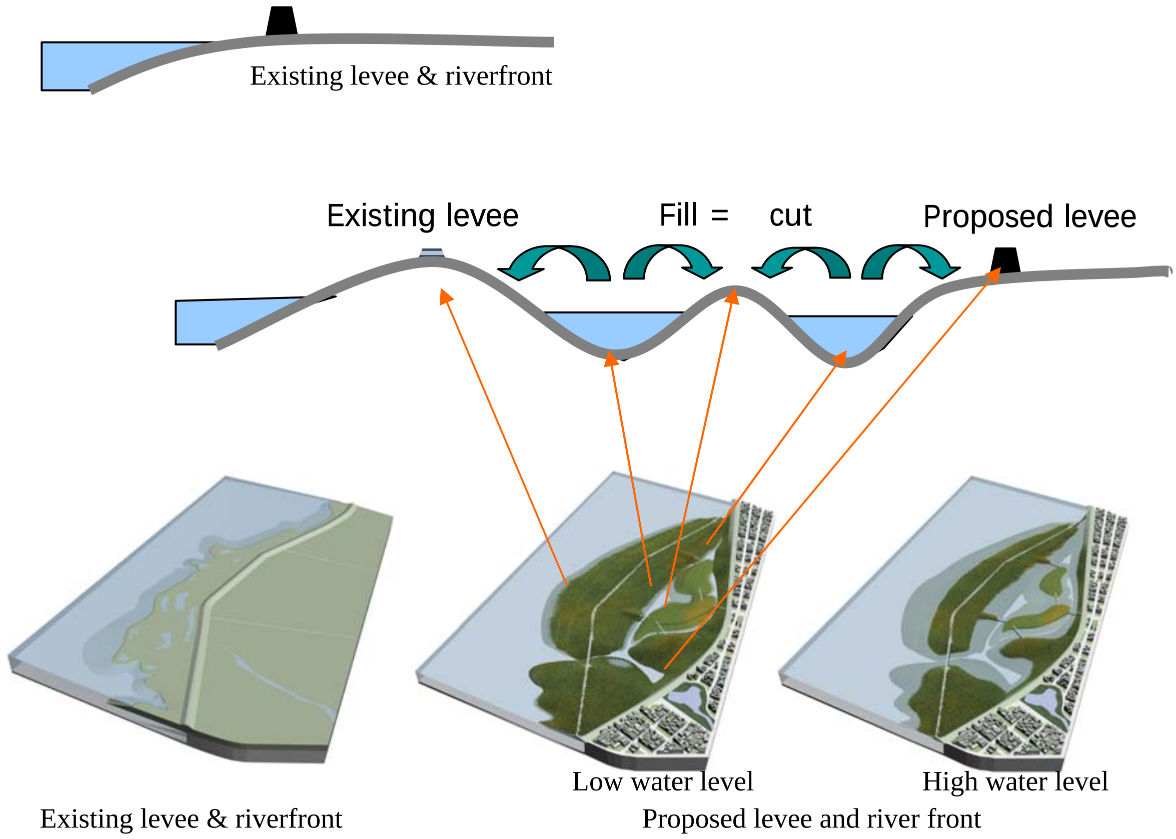


Figure 3.13 Levee relocation and proposed floodplain in the Hydrology scenario

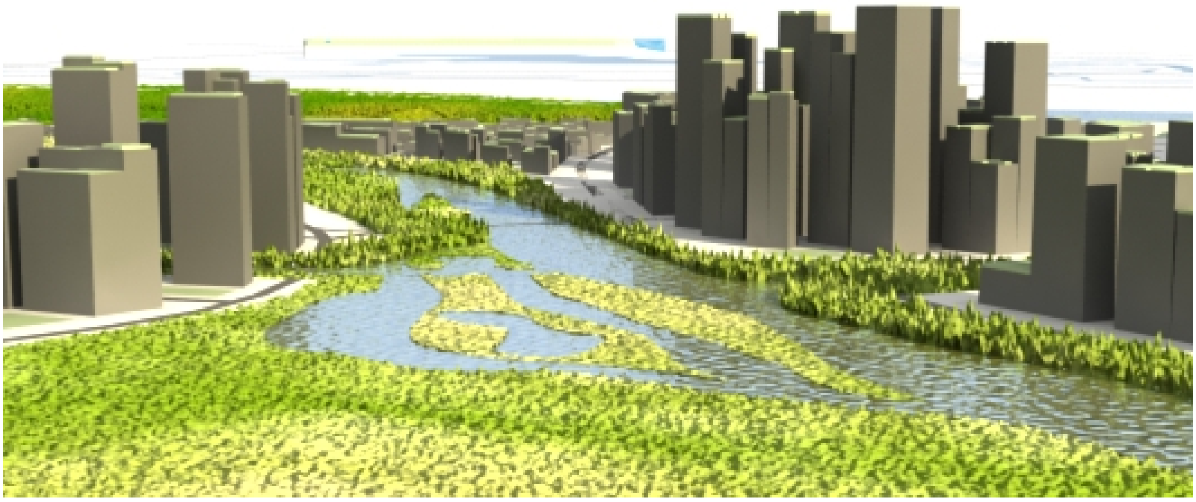
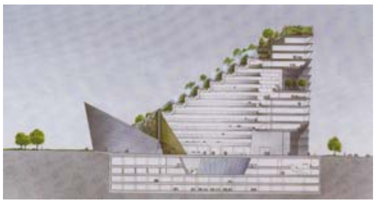


Figure 3.14 Model view of the urban park and architecture with green



Green building technology precedents

Figure 3.15 Visualization of the Hydrology scenario (plan view)

