Strategies for coastal Cities to Cope with Flood disaster and Urban Heat Island Effect in the Context of climate Change

- A Case study of Shanghai, China

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With the global warming and the acceleration of urbanization, China's climate has also undergone significant changes. Precipitation increased in many areas, and the frequency of extreme events greatly increased. Therefore, people begin to think more about how to adapt to climate change in urban planning and how to have stronger disaster resistance in urban functional structure and layout space.

With the rapid development of economic construction in Shanghai, the temperature difference between urban and rural areas continues to expand, the intensity and area of heat island continue to increase, the phenomenon of high temperature in summer continues to strengthen, high temperature disasters occur frequently, and the urban thermal environment problems are becoming more and more prominent. Urban heat island is formed under the combined action of human factors (mainly urbanization and industrialization) and local weather and meteorological conditions. With the increasing urban hardening rate and excessive development, the original surface runoff is destroyed and the urban heat island effect is gradually aggravated. Therefore, for urban planning, increasing green space area and reducing urban hardening rate through LID measures can reduce the impact of heat island effect.

The rainfall in Shanghai is mainly concentrated from June to October every year. It often rains for several consecutive days. The rainfall is concentrated and lasts for a long time, and the instantaneous rainfall is heavy, which easily causes the water level of the river to rise sharply. At this time, the city due to the original municipal pipe network facilities is not perfect and the design is not reasonable, resulting in rainwater drainage is not smooth, resulting in waterlogging. On the other hand, global warming has accelerated the melting of glaciers and caused sea levels to rise, leading to flooding in coastal areas. By introducing the concept of sponge city into urban waterlogging prevention and control, especially by effectively reducing surface runoff and flood peak through low-impact development measures, the adverse effects and damage caused by urban waterlogging can be alleviated.

Therefore, the paper takes the construction concept of "sponge city" and low-impact development measures as an important strategy to alleviate the above problems. The author starts from the theoretical research, and then makes a systematic analysis of the weather of Shanghai in the past 60 years, and concludes that the main climate problems of Shanghai are urban waterlogging and urban heat

island effect. Then, according to the pilot project of sponge city construction in Shanghai, four representative pilot projects were selected for planning practice. Systemic strategies and low impact development measures are proposed to mitigate urban waterlogging and urban heat island effect. The present situation of Shanghai and the main problems of sponge city construction are analyzed with the four pilot projects as representatives. In terms of empirical exploration, it mainly analyzes how to construct sponge city system from the perspective of LID layout. Finally, make a summary of the foregoing and put forward deficiencies.

Key Words: Climate Change, Urban Heat Island, City Waterlogging, Sponge City, Low Impact Development

CONTENT

1 Introduction

1.1 Research Background

1.1.1 Challenges brought by climate change to urban development in China

The fifth assessment report of the First Working Group of the United Nations Intergovernmental Panel on Climate Change, "Climate Change 2013: The Physical Science Basis", from three different perspectives: observation, attribution analysis, and future prediction, shows that the earth system is experiencing a global warming which is a significant change in the main feature. Since 1950, many of the changes observed in the climate system are unprecedented in the past few decades or even in the millennium. Almost all regions of the world have experienced a warming process. The warming is reflected in the rise of the earth's surface temperature and ocean temperature, the rise of sea level, the melting of Greenland and Antarctic ice caps and the retreat of glaciers, and the increase in the frequency of extreme weather events. The global surface temperature continued to rise, and the global average temperature from 1880 to 2012 has risen by 0.85°C [0.65-1.06°C]; in the past 30 years, the warming rate of the surface temperature every 10 years is higher than any period since 1850 ***[Stocker T.Qin D., Plattner G., et al.2013; Shen Yongping, Wang Guoya. 2013]***. Climate change refers to the change in the climatic state that can be identified (such as using statistical tests), that is, the change in the average value and/or the variability of various characteristics, and lasts for a long time, generally up to several decades or longer. Climate change may be caused by natural climate variability or man-made climate change. Changing climate can cause extreme weather and climate events to change in frequency, intensity, spatial scope, duration and time of occurrence, and can lead to unprecedented extreme weather and climate events. Changes in extreme events may be related to changes in the average, variability, or probability distribution pattern or all of these changes ***[PANEL Intergovernmental. 2012]***. Therefore, the analysis of the characteristics of climate change under the background of global warming and the prediction research of future climate change has become the focus of the government and the general public.

However, in the future, the global climate will become substantially warmer and the temperature will continue to rise, which will affect the changes in precipitation, leading to increased precipitation in some areas and changes in the distribution of precipitation. The change of precipitation is closely related to the ecological environment and ecological security, and it will have a profound impact on water resources, agriculture and ecosystems ***[Zuo Hongchao, LV Shihua, Hu Yinqiao. 2004]***. With the global warming, China's climate has also undergone significant changes, precipitation in many areas has increased, and the frequency of various extreme events has greatly increased. Relevant scholars pointed out that due to global warming, the evaporation of land water bodies and oceans has increased, and the circulation of water vapor has been accelerated. The resulting increase in precipitation is the root cause of the possibility of greater floods in the Yangtze River. The analysis of precipitation in China in recent decades also shows that since the 1970s, the precipitation in the Yangtze River Basin has been increasing ***[Xu Ying, Ding Yihui. 2004; Mei Wei, Yang Xiuqun.2005]***.

Climate warming has accelerated the melting of glaciers, caused sea level rise, and then caused floods in coastal areas. On the other hand, due to the imperfect and unreasonable design of China's original municipal pipe network facilities, when the rainfall is large, it is very easy to cause water on the ground due to insufficient discharge capacity in a short time, which will evolve into a waterlogging disaster. These problems not only cause inconvenience in life and work for urban residents, but also easily cause water quality and soil pollution caused by rainwater runoff.

1.1.2 The damage to the site caused by urbanization and the damage to the site's ability to adjust, aggravate the urban heat island effect

According to the World Bank (WBG) report ***[China Society of Urban Science. 2009]***, urban population accounts for 50% of the world's total population, but urban greenhouse gas emissions account for 80% of global emissions. Cities have become the world's largest source of CO2 emissions, and reducing urban greenhouse gas emissions has become the main battlefield and key to the international community's response to climate change. On the other hand, cities are concentrated areas of high-density population, buildings, wealth and infrastructure, and are also high-risk areas affected by climate change ***[BIRKMANN J, GARSCHAGEN M, KRAAS F, et al. 2010; Wang Weiguang, Zheng Guoguang. 2013]***. Extreme weather and climate events can cause huge disasters and far-reaching impacts on cities. The resulting property losses have also become more serious ***[SHI J, CUI L L.2012]***. As a result, people have begun to think more about how urban planning can deal with climate change, and how the urban functional structure and layout space can have stronger disaster resistance capabilities.

The relationship between urbanization and climate change is very close. On the one hand, the choice of the urbanization process will have an impact on climate change. The increase in urban population will lead to an increase in carbon emissions. Urban human activities will affect the local climate and environment to form such as "Heat island” and "Rain Island" or other urban local climate change characteristics ***[WONGNH, JUSUFSK, TANCL. 2011; SHI J, LIANG P, WAN Q L, et al.2011]***. Urban Heat Island (UHI) refers to the urban thermal environment phenomenon where the temperature in the center of the city is significantly higher than the temperature around the city. It is the difference in heat balance between the city and the suburbs caused by changes in the urban spatial structure and human activities. On the other hand, climate change also has many impacts on urban planning and construction, especially in low-altitude coastal areas along the Yangtze River, high-polluted inland areas, and the comfort of urban residents' living environment ***[SHI J, CUI L L. 2012; SHI J, LIANG P, WAN Q L, et al. 2011]***. In the context of global climate change, the frequency and intensity of extreme weather and climate events and disasters are changing, and urbanization will face greater vulnerability and risk ***[SHI J, CUI L L. 2012]***.

Moreover, due to the characteristics of high population density and high development intensity brought about by urban agglomeration, on the one hand, it brings huge benefits to economic development, but also leads to the emergence of contradictions between economic development and ecological protection, and adversely affects the urban ecological environment. The increasing rate of urban hardening and excessive development have destroyed the original surface runoff and gradually aggravated the urban heat island effect. Therefore, to promote the sustainable development of cities and towns, it is necessary to coordinate the reduction of greenhouse gas emissions and cope with the risks and disasters brought by climate change in urban governance and planning and design, and to build low-carbon and resilient cities ***[LEICHENKO R. 2011]***.

1.1.3 Development and promotion of low-impact development theory

The Chinese government puts forward: "To reduce the rainwater problem, we must conform to nature, give priority to keeping limited rainwater, give priority to more use of natural forces to drain water, and build a sponge city with natural accumulation, natural infiltration, and natural purification." Since 2015, China has launched two batches of 30 sponge city pilot cities, most of which are located in better social and economic conditions or in new areas that are easy to control. However, China has a vast territory, and there are large differences in geography, hydrology, and humanities among regions and cities. However, in the current process of sponge city construction, no reference decision has been made based on the characteristics of each region.

As a pilot project, Shanghai Pudong New Area has rapid economic growth and a high level of urbanization, but there are still many problems in water safety, water environment, and water ecology. For example, the structure of the water system is not perfect, the design standard of rainwater pipe network is low, the construction of sewage pipe network is not perfect, and the way of river construction deviates from the concept of ecological development. These bring inconvenience to residents' lives and are not conducive to the sustainable development of the city, so it is especially necessary to carry out sponge city planning for the corresponding problems.

1.2 Research purpose and significance

1.2.1 Research purpose

This research aims to mitigate urban waterlogging and urban heat island effects in the context of climate change, and discusses the construction of sponge city systems and the layout of low-impact development measures, as well as measures to reduce and alleviate urban greenhouse gas emissions. The current situation and causes of waterlogging and heat island effects in Shanghai are analyzed from three aspects: theoretical discussion, system construction and practical application. In this regard, the planning and design optimization plan and the planning system improvement strategy are proposed. It is expected that the urban planning of Shanghai in the future will be provided a theoretical foundation and practical suggestions when it involves the prevention of waterlogging and the mitigation of the heat island effect.

1.2.2 Research significance

1.2.2.1 Theoretical significance

From a theoretical point of view, this study starts from the study of urban waterlogging and heat island effects in Shanghai under the influence of climate change, and fully understands the current known theoretical systems and practices at home and abroad. Investigate and analyze such problems in coastal cities, put forward a design strategy system for mitigating coastal urban waterlogging and urban heat island effects, and provide theoretical support for how to arrange low-impact development facilities and how to mitigate urban heat island effects. This research hopes to provide more research data for future urban construction.

1.2.2.2 Practical significance

From the perspective of specific practices, first of all, the characteristics of all parties and waterlogging texture of waterlogging sites in the field are analyzed and summarized, such as internal and external causes of waterlogging, so as to let more people know the causes and solutions of urban waterlogging. Secondly, for those engaged in the research and construction of sponge city planning, the enriched theoretical system can provide them with more guidance on how to optimize the waterlogging site and design the waterlogging site in the future, so as to realize the practical value of the theory.

In terms of mitigating urban heat island effect, the causes are summarized and the solutions are proposed. It is hoped that more practical measures will be given to urban planning designers in terms of how to reduce urban greenhouse gas emissions and mitigate the heat island effect.

1.3 Relevant technical approaches in the world

In the 1970s, research shows the problem of rainstorms were carried out in the West. However, in the following two or three decades, as the process of global urbanization continues to accelerate and the global climate heats up, it becomes more and more obvious that the rain, flood and climate problems urgently need to be reduced by human. For this reason, the western developed countries gradually explored and formed the macroscopic storm flood management theory system. Among them, the representative ones are the LID (Low Impact Development LID) system, BMPs (Best Management Practices (BMP) system and SUDS (Sustainable Urban Varied System) system. Compared with the traditional stormwater management based on "drainage", the core contents of these three systems have shifted to the development of compound green ecological stormwater management network, which not only reduces the problem of stormwater, but also res the problem of urban ecology, which has undergone a fundamental change.

1.3.1 Development and promotion of LID technology in the United States

The full name of LID, Low Impact Development, is a rainstorm management and non-point source pollution treatment technology developed in the late 1990s. It aims to control the runoff and pollution generated by rainstorm through decentralized and small-scale source control, so as to make the development area as close to the natural hydrological cycle as possible.

LID (low-impact development) is an ecological technology system that can easily realize the collection and utilization of urban rainwater. The key lies in in-situ collection, natural purification, nearby utilization or recharge of groundwater.

It mainly includes: ecological grass ditch, sunken green space, rainwater garden, green roof, underground storage infiltration, permeable road. Low impact development (LID) is a kind of stressed by source scattered small control facilities, maintain and protect the hydrological features of the site, effectively alleviate with the increase of the peak flow and runoff coefficient increases caused impervious area increases, non-point source pollution load of urban stormwater management concept, in the 1990 s began in the United States, Maryland. ***[baike.baidu.com]***

The rapid urban development of the United States in the 20th century led to the emergence of a large number of rainwater problems, which also prompted them to recognize the importance of rainwater management earlier, and they hoped to take some measures to alleviate the rain problems. Best Management Practices (BMPs) were first proposed in 1972 in the United States Federal Water Pollution Control Act. In the 1990s, Prince George's County, Maryland, proposed the concept of low-impact development (LID), which emphasizes the protection of water quality through the protection and utilization of natural features such as on-site natural hydrology and soil. ***[Stern D N，Mazze E M. 1974].***

Compared with BMPs, it is different from the previous control of stormwater runoff in the whole area and focuses on the use of small-scale decentralized control measures to control stormwater runoff ***[Zhou,X.B.& Che,W.2009][Dietz M E.2007]*** At the same time came the first design technical standards.

At the same time, the Sustainable Development Council of the United States proposed the Concept of Green Infrastructure (GI) ***[Che, W.& Ma,Z.2009]*** From 2000 to 2005, LID design concept was gradually accepted and LID technology facilities were promoted and applied. From 2006 to 2010, LID concepts began to be applied to stormwater management and non-point source pollution control ***[Zhang Yuan, Yu Bingqin, Che Shengquan. 2014]***

Rainwater management in the United States has developed from a simple drainage system to the control of water quantity and quality ***[Ignacio F. Bunster.2013]***, and has formed the current multi-purpose and sustainable management system. New York, Los Angeles, Chicago, Philadelphia, Washington, Portland and other cities have carried out engineering practices and achieved good results. Thereafter, the discussion carried out by Morning Post in 2015 provided new theories and practices for the construction of sponge cities in the new era ***[Zhang Xiao-xin, MA Hong-tao. 2012].*** After half a century of development, it has provided theoretical and practical support for the formation of the concept of "sponge city".

Low-impact development mainly adopts measures such as biological retention facilities, roof greening, shallow gullies of vegetation, and rainwater utilization to maintain the original hydrological conditions before development, control runoff pollution, reduce pollution discharge, and realize sustainable water cycle in the development area. Low-impact development emphasizes that urban development should reduce its impact on the environment. Its core is to build urban drainage system suitable for nature based on the idea of source control and load delay, to control storm runoff by rational use of landscape space and taking corresponding measures to reduce non-point source pollution in cities and towns.

1.3.2 Development and evolution of SUDS system in the UK

The UK reduces its storm and flood problems by establishing a sustainable drainage system (SUDS). The SUDS system requires that runoff and potential pollution sources be treated from the source as much as possible to protect water resources from point source and non-point source pollution. In May 1999, the UK updated its national Sustainable Development strategy and Agenda 21. In order to reduce the problems caused by frequent floods, serious pollution and environmental damage caused by the traditional Drainage system, the SUDS(Sustainable Urban Drainage System) system was established by incorporating long-term environmental and social factors into the Drainage system and system. The recreational value of water quality, water quantity and surface water in urban environment is considered comprehensively. The SUDS system has been upgraded from a traditional drainage system with discharge as the core to a sustainable drainage system with a high level of benign water circulation. In the design, the water quality, water quantity, landscape potential and ecological value of runoff are considered comprehensively. From the original optimization of urban drainage facilities to the optimization of the entire regional water system, not only rainwater, but also urban sewage and reclaimed water should be taken into account, so as to improve the overall urban water cycle by adopting comprehensive measures.

By 2000 a set of guidance documents had been published, providing similar but separate design manuals for Scotland, Northern Ireland, England and Wales.***[CIRIA,2001]*** Finally, an authoritative SUDS manual was formed to guide the full implementation of SUDS in the UK, which took into account both rural and urban land use. Compared to the BMPs, the SUDS is more comprehensive through a series of rainwater treatment practices and techniques that work together to form a system.

It not only deal with the problem of urban rainwater, but also puts forward some solutions to the discharge of urban sewage. The Su DS is widely used in England, Wales, Scotland, Ireland and Sweden.

1.3.3 Application practice of WSUD in Australia

In the 1990s ***[CIRIA, 2007],*** Australia proposed water-sensitive urban design (WSUD) ***[Mouritz, M.1992.]*** to reduce the water problem brought by the rapid urban development. He has engineered and systematized water recycling and water treatment problems and advocated for planning and design to mitigate the effects of environmental degradation.

In the process of urban development, many Cities in Australia are confronted with challenges such as urban flood control, water shortage and water environment protection. As a new cutting-edge city in Urban Water environment management, especially in the field of modern storm water management, Melbourne is represented by WSUD Water Sensitive Urban Design initiated by it and relevant cutting-edge research, making it a world leader in the field of urban storm water management.

WSUD, led by Melbourne, emerged in Australia in the 1990s. At that time, the urban stormwater diversion system was basically perfect, and the discharge of urban point source pollution was basically completely controlled through the construction of sewage treatment facilities. However, the expected ecological urban river course did not appear as scheduled, and the non-point source pollution of urban stormwater runoff has become an unavoidable problem to improve the ecological health of river courses.

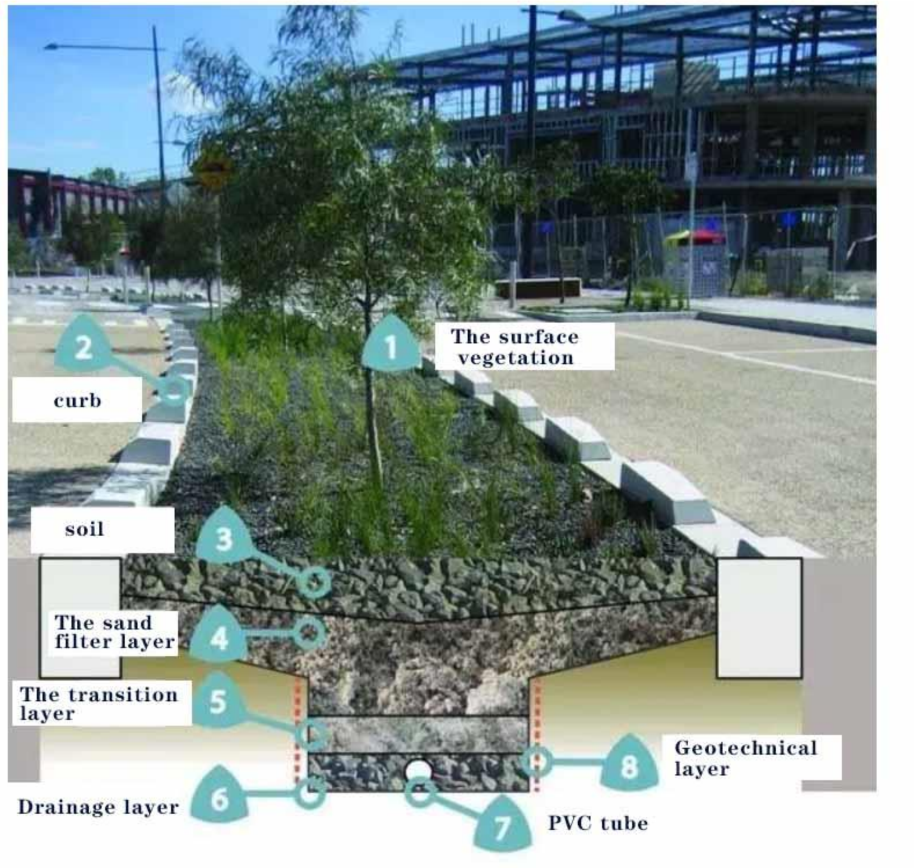


FIG.1.1 WSUD in Australia

(Source: BBS.co188.com)

An important principle of WSUD is source control. Water and water quality problems should be solved on the spot and not brought into the surrounding area, so as to avoid increasing flood control and environmental protection pressure in the lower reaches of the river basin and reducing or saving investment in flood control and drainage facilities construction or upgrading.

Its stormwater quality management measures, such as roof gardens, ecological retention systems, constructed wetlands and ponds, can also hold stormwater to varying degrees, thereby reducing the need for drainage facilities. Green waterfront buffer zone can effectively reduce river erosion and maintain river stability while ensuring flood discharge. Rainwater collection and reuse provide alternative sources of water and reduce the use of tap water for non-potable purposes. The design of stormwater management facilities integrated with the landscape can create attractive public space and enhance the livability of the city.

Centering on the technical core of urban stormwater management, Australia has carried out a lot of cutting-edge research and interdisciplinary discussions. In the concept of water-sensitive city proposed by Melbourne, it also introduced the all-water link management system of rainwater, groundwater, drinking water, sewage and reclaimed water for the first time.

The water quantity control measures adopted in engineering practice mainly include permeable pavement, sunken green space, underground reservoir and stormwater retention reservoir (artificial lake, stormwater park). Water treatment measures mainly include road rainwater mouth intercepting device, vegetation buffer zone, drainage grass ditch, ecological drainage grass ditch, sediment filtration device, sediment storage pond, rainwater garden, artificial lake and artificial wetland, etc.

WSUD is a relatively well-structured sustainable water resource management system ***[Ju Maosen.2015]***.Compared to BMPs and LID, WSUD is more comprehensive. Strengthen the urban development in the protection and the natural water system, on the basis of the rainwater treatment facilities into the landscape, including multiple uses in many aspects, such as the rain aesthetic and recreational value to achieve the best of the project, at the same time protect the urban drainage water quality, for the rain in the light of the local processing intercept measures and reduce the impervious area, to reduce the peak flow of urban stormwater runoff; While adding additional value, it also reduces the construction cost of drainage infrastructure ***[Wong, T. H. F. & Eadie, M. L .2000].*** A series of measures proposed by WSUD achieve multi-objective management objectives through the practice of planning and design, and meanwhile change the traditional planning methods ***[Victorian Stormwater Committee,1999].***

1.3.4 Development and application of stormwater management practices in Japan

In Japan, because of the special national conditions, the implementation of the "sponge city" was much earlier. Japan's rainwater storage infiltration program was introduced as early as 1980. In 1992, the Construction Ministry expanded the urban master plan by adding rainwater gully, seepage pond and permeable ground. It is stipulated that in the urban development and construction, for each hectare of construction land to be developed, there must be an additional rainwater storage pond with a capacity of not less than 500m. Japan has also established a number of non-governmental associations, the most famous of which is the "Japan Rainwater Storage Infiltration Technology Association". In the early stage of rainwater utilization project in Japan, rainwater regulation pools were mainly built in parking lots, parks, green spaces and other places. After that, a multi-functional regulation pool was developed with landscape effect. At present, Japan's rainwater utilization can not only meet the domestic demand, but also export to foreign countries to form a new industry.

Japanese sponge city construction law and Incentive measures: All the laws and regulations promulgated by the Japanese government are based on the guidelines for rainwater utilization, which are compiled by the Japanese non-governmental organization "Rainwater Storage and Infiltration Technology Association". In the "second-generation urban Drainage Master Plan", it is stipulated that rainwater infiltration facilities must be installed in newly-built or reconstructed large public buildings, and permeable pavement, sunken green space and permeable pond are added into the urban planning. In terms of economic policies, Japan promotes the implementation of rainwater utilization projects by means of tax reduction, subsidies, funds and policy-based loans. In 1996, the pilot project of "Subsidy system for promoting rainwater Utilization in Motian District" was established, and the subsidy was divided into three levels according to the size of the water storage device, with the subsidy amount ranging from 25,000 to 1 million yen.

1.4 Technical approach status of Sponge cities in China

1.4.1 Definition of “Sponge City”

"Sponge city construction technology guide - low impact development of rainwater system build (for trial implementation)" and other research results, both on the 'sponge' made clear the definition of the concept of city, the city can be like a sponge, adapt to environmental changes and respond to natural disasters, etc, with good "flexibility", the rain water, water storage, water seepage, water purification, the accumulation of water when necessary to use them.

Sponge city combines natural ways with artificial measures, follows the principle of ecological priority, under the premise of ensuring the safety of urban drainage and waterlogging prevention, maximizes the storage, infiltration and purification of rainwater in urban areas, and promotes the utilization of rainwater resources and the protection of ecological environment. The comparison between the construction modes of traditional city and sponge city is shown in Table1.1.***[Wu P,Tan M.2012.]***

Traditional City	**Sponge City**
Change nature	Comply with the natural

Use land primarily	Human is in harmony with nature
Change the original ecology	Protect the original ecology
Extensive construction	Low impact development
High surface runoff	Low surface runoff

TABLE. 1.1Comparison of construction modes between traditional city and sponge city

(Source: Qiu Baoxing. 2015.)

1.4.2 The Target

Sponge city's main goal is to make the city "resilient" to environmental changes and natural disasters, including the protection of the original water ecosystem; Restoration of damaged water ecosystems; Low impact development; Through a variety of low-impact measures and system combinations, effectively reduce surface water runoff and reduce the impact of heavy rain on urban operation ***[Qiu Baoxing. 2015]***

1.4.3 Main Considerations

China faces a similar situation with other countries in terms of integrated urban water management, but there are also some special problems.

Similar situation:

①the city is large and crowded, the use of source control measures to deal with urban runoff occupy more problems.

②China has a vast territory with large regional differences in geographical climate and social and economic conditions.

China's special problems:

①China per capita available water shortage, highlighted the importance of solving the shortage of urban water resources. ***[Wu P,Tan M.2012.]***

②China is still in the process of rapid urbanization, the old and new problems overlap each other, increasing complexity.