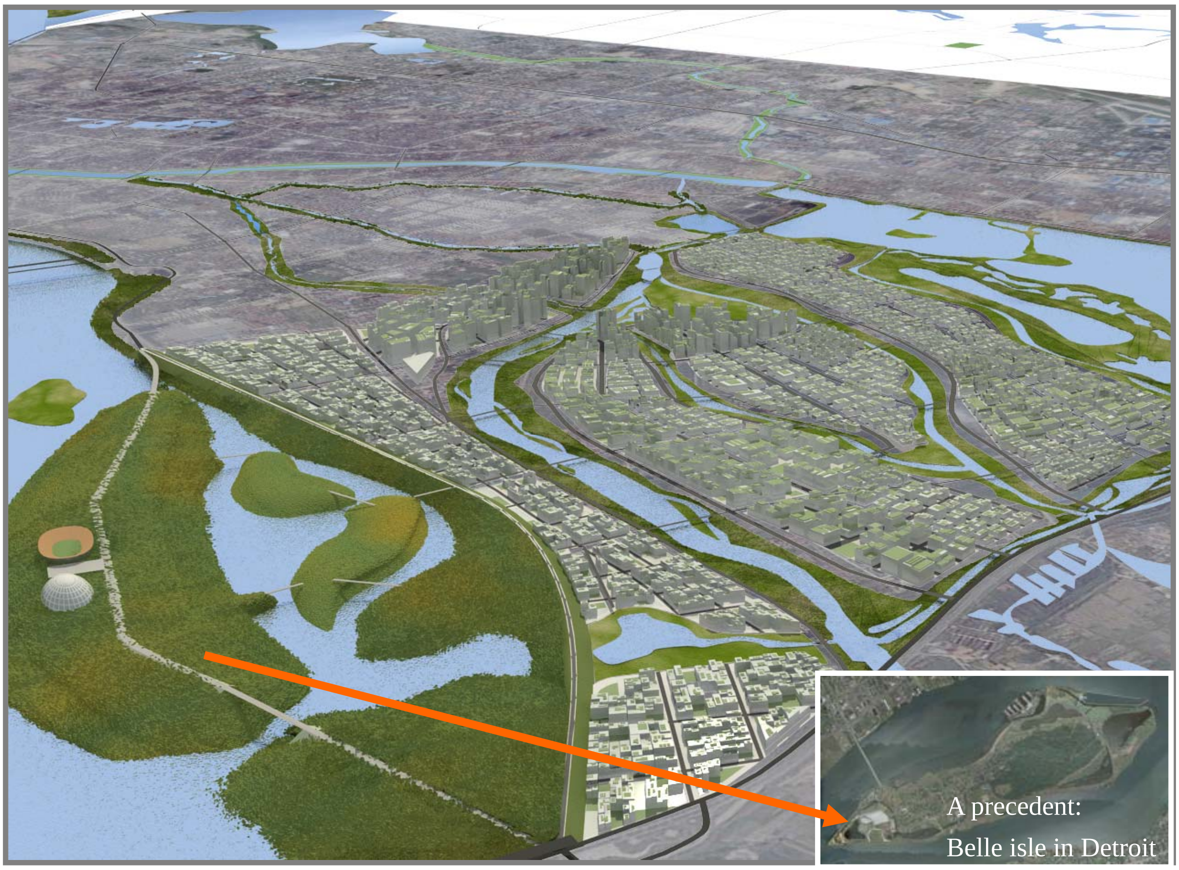


Figure 3.16 Visualization of the Hydrology scenario (view from the Gan River looking northeast)

3.2.3 Scenario Ⅲ: New residential water grids

While the main goal of this thesis is to educate stakeholders about ecologically desirable futures, the city is still challenged by the increasing demand for new homes with a growing population and thriving economy. I intended to create one scenario that will meet this demand in a highly compact manner and also acknowledge the cultural and hydrological history of the site.

The object of the residential scenario is to maximize the number of the new homes that the site can offer to the new residents. While wildlife habitat value and public green space are still highly valued, they are compromised to accommodate new urban development when there is a strong conflict. For instance, the riparian zones are narrower than the other two scenarios and the existing levee will be maintained in the current location.