Factors considered in sponge cities include:

① Climatic conditions and geographical location. China has a vast territory, and the climatic conditions and urban water and land resources vary greatly from place to place. The construction of sponge cities in different locations must take into account the special climatic and geographical conditions of each place.

②Ecological environmental factors. Sponge city emphasizes the implementation of green infrastructure, which should consider local ecological environment factors, coordination with local biological species and adaptation to local climate.

③Social and economic conditions. In the implementation of sponge city, cultural and economic conditions, cultural tradition, urban population, economic development and environmental requirements need to be considered. In particular, two points should be paid attention to: Under the background of continuous rapid urbanization, the pressure on land resources.

1.4.4 Main Measures

According to functional classification, the main technical measures of sponge city can be divided into six categories, namely infiltration, stagnation, storage, net, use and discharge. The measures depend on each other and work together to build a new sponge infrastructure. Sponge infrastructure should be combined with traditional drainage systems, especially in middle and high density urbanized areas. The relationship between urban water problems, sponge city construction, corresponding measures and sponge city goals is shown (Figure1.2).

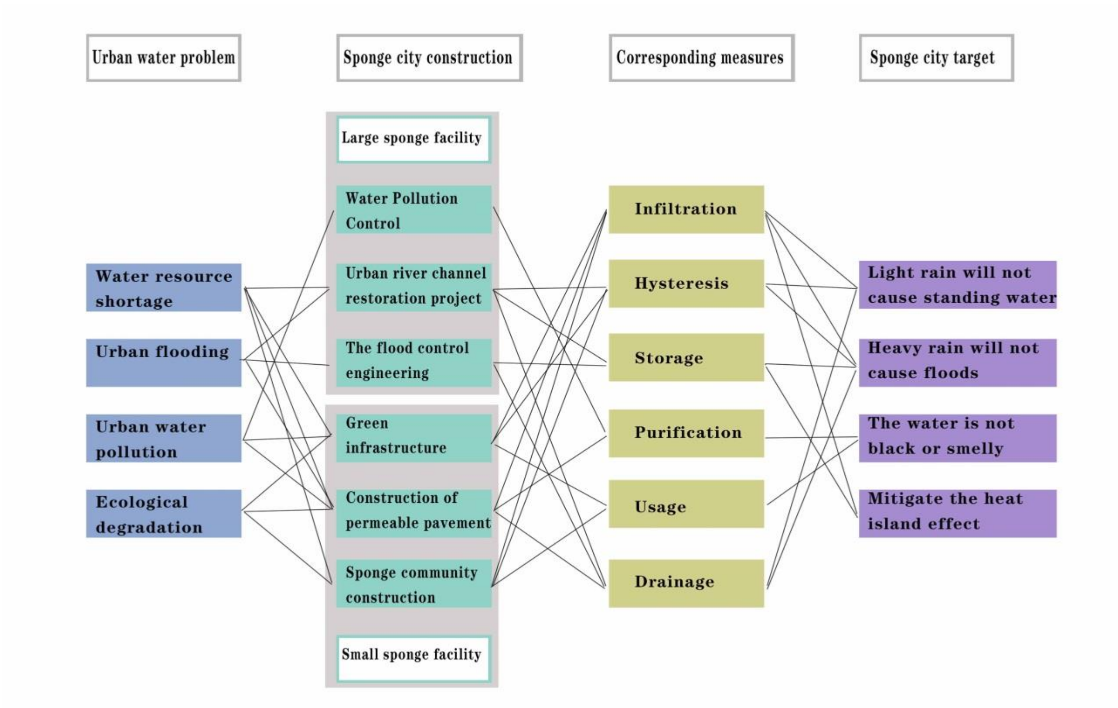


FIG.1.2 Measurement

(Made by author)

(Source: Hao W.Chao M Jiahong L, 2018.)

1.4.5 Application of sponge city in China

Since 2015, the chinese government has published two batches of 30 sponge city pilot cities, which greatly promoted the development of sponge city construction. However, how to give play to regional characteristics and formulate the key points of sponge city construction in line with local natural and cultural conditions has also become the top priority.

Affected by the monsoon climate, the plain river network is densely covered and prone to large rainfall in a short period of time. At the same time, there are also problems such as high water table and poor ground permeability.

JiaXing***[wang xianping. 2016]*** The construction of sponge cities should focus on reducing runoff pollution and promoting water environment protection. On the one hand, the infiltration capacity of soil should be increased through complex biological retention measures. On the other hand, suitable plants can be planted to alleviate the impact of high water table.

ChangDe ***[Tang Xiuxiu2008.] [Zou Yu, Xu Yiqing, Qiu Canhong.2015.]*** The paper focuses on river treatment and park reconstruction to solve the problem of water pollution under the condition of urban rainwater and sewage confluence. At the same time, the urban waterlogging problem under the circumstance of heavy rain can be alleviated through the renovation of residential areas and the construction of new roads. Because cities in coastal areas are located at the junction of inland rivers and oceans, the hydrology and water quality conditions are relatively complex, and under special circumstances, they are prone to seawater inversion and other problems.

XiaMen ***[wang Ning, Wu Lianfeng. 2015.]*** Through the construction of sponge city to regulate and store rainwater, protect fresh water and build flood control and drainage system.

NingBo ***[Xia Yang, cao liang, zhang tingting, 2016.]*** The construction of sponge city focuses on three aspects. The first is to relieve the pressure of urban flood control and drainage. The second is to protect and improve urban water ecosystem. The last is to increase the resource utilization of rainwater. ***[Ye Xiaodong.2016]*** Due to the particularity of natural topography, meteorology, hydrology and urban construction conditions, mountain cities also have their particularity in the purpose and way of sponge city construction.

JiNan ***[Gong Yongwei, Zhang Xinbo, Li Huiwen.2017.]*** It not only uses sponge facilities to store rainwater and break through urban space restrictions, but also uses natural spongy bodies such as mountain forests, valleys and wetlands around the city to collect rainwater, conserve water resources, protect vegetation and conserve water and soil. The arid region of northwest China is greatly affected by continental climate, with little rainfall, perennial drought and serious soil erosion caused by overexploitation.

XiXian ***[Zhang Liang. 2016.]*** We should strengthen the control and conservation of ecological protection areas, protect water resources and other ecologically sensitive areas, maintain hydrological characteristics, and improve the utilization ratio of reclaimed water resources.

GuYuan ***[Wei Jincheng, Cheng Xiaowen. 2018.]*** It is mainly based on the planning and control of rainwater resource collection, recovery and reuse in order to alleviate the shortage of regional water resources.

1.4.6 Overview of China's Current Situation

In recent years, the research on sponge cities in China has been deepened gradually, with more and more relevant practices. However, compared with foreign researches, the research on sponge cities in China still needs to be further deepened. Based on the research of the existing achievements and combined with China's national conditions, this paper puts forward some views:

(1) As China has a vast territory, it is difficult to balance the differences among cities and regions in terms of physical geographical conditions, social and economic conditions or cultural customs, which leads to different emphasis on regional construction. Therefore, when the sponge city construction strategy is specified for different regions, multi-level and three-dimensional control should be carried out, and strategies and plans should be formulated according to the actual situation of each region.

(2) In the construction of sponge cities, the concepts of ecological city, smart city and resilient city should be considered to better play their roles. One of the most important aspects of eco-cities is about water. Sponge cities mainly implement water circulation and stormwater management. They have a lot in common. Smart city involves big data design method, and the planning and design of sponge city also involves this aspect. Resilient cities are more about multiple recycling of water resources. Therefore, the construction of sponge city should consider these three concepts, so that sponge city is not limited to the urban rain drainage system, but also can achieve the purpose of water resources recycling, reducing carbon emissions and saving water resources.

(3) Sponge city construction needs more active participation of citizens.

(4) The construction of sponge cities needs to strengthen interdisciplinary cooperation and cross-scale research. Construction sponge need to consider about entire spatial planning, realizes the sponge city and overall urban planning, national spatial planning and relevant planning "more fusion rules", to avoid the contradictions and conflicts between different planning, aimed at the complexity of urban construction, sponge is require multidisciplinary cooperation, more professionals together, solve the problem of different sizes, and maximize the environmental, economic and social benefits.

1.5 Research Methods

1.5.1 Research Content

The main research content of this paper is to analyze some impacts of climate change on the city of Shanghai, such as urban heat island effect and flood disaster, and put forward corresponding urban planning strategies aiming at these problems, hoping to make certain contributions to the future urban development.

1.5.2 Innovations

(1) To reduce the problem of urban heat island effect, corresponding mitigation and adaptation measures are proposed to improve urban sustainability.

(2) From the perspective of LID, more landscape solutions to urban waterlogging caused by short-term rainfall are proposed to provide a solid theoretical basis for the implementation of more practical schemes.

1.5.3 Research Methods

For this study, the main methods used are literature induction analysis, climate analysis and other methods.

(1) Literature review:

Through reading a large number of literature and books related to climate change, this paper summarizes the current research on relevant urban theories and practices at home and abroad.

(2) Application method of climate analysis：

The method of accumulated anomalies: by averaging the original data, the increasing or decreasing trend of the sequence over time can be seen by using the offset value. The accretion interval is a method to judge the changing trend of the climatic sequence through the straight curve view. For the climatic variation X, the cumulative distance level at a certain time can be shown in the table as follows***[Zhu Yali. 2012]***:

Time-interval sequence moving and leveling method: For the sequence X of the sample with an original capacity of N, the sliding and leveling sequence table is shown as follows ***[Zhu Yali. 2012]***:

In the formula, K is the slip length. Through the sliding motion plane, the larger push on the initial value can be filtered, and the basal development trend can be shown over a long period of time ***[Wei feng ying.2007]***.

Linear regression method: by means of the linear regression equation y = A + B T, the trend of the air temperature rising or falling on the scale in 60 years can be clearly shown. The optimal point of linear regression method is whether there is a trend of gradual increase or decrease in the sequential sequence in a direct view, and the slope rate of linear equation indicates the average trend change rate of sequential sequence in a time interval (the slope rate B × 10 years is defined as the water dip rate, and the single position is mm / 1 0 a) ***[Wei feng ying.2007]***.

2 Analysis of Flooding and Heat Island Effect in Shanghai

2.1 Description of Shanghai

2.1.1 Overall Description

2.1.1.1 Shanghai location overview

Shanghai is a provincial-level administrative region, a municipality directly under the Central Government, a national central city and a megacity of the People's Republic of China. It is China's international economic, financial, trade, shipping, scientific and technological innovation center [***Reply of the State Council on the Master Plan of Shanghai, www.gov.cn [date: 2019-03-16]***, and national logistics hub ***[Shanghai People's Government].***

The city has 16 districts under its jurisdiction, covering a total area of 6,340.5 square kilometers. In 2019, the city had a permanent population of 24.2814 million, a permanent population of 14.5043 million, and a permanent population of 9.7771 million from outside. ***[China Statistical Information Net & China Economic Net]*** Shanghai is located in the Yangtze River Delta region, in the east of China, at the mouth of the Yangtze River, near the East China Sea in the east, and connected with Jiangsu and Zhejiang provinces in the north and west

FIGURE 2.1 The map of the world

(Source: Made by Author)

2.1.1.2 Data source

We use Shanghai's nearly 59 years of weather data from Shanghai Meteorological Station. The data is continuous and complete, study period is from 1959 to 2017. The seasons are divided into meteorological standards: March to May is spring, June to August is summer, September to November is autumn, and December to next year’s February is winter.

2.1.1.3 Shanghai climate description

Based on the existing meteorological data, we calculated the average monthly precipitation and monthly average temperature of Shanghai in the past 59 years, and obtained the climate map shown in Figure 2.2. The highest average temperature in the month is June, July and August, and the lowest months are December, January and February. During the year, the temperature usually varies between0° C and 30 ° C. The months with the highest monthly average rainfall are June, July, August and September, and the lowest months are December, January and February. Therefore, the average monthly rainfall varies from 40 mm to 170 mm in one year. Therefore, we conclude that Shanghai is characterized by four distinct seasons, abundant sunshine and abundant rainfall. Shanghai has a mild and humid climate with shorter spring and autumn and longer winter and summer, belonging to North subtropical monsoon climate.

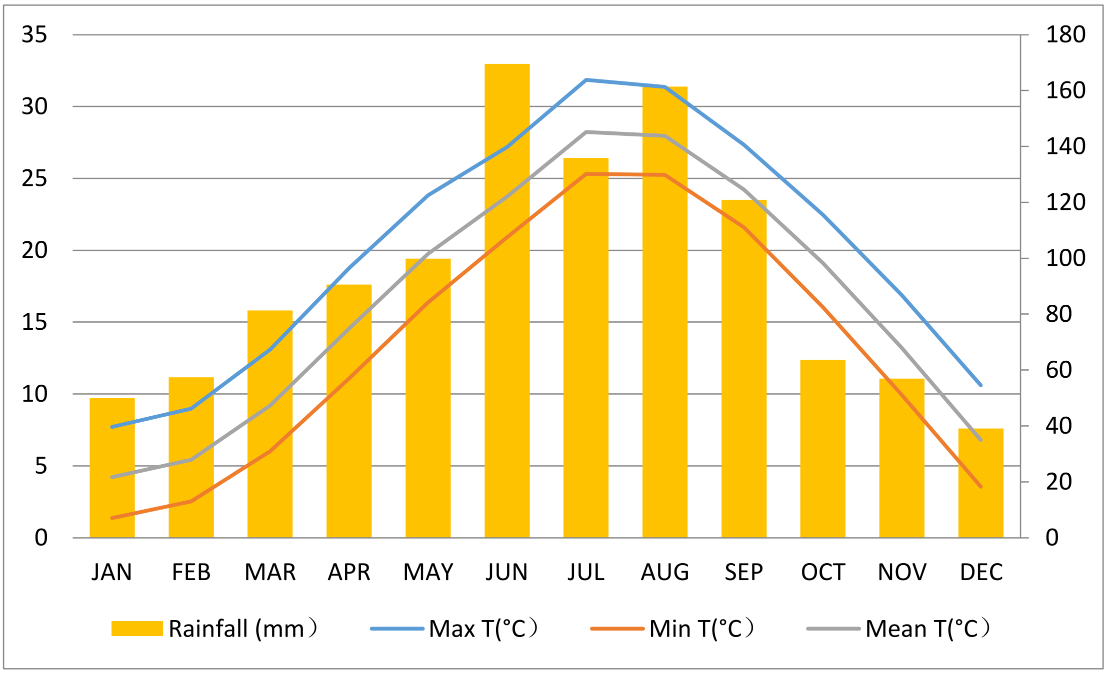


FIGURE 2.2 Climate Map In Shanghai (1959-2017)

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

2.1.2 Analysis of temperature variation characteristics

2.1.2.1 Annual temperature variation characteristics

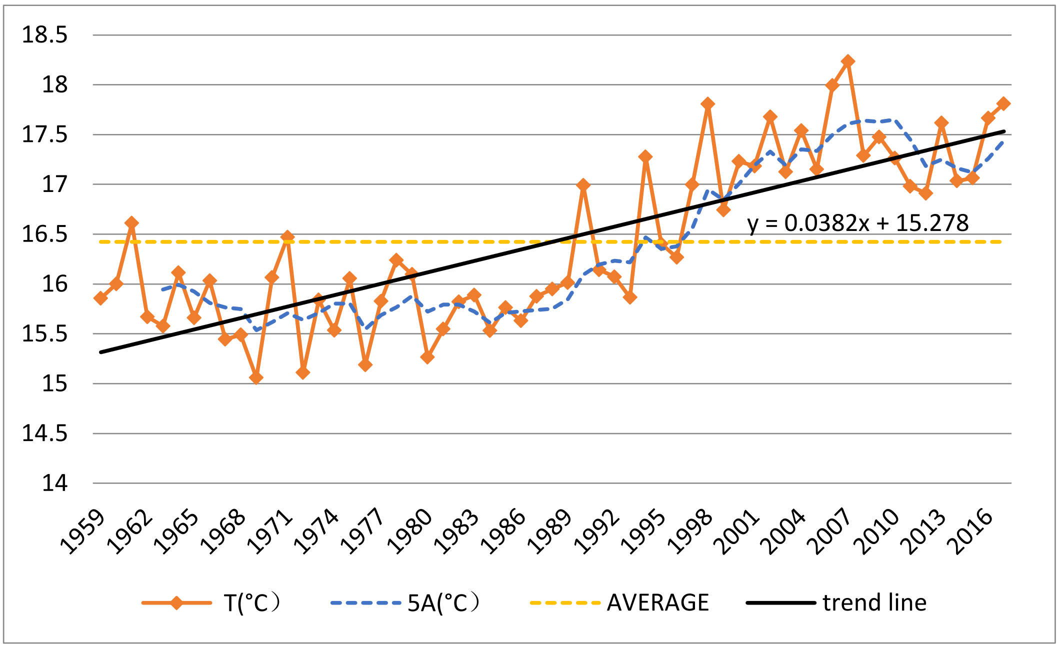


FIGURE 2.3 Shanghai 1959-2017 Annual Average Temperature Trend

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

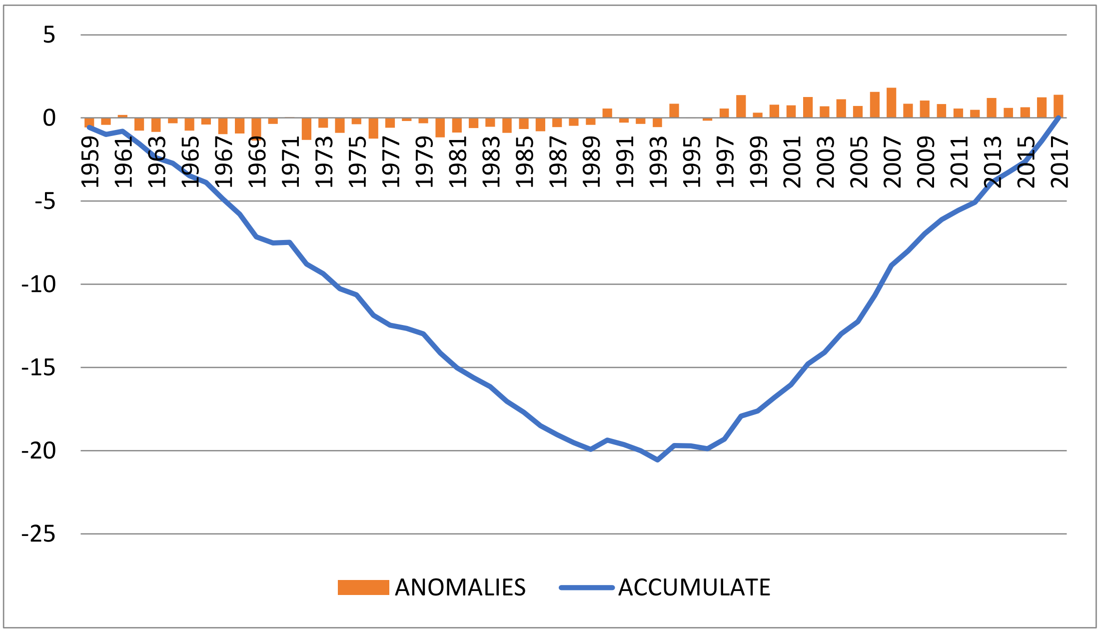


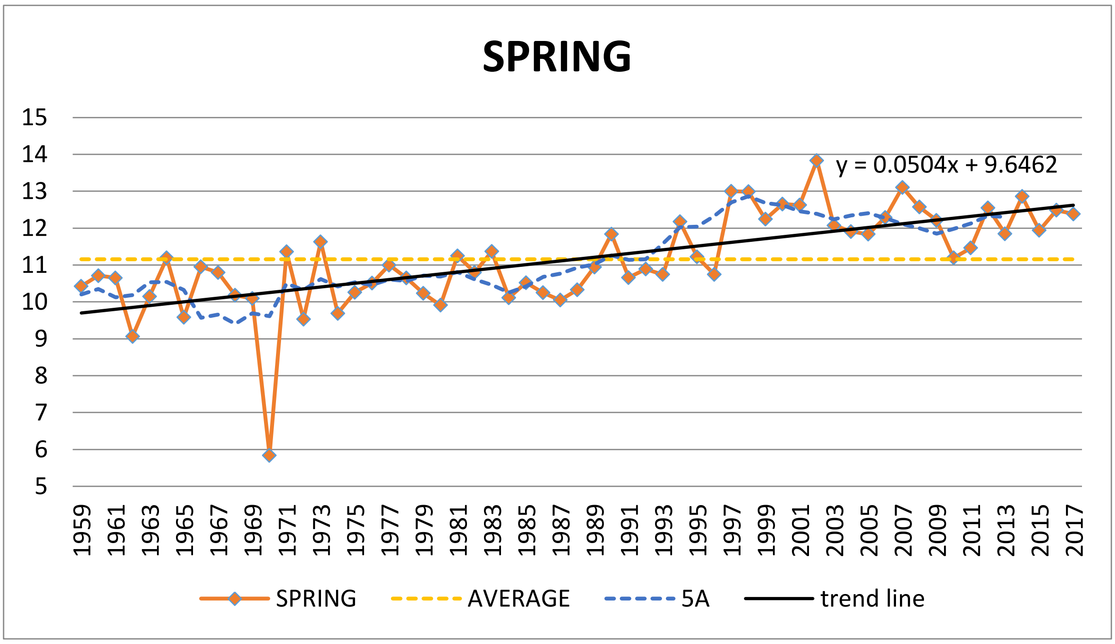
FIGURE 2.4 Shanghai Annual Temperature Accumulated Variance

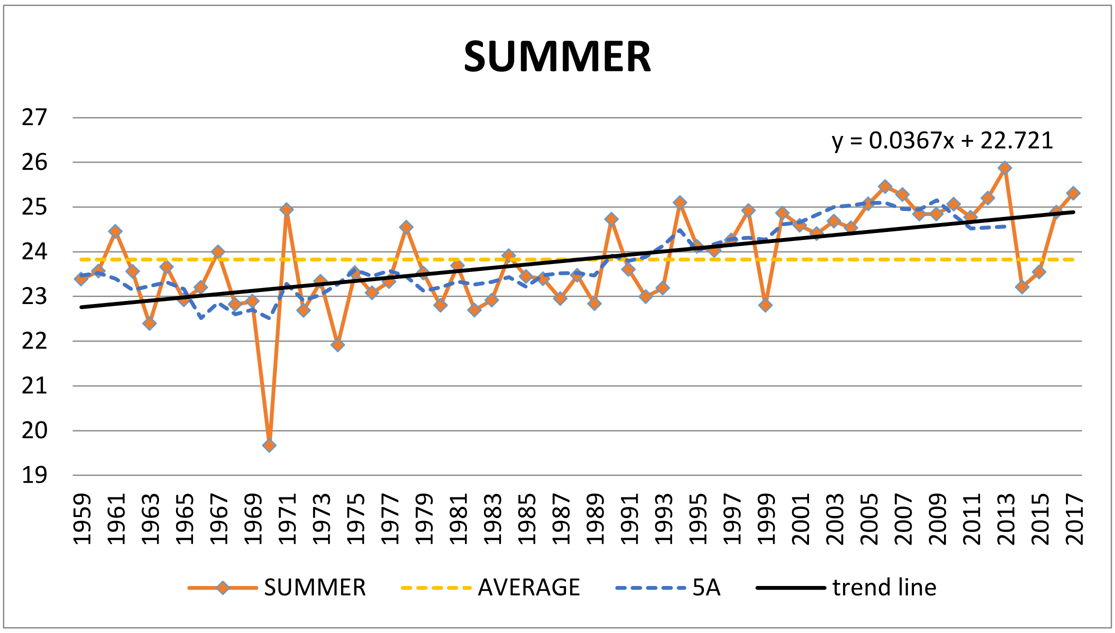
(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

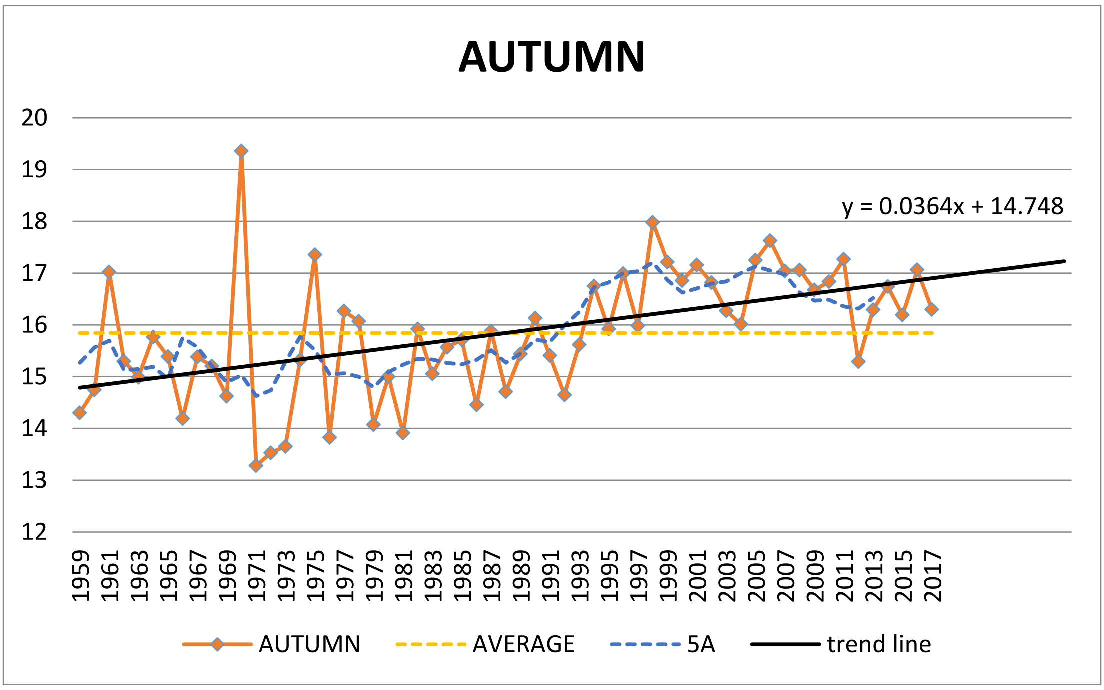
According to the figure 2.3 (mean annual temperature changes of Shanghai for nearly 59 years), the average temperature is around 16.42°C in 1959-2017. Following the linear trend, the mean annual temperature was rising, and the climate tendency rate is 0.382°C / 10a. In 30 years before 1989, the annual average temperature is mostly fluctuated below the average climate temperature. From 1959-1989, The annual average temperature was between 15.5-16 ° C. After 1990, the temperature increased significantly into the range of 16.5-17.5 °C. The linear trend equation for annual mean temperature change is: Y=0.0179x +13.575

From the annual average temperature difference, Figure 2.4 shows the overall trend of the cumulative temperature difference over the past 59 years. Since 1959, the cumulative temperature difference has continued accumulating to negative numbers until the average temperature start rising in the 1990s, and the cumulative temperature difference had risen to near zero. It can be inferred that the temperature changing point is around 1993. Therefore, the colder period might exist in 34 years before this time point, while approximately 24 years after was warmer period.