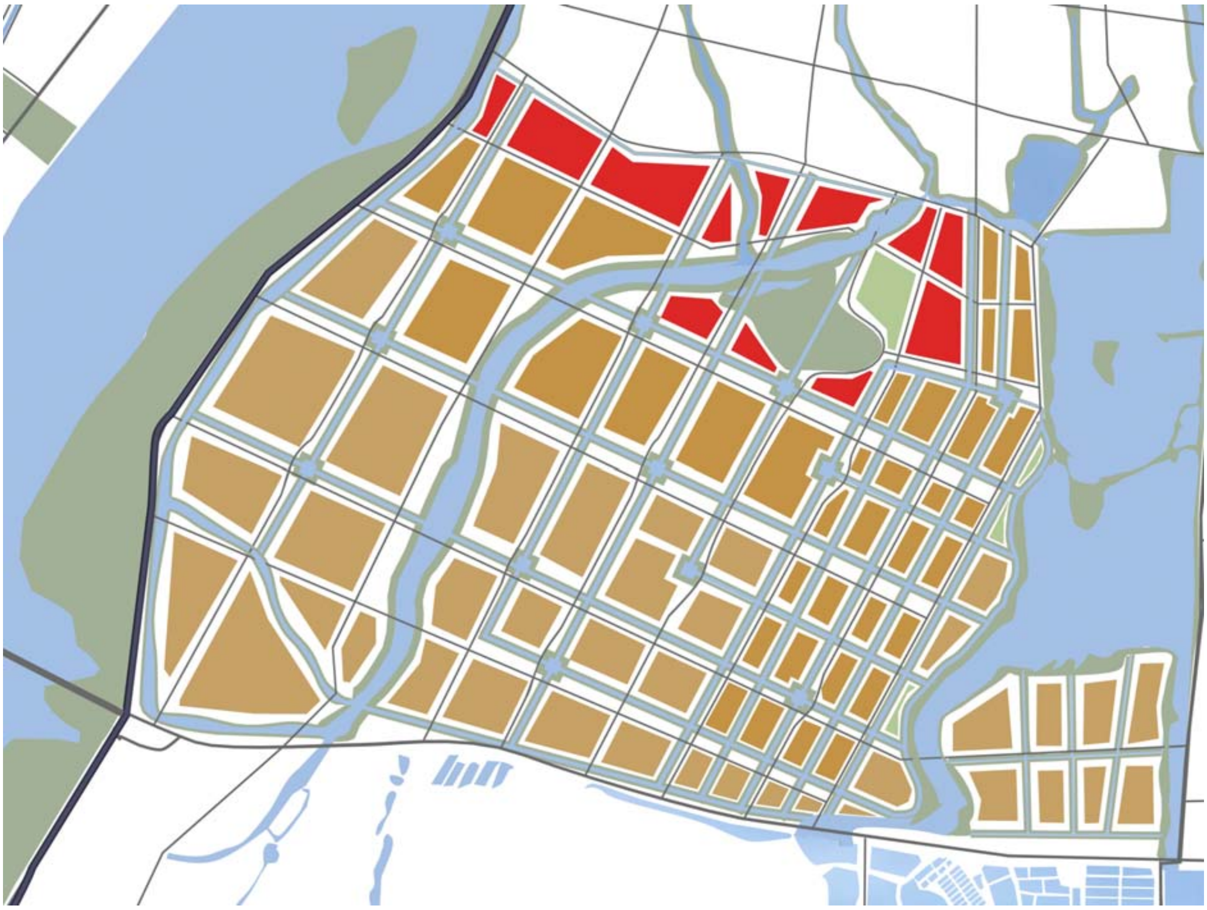


Figure 3.17 Land use plan for the Residential scenario.

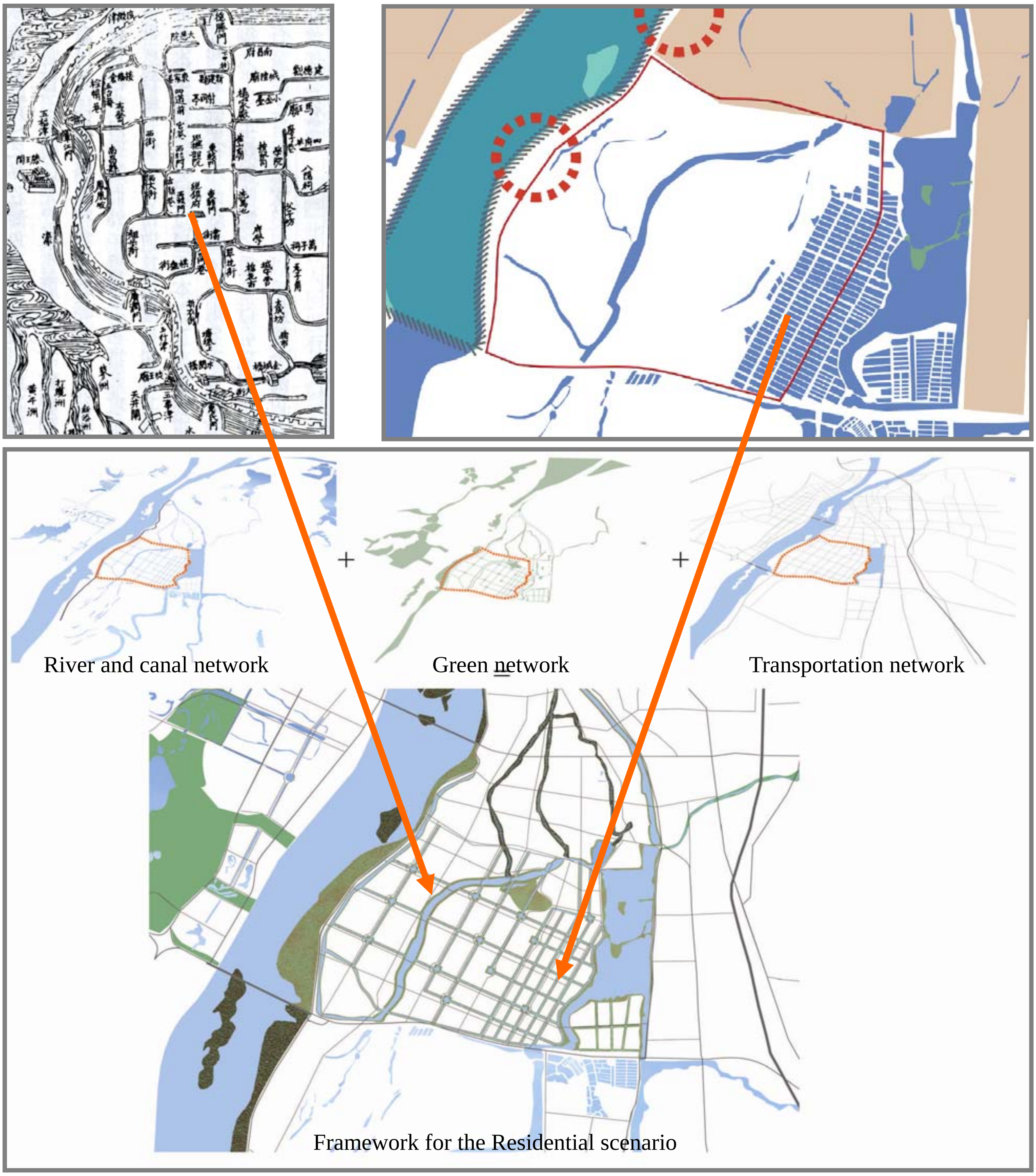


Figure 3.18 Design inspiration for the city fabric, transportation, recreational open space and urban grid system in the Residential scenario.

Important Design Characteristics of the Residential Future:

	Habitat			
Type	Wetland & riparian zone	Terrestrial	Urban green space	water surface
Area / acre	424	59	26	376

Development			
Residential			Commercial & mixed use
1958 acres	156,648 homes	496,945 residents	187 acres

- The Residential future contains 59 acres of terrestrial habitat, 424 acres of wetland habitat consisted of all the nature canal bank and river riparian zones, 26 acres of urban park space and 376 acres of water surface. 1958 acres of residential development will be able to accommodate up to 156,648 new units and 496,945 new residents (based on an average four floor residential building and an average family size of three). 187 acres of commercial and mixed use development are an extension of the existing commercial activities outside of the project site.

- The city grid fabric draws inspiration from the fish farm pattern that exists in the project site and the historic city layout in the 14th century when people's lives relied on natural water sources and were highly affected by the natural water channels. It was the river networks and the nature that make the pattern of the city. This scenario tends to respect the historic form of the city and create an extensive network of canals that are linked to the existing rivers and weave throughout the district. These canals not only help detain stormwater, but also provide some habitat value via their natural stream banks, as well as environmental amenities in a densely developed city.

- Transportation is a perfect grid system that corresponds to the canal system.

- This is the only scenario that maintains the existing levee.

- The future creates 15-meter riparian buffers along all the streams and canals.

- A series of 4-acre community wetland parks are proposed at the grid nods throughout the district.

- Extensive fish farms are removed and replaced by high density residential development with higher density of canal network than the rest of the site. 80-meter wetland buffer are proposed as a lake front park that provides both recreational functions and urban surface runoff infiltration service.

- Commercial development will be concentrated along the northern boundary of the site that is adjacent to the existing commercial area.

- The mature vegetation and the historic nursery site are reserved for an urban woodland park.

- A provincial sports center is proposed on the north side of the woodland park.

- The floodplain outside of the levee will be reserved as a river front park that embraces its natural form and allows regular flooding.

- Sediment excavation for the city canals and the community wetland parks will be used to strengthen the existing levee.

Figure 3.19 Visualization of the Residential scenario (plan view)

Figure 3.20 Visualization of the Residential scenario (view from the Gan River looking northeast)