2.1.2.2 Seasonal temperature variation characteristics




SUMMER
27
26
25
24
23
22
21
20
19
y = 0.0367x + 22.721
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
SUMMER
AVERAGE
5A
trend line


AUTUMN
20
19
18
17
16
15
14
13
12
y = 0.0364x + 14.748
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
AUTUMN
AVERAGE
5A
trend line

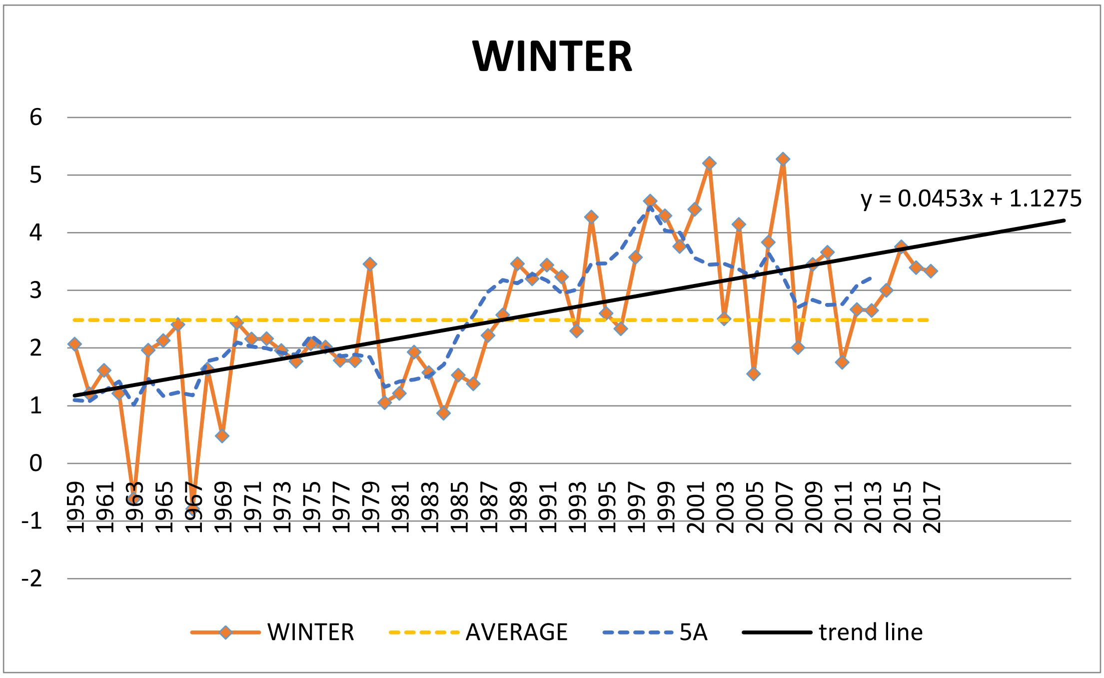
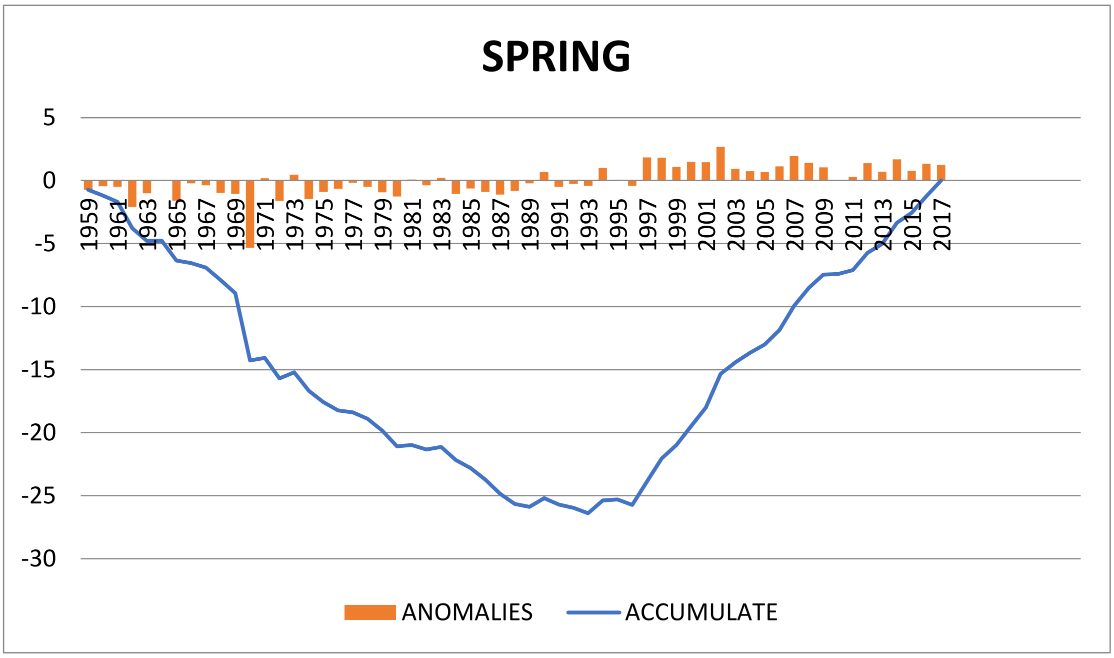
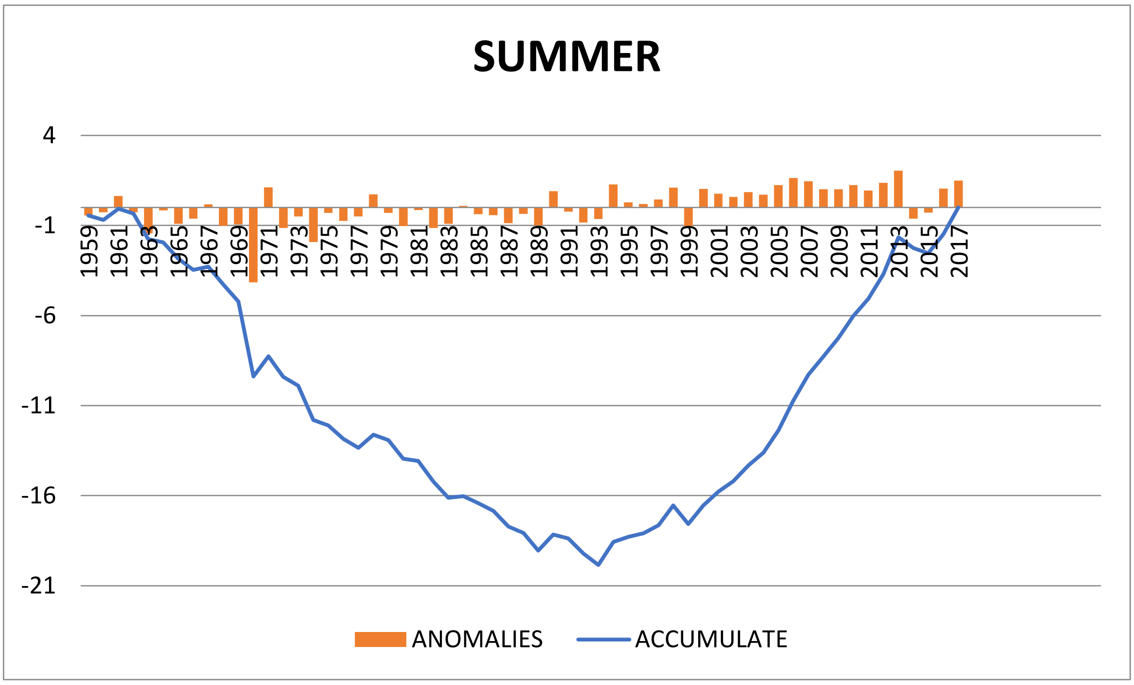


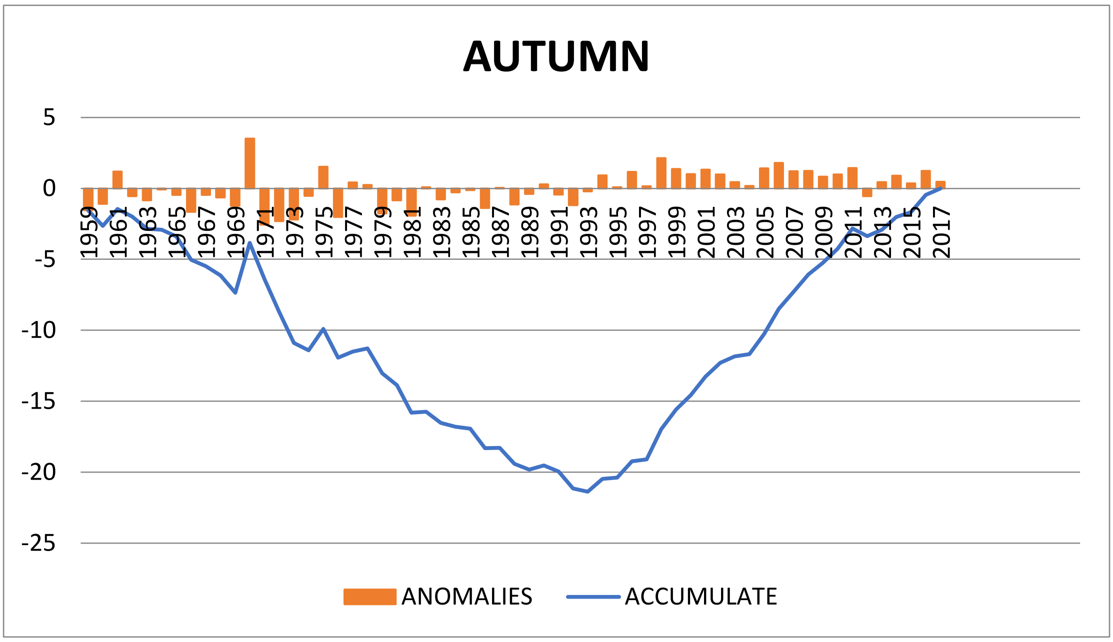
FIGURE 2.5-5.8 Shanghai 1959-2017 Seasons Changes in Temperature Trends

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

Following by the Figure 2.5-2.8, the trend of average temperature changes in the four seasons in 59 years. Although the average temperature in the four seasons was increasing, and the climate tendency rate of summer temperature is 0.367 ° C / 10a, the climate tendency rate of autumn is 0.364 ° C / 10a ,which means summer and autumn temperature rises has the closely relationship with climate warming, next is winter, spring is the least significant season. It can be seen from the graph that during 58 years, the average temperature rise mainly occurred in spring and winter.


SPRING
5
0
-5
-10
-15
-20
-25
-30
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
ANOMALIES
ACCUMULATE


SUMMER
4
-1
-6
-11
-16
-21
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
ANOMALIES
ACCUMULATE



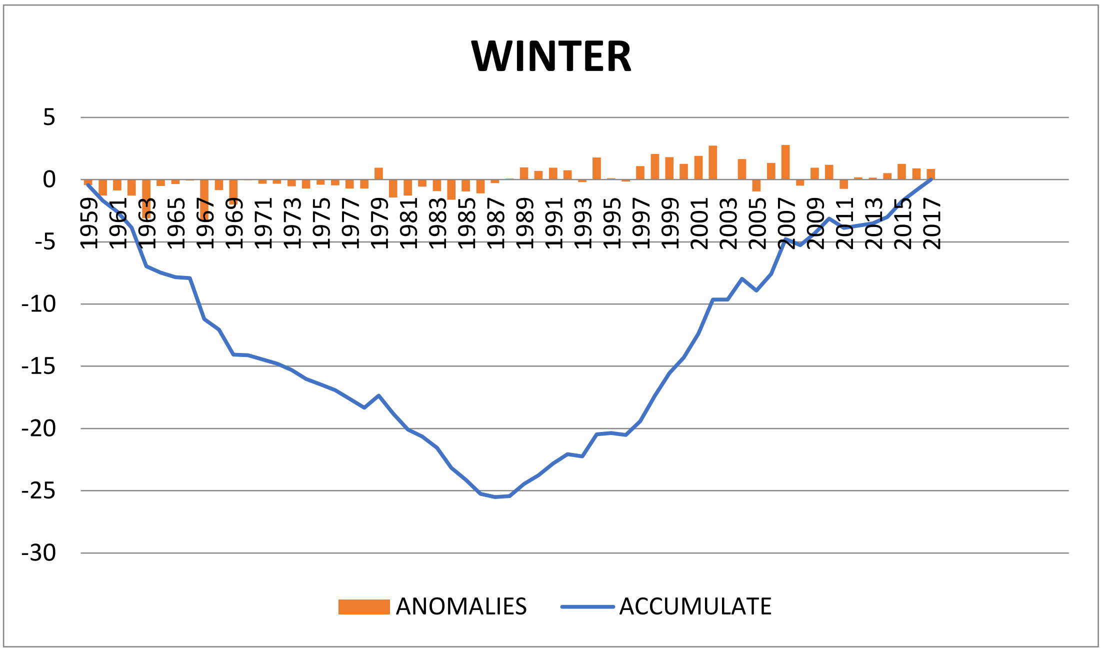
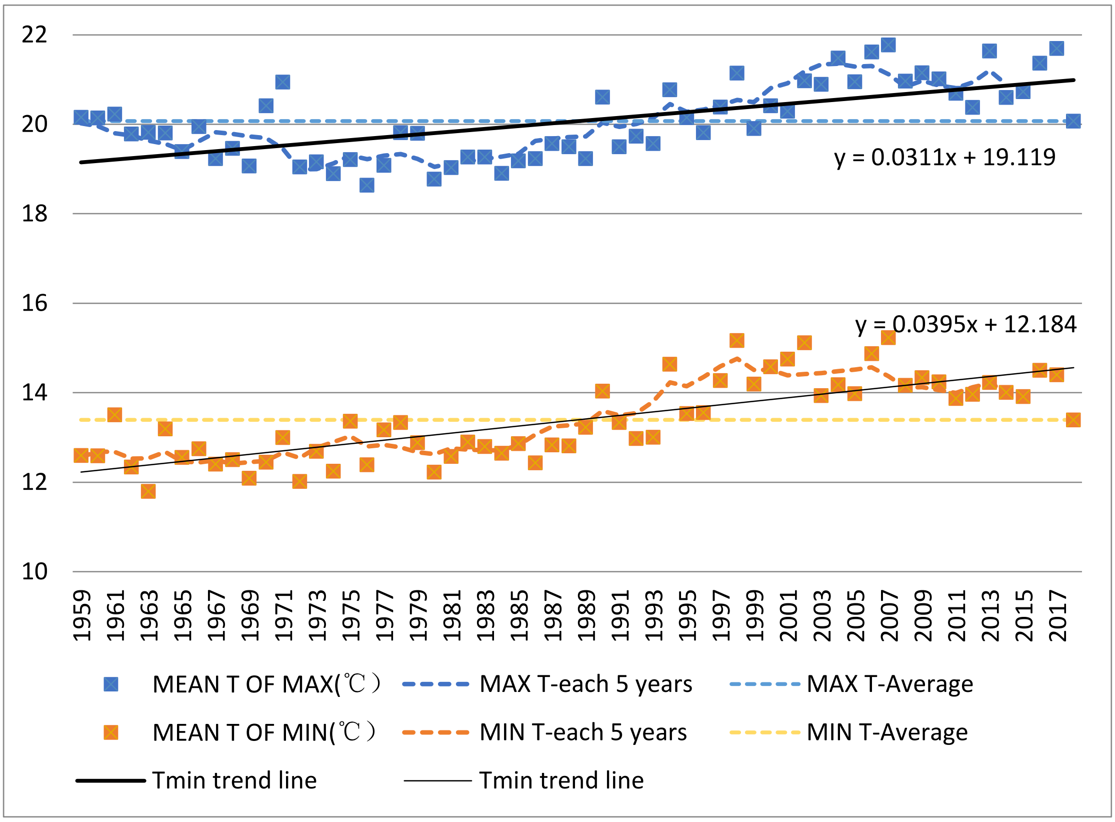


FIGURE 2.9-2.12 Shanghai 1959-2017 Seasonal Temperature Accumulated Variance

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

The trend of the average temperature difference accumulation between the four seasons and the annual average temperature difference accumulation chart is similar. Both charts show a downward trend first, and then rise sharply after reaching a minimum quality. The changing point of spring, summer and autumn is around 1993. But the winter turns earlier than the other three seasons, around 1987.

2.1.2.3 Analysis of the variation characteristics of the maximum and minimum temperatures



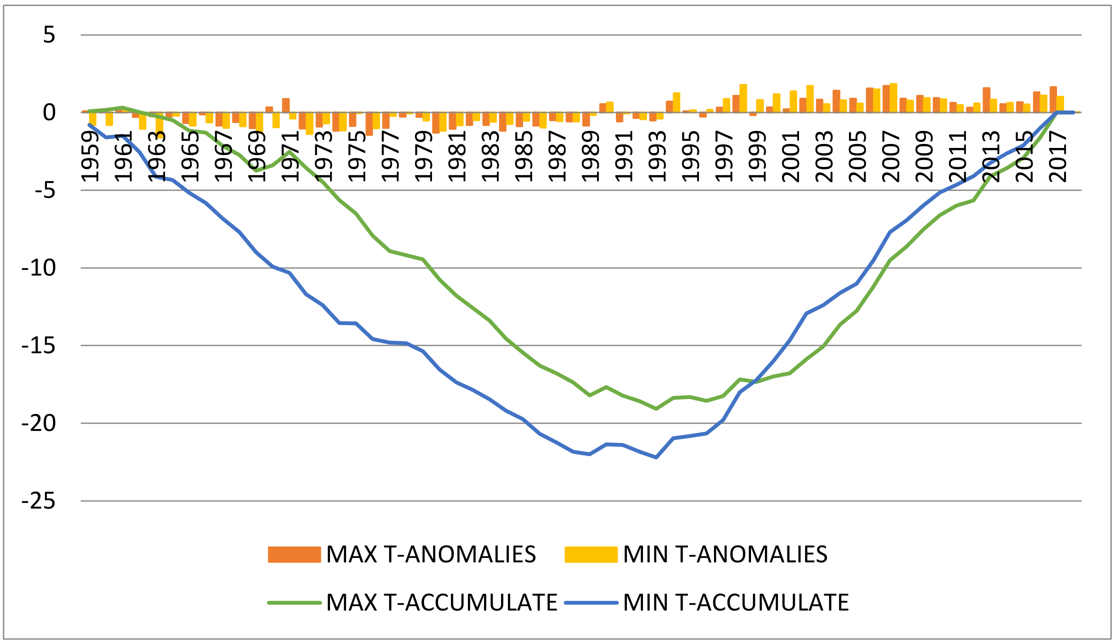


FIGURE 2.13&2.14 Annual average maximum/minimum temperature

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

Shanghai's average maximum temperature has shown an upward trend in the past 59 years, with a climate tendency rate of 0.311 ° C / 10 a. The climate tendency is lower than the annual average temperature. The 59-year changes can be seen by the 5a moving average curve in Figure 2.13. The maximum value appeared in 2007 at 21.77°C. From the annual average maximum temperature anomaly figure, we can see the average maximum temperature cumulative anomaly in 59 years. It has been in a downward trend from 1959-1993 and reached a minimum in 1993. Since 1993, it has started to rise again. Therefore, the point of the highest temperature can be found in 2007. The linear trend equation is: y=0.0311x+19.119.

Shanghai's average minimum temperature in recent 59 years is also on the rise, with a climate tendency rate of 0.395 ° C / 10 a. The climate tendency rate of annual minimum average temperature is higher than the annual average temperature and the average maximum temperature. The 59-year changes can be seen by the 5a moving average curve in Figure2.13. Compared with the average maximum temperature, the upward trend of minimum temperature is more obvious. In 1963 reached a minimum temperature of 11.79 °C. In 2007, it reached the highest value of 15.23 °C. The linear trend equation is: y=0.0395x+12.184.

2.1.3 Analysis of precipitation variation characteristics

2.1.3.1 Annual precipitation variation characteristics

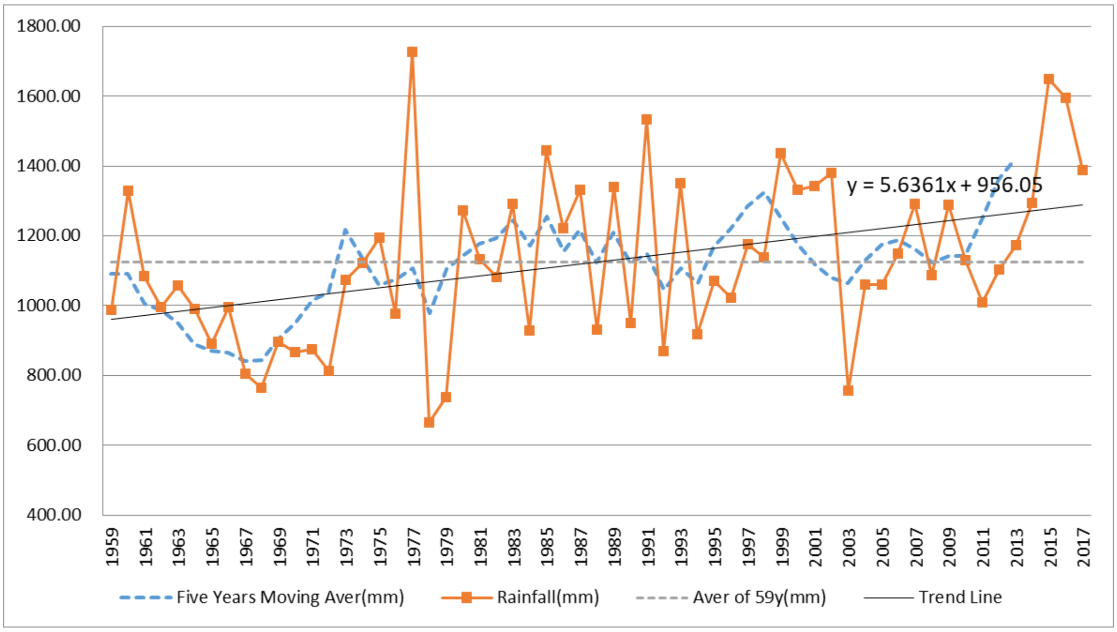


FIGURE 2.15 Shanghai 1959-2017 Annual Precipitation Trend

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

By analyzing the time series of annual precipitation changes of Shanghai for nearly 59 years. Figure 2.15 shows the annual precipitation trends in Shanghai for nearly 59 years. It can be seen from the figure that the annual precipitation of Shanghai has fluctuated greatly in the past 59 years, showing a turbulent change trend. The annual precipitation tendency rate is 56.361mm/10a. The average annual precipitation is 1125.13mm, and the annual precipitation shows a significant increasing trend. It can be seen from figure2.15 that the linear trend of annual precipitation tends to increase significantly. The maximum and minimum values for 59 years appeared in 1977 and 1978, respectively are 1727.40 mm and 665.60 mm. The maximum and minimum values appear in the adjacent two years, indicating that the rainfall in these two years has undergone great changes under the influence of various factors. The simple equation for annual precipitation changes is y=5.6361x+956.05.

From the 5a moving average trend, the trend can be divided into six stages:

From 1959 to the late 1960s, precipitation tended to decline. Then, by the mid-1970s, there was a significant increase in rainfall. From the mid - '70s to the mid -' 90s, rainfall fluctuated slightly around the average, except for another sharp drop in

1978.It began to rise in the mid-1990s and then fell in the early 2000s.And finally, from the early 2000s to the early 2010s, it was a slow upward trend. The 5a moving average curves of 1959-1979, 1991-1995 and 2001-2005 were all lower than the climatic average. As can be seen from the figure, during this period, Shanghai received less precipitation and was in a relatively dry season. The 5a moving average curve after 1979-1991, 1999-2001 and 2005 fluctuated on the mean line and was in a relatively wet period.

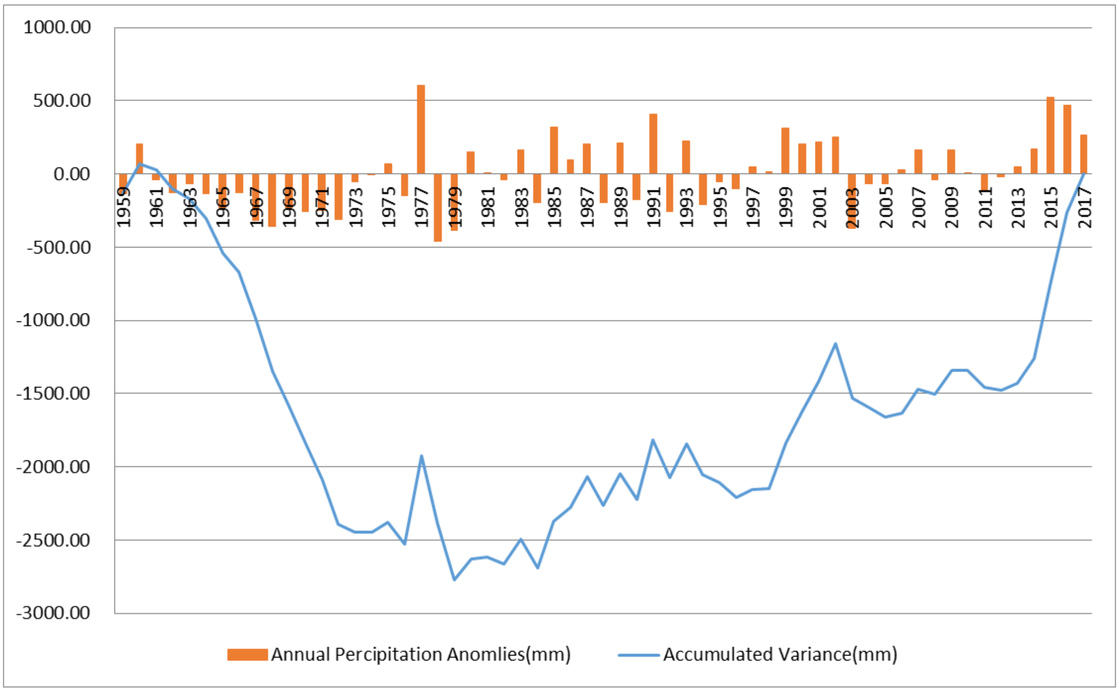


FIGURE 2.16 Shanghai Annual Precipitation Anomalies/accumulated Variance

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

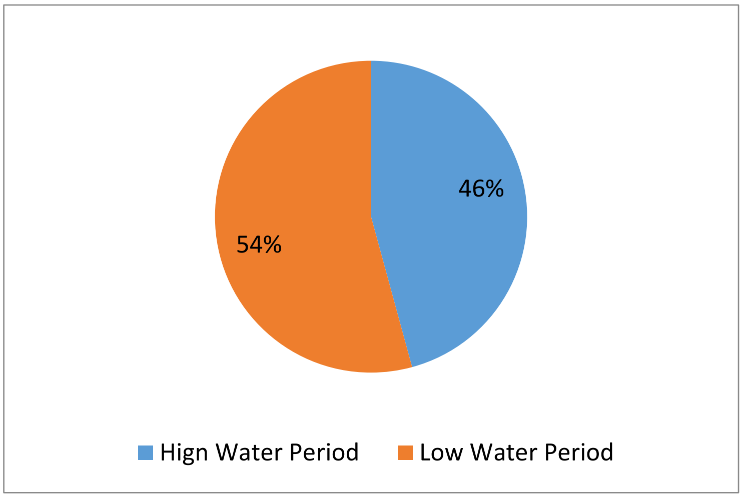


FIGURE 2.17 Percentage of High Water Period and Low Water Period

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

As can be seen from Figure 2.16, the accumulated anomalies from the early 1960s to the early 1970s showed a significant downward trend, during which the negative anomalies was greater than the positive anomalies. However, from the 1970s to the early 2010s, it was in a slowly rising trend, accompanied by significant changes and fluctuations in the middle, and it dominated by positive anomalies. Since the beginning of 2010, the accumulation of agglomeration has shown an obvious trend of growth.

Thus, it can be found that between 1959 and 2017, Shanghai experienced two phases of annual precipitation: dry period - wet period, with the early 1970s as the dividing line.

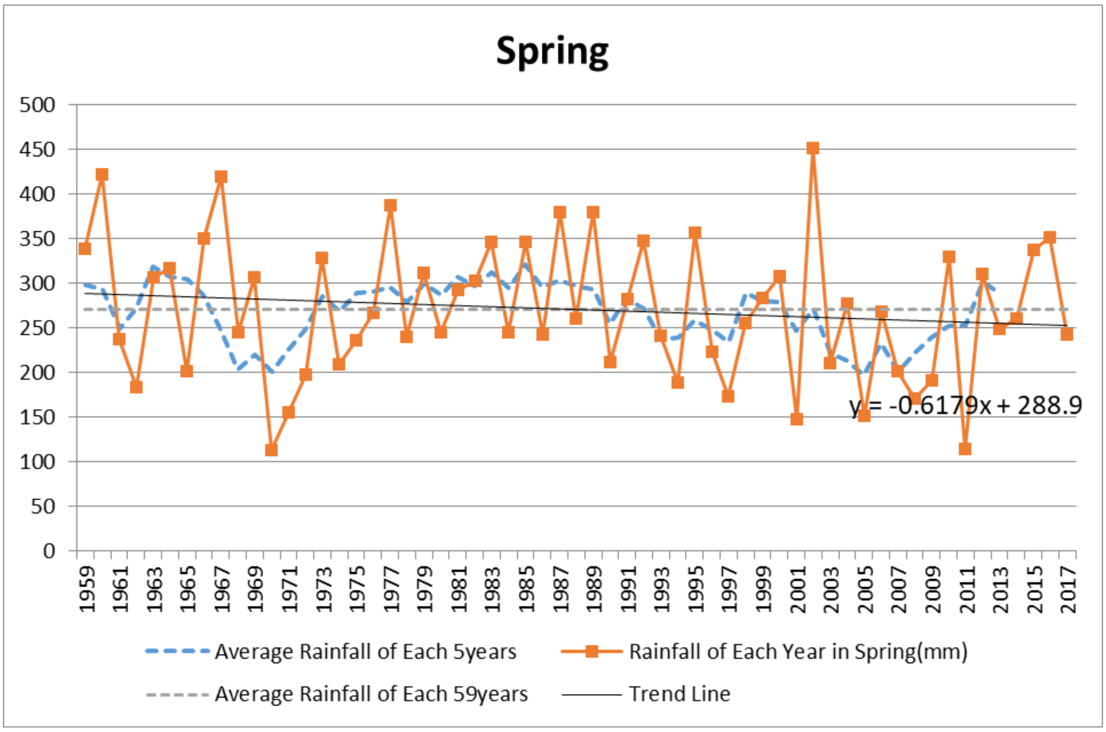
As can be seen from Figure 2.17, the 59 years precipitation positive anomaly rate is 46%, and the negative anomaly rate is 54%. In wet years, the negative anomaly rate of annual precipitation is greater than the positive anomaly rate, indicating that precipitation is more concentrated. It is prone to floods. In low water years, the annual precipitation negative anomaly is greater than the positive anomaly, indicating that the annual precipitation is relatively low. The incidence of drought is greater than that of flood, but major drought is less likely to occur.

2.1.3.2 Seasonal precipitation variation characteristics

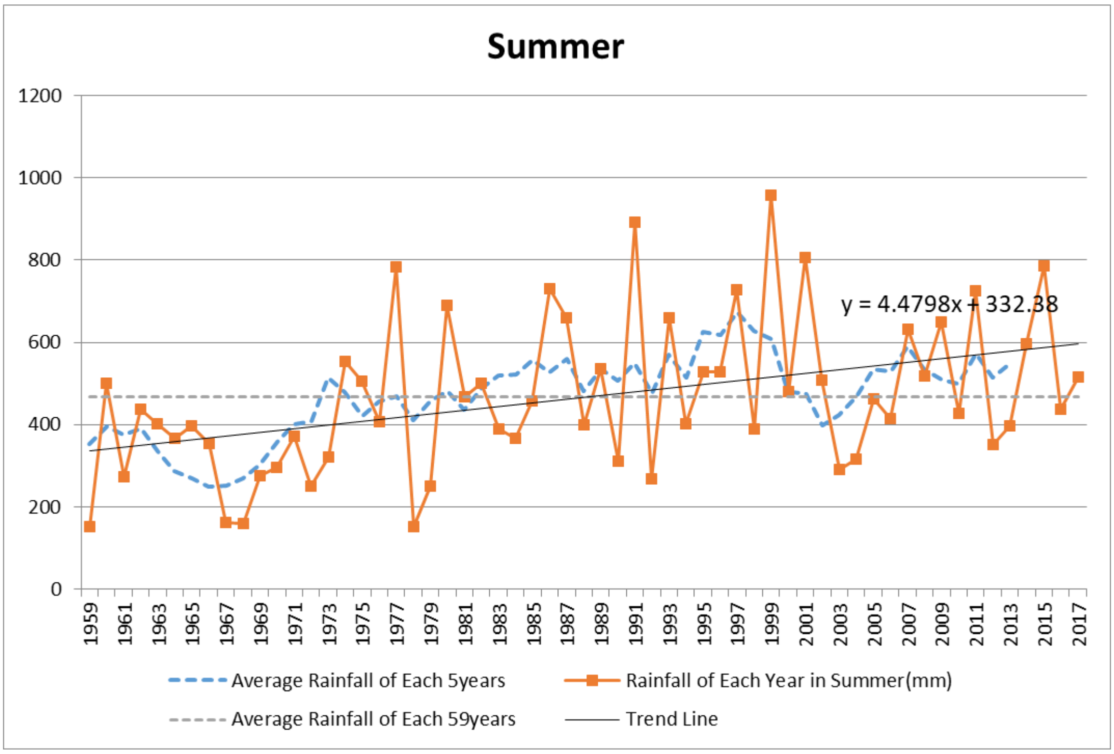
	Spring	Summer	Autumn	Winter	Annual
Average annual rainfall(mm)	270.37	466.77	241.56	146.43	1125.13
Percentage of annual average precipitation	24%	41%	21%	13%	100%
Climate tendency rate(mm/10y)	-6.179	44.798	5.039	12.702	56.361

TABLE 2.18 Shanghai 1959-2017 seasons precipitation change in the statistics

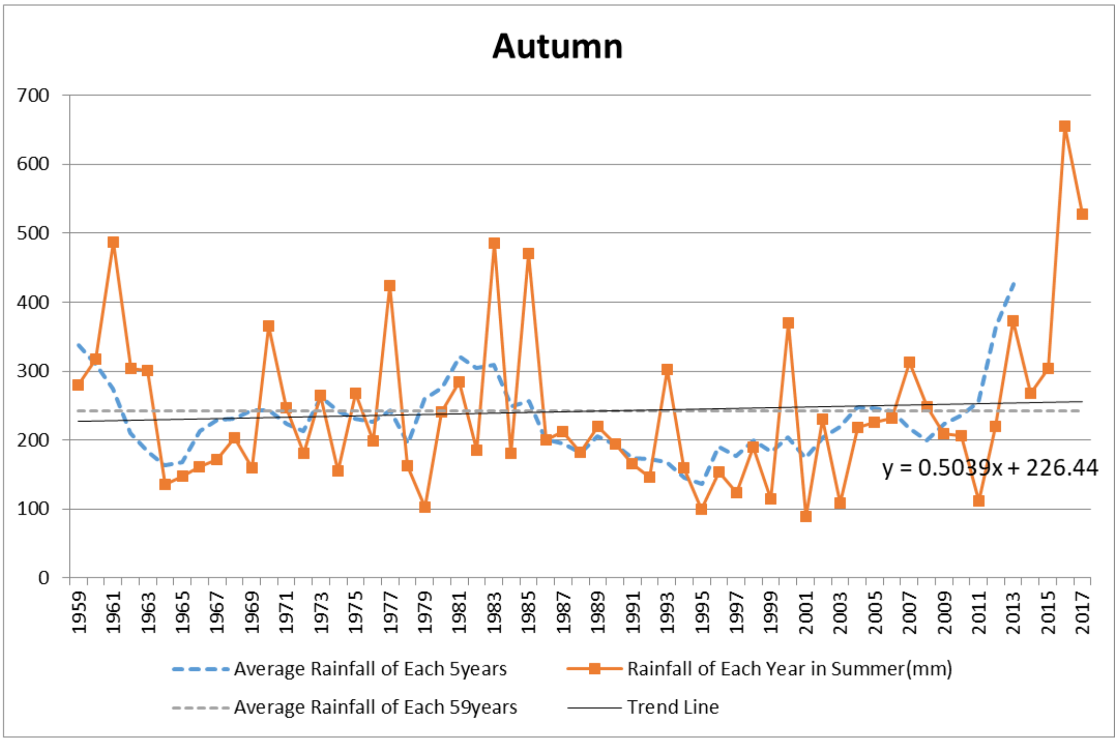
(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)



Spring
500
450
400
350
300
250
200
150
100
50
0
y = -0.6179x + 288.9
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Average Rainfall of Each 5years
Rainfall of Each Year in Spring(mm)
Average Rainfall of Each 59years
Trend Line



Summer
1200
1000
800
600
400
200
0
y = 4.4798x + 332.38
1959
1961
1963
1965
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993
1995
1997
1999
2001
2003
2005
2007
2009
2011
2013
2015
2017
Average Rainfall of Each 5years
Rainfall of Each Year in Summer(mm)
Average Rainfall of Each 59years
Trend Line



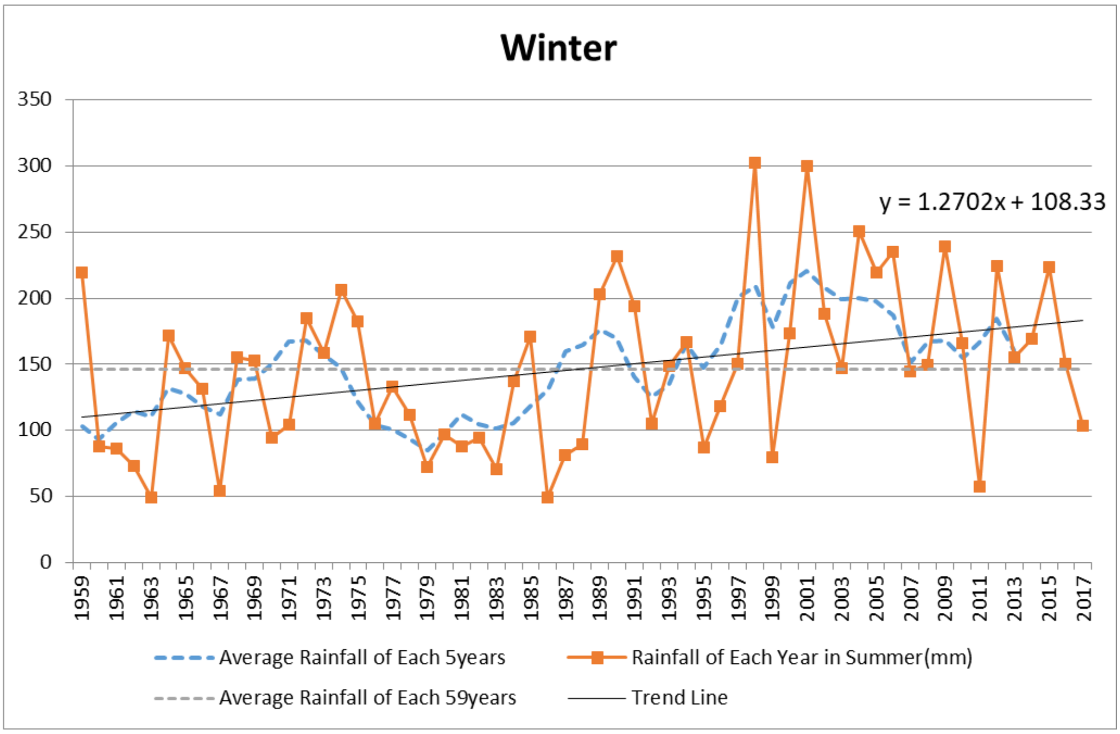


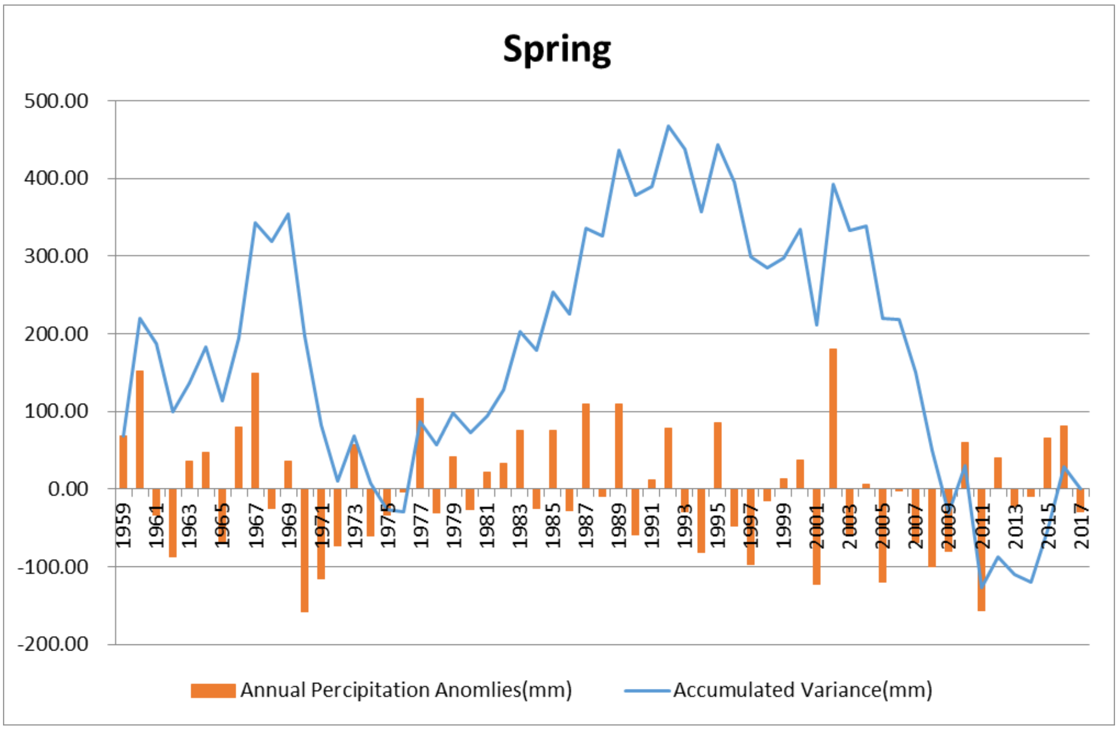
FIGURE 2.19-2.22 Shanghai 1959-2017 Seasons Changes in Precipitation Trends

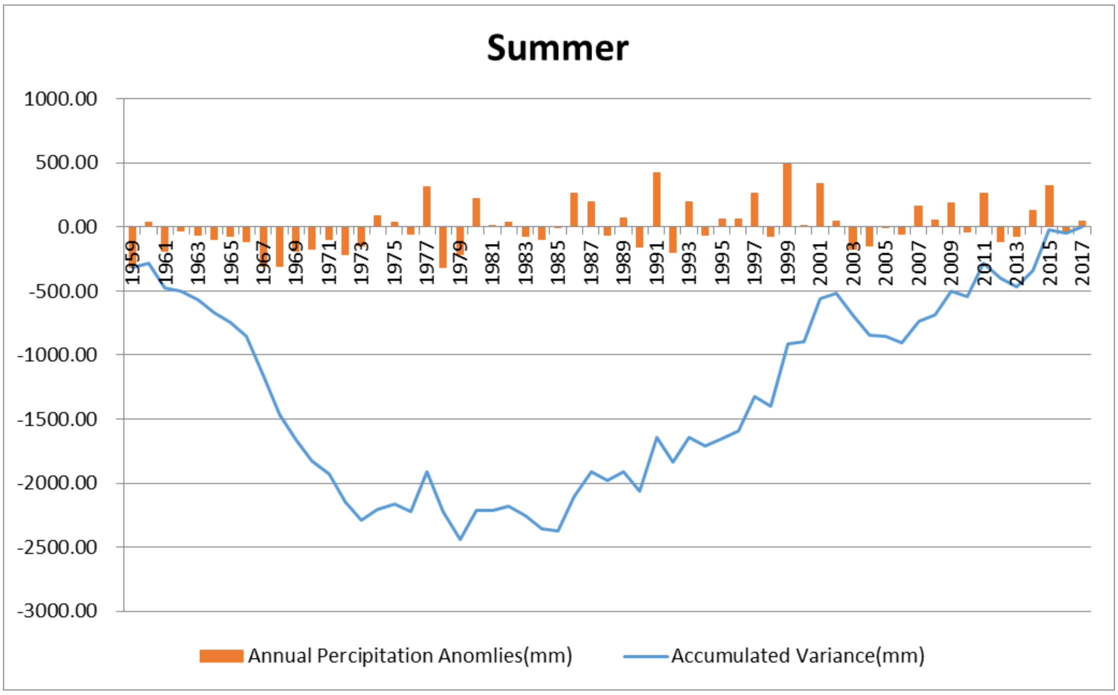
(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

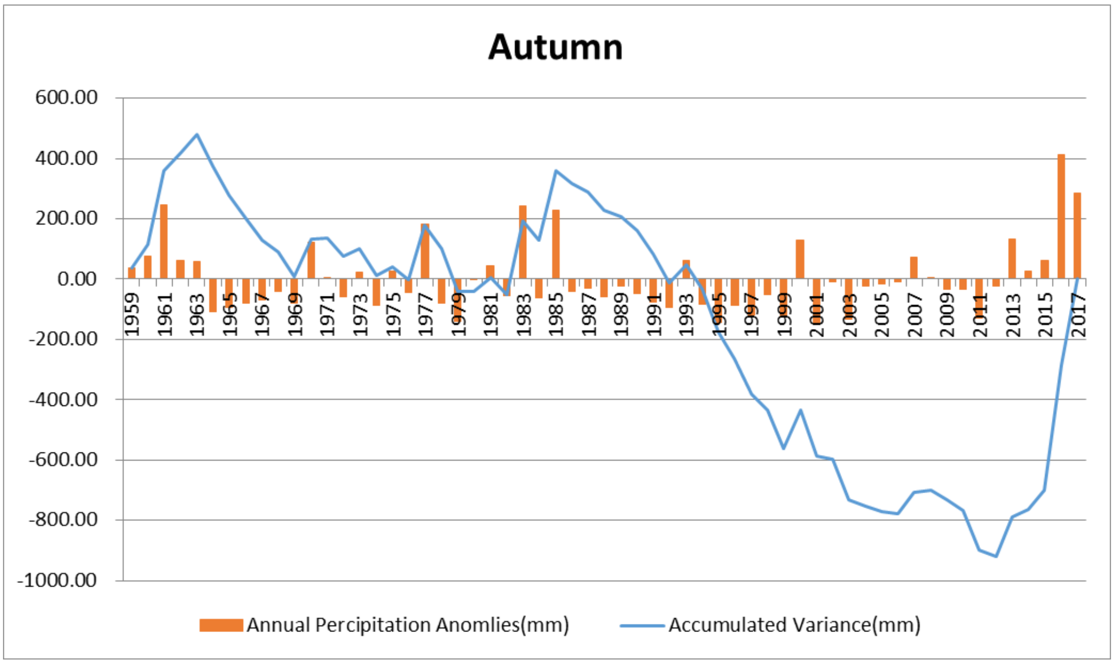
As can be seen from Table 2.18, the average annual precipitation of Shanghai in the past 59 years is 1,125.13mm, and the precipitation mainly concentrates in spring and summer. The average precipitation in spring is 270.37mm, accounting for 24% of the average annual precipitation; the average precipitation in summer is 466.77mm, accounting for 41% of the average annual precipitation.

The seasonal variation of precipitation trend in Shanghai from 1959 to 2017 (FIG. 2.19-2.22) shows that the seasonal variation of precipitation shows different fluctuation trends. The climatic tendency rate of spring precipitation is -6.179mm/10a, 44.798mm/10a in summer, 5.039mm/10a in autumn, and 12.702mm/10a in winter. Therefore, it can be seen that the climate trend rate in spring is negative, indicating a downward trend in spring. The rest of them are positive, while the climate trend rate in summer is the largest and the trend increase is the most obvious, followed by winter. Therefore, the climatic tendency rate of summer precipitation occupies a dominant position in the climatic tendency rate of annual precipitation. Therefore, the summer rainfall in Shanghai has the most significant impact on the annual precipitation.

As can be seen from the seasonal variation Figure 2.19-2.22, the downward trend of rainfall in spring is not obvious, and its 5a moving average trend fluctuates up and down near the climate average. The trend of increasing rainfall in summer and winter is the most obvious, while the absolute value of climate trend rate in autumn is the smallest, but the overall value fluctuates greatly.