Chapter 4 Scenario comparison and evaluation

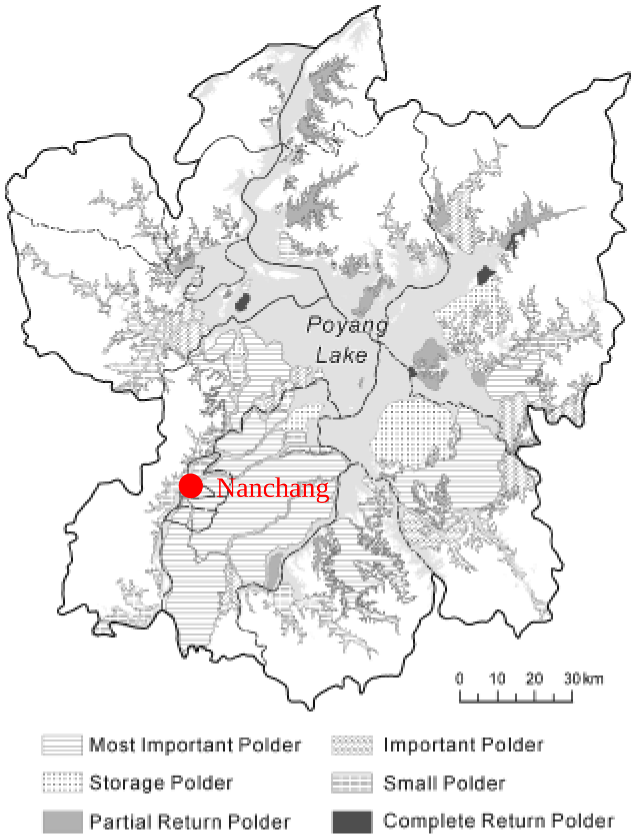


Figure 4.1. Polders created by different types of levees in the 20th century in the Poyang lake Region (Jiang et al, *in press*)

Inhabitants in a floodplain that relies on the levees' protection are vulnerable to flooding. City of Nanchang, including the project site, is located in an area identified as the "Most-Important-Polder" in the Poyang Lake Region (figure 4.1). It is critical to evaluate the vulnerability of the alternative futures to flooding in order to test whether they are plausible. As discussed in chapter 1, the potential impacts of the Three-Gorges Dam on the hydrological pattern in the Poyang Lake Region indicate a rising flooding risk in the early summer. An assurance of safety from flooding is essential to the public.

Figure 4.2. Current site condition and the three alternative futures for the project site: Tauhua district in Nanchagn, China

The expected effects of these scenarios and the current site condition are summarized for their vulnerability to flooding

The current site:

The magnitude of land reclamation is relatively low compared to any form of urban development. As discussed in Chapter 1, the predominance of agriculture and nutrient rich fish farming precludes the full realization of Taohua's ecological functions and services despite its undeveloped status. Nutrient rich discharges from agriculture and aquaculture fields are significantly affecting the water quality in the nearby water bodies. Existing levee and river gates provide the single source of protection from flooding. In the events of high river level such as the floods in 1998, a breaching of the levees can have disastrous impacts on the entire Nanchang city. Most of the wetlands and stream channels have been reclaimed for farm fields or aquaculture activities without strategic planning. Their ability to detain floodwater is substantially decreased. The contribution of this floodplain site to enhancing the urban landscape resilience of the broader Nanchang Metropolitan can be potentially improved.

The Biodiversity scenario:

This scenario intends to reserve and restore wetland habitats for migrating birds and the magnitude of urban land reclamation is less than half of the total area. The expected wetlands and river riparian zones not only provide ideal habitats for water birds, but are also able to detain and store floodwater from flooding and inundation. Relocated levee creates a large wetland park that is regularly flooded. The floodwater detaining capacity and the city's resistance to flooding is improved. The widened Gan River channel helps alleviate the bottleneck effects on the river from the development on the west bank (figure1.21).

The Hydrology scenario:

The focus of this scenario is to improve flood management and reestablish hydrological connectivity. The magnitude of the land reclamation is expected to be the lowest among the three alternative scenarios. With the entire segment of the levee in the project site relocated inland, more floodwater storage is created. The widened Gan River channel significantly alleviates the pressure from the development on the wet bank. In addition, the restored and reconnected river corridors further increase the capability to detain water during flooding and improve the hydrological integrity of the region. This scenario is expected to have the largest water surface area in the district and most greatly contribute to resistance to flooding.

The Residential scenario:

With a goal to accommodate the highest number of residents in a desirable future, the magnitude of urban land reclamation in this scenario is the highest among the three scenarios.

Habitat values and floodwater detaining capacity are valued might be compromised when conflicting with residential development. Therefore, the landscape resistance to flooding is lower compared to the Biodiversity scenario and the Hydrology scenario. However, it is expected to be higher than the current condition because of the extensive canal systems throughout the district. The scenario maintains and improves the exiting levee as the major projection from flooding.