Summer
1000.00
500.00
0.00
-500.00
-1000.00
-1500.00
-2000.00
-2500.00
-3000.00
1959 1961 1963 1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017
Annual Percipitation Anomlies(mm)
Accumulated Variance(mm)


Autumn
600.00
400.00
200.00
0.00
-200.00
-400.00
-600.00
-800.00
-1000.00
1959 1961 1963 1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009 2011 2013 2015 2017
Annual Percipitation Anomlies(mm)
Accumulated Variance(mm)

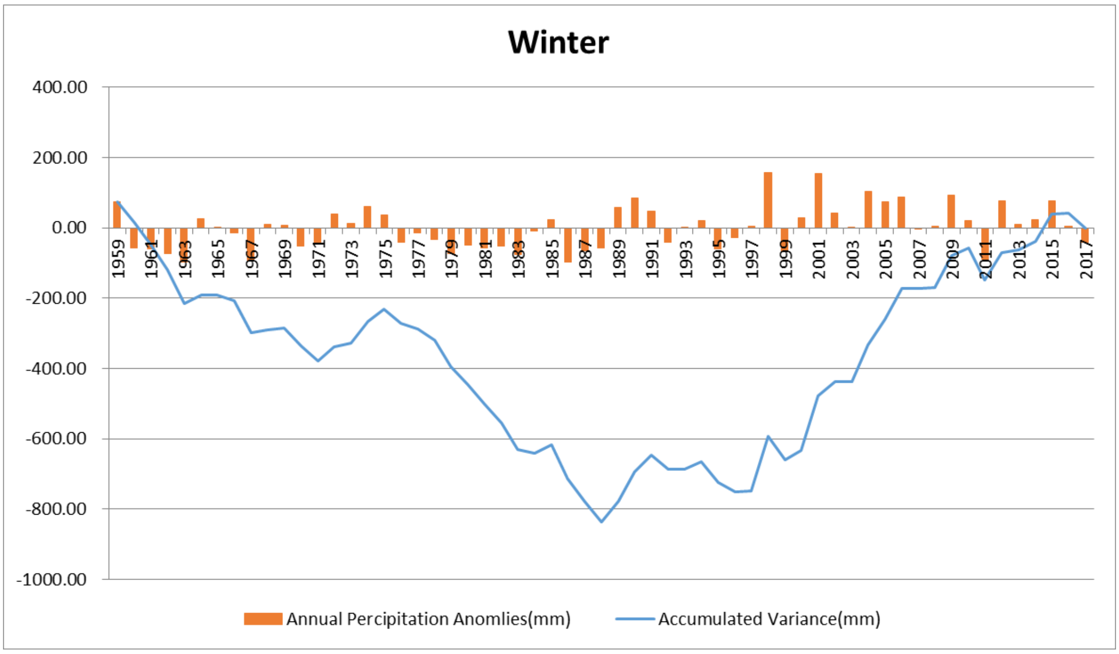
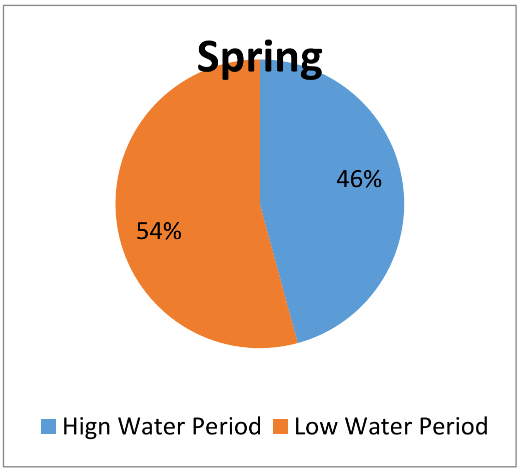
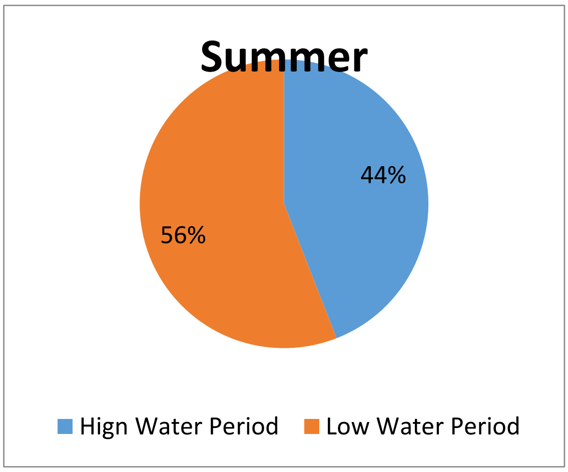


FIGURE 2.23-2.26 Shanghai 1959-2017 Seasonal Precipitation Anomalies/Accumulated Variance

(Source: Made by Author)





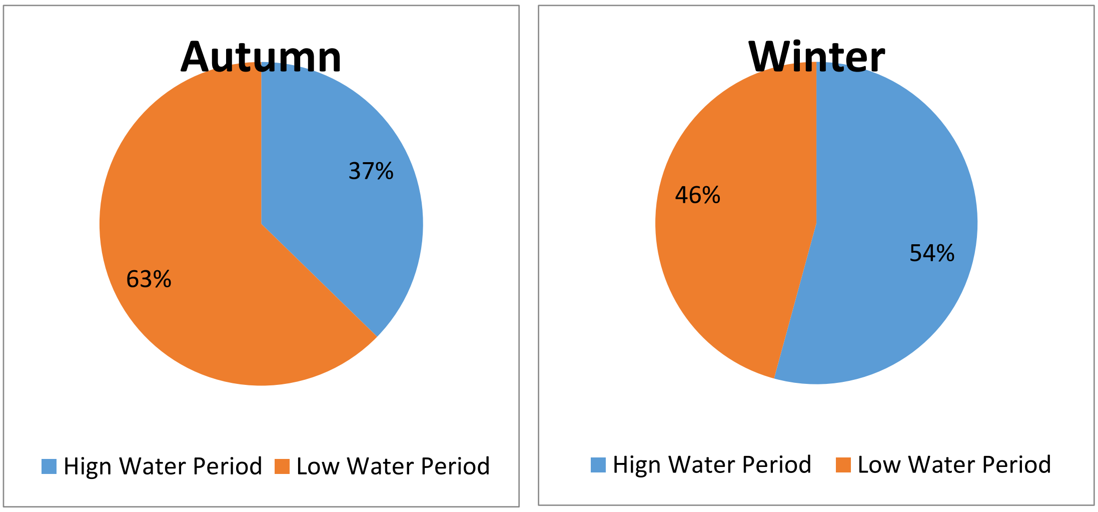


FIGURE 2.27 Percentage of High Water Period and Low Water Period in Different seasons

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

It can be seen from the four seasons' precipitation anomalies/cumulative anomalies (Figure 2.23-2.26) from Shanghai 1959-1969 and the percentage of high water period and low water period in different seasons (Figure 2.27):

From 1959 to 1969, the cumulative anomalous line in the spring showed a fluctuating rising trend, and the positive anomaly was greater than the negative anomaly, and it was in the wet season. From 1969 to 1975, there was a sharp downward trend, and the negative anomaly was greater than the positive anomaly, and it was in the dry season. However, from 1975 to 1993, the fluctuation trend was on the rise, which was in the wet season, and then showed a downward trend until 2011, which was in the dry season. From 1959 to the spring of 2017, the positive anomaly rate of spring precipitation was 46% and the negative anomaly rate was 54%.

The cumulative anomaly in the summer of 1959-1973 showed a downward trend and was in the dry season. From 1973 to now, the overall trend of fluctuations and rising, positive anomaly is greater than negative anomaly, and in the wet season. From 1959 to 2017, the positive precipitation anomaly rate was 44% and the negative precipitation anomaly rate was 56%.

In the autumn of 1959-1962, the accumulated anomalies showed an upward trend, and the positive anomalies were greater than the negative anomalies, which were in the wet season. From 1962 to 1968, it showed a downward trend, with negative anomaly greater than positive anomaly and in the dry season. From 1968 to 1982, however, the overall trend fluctuated slightly and the overall change was not obvious. After a brief rise from 1982 to 1986, fluctuations were in a downward trend until 2013, and the negative anomaly was greater than the positive anomaly, which was in the dry season. And then it went up again. From 1959 to 2017, the positive precipitation anomaly rate was 37%, and the negative precipitation anomaly rate was 63%.

From 1959 to 1988, the cumulative anomaly in winter showed a fluctuating downward trend, with negative anomaly greater than positive anomaly and in the dry season. From 1988 to 2017, there was an upward trend of volatility, positive anomaly was greater than negative anomaly, and it was in wet season. In the winter of 1959-2017, the positive precipitation anomaly rate was 54% and the negative precipitation anomaly rate was 46%.nghai 1959-2017.

It can be found that except winter, the negative precipitation anomaly rate is greater than the positive precipitation anomaly rate in the other seasons in 59 years, which is consistent with the result that the negative precipitation anomaly rate is greater than the positive precipitation anomaly rate every year in 59 years. In the wet season, the negative anomaly rate of annual precipitation is greater than the positive anomaly rate, indicating that precipitation is more concentrated and prone to floods. In the dry season, the annual precipitation negative anomaly is greater than the positive anomaly, indicating that the annual precipitation is relatively low. The incidence of drought is greater than that of flood, but major drought is less likely to occur. The absolute difference of the positive and negative anomaly rate of precipitation in autumn is the largest, and the precipitation is the most concentrated in the wet season, which is prone to flood disaster. In the dry season, precipitation is also significantly less, prone to drought. In the autumn, due to the influence of atmospheric circulation, the precipitation rate is large, the abundance and drought are frequent, and the flood disaster and drought are easy to occur alternately. Except for autumn, because the summer rainfall accounts for 41% of the annual precipitation, and the negative anomaly rate of annual precipitation is greater than the positive anomaly rate, it is very likely to have flood disasters in wet season.

2.1.4 Identification of climatic problems and climatic hazards

After an overall analysis of Shanghai's climate data, we also need to focus on some of the extreme climate data. Because these data have an important impact on climatic problems and may cause climatic hazards. After analyzing the extreme data of 59 years, according to the trend, it can also provide pre-judgment and warning for possible future climate problems. To remind relevant government departments to take timely measures and provide reference for planners in the process of designing cities.

2.1.4.1 Extreme precipitation analysis

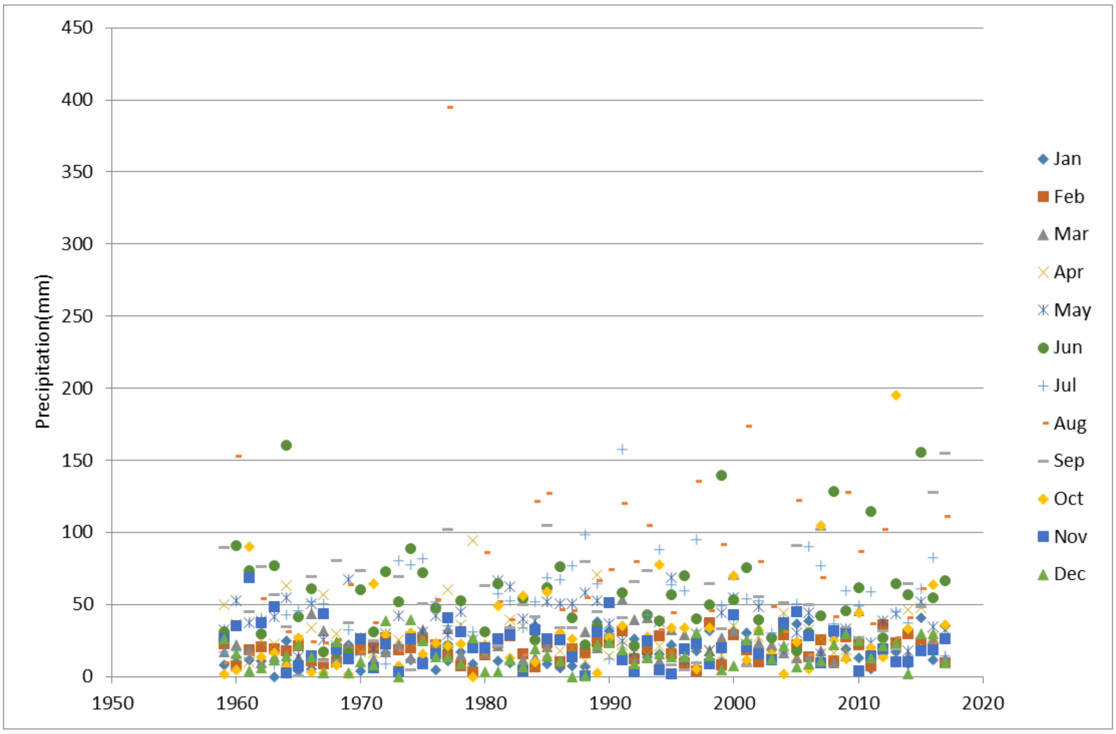


FIGURE 2.28 Scatter chart of annual maximum monthly precipitation in Shanghai 1959 -2017

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

Our data only provides rainfall, and we specifically analyze the floods caused by heavy rains. Floods caused by heavy rains require long-term, large-scale continuous precipitation. Therefore, we first select the maximum daily precipitation that occurs in the 12 months in each of the past 68 years like the Figure 2.28 shows. Calculate a value of more than 80% of daily precipitation of approximately is 50 mm. Therefore, we temporarily set the screening value to 50mm.

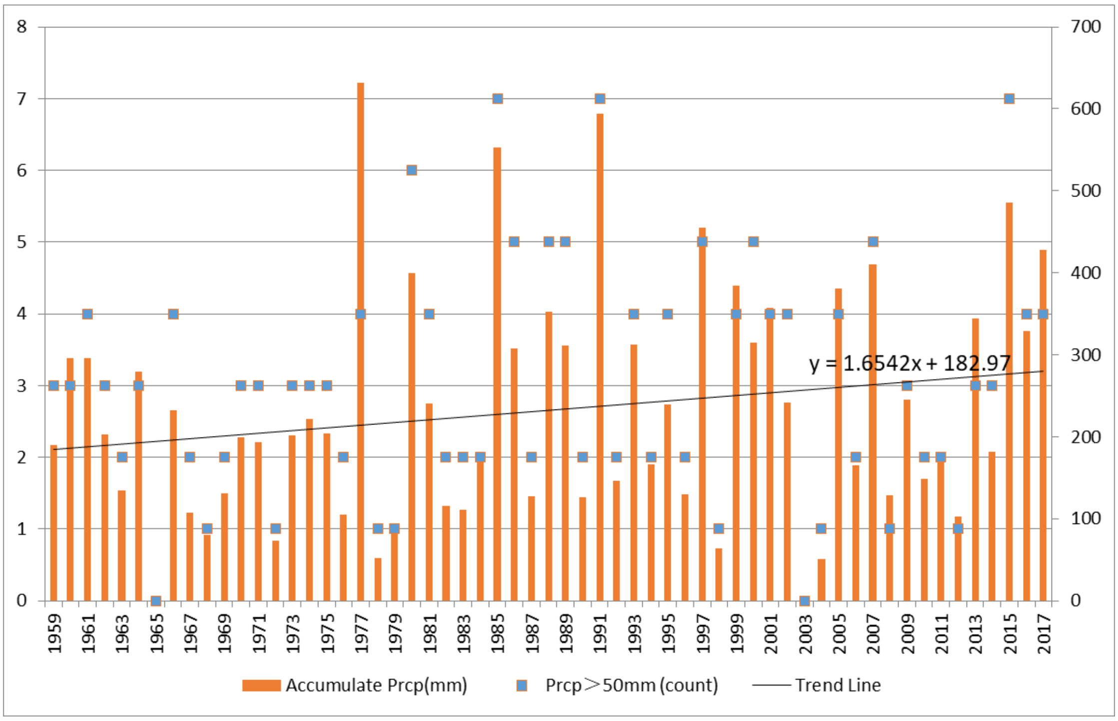


FIGURE 2.29 Number of Days with Rainfall over 50mm per Year in Shanghai 1959-2017

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

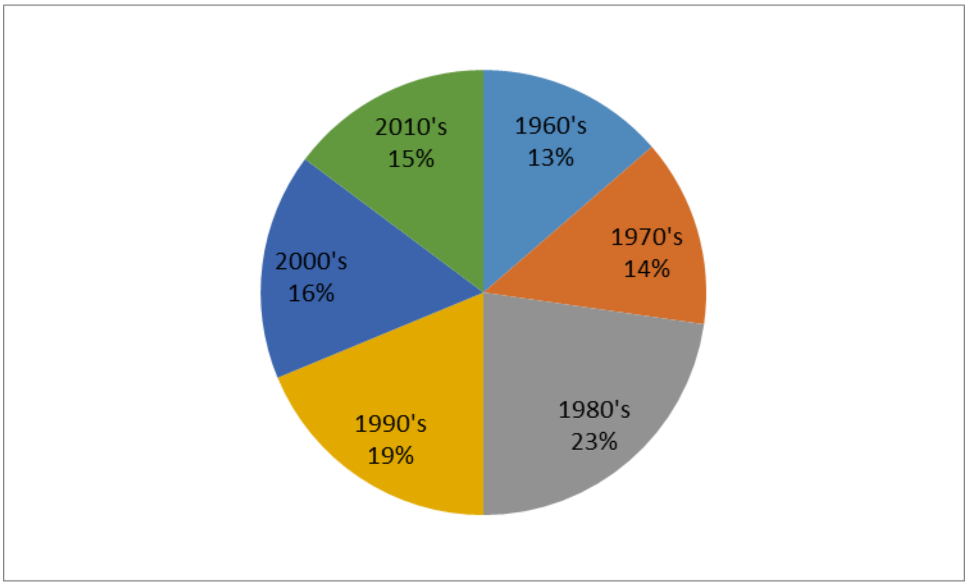


FIGURE 2.30: Proportion of Days with Rainfall Exceeding 50 mm per Decade in Shanghai 1959-2017

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

First we analyzed the number of days with heavy rainfall. As shown in FIG. 2.29, we calculated the number of days with rainfall over 50mm, and it can be seen that the number of days with heavy rainfall per year has been on the rise in the past 59 years. In 1985, 1991 and 2015, there were 7 times of daily precipitation exceeding 50mm, and the cumulative value of these 7 times of precipitation was also very high. It should be noted that in 1977, although only four days' precipitation exceeded 50mm, the cumulative precipitation reached the maximum of 632mm.Therefore, in these four times, there must be heavy precipitation, which may lead to flood disaster.

As can be seen from the pie chart 2.30, although the overall data fluctuated slightly, the data in the 1980s was significantly larger, accounting for 23% of the total. The overall trend is on the rise. Although the data only covers 2017, we cannot ignore that the data of the 28 years from 1990 to 2017 is the same proportion as that of the previous 31 years, so the possibility of problems caused by heavy rainfall is still increasing.

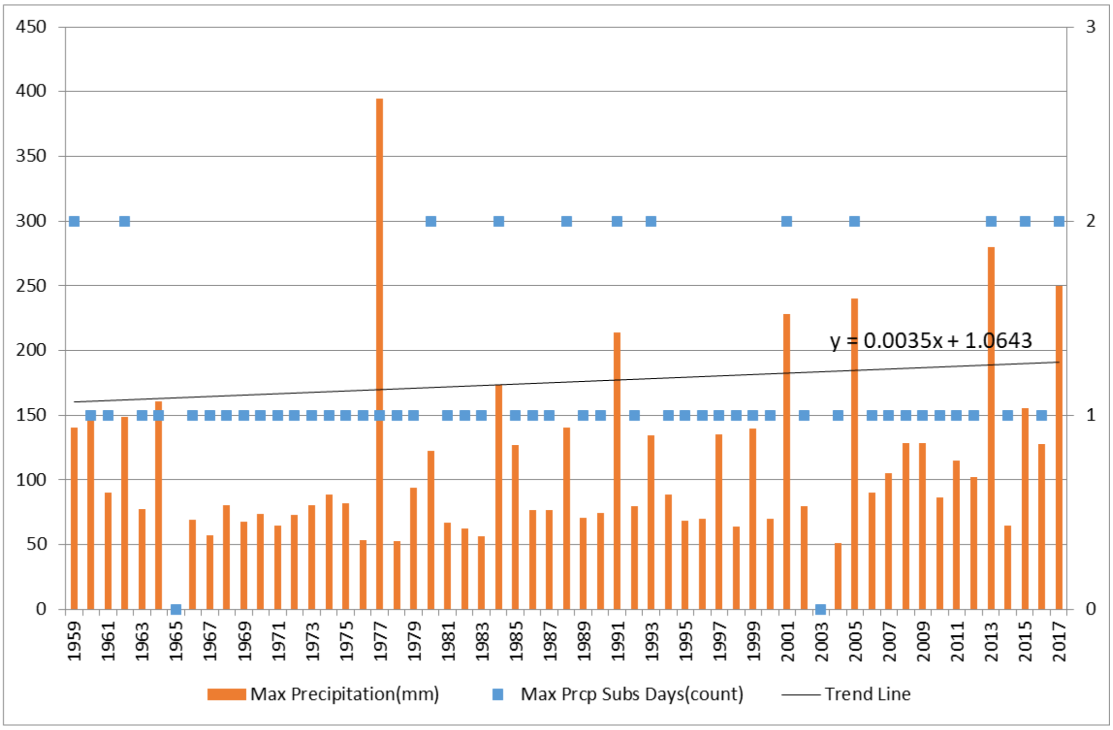


FIGURE 2.31 Maximum Number of Days That Rainfall Continues To Exceed 50mm per Year in Shanghai 1959-2017

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

In order to get closer to the possible flood disasters and calculate the subsequent rainfall for a short period of time, we calculated the maximum number of subsequent days that the annual rainfall exceeded 50 mm, as shown in Figure 2.31. The overall subsequent days have an upward trend, and we can see 12 consecutive days of heavy rainfall. It is worth noting that in 1977, the precipitation in a single day reached 394.5mm.Such a short period of heavy rainfall is likely to have a huge impact on the city, especially in the design and arrangement of urban storm water management facilities. In addition to the number of times of heavy precipitation in a single day, there were 9 times in the 59 years when the total rainfall reached 150mm or more, respectively in 1964, 1977, 1984, 1991, 2001, 2005, 2013, 2015 and 2017.We speculate that there is a high probability of flooding caused by heavy rainfall in these 9 years. For example, according to news reports, in 1991 China's Jianghuai river basin and the Taihu Lake Basin were hit by heavy rainstorms and floods during the Meiyu period, affecting 130 million people in Anhui, Jiangsu, Henan, Hubei, Hunan, Zhejiang and Shanghai, killing more than 1,200 people and injuring more than 250,000. Only 55 counties and cities in Anhui and Hubei provinces were flooded, resulting in direct economic losses of more than 60 billion yuan. In addition, 5 of these 9 phenomena occurred in the 21st century, indicating that with climate change, the frequency of heavy rainfall in Shanghai has become more and more frequent in recent years. Therefore, at the level of urban design, it is necessary to make more detailed plans for the prevention and control of future rainstorm disasters in Shanghai.

2.1.4.2 Heat wave analysis

According to previous analysis, Shanghai has a North subtropical monsoon climate, with a mild and humid climate with shorter spring and autumn and longer winter and summer. Therefore, we conducted a specific analysis of possible high temperature climate issues. So we first select the highest daily temperature for nearly 59 years. A value greater than 95% of the maximum temperature was calculated to be approximately 33.9 °C. Therefore, we consider the value of temperature above 33.9 degrees as high temperature weather and screen it for later analysis.

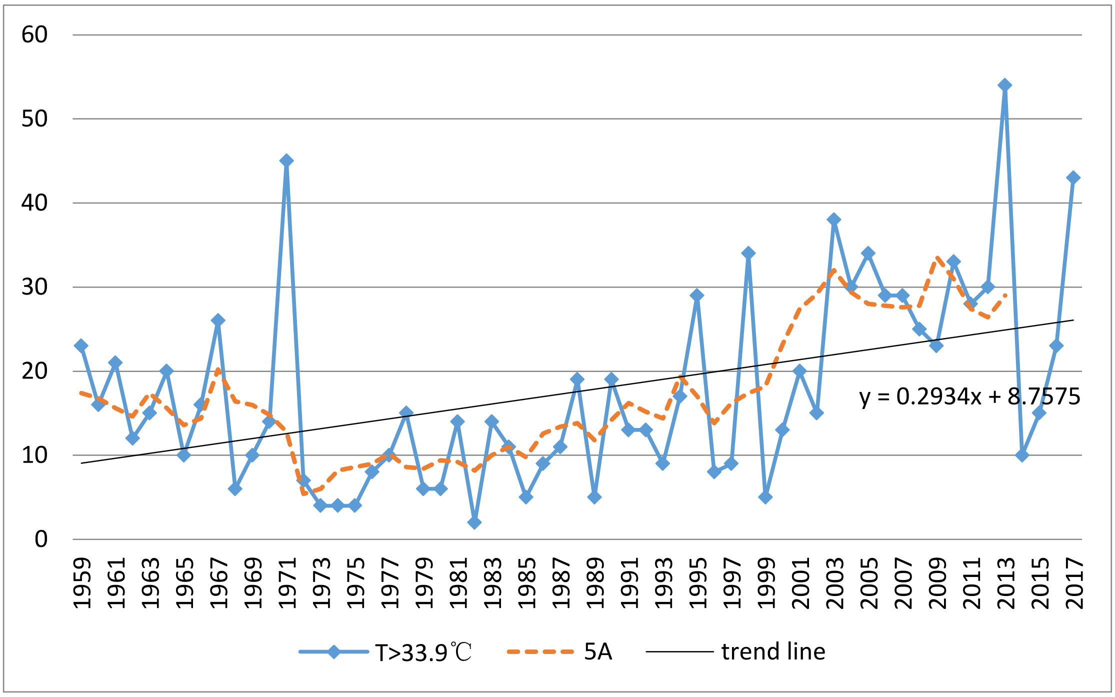
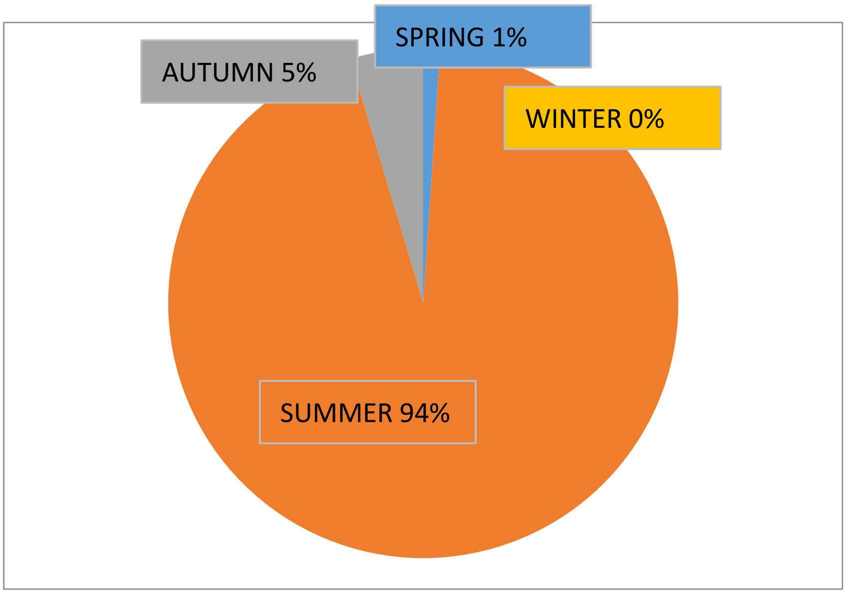


FIGURE 2.32: The Number of Days When The Temperature Exceeds 33.9 Degrees Per Year (1959-2017)

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)



PIE CHART 2.33: The Proportion of Days In Which The Temperature Exceeds 33.9 ° C In Different Seasons (1959-2017)

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

Figure 2.32 shows that the days of annual temperature exceeds 33.9 degrees each year, which is on the rise in the past 59 years, and the climate tendency rate is 2.93 days/10a. In the 36 years before 1995, the frequency of high temperature weather fluctuated less and the upward trend was not obvious. But in 1971 there was an obvious change; it has 45 hot days that temperature exceeds 33.9 degrees.

After that, the number of high-temperature weather after the 1990s increased significantly, indicating that the city may have experienced an accelerated stage of urban development, resulting in an increase in the frequency of hot weather.

From Pie Chart 2.33, we can see that 94% of the high temperature weather appears in the summer, and the summer is the season where the high temperature weather frequently occurs, and the possibility of climate problems is high.

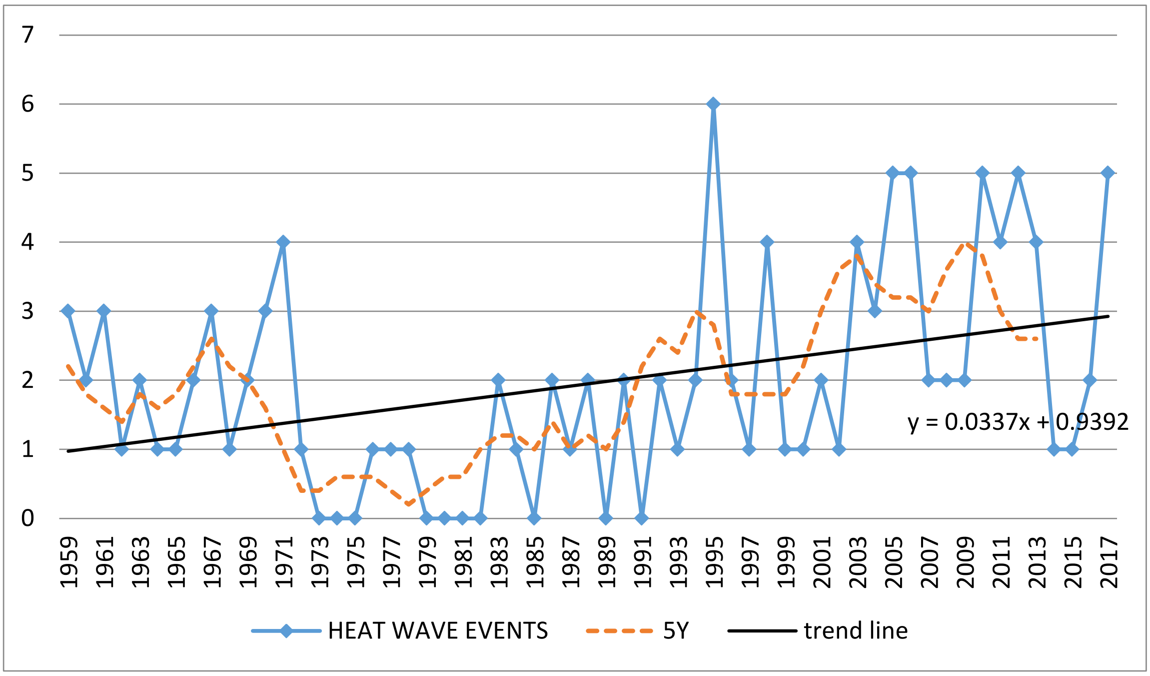
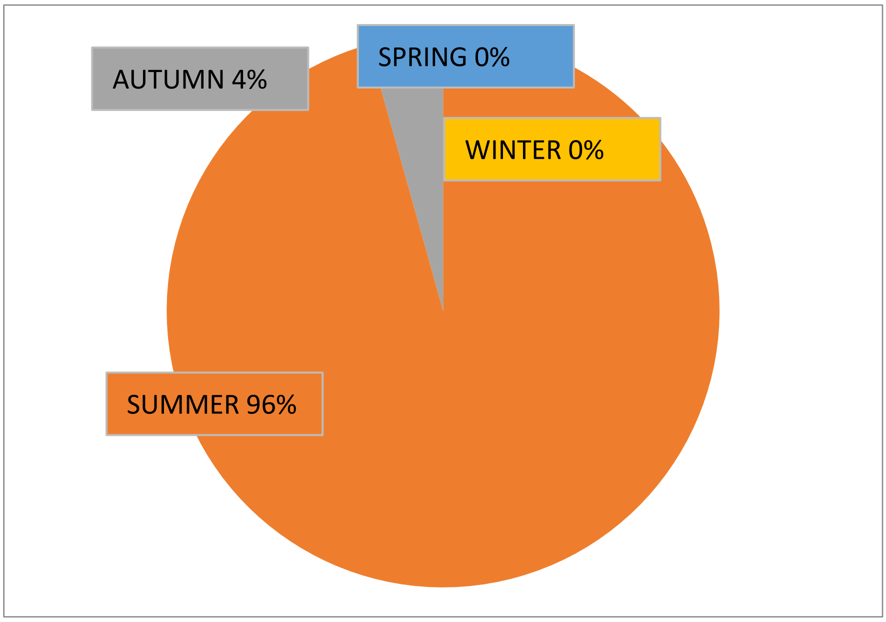


FIGURE 2.34: The Number Of Heat Wave Events Per Year (1959-2017)

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)



PIE CHART 2.35: The Proportion Of Heat Wave Events In Different Seasons (1959-2017)

(Source: Made by Author，According to Meteorological data of Shanghai from 1959 to 2017 - China Meteorological Data Network. The detailed data table is in the attachment)

We call the weather that exceeds 33.9 ° C for three consecutive days as heat waves. Heat waves are a climate disaster that has a great impact on both humans and nature. As shown in Figure 2.34, the number of occurrences of heat waves is increasing year by year, which basically corresponds to the data analyzed in Figure 2.35. It rose slightly before the 1990s, and the frequency of heat waves after the 1990s was very high until now. After 2000s , it tends to be stable, but it can be seen that there is still an upward trend. Therefore, in recent years, it is still impossible to ignore the impact of possible heat waves. From Pie Chart 4-8, especially in the summer, it is necessary to increase the response.

2.1.5. Summary

Changes in regional climate will lead different disasters. However, those disasters will also have different impacts on regional economy and people's health, etc. Based on the meteorological data of Shanghai in the past 59 years, this paper uses linear regression analysis and various tables to make statistical diagnosis and analysis on the change characteristics of precipitation and temperature, and summarizes the climate change characteristics of Shanghai in the nearly 60 years:

Shanghai is characterized by four distinct seasons, abundant sunshine and abundant rainfall. Shanghai has a mild and humid climate with shorter spring and autumn and longer winter and summer, belonging to north subtropical monsoon climate. July has the highest temperature, and June has the highest monthly average rainfall.

The average temperature is around 16.42°C in 1959-2017, the mean annual temperature was rising, and the climate tendency rate is 0.382°C / 10a. And according to the annual temperature accumulated variance analysis, we know that before 1993 is the colder period, and after that is the warmer period. Based on the seasonal temperature variation characteristic analysis, we know the average temperature in the four seasons was always increasing, winter and spring has the higher climate tendency which may be mainly affected by the climate warming in Shanghai. And the seasonal temperature accumulated variance is similar with annual, they almost shows that around 1993 are the changing point from colder period to warmer period. Only the winter turns earlier than the other three seasons, the point is around 1987. We also analyzed the characteristics of the maximum and minimum temperature; we found that Shanghai's average maximum and minimum temperature has shown an upward trend in the past 59 years. And compared with the average maximum temperature, the upward trend of minimum temperature is more obvious. But from the 5a moving average curve, since 2007 the maximum and the minimum temperature are all on a downward trend.

From the annual precipitation of Shanghai we found the annual precipitation tendency rate is 56.361mm/10a. And the average annual precipitation is 1125.13mm, and the annual precipitation shows a significant increasing trend. The maximum and minimum values for 59 years appeared in 1977 and 1978, respectively are 1727.40 mm and 665.60 mm. The maximum and minimum values appear in the adjacent two years, indicating that the rainfall in these two years has undergone great changes under the influence of various factors. And it can be found that between 1959 and 2017, San Francisco experienced two phases of annual precipitation: dry season - wet season, with the early 1970s as the dividing line. About the seasonal analysis, the average precipitation in summer is 466.77mm, accounting for 41% of the average annual precipitation, and the negative anomaly rate of annual precipitation is greater than the positive anomaly rate, it is very likely to have flood disasters in wet season.

We also analyze some climatic problems and climatic hazards like heat waves and Extreme precipitation analysis. The number of high-temperature weather after the 1990s increased significantly, indicating that the city may have experienced an accelerated stage of urban development, resulting in an increase in the frequency of hot weather. In recent years, it is still impossible to ignore the impact of possible heat waves, especially in the summer, it is necessary to increase the response. We also calculated the number of days with rainfall over 50mm, and it can be seen that the number of days with heavy rainfall per year has been on the rise in the past 59 years. In addition, there were 9 consecutive short periods of rainfall exceeding 150mm, among which 5 occurred in the 21st century, indicating that with the climate change, the frequency of heavy rainfall in Shanghai has become more and more frequent in recent years.

2.2 The main problems facing Shanghai's sponge city construction

2.2.1 Heat island effect

According to the previous climate analysis, the number of high-temperature weather after the 1990s increased significantly, indicating that Shanghai may have experienced an accelerated stage of urban development, resulting in an increase in the frequency of hot weather. In recent years, it is still impossible to ignore the impact of possible heat waves, especially in the summer, it is necessary to increase the response.

Moreover, since China's reform and opening up (1978), Shanghai has entered a stage of rapid urbanization, with the city's area and population continuously expanding, and it is now one of the areas with the highest level of urbanization and the most developed economy in China. However, with the rapid development of economic construction, the temperature difference between urban and rural areas in Shanghai continues to expand, the intensity and area of heat islands continue to increase, the phenomenon of high temperature in summer continues to increase, high temperature disasters frequently occur, and urban thermal environmental problems are becoming more prominent ***[Xu Wei, Yang Han Wei, ZHANG Shipeng, MAO MAO, Chen Chen, LIANG Ping, XIA Li.2016]***.

According to statistics, from 1961 to 1970, the heating rate of Shanghai urban and suburban heat island was about 0.09℃/10 years. From 1971 to 1980, the heating rate of urban and suburban heat island in Shanghai increased to 0.12℃/10 years. From 1981 to 1990, the heating rate of urban and suburban heat island in Shanghai decreased to 0.09℃/10 years. From 1991 to 2000, the heating rate of urban and suburban heat island in Shanghai was about 0.22℃/10 years. From 2001 to 2006, the heating rate of urban and suburban heat island in Shanghai was about 0.17℃/5 years, but since 2006, the intensity of urban and suburban heat island in Shanghai has decreased significantly. Thus it can be seen that the period from 1991 to 2006 was the period with the fastest growth of intensity of Shanghai city and suburban heat island, which was also the period with the most rapid development of Shanghai's industrialization and urbanization ***[Bao Wenjie. 2010]***.

It is found that urbanization changes the atmospheric dynamics characteristics and heat exchange properties of the underlying surface in cities, causes rapid changes of land cover and land use, and promotes the formation of urban heat island. The bigger city, the more people, the stronger urban heat island. The formation and development of an urban heat island are closely related to its geographical location and geometric shape. The release of artificial heat from factories, mines, enterprises, government offices and units in cities and the lives of urban residents,It also promotes the formation of urban heat islands ***[Ding Jincai, Zhang Zhikai,Xi Hong et al. 2002]***.Many studies have shown that the formation of urban heat island is closely related to weather conditions. Urban heat island is not only closely related to wind speed, but also the intensity of heat island changes with the amount of cloud cover. The formation and intensification of the urban heat island effect can be further promoted by the climate conditions such as clear and cloudless weather, calm wind and small atmospheric pressure gradient. Many studies have also shown that, Changes in land use and vegetation cover are the major factors in the formation and evolution of urban heat island effect ***[Cao Aili, Zhang Hao, Zhang Yan et al. 2008]***.Because each land use type has different thermal characteristics, radiation characteristics and anthropogenic heat, it shows that the urban land use type such as cement, tile structure building, square, residential land, bridge deck and road has high anthropogenic heat release and high temperature, while the bare land, vegetation and water body dominated by soil have low temperature. Therefore, with the expansion of cities and the change of land use types, the urban heat island effect will produce corresponding changes.

Urban heat island is formed under the interaction of human factors (mainly the rapid advancement of urbanization and industrialization) and local weather and meteorological conditions. Among them, local weather and meteorological conditions are external causes, and land use changes caused by population growth, urbanization and industrialization are internal causes ***[Li Rong.2009]***.It can be inferred from the above research results that controlling the intensity of urban economic development and energy consumption and combining the total population control with the reasonable distribution of population density are important measures to effectively curb the urban heat island effect in Shanghai. For urban planning, in the face of the increasingly severe summer high temperature phenomenon, urban planning still needs to consider the living environment conditions of daily residents, so as to reduce the impact of the heat island effect.

2.2.2 Urban waterlogging risk

The rainy season is an important climate feature over Eastern China including Shanghai where anomaly in either its timing or length can lead to adverse economic and social consequences ***[Journal of the Meteorological Society of Japan. 2008]***. In particular, there will be plum rain season in June and July every year in Shanghai, accounting for about 16% of the annual precipitation. Moreover, after 1961, the length of the rainy season in Shanghai increased significantly, and the end date of the rainy season was also uniformly delayed, thus prolonging the rainy season. Rainfall is mainly concentrated in June to October every year, and it often occurs for several consecutive days of rain, rainfall concentration, heavy rain frequent, continuous time, and instantaneous rainfall is large, easy to cause the river level surge, urban rain discharge is not free, causing waterlogging. Especially from July to September, we often encounter ocean floods, typhoons and rainstorms, as well as continuous heavy rain in the upper reaches of the Huangpu River, which makes the water level of the river flowing through Shanghai high. According to the previous data analysis conducted in this paper, summer rainfall in Shanghai accounts for 41% of the annual precipitation, and since the 21st century, the frequency of short-term heavy rainfall in Shanghai has also been increasing gradually, so the risk caused by this has also been increasing gradually. All these factors add up to more challenges for Shanghai's flood management facilities. In addition to these climatic factors, Shanghai's water environment also has some other problems.

(1) Hydrological characteristics

The East China Sea alluvial plain at the mouth of the Yangtze River has many rivers in the city. There are 33 127 rivers in the city, with a total length of 24,915 km, river network density of 3.93 km/km2, an area of 569.6km2, 20 lakes, an area of 73.1km2, a total area of 642.7km2, and a river surface rate of 10.1%.The river is affected by the tide, day and night tide ebb and flow, the river water level changes greatly. Most of the urban rivers flow into the Huangpu River, flow through the Mouth of the Yangtze River, into the East China Sea, a small number of rivers directly into the East China Sea or the Yangtze River. Shanghai rivers and coastal water level affected by tide, near the sea tide the difference between the high and low water level is 3.6 m (station) to Luchao port, Huangpu river into the Yangtze river estuary tidal level there are about 2.7 m height difference (drawing station), the Huangpu river middle tidal level height difference of 2.2 m (Huangpu park station), the Huangpu river section of tidal level height difference of 1.1 m or so (the market cross station). Sluicles have been built in Shanghai to prevent backward water flowing into the Huangpu River, the Yangtze River and the East China Sea, and to regulate the water level and discharge of inland rivers. Shanghai's high water table, usually dug from the ground 0.5-1 m, will find groundwater, soil infiltration rate is low, Shanghai like a sponge full of water ***[Dai Shenzhi. 2016]***.

(2) Water environment problems

The water quality is due to factors that Shanghai cannot control: in addition to salt caused by seawater pouring back into the Yangtze river, water pollution in the upper and middle reaches of the Yangtze River is also affected, and in the event of sudden water pollution accidents such as Liaohua incident in the upper reaches of the Yangtze River, the water source of the Yangtze River is difficult to use. The upstream water source of the Huangpu River is Jinze Reservoir, which has been built in an attempt to improve the raw water quality, but the reservoir is still in the lower reaches of the River and lake systems in Zhejiang and Jiangsu provinces, and its raw water quality is affected by the water quality pollution of the river and lake systems in Zhejiang and Zhejiang provinces, which makes it difficult for Shanghai to control the water quality ***[Shi Ping, Guo Yu, Liu Long.2020]***. Shanghai water supply source situation, can draw a conclusion: Shanghai own water resources is very rich, but water quality is poor.

(3) Water security problems

Shanghai city has high underground water level, land development intensity is high, the impervious area, soil, the characteristics of low invasion rate, more cities because of the high building density, high building plot ratio and impermeable area such as road, square, the shop is hard, stormwater runoff is fast, more and river levels high and less storage space, factors such as storm sewer drainage discharge is blocked, torrential rain, causes larger range of waterlogging in cities; Urban water security has been seriously affected. Especially in the case of typhoon, urban water security problems are more serious ***[Dai Shenzhi. 2016]***. On August 8, 2012, under the influence of Typhoon haikui, the average daily precipitation in Shanghai was 100.2mm. The station of Zhennan Road in Putuo District was as high as 224.3mm, and the maximum hourly rainfall in People's Park Station was 58.9mm, which caused extensive waterlogging in the urban area. For example, since October 6, 2013, under the influence of the two typhoons "Fitow" and "Danas", the whole city has been subjected to torrential rain from torrential rain, with the maximum rainfall reaching 332 mm in 24 hours, causing severe waterlogging in Shanghai. Heavy rains and typhoons are the most prominent natural disasters in Shanghai.

2.3 Reason Analysis

2.3.1 Meteorological reasons

Shanghai is located in the middle and lower reaches of the Yangtze River. From mid-late June to early July every year, the subtropical high moves north, and the rain belt stays in the Yangtze River and Huaihe River for a long time. Plum rain occurs in Shanghai, with large short-term rainfall and frequent extreme weather. At the same time, with the development of the city, the problem of climate warming is aggravated and the sea level is rising year by year. As a coastal city, Shanghai is also affected by floods.

2.3.2 Natural environmental reasons

The territory of Shanghai is entirely flat, with only a few hills in the southwest, which is part of the Alluvial plain of the Yangtze River Delta. The average altitude is about 4m above sea level. The terrain of the land is generally tilted slightly from east to west. Shanghai is located in the lower reaches of Taihu Lake and the Huangpu River. The urban ground elevation is generally 3.0-3.5m, and the lowest point is only 2.2m. The ground is lower than the perennial high tide level. The main stream of the Huangpu River is 79.18km long. It is connected with Taihu Lake at the top and reaches the sea at the mouth of the Yangtze River at the bottom. The water surface drops gently and the current flows reciprocally, with reverse flow at high tide and forward flow at low tide.

Although Shanghai is a region slightly to the north of south China, it has abundant rainfall because it is a coastal area and also the middle and lower reaches of the Yangtze River. The middle and lower reaches of the Yangtze River have a subtropical monsoon climate. In summer, there are many typhoons and rainstorms. In the upper reaches of the Yangtze River, vegetation is seriously damaged, which leads to soil erosion, riverbed elevation in the lower reaches, silt deposition and formation of overland rivers

2.3.3 Infrastructure reasons

Rainwater pipe network design standard is low, easy to appear waterlogging situation.

The existing rainwater drainage pipe network in Pu Dong New District is designed to have a recurrence period of 1-2 years or less. The rainwater drainage pipe network has a small diameter, low waterlogging removal capacity, and water accumulation and waterlogging are easy to occur during rainstorm. According to the 2017 survey results of Pu Dong New District, there are a total of 116 water spots, which are divided into three categories: lower overpasses, municipal roads and residential areas, including 32 lower overpasses, 39 municipal roads and 45 residential areas. Due to the factors such as small drainage pipe, blockage, insufficient drainage capacity, low-lying terrain, and the influence of engineering construction, the overall drainage capacity of rainwater pipe network decreases, resulting in the occurrence of rainwater overflow and other phenomena.

2.3.4 Urban construction reason

The city is in the stage of high-intensity development and rapid expansion. The urban land area increases rapidly and the hardening area increases sharply, which leads to the decrease of water outlet and drainage capacity of the underlying surface and the weakening of rainwater regulation capacity. At the same time, the urban heat island effect intensifies. In addition, under the influence of urban expansion, the urban three-dimensional design is not perfect, which leads to the emergence of low-lying places such as urban overpass, which leads to the increase of urban waterlogging points. In this process, the ecological pattern was destroyed, and the unstable ecological pattern reduced the effective control of dust and other pollution.

2.3.5 Economic and social reasons

There are differences in Shanghai's social space, including complex population, economy and housing patterns, which also affect the differences in Shanghai's social vulnerability to natural disasters. The complex differentiation of social and economic space is related to the transformation of Shanghai's urban development and the constant migration of foreign population. Before 1843, Shanghai was only a small town with a population of 500, 000 and a city area of 3 square kilometers. By 1979, Shanghai had grown into a large city with a population of more than 10 million and an area of 255 square kilometers ***[Zhu Yanping 2007]***. After 1990, Shanghai began its third transformation and participated in the competition of globalization. It achieved great development in economy, trade, shipping and other aspects. By 2014, the area of Shanghai had reached 2,968 square kilometers, with a permanent resident population of 24.25 million (Shanghai Bureau of Statistics).

2.3.6 Conclusion

Meteorological reasons	1.Rainy season, short rainfall
Natural environmental reasons	1.The terrain is low and flat, not conducive to the discharge of floods 2.The lower river bed is raised and silted up to form an overland river
Infrastructure reasons	1. Rainwater pipe network design standard is low, easy to appear waterlogging situation.
Urban construction reason	1. The city is under intense development 2. Under the influence of urban expansion, urban three-dimensional design is not perfect
Economic and social reasons	1. There is differentiation in social space

3 Design Strategies for Waterlogging Prevention Sites in Shanghai Based on the Concept of "Sponge City"

3.1 Site selection

3.1.1 Sponge city and sponge mechanism

Sponge city is a new generation of urban storm water management concept in China, which means that cities have good "resilience" in adapting to environmental changes and responding to natural disasters brought by rain. It can also be called "water resilient city". The international generic term is "low-impact development of rainwater system construction". When it rains, absorb water, store water, seep water, purify water and drain water. When necessary, the stored water shall be "released" and utilized.

Sponge city construction can make the city "resilient to" environmental changes and natural disasters, protect the original water ecosystem, restore damaged water ecology, implement low-impact development, effectively reduce surface water runoff through low-impact measures and system combination, and reduce the impact of heavy rain on urban operation. That is to say, in urban construction, the behavior of separating the relationship between city and human and nature, such as common cement pavement and hardened square, will be changed.

FIGURE 3.1.1: Schematic Diagram of Rainwater Circulation in Sponge City

(Source: Made by Authors, Referred toYuan Yuan 2016)

Mechanism is a landscape matrix, including natural and artificial vegetation and water, which plays a core role in ecological regulation. It not only plays the basic function of development and protection of biodiversity, but also plays the extension function of conservation ecology, ecological conservation and protection of sponge ecology, such as water and soil conservation, reducing soil erosion, reducing environmental pollution, mitigating greenhouse effect and providing areas for wildlife migration and habitat. In addition, sponge matrix is also the largest control body in the region, the largest spongy body in the urban area and the bottom line of ecological control. With the acceleration of urban development, while destroying the ecological environment, it also changes the composition of the ecological environment in urban areas. The ecological landscape and resources have changed from the previously single agricultural and forestry landscape to more diversified elements. As for sponge matrix control, after a full field investigation and investigation of the natural geographical environment and human management elements in the region, different ecological elements are analyzed and evaluated to delimit different levels of ecological sensitive areas. For the key ecological elements that may have ecological problems or influence on the surrounding environment, it is necessary to adjust and construct the current problems in water environment, water resources, water ecology and water security in different regions according to the general and scientific principle and in combination with practice ***[Sun Bo.2020]***.

After complete the overall ecological matrix sponge layout, key ecological sensitive area to area, targeted, including sponge park, multi-level system of sponge base, multi-level system of sponge park contains total area, small sponge, sponge at the end, to ensure that improve the effect of water ecological restoration, the specific function and typical architecture as shown in table 3.1.2.

Sponge Park Levels	Representative buildings	Role
Regional sponge system	Suburban sponge park	Connect the planning area with the outside sponge
Small sponges	Community sponge park	Adjust the surrounding land surface runoff

Terminal sponges	Vitality Sponge Park	Nodes of internal and external interaction

FIGURE 3.1.2: Multi-Level Sponge Park And Its Function

(Source: Made by Authors, Referred to Sun Bo 2020)

Sponge corridor not only divides all substrates, but also connects them through corridors. The connection through water system corridors and green ecological corridors forms a unique ecological structure of the region. The control of sponge corridor is closely related to the ecological structure and planning of the whole city, rather than the ecological function system that exists independently outside the urban functional structure. The sponge corridor system relies on the existing river system of the city and the ribbon green system to achieve the ecological goals.

3.1.2 Sponge city construction in Shanghai

Sponge cities were fully piloted after the China Urbanization Work Conference, and Shanghai became the third batch of pilot cities in China in 2016.

In fact, the construction of the sponge city in Shanghai has been launched since the beginning of 2016. What was implemented that year was the total and intensity dual control actions such as energy and water consumption and construction land. Based on the summary of the Shanghai Urban and Rural Construction Committee, one is to study and formulate implementation opinions for promoting the construction of Shanghai's sponge city, and the other is to study and formulate a standard system for sponge cities that suit the characteristics of Shanghai. On this basis, a unified deployment of the construction planning and construction of the sponge city, combined with the construction of Shanghai suburban new city, six key functional areas, five major transformation areas, and large-scale development areas.