Scenarios		Biodiversity	Hydrology	Residential
Habitat (acre)	Wetland & riparian zone	994	681	424
	Terrestrial	92	364	59
	Urban green space	144	79	26
	Water surface	444	527	376
Development	Residential area (acre)	1319	1110	1958
	New residential units	105520	88800	156648
	Commercial & mixed use (acre)	271	269	187
Levees & bridges (km)	Levee demolition	1.80	4.00	0
	Levee construction	2.40	3.90	0
	Bridge construction	1.26	3.25	4.01

Table 4.1. A comparison of land use in three scenarios

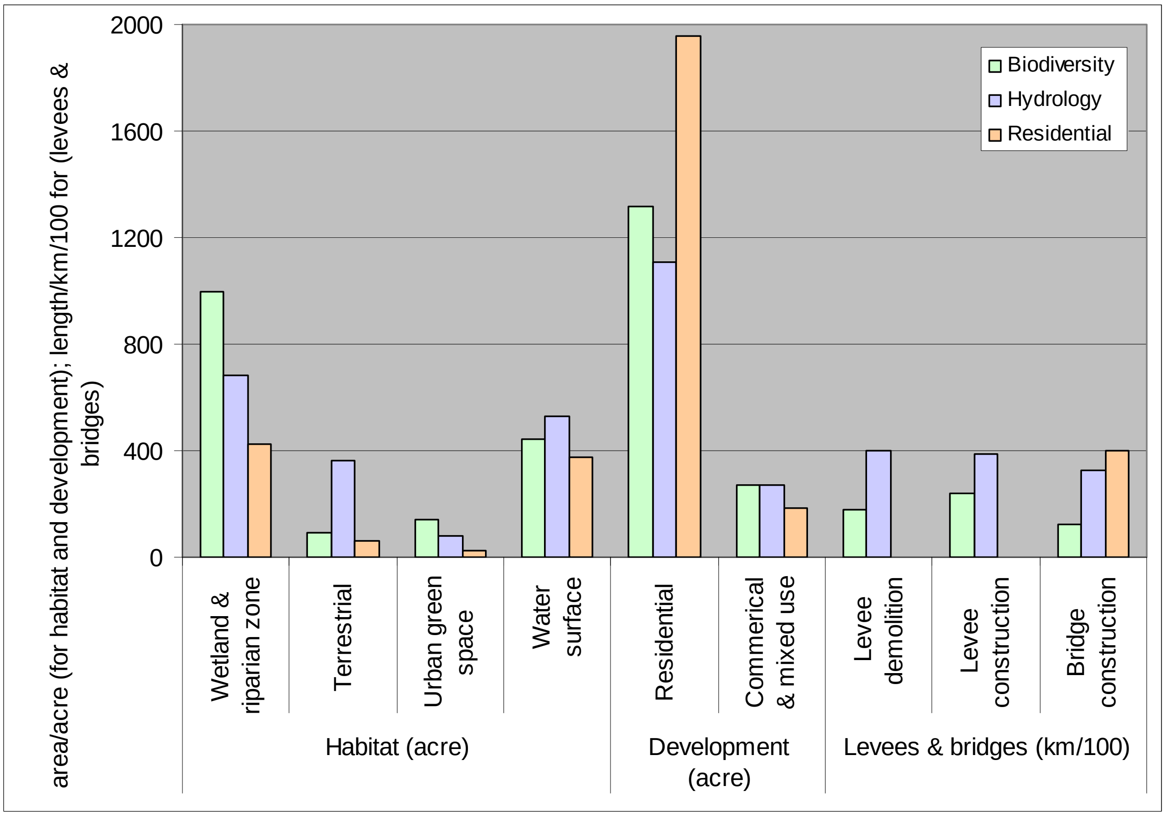


Figure 4.3. A comparison of areas in land uses in futures for the three alternative scenarios

Since the key species for biodiversity conservation are migrating birds, the biodiversity scenario creates preferable seasonal wetland with shallow still water as the target habit. While the hydrology scenario is meant to focus on hydrological connectivity and floodwater detention, reestablishment of free migrating passage for aquatic organisms substantially enhances aquatic biodiversity, and this may be attractive to birds. Extensive permanent wetlands proposed along the Xiang Lake in the hydrology scenario also provide high quality bird habitat, however, its connection to the wetlands on the west bank of the Gan Rivers is much weaker compared to the biodiversity scenario. Overall, the total size of habitat including water surface in the biodiversity scenario and the hydrology scenario are comparable, and both scenarios will greatly enhance biodiversity in ways that different wildlife types will benefit.