The construction of Shanghai’s sponge city starts from the top-level design, which includes the delineation of the urban development boundary, the comprehensive promotion of urban organic renewal, the acceleration of the secondary development of industrial land, the reduction of 7 square kilometers of inefficient construction land, the improvement of the carbon emission trading mechanism, and the expansion Application scale of prefabricated building, etc. The person in charge of the Shanghai Municipal Commission of Housing and Construction said: “I hope to basically form a rainwater technology and facility system for ecological protection and low-impact development by 2020, and achieve a 75% control rate in the old city area through trials and renovation.”

According to the opinions on the Implementation of Sponge city Construction issued by Shanghai Municipality, the basic goals by 2020 are as follows: the green space system, buildings and communities, roads and squares, drainage system and other new and reconstruction projects shall meet the relevant goals and indicators of sponge city construction planning, and the control rate of the total annual runoff in the pilot area shall not be less than 80%;Measures should be taken to combine water storage and drainage to gradually raise the standard of urban drainage and waterlogging prevention. The rainwater drainage system in built-up areas of cities and towns in Shanghai should not be less than once a year, and the strong rainwater drainage system in built-up areas of central cities should meet the requirements of the new planning standard. To improve the operation efficiency of 11 rainwater storage tanks and initial rainwater interception facilities of the distributary drainage system in Shanghai.

Therefore, Shanghai announced 16 municipal sponge city construction pilot areas, totaling 72 square kilometers, to better promote Shanghai's sponge city construction.

3.1.3 Selected sponge city construction pilot

Combined with different levels of sponge parks and representative buildings, the author chooses these four types of sponge parks to be put into practice for planning and design, as shown in Figure 3.1.3-3.1.4.These four types are Ecological Wetland Sponge Park, Waterfront Dynamic Sponge Park, Community Sponge Park and Country Sponge Park.

Then, according to the four different types, the author selected four sites as shown in Figure 3.1.5 of 16 pilot areas of sponge in Shanghai for analysis and design. In these four different pilots, the author conducted site analysis, historical interpretation, proposed the design concept and the sponge system concept.

FIGURE 3.1.3:Ecological Wetland Sponge Park (Left) & Waterfront Dynamic Sponge Park (Right)

(Source: Sun Bo 2020)

FIGURE 3.1.4:Community Sponge Park (Left) & Country Sponge Park (Right)

(Source: Sun Bo 2020)

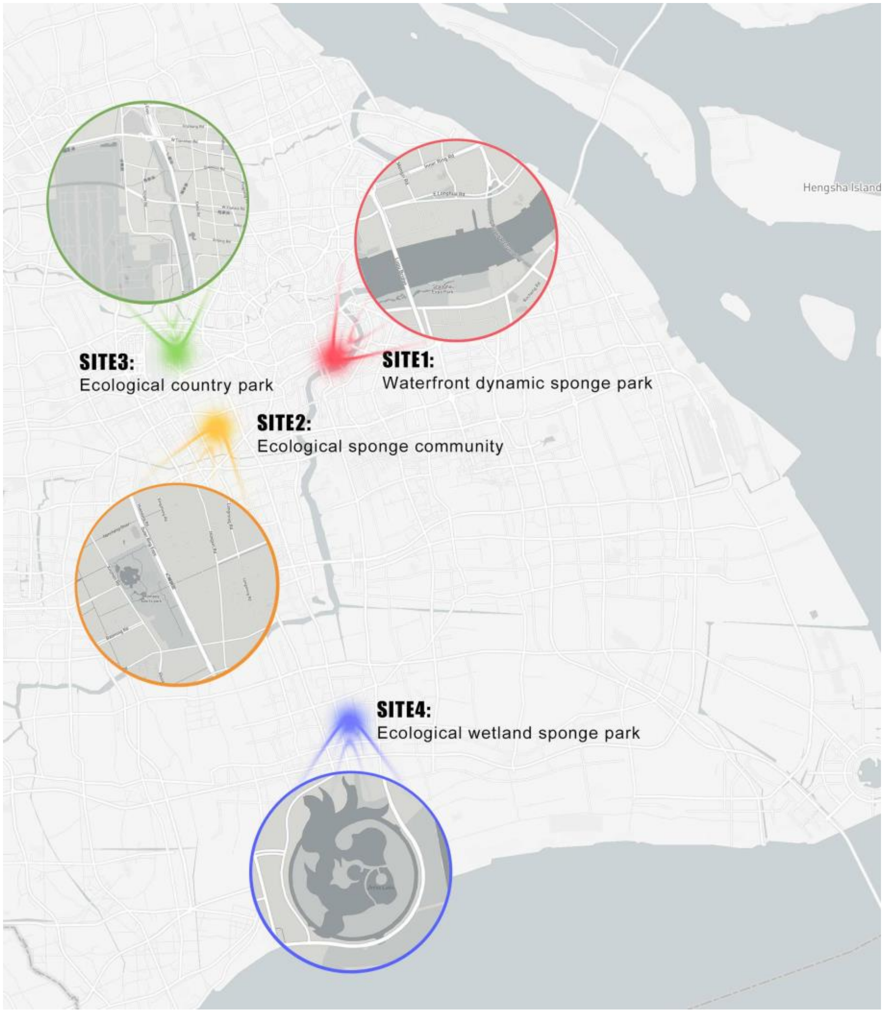


FIGURE 3.1.5: Site selection

(Source: Made by Authors)

3.2 Waterfront dynamic sponge park in Yangpu district

3.2.1 Introduction

We chose the pilot area of the southern section of Yangpu District in Shanghai as the first design site. The specific location of the legal person of the venue is shown in Figure 3.2.1. The venue is located in the southern section of Yangpu District, bordering the Huangpu River, roughly in the northeast of downtown Shanghai. The site area is about 1.7 square kilometers. The waterfront of one section of the site has been designed as shown in the figure.

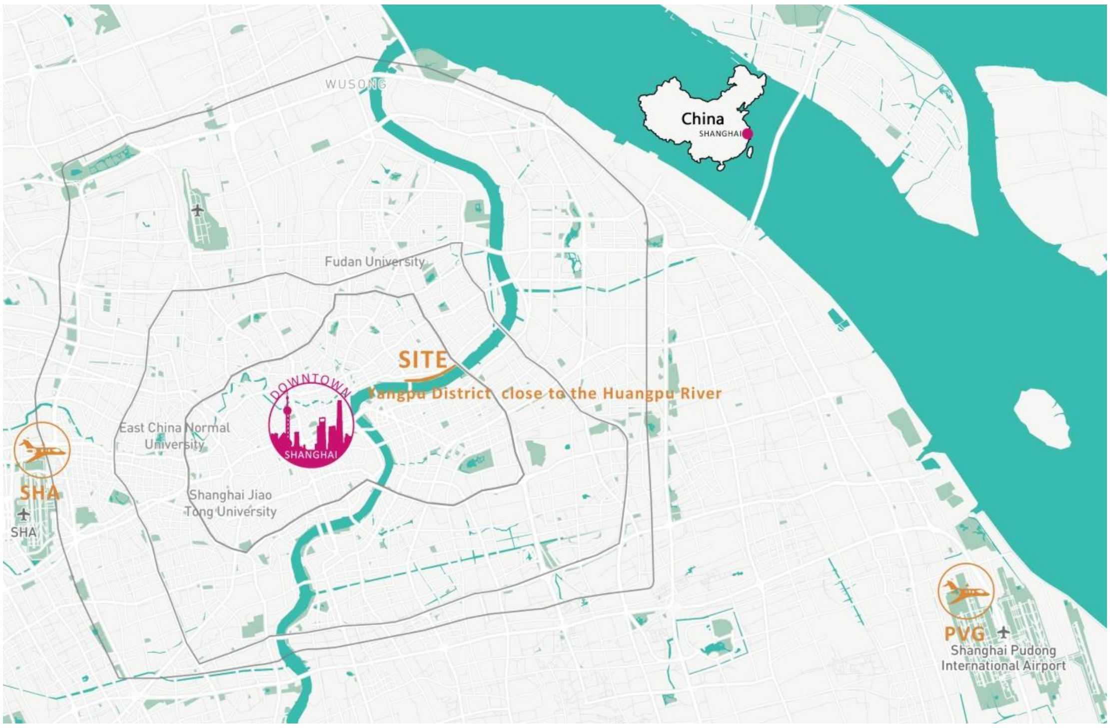
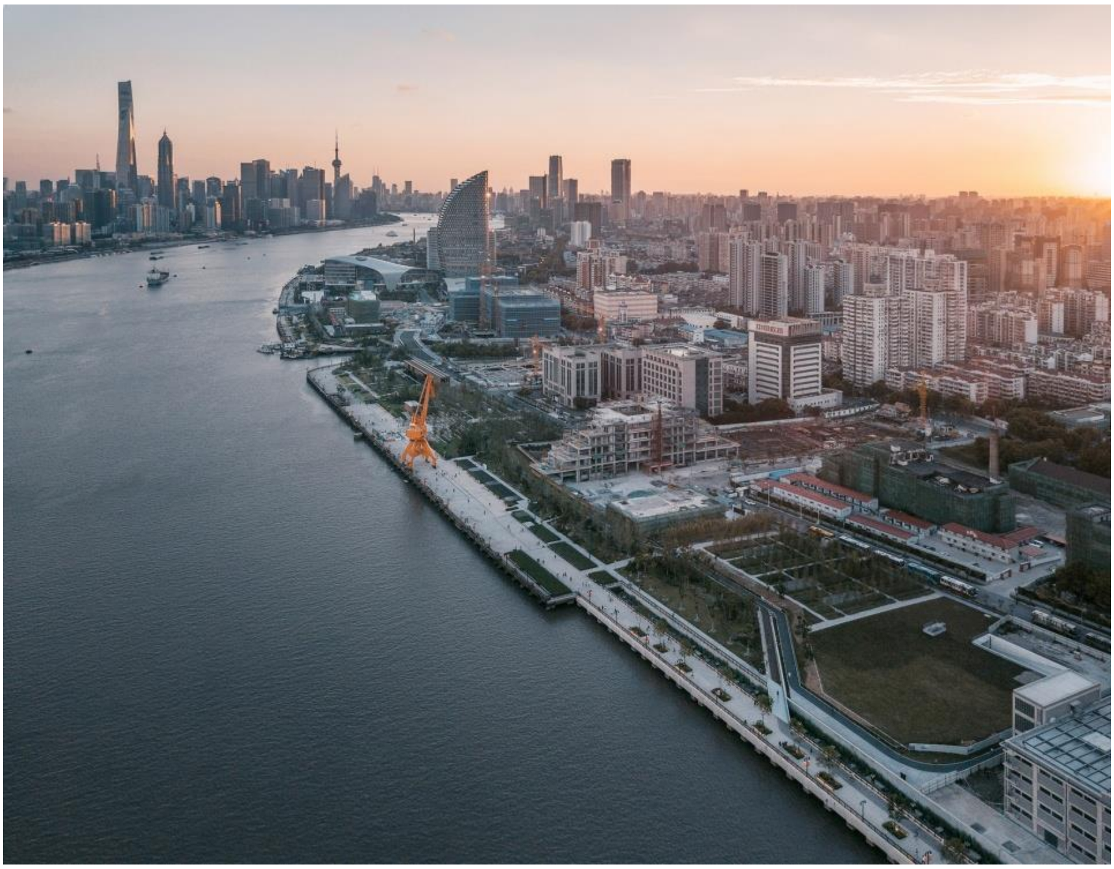


FIGURE 3.2.1: Site Location Map in Shanghai

(Source: Made by authors, Referred to mapbox.com)

An Aerial View of the Site

(Source: www.google.com*)*



The Space Design by the Riverside

(Source: map.baidu.com)

3.2.2 Context analysis

3.2.2.1 Land use analysis

From Figure 3.2.2, we find that there are still many types of sites and surrounding land types. The main types of land used in the site include industrial and commercial land and some green spaces. In addition, the site also includes a cruise ship dock and some cultural and artistic land. Because our site is a strip plot, we calculated the range within a 10-minute to 30-minute walk from the center of the site. Within the range of 10 minutes, the interior of the site is dominated by industrial space, and there are more residential areas around it. Within 20 minutes, the interior is dominated by commerce and industry. In addition to the main residential land, commercial, educational and industrial spaces have also increased. In the further 30 minutes, the area around the site is dominated by residential and industrial areas. It can also be noticed that there are commercial gathering places, Lujiazui Financial Center and Central Green Space at the location opposite the river to the southwest of the site. Therefore, the site and its surroundings are still a land type with a large proportion of industry and residence, along with some other land types. The details of the venue are shown in the photos.

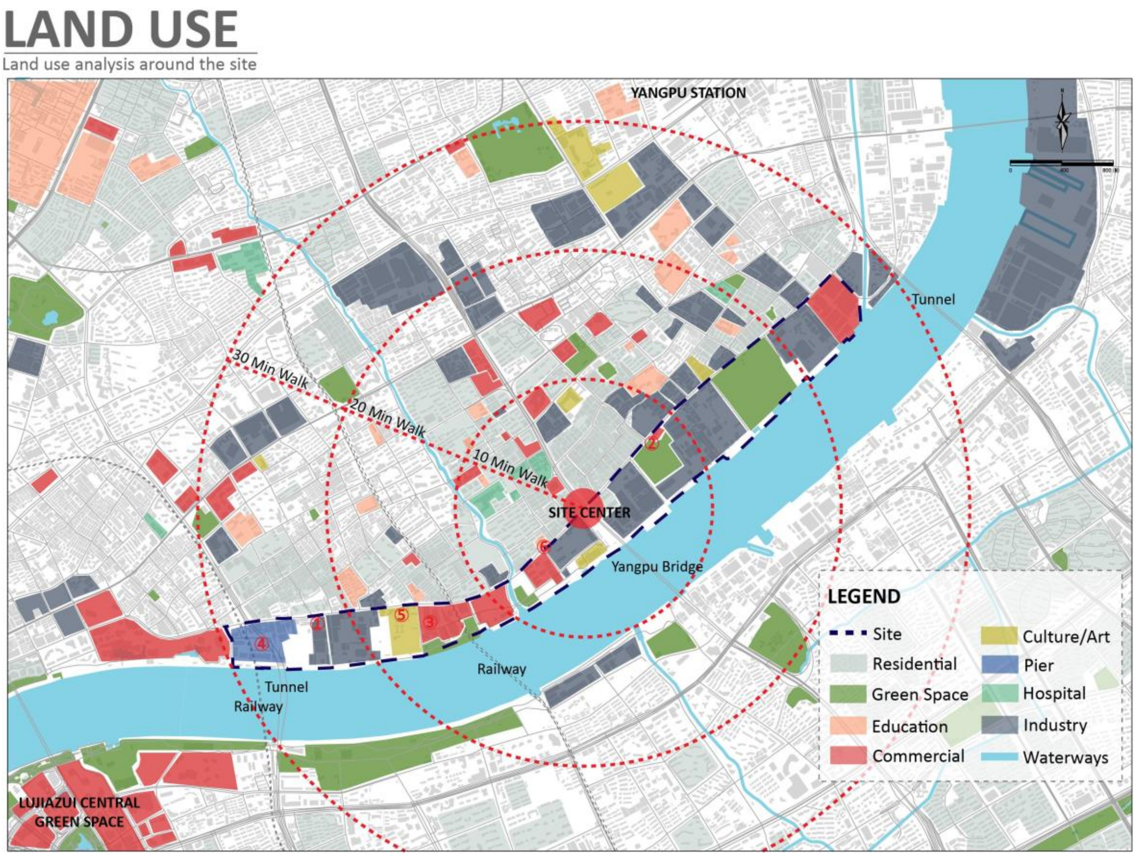
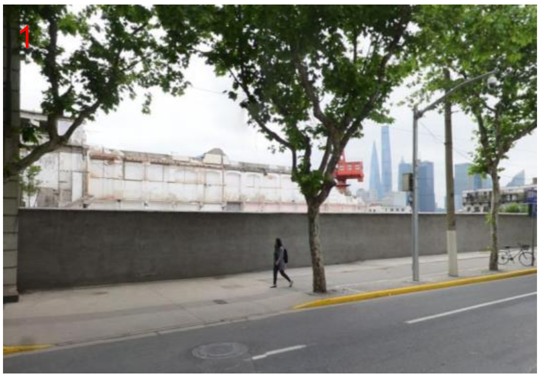


FIGURE 3.2.2: Land Use Analysis about the Site

(Source: Made by Authors ,Referred to map.baidu.com)



Industry Area in the Site

(Source: map.baidu.com)

Commercial Area in the Site (Left) & Pier in the Site (Right)

(Source: map.baidu.com)

Cultural Area in the Site (Left) & School around the Site (Right)

(Source: map.baidu.com)

In addition, we also conducted a separate analysis of the green space system of the site, as shown in Figure 3.2.3. The distribution of green space in the site is relatively scattered. Inside the site is mainly uncultivated land, as well as some parks and open spaces. In the 30-minute range around the site, parks and uncultivated land are mainly used, along with other open spaces. The square-type land is mainly opposite the Huangpu River, close to the Lujiazui Financial Center. In addition, the residential land surrounding the site also includes some green space.

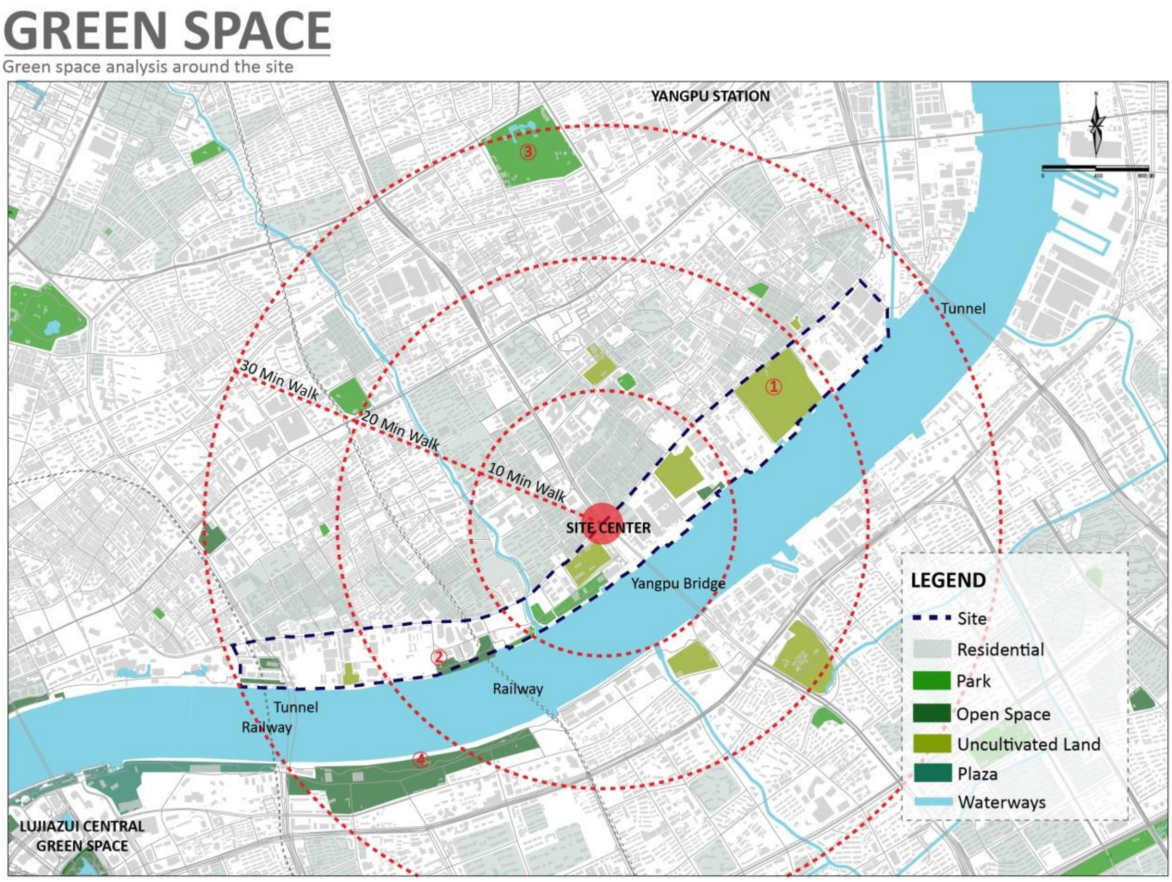


FIGURE 3.2.3: Green Space Analysis about the Site

(Source: Made by Authors ,Referred to map.baidu.com)

Uncultivated Land in the Site (Left) & Open Space in the Site (Right)

(Source: map.baidu.com)

Yangpu Park around the Site (Left) & Plaza across the River (Right)

(Source: map.baidu.com)

3.2.2.2 Transport analysis

The traffic around the site is shown in Figure 3.2.4.The site is located along the Huangpu River, with 2 main urban roads and 3 secondary roads around the site. Huangpu Bridge and two tunnels pass through the site. In addition, there is a waterway from the Huangpu River through the site flow into the city .For some important traffic nodes; we have attached pictures below for your reference, such as Huangpu Bridge and tunnels as well as major city roads.

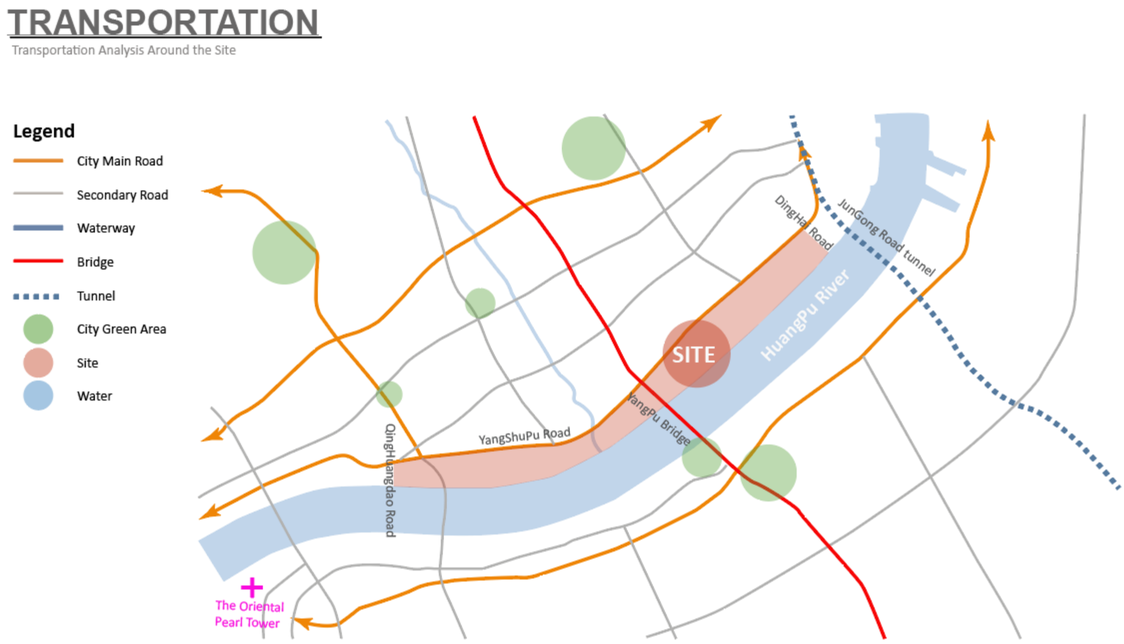
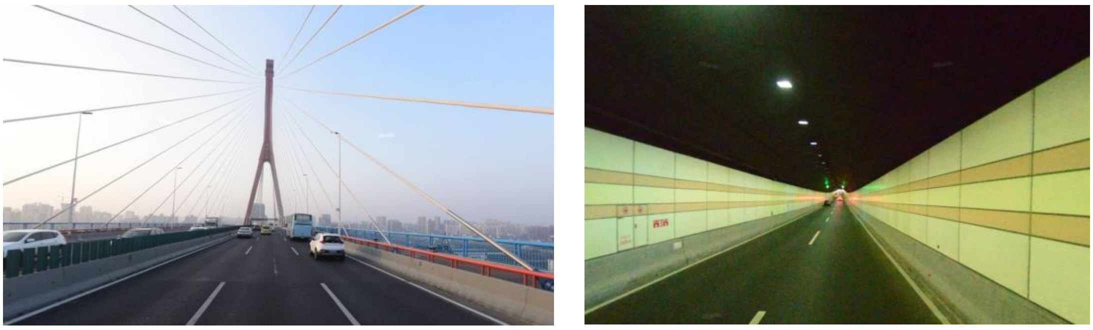


FIGURE 3.2.4: Transportation Analysis about the Site

(Source: Made by Authors ,Referred to map.baidu.com)



Yangpu Bridge(Left) & Jungong Road Tunnel(Right)

(Source:map.baidu.com)

YangShuPu Road(Left) & QinHuangDao Road(Right)

(Source:map.baidu.com)

After that, we also analyzed the public transportation around the site. It was found that there were two day subway lines around the site and 6 stations near the site. In addition, as shown in FIG. 3.2.5 and the photos near the exhibition site, we can see that there are many bus stops near the site, with as many as 11 stops, so the bus travel is very convenient. There is also a subway line, Huangpu Bridge and tunnel to the opposite side of the river.