In both the biodiversity and hydrology scenarios, the existing levees will be removed and new levees are proposed. With the entire levee in the site relocated, the hydrology scenario requires the most earthworks with nearly 4 km of new levee construction.

The residential scenario will be able to provide 156,648 new homes that are almost twice as many as the 88,800 new units that the hydrology scenario can have. The biodiversity scenario will provide 105,520 new homes, that is 16,720 units more than the hydrology scenario, but significantly fewer than the residential scenario. Besides the biggest area of total residential and commercial development, the residential scenario also requires the most bridge construction although no levee demolition or construction is needed.

In all three scenarios, public accessibility to the water bodies will be substantially enhanced. In the Biodiversity scenario, the seasonal wetland habitat outside of the new levee will become the largest park in Nanchang. It makes bird watching and flood watching a great city amenity and provides great environmental education opportunity to the public. The continuous wildlife habitats also function as a series of connected parks for the residents.

In the Hydrology scenario, the floodplain along the Gan River provides different types of public open spaces, ranging from frequently flooded lower wetland to 100-year-flood safe island park that contains a regional sports center. After creating two openings, the existing levee will be converted to a scenery drive that connects the major islands. All the restored stream networks will promote the public awareness of the hydrological history of so called Flooding City.

Despite its low level of wildlife habitat value, the urban residential scenario provides the greatest accessibility to water front by introducing canals. The district is organized by canals and urban life is surrounded by water. In a canal fabric, a pedestrian friendly natural river front is accessible in all directions within each neighborhood.

Chapter 5 Conclusion

Located in a unique region that has a long flooding history and hosts thousands of water fowl each year, Tauhua district has to make choices among the alternative futures. In particular, the completion of Three-Gorges dam will potentially slow down the discharge from the five Jiangxi rivers into the Poyang Lake. And increase the flood risk in the upstream floodplains with dense development. Biodiversity conservation, flood management, and urban population growth are all prominent issues that the City of Nanchang has to include in its policy making process. Only with a clear expectation of the ecologically and socially desirable futures can the decisions be made to make the policy goals achievable and plausible.

During the site visit, I constantly asked the interviewees what they hoped the new district would be like. No clear expectations were expressed. With more specific questions, such as 'natural riverfront vs. concrete channel' 'allow part of the river front to be frequently flooded', most of the interviewees could give a clear answer. Often, these answers are in conflict with each other. Expectations from different sectors have great influences on the future plan for the landscape. The overall goal of these scenarios is to educate and provoke a conversation among these sectors including the author (the designer), the local community, the city government, and the scientists, and the developers. Different expectations might come into conflict in a fast growing city. Then what the future should be, instead of what it is likely to be, becomes a key question in the discussion.

With a high level of uncertainty in a fast growing city, normative alternative visions for future landscapes will greatly facilitate the decision making process. City of Nanchang is eagerly promoting its public image as an ecological city, which makes a normative design approach more appropriate for the topics that are discussion for the future of the city.

By no means will these scenarios serve as the final plan for the city. With the specific design characteristics and graphic presentations, the implication of the proposed ecological planning goals become explicit and visible, which helps engage the discussion about the social-ecologically desirable futures.

For the future studies, I would like to pose the question: "if it is possible, what is the best way to reconcile these radically different scenarios?" For example, after evaluation of the completed futures, I see opportunities to enhance biodiversity and improve floodwater detention capacity at the same time.

This report will be sent to City of Nanchang and the potential developer Talent Inc in Beijing. With further feedback from these stakeholders, I anticipate that these scenarios will provide practical design guidelines to the development of the new district.

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