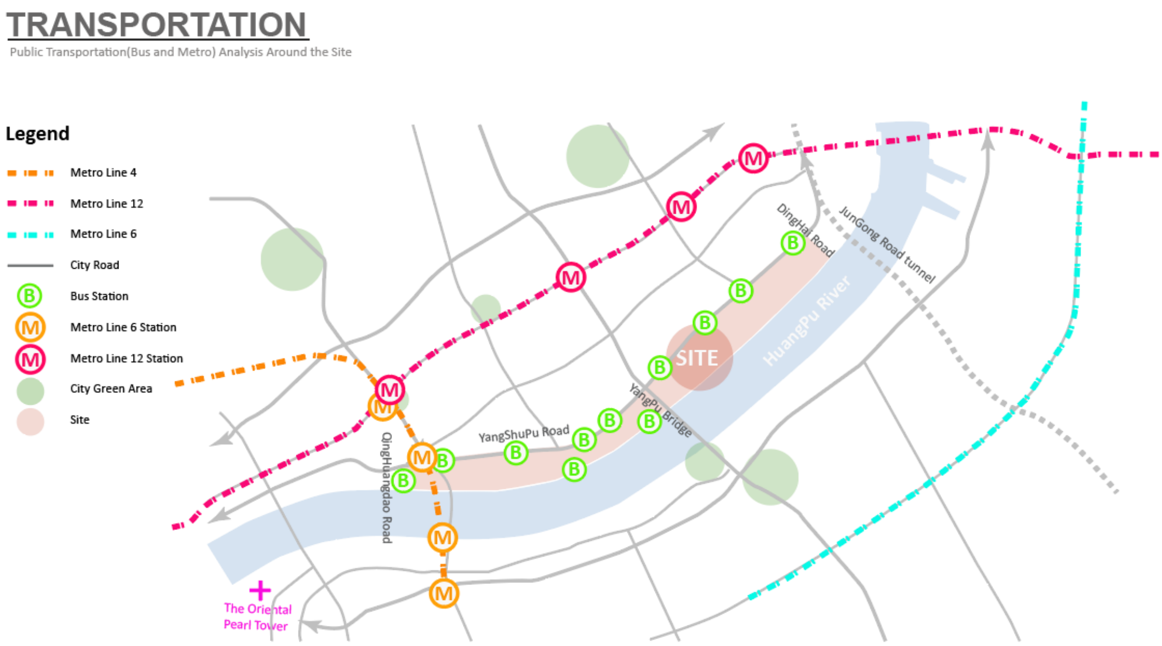


FIGURE 3.2.5: Public Transportation Analysis(Bus and Metro) about the Site

(Source: Made by Authors ,Referred to map.baidu.com)

Bus Station and Metro Station (Line4&12) of Yangshupu Road

(Source: map.baidu.com)

In addition, we also made a key analysis of the public transport within the site, marking a major urban road and some secondary roads, as shown in Figure 3.2.6.There is a bicycle path and pedestrian along the river for sightseeing.We can see from some road maps that there is less green space around the road.

FIGURE 3.2.6: Public Transportation Analysis(Bicycle and Pedestrian) in the Site
(Source: Made by Authors ,Referred to www.google.com)

3.2.2.3 Water level analysis

We drew the water level section of the site near the river, as shown in Figure 3.2.7. At present, the normal water level of Huangpu River is 2.5-3.2 meters, and the ground height of riverside wharf is 5 meters. The 100-year water level is 5.2 and the 1000-year water level is 7.2 meters. According to the requirements of Shanghai's Flood Control and Waterlogging Control Pan (2020-2035), the urban section of the Huangpu River should meet the once-in-a-millennium water level standard in urban flood control.

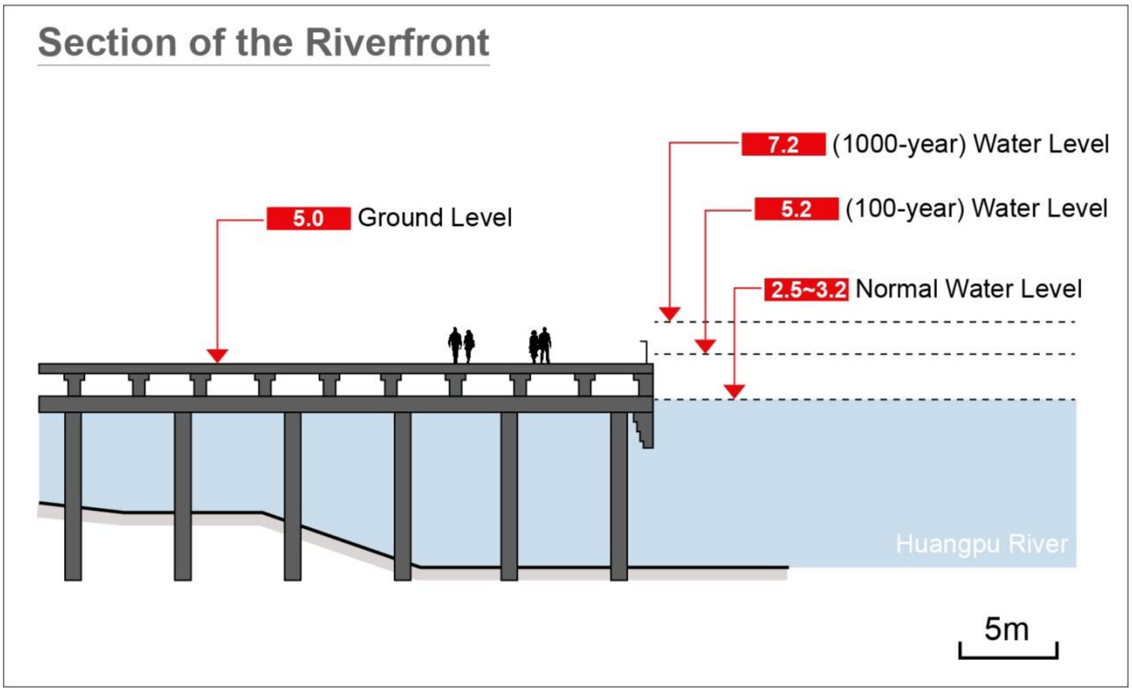


FIGURE 3.2.7: Section of the Riverfront

(Source: Made by Authors, Referred to Chen Zhan 2015)

3.2.3 History and development

The riverside belt of Yangpu District is the source of Shanghai and the entire Chinese industry. After the land was set up as a concession, it became an industrial zone at the end of the 19th century. As early as 1882, the Qing government of China built a weaving layout and paper mill here. At the end of the 19th century, businessmen from Britain, the United States, and Japan set their sights on this place. The Yangshupu area has successively built China's first power plant, first gas plant, first water plant, and first textile factory. After the founding of the People's Republic of China in 1949, the function of the industrial base was further strengthened. The factories included electromechanical, metallurgy, shipbuilding, chemical, instrumentation, light industry, textile, building materials and other industries. The total industrial output value of Yangpu District once accounted for 25% of the city. After the 1990s in the last century, a large number of factories in Yangpu District were closed and moved, and the old industrial base was facing a difficult transformation. In China, the earliest start of modern industry was Shanghai; in Shanghai, the earliest start of modern industry was Yangpu ***[Zhang Cailian. 2012]***. The Yangpu Old Industrial Zone along the Huangpu River is called “the world's only is remaining largest riverside industrial zone” by UNESCO experts.

Yangpu District is now the center of Shanghai's technology and financial innovation and innovation plan. It has the world’s only remaining largest riverside industrial zone and top domestic educational resources. The riverside coastline of Yangpu District is 15.5 kilometers, with a land area of 12.93 square kilometers, divided into three sections: south, middle and north. Our site is located in the southern section and has many factories with historical memorial value.

An Aerial View of the Old Riverside Industrial Zone in Yangpu District

(Source: map.baidu.com)

We marked the locations of important industrial sites and other important places in the site, as shown in Figure 3.2.8. Important factories or industrial sites are marked in red, and we explained these locations in detail later.

HISTORY

Historical factories analysis around the site

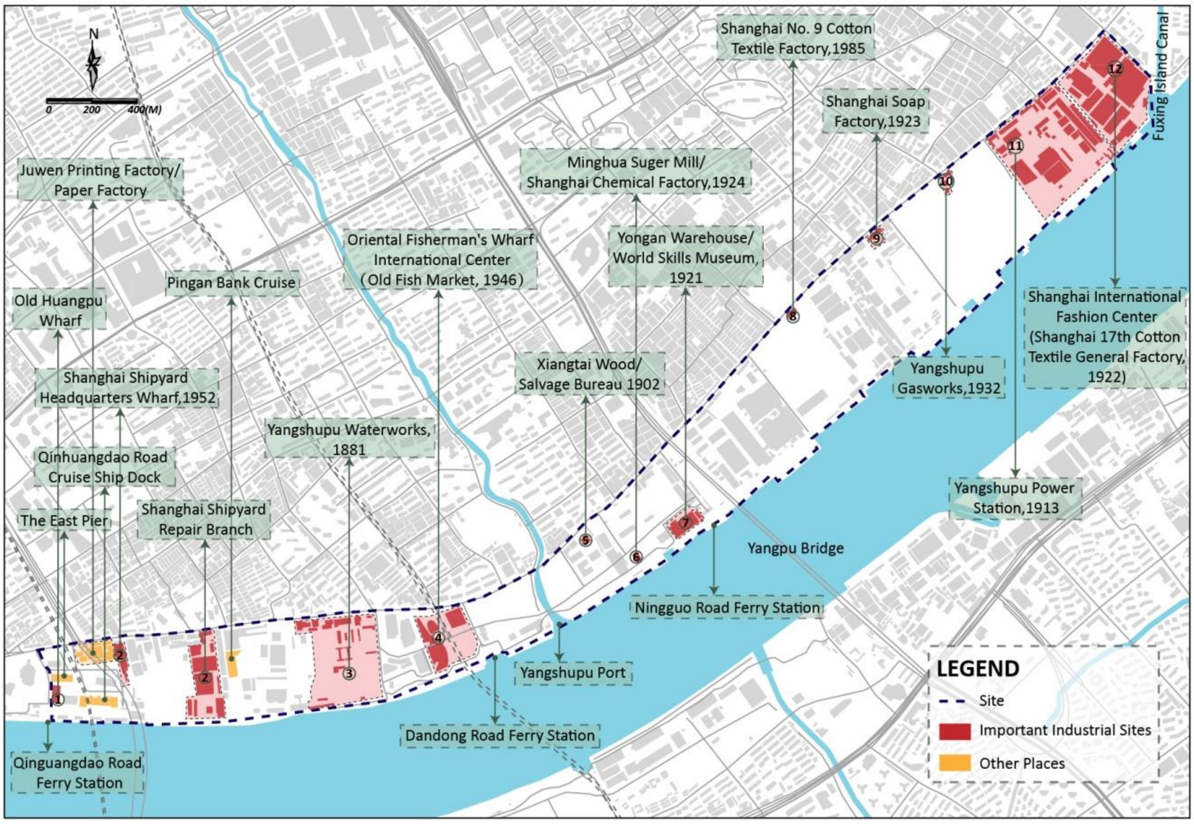


FIGURE 3.2.8: Historical Factories Analysis about the Site

(Source: Made by Authors ,Referred to map.baidu.com)

1. Old Huangpu Wharf

The former site of Huangpu Wharf is right at the junction of Yangpu District and Hongkou District, under the Yangshupu Road Station of Metro Line 4. It is an immovable cultural relic, which existed in the Republic of China (1912-1949). The shoreline of the wharf is more than 300 meters, and it is now connected to the riverside and is a very good trail. It was originally dedicated to the Japanese company Dalian Steamship Co., Ltd., and was taken over by the Central Trust Bureau after the victory of the Chinese War of Resistance. The pier was formerly the Shanghai Grease Factory and Shop No.16, with old-fashioned Shikumen groups and European-style terraces. Now it shows a Shanghai style: characteristic bars, restaurants, leisure clubs, and individual shops. In addition, this area now has restaurants, Argentine Manor, wedding photography, Jiahe Fund, East Bund Art Creation Space, etc. It is still a relatively comprehensive commercial area. This is the harmonious blending of the new and the old, and the old wharf that has experienced vicissitudes in the past glows with new vitality ***[map.baidu.com]***.

Old Huangpu Wharf Photos

(Source: map.baidu.com)

2. Shanghai Shipyard, 1952

The predecessor of Shanghai Shipyard was British Merchants Yinglian Shipyard and China Merchants Machinery Shipyard. On August 15, 1952, the Shanghai Military Control Commission announced the expropriation of the British Union Shipyard and changed its name to "Military Management British Union Shipyard". On January 1, 1954, the military management of the British Union Shipyard's main factory (now the Puxi branch) was merged into the Shanghai Shipbuilding Factory. In June 1982, the Ministry of Communications was placed under the leadership of China State Shipbuilding Corporation. In March 1985, it was renamed Shanghai Shipyard. Shanghai Shipyard is a large-scale backbone enterprise with integrated production capacity of shipbuilding/machine building and ship repairing under China State Shipbuilding Corporation. It has a history of more than 150 years. As one of the main pillars of Shanghai Shipyard, Shanghai Shipyard's Ship Repairing Branch is specialized in ship repairing and production. It is located in a superior location in the center of the city. The eastern and western parts of the factory are located on both banks of the Huangpu River, with a 1500m coastline ***[https://baike.baidu.com /item/Shanghai Shipyard]***.

Shanghai Shipyard Photos

(Source: map.baidu.com)

3. Yangshupu Waterworks, 1881

The Yangshupu Water Plant was founded in August 1881, and the Yangshupu Water Plant, which was built on August 1, 1883, to supply water to the outside world, belongs to the Shanghai Municipal Water Supply North Co., Ltd. It is located in the east of downtown Shanghai, on the west side of Yangpu Bridge. It covers an area of 129,000 square meters. It is one of the earliest surface water plants in China's water supply industry with the largest production capacity. The shape of the building is in the form of a traditional British castle. The load-bearing wall is made of clear water brick walls, embedded with red brick waistlines, and the surrounding walls are pressed against the crenellation gaps. The crenellations, window frames, waistlines, etc. are all made of cement powder and convex lines. The turning junction is shaped like a cement corner stone, like a medieval British castle, especially the decorative elements, making this building an anomaly among industrial plants in Shanghai ***[https://baike.baidu.com/item/YangshupuWaterworks/9638527]***. The British classical castle-like buildings in the factory area are excellent modern architectural relics in Shanghai, and they are also the only modern buildings in Shanghai built by enterprises. Because of its profound historical background and rich cultural heritage, it has been listed by the Shanghai Municipal People's Government as a key protection and preservation unit for comprehensive development on both sides of the Huangpu River.

Yangshupu Waterworks Photos

(Source: https://baike.baidu.com/item/YangshupuWaterworks/9638527)

4. Oriental Fisherman's Wharf International Center (Old Fish Market, 1946)

Not far to the east of the Yangshupu Waterworks, there is a very distinctive building. In terms of appearance, there are high-rise buildings resembling sails, and podiums like fish swimming, and slightly smaller "shell-like" buildings. It is unique. This is now the "Oriental Fisherman's Wharf". Fisherman’s Wharf has undergone scientific transformation and planning, and Yangpu Riverside introduces creative culture and smart office formats. It has become a diversified carrier to promote social exchanges and cultural and artistic exchanges, and at the same time become an innovation base for nurturing smart industries, making this land glow in the new era new vitality. This was once the famous "Shanghai Fish Market" in history, and it is also an important part of the profound historical heritage beside the river in Yangpu District ***[https://www.thepaper.cn/newsDetail_forward_9591969]***.

Oriental Fisherman's Wharf International Center Photos

(Source: map.baidu.com)

Exterior of the Shanghai Fish Market Office Building (Left) & Shanghai fish Market in 1937 (Right)

(Source: https://www.thepaper.cn/newsDetail_forward_9591969)

5. Xiangtai Wood/Salvage Bureau 1902

Xiangtai Wood was founded in 1902 by German merchants. It is one of the largest wood processing plants in old China.

Xiangtai Wood Photos

(Source: map.baidu.com)

6. Minghua Suger Mill/Shanghai Chemical Factory, 1924

The Shanghai Chemical Plant is located at No. 1578 Yangshupu Road. It was founded in 1924 and was the former Shanghai Sugar Company. In 1946, it became the Shanghai branch of the National Government Central Chemical Plant. After 1949, it was renamed Shanghai Chemical Plant. The Shanghai Chemical Plant occupies an area of 72,000 square meters, with a building area of 55,800 square meters. The existing old building of the original Nissho Sugar Factory is a large warehouse with a total of 4 floors and a modern style beamless floor structure. It covers an area of 2688 square meters, with a construction area of 10,752 square meters, and faces south from the north. The external facade of the building is a roughened cement wall. The front facade is made up of a typical modern style of long format windows, with simple and smooth moldings on the top. It is now a chemical plant finished product and raw material warehouse. The inner wall of the building is well preserved ***[https://baike .baidu.com/item/Shanghai Chemical Factory/1251806]***.

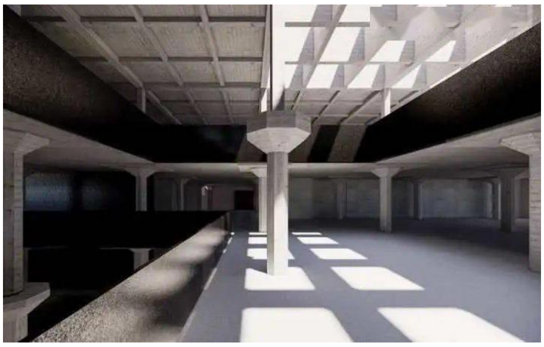
Minghua Suger Mill Photos

(Source: map.baidu.com)

7. Yongan Warehouse, 1921/World Skills Museum

The Yongan warehouse under the Yong'an Cotton Yarn Factory Company was one of the important logistics warehouses at the time. Every day, a cargo ship enters the port, batches of goods are disembarked from here on the shoulders of dock workers and transported to Nanjing Road, supporting the prosperity of Yong'an Department Store. At the same time, it also serves as a warehouse for cotton spinning mills to store various raw materials and equipment accessories for textiles. The warehouse of Shanghai Yongan Textile Company, designed in 1921 by the British Merchants, has a reinforced concrete beamless floor structure with a neat facade. It was completed in 1922. The internal space is an octagonal angular bucket-shaped column cap floor, which is very distinctive ***[https://www.sohu.com/a/424158532_210176]***.

In June 2018, the building on the west side of Yongan Warehouse was selected as the location of the World Skills Museum by the World Skills Organization. The museum will focus on 5 functions including exhibition and display, education and communication, international exchange, collection and storage, and scientific research, and will be transformed into a world skill. Exhibition center, world skills cooperation and exchange platform, international youth skills education base and official documentation center.

Yongan Warehouse Old Photos

(Source: https://www.sohu.com/a/424158532_210176)

World Skills Museum Photos Now

(Source: map.baidu.com)

8. Shanghai No. 9 Cotton Textile Factory 1985

Shanghai No. 9 Cotton Mill is a key enterprise in Shanghai cotton spinning and linen spinning, and one of more than ten cotton mills in Yangpu District. Its predecessor was Dachun Yarn Factory, founded in 1895. After the liberation of Shanghai in 1949, China Textile No. 2 Hemp Mill and China Textile No. 14 Mill were merged and renamed as China Textile Company Shanghai No. 9 Cotton Mill. In July 1950, it was renamed as State-owned Shanghai No. 9 Cotton Mill. Before 2014, all the buildings of the plant had been demolished. In 2014, the renovation project of the old office building of Nissho Shanghai Textile Co., Ltd. was approved by the Shanghai Yangpu District Cultural Bureau. The project owner is Shanghai Yangpu Riverside Investment and Development Co., Ltd. ***[http://blog.sina.com.cn/s/blog_a598306e0102wixs .html]***.

Front of the former site of Shanghai Textile Co., LTD

(Source: map.baidu.com)

Curved corner at the west end of the old office building on the site of Nissho Shanghai Textile Co., Ltd.

(Source: map.baidu.com)

9. Shanghai Soap Factory, 1925

Shanghai Soap Factory was founded in 1923 and has a history of 97 years. In 1990, it was rated as a national first-class enterprise. In 1994, Shanghai Soap Co., Ltd., a Sino-foreign joint venture controlled by Shanghai Soap Factory, was established. Currently, it is jointly affiliated to Shanghai Soap (Group) Co., Ltd. Nowadays, several spaces are connected by pipelines to form a rich and diverse underground space displaying historical pictures, machinery and equipment, and implanting various experience spaces such as handmade soap making experience, essential oil and fragrance experience ***[https://baike.baidu.com/item/ Shanghai Soap Factory /9542304]***.

Shanghai Soap Factory Photos

(Source: map.baidu.com)

10. Yangshupu Gasworks, 1865

Yangshupu Gaswork was built in 1932 and was completed and put into operation two years later. Yangshupu Gasworks has a modernist artistic style and is now recognized as "Shanghai Excellent Historic Building" and "Yangshupu District Cultural Relics Protection Unit" ***[https://baike.baidu.com/item/Yangshupu Gasworks/1251576]***.

Yangshupu Gasworks Photos

(Source: map.baidu.com)

11. Yangshupu Power Station, 1913

The Yangshupu Power Station can be traced back to the riverside power station built in 1913 and was once the largest thermal power plant in the Far East. The most famous symbol of Shanghai was the huge chimney, 105 meters high, which was once the tallest building in China. In 2010, in accordance with the municipal government's requirements for energy conservation and emission reduction, Yangshupu Power Plant officially ceased production. According to the plan of Yangpu District, these old buildings in the factory will be preserved, combined with the overall plan along the Huangpu River, to engage in the overall development of cultural and creative exhibition, leisure and entertainment ***[https://baike.baidu.com/item/ Yangshupu Power Station]***.

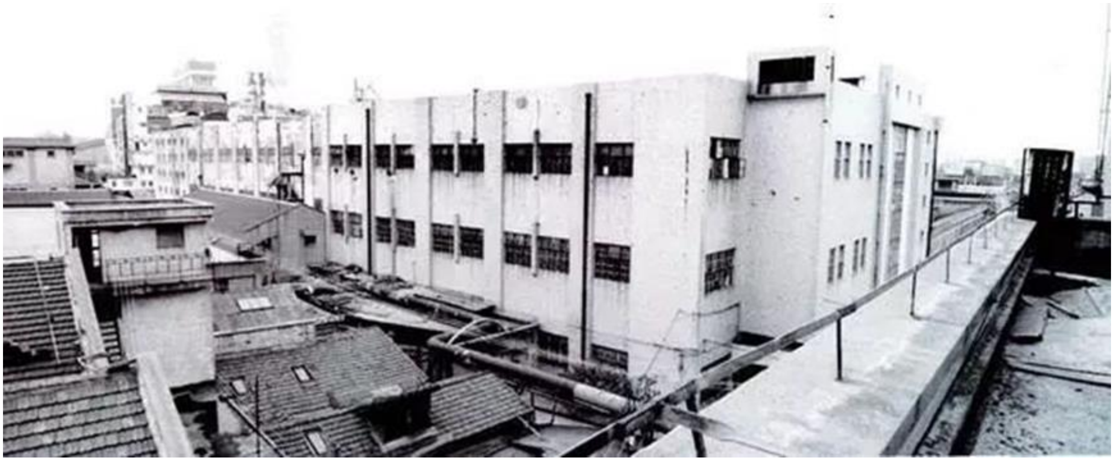
Yangshupu Power Station Photos

(Source: https://baike.baidu.com/item/ Yangshupu Power Station)

12. Shanghai International Fashion Center (Shanghai 17th Cotton Textile General Factory, 1922)

The Shanghai Seventeenth Cotton Textile Factory was formerly the Yufeng Yarn Mill built in 1922 and was transformed into the Shanghai International Fashion Center in 2013. The newly-added cruise ship terminal in the Fashion Center serves as a part of the cultural entertainment and tourism industry. The site of the former Shanghai Seventeenth Cotton Textile Factory is located between Yangshupu Road on the East Bund of Yangpu District and the Huangpu River. It faces Fuxing Island, the only enclosed inland island in the Huangpu River to the east, and Shanghai’s earliest power plant to the west. -Yangpu Power Plant, south of Shanghai's mother river-Huangpu River, has a unique geographical advantage. The factory roof adopts a neat zigzag design, conveying a distinctive architectural form. Now the Shanghai

International Fashion Center is positioned as a landmark carrier and operational base for the interaction and docking of the international fashion industry. The center has six functions: fashion multifunctional show, reception club, creative office, boutique warehouse, apartment hotel, catering and entertainment; it will be the professional show with the most complete facilities and the most complete supporting facilities in Shanghai and even China, and also the first choice for the world's top brands Place, Shanghai International Fashion Cultural Festival and Shanghai Fashion Week ***[https://baike.baidu.com/item/ Shanghai International Fashion Center]***.



Old Photos of Textile Mills

(Source: https://www.sohu.com/a/213482233_99914565)

Shanghai International Fashion Center Photos for Now

(Source: https://www.sohu.com/a/213482233_99914565)

3.2.4 Strategies for coping with climate change

3.2.4.1 Challenges and goals

Based on the previous climate analysis in Chapter 2 and the site analysis in the first section of this chapter, we summarize the challenges facing the site into the following parts:

1. Firstly, it is the challenge brought by climate change. The main climate problems facing the site are urban heat island effect and urban flood disaster. Heat island effect: The mean annual temperature was rising, and the climate tendency Rate is 0.382°C / 10a; based on the seasonal temperature variation characteristic analysis, we know the average temperature in the four seasons was always increasing; the number of high-temperature weather after the 1990s increased significantly. In terms of flood, from the annual precipitation of Shanghai we found the annual rate is 56.361mm / 10a; the number of days with rainfall over 50mm, and it can be seen that the number of days with heavy rainfall per year has been on the rise in the past 59 years. In addition, due to the riverside, the current site does not meet the flood control requirements of Shanghai.

2. Secondly, based on the historical analysis, we know that there are many problems left over from history on the site. Many factories have been abandoned, and some are still in operation.

3. In terms of traffic, the traffic system of the site is not well, with many dead roads and lack of bicycle and walking space.

4. At last, the green space of the site is scattered and lack of green space.

Therefore, we propose four design goals for different challenges as follows:

1. In terms of climate, we propose to reduce carbon dioxide emissions and cool cities to adapt to the heat island effect, while in terms of flood disaster, we propose to reduce surface runoff, increase rainwater infiltration and redesign riverside topography according to flood control requirements.

2. In terms of history, our goal is to integrate history into landscape design, retain or transform important industrial historical sites, and create a characteristic riverside industrial landscape belt.

3. In terms of transportation, it is necessary to increase the accessibility of public transportation and improve the existing transportation system.

4. In terms of green space, it is necessary to integrate the existing green space, improve the existing green landscape, and travel through the green corridor of the city.

We match the challenge to the goal, as shown in Figure 3.2.9.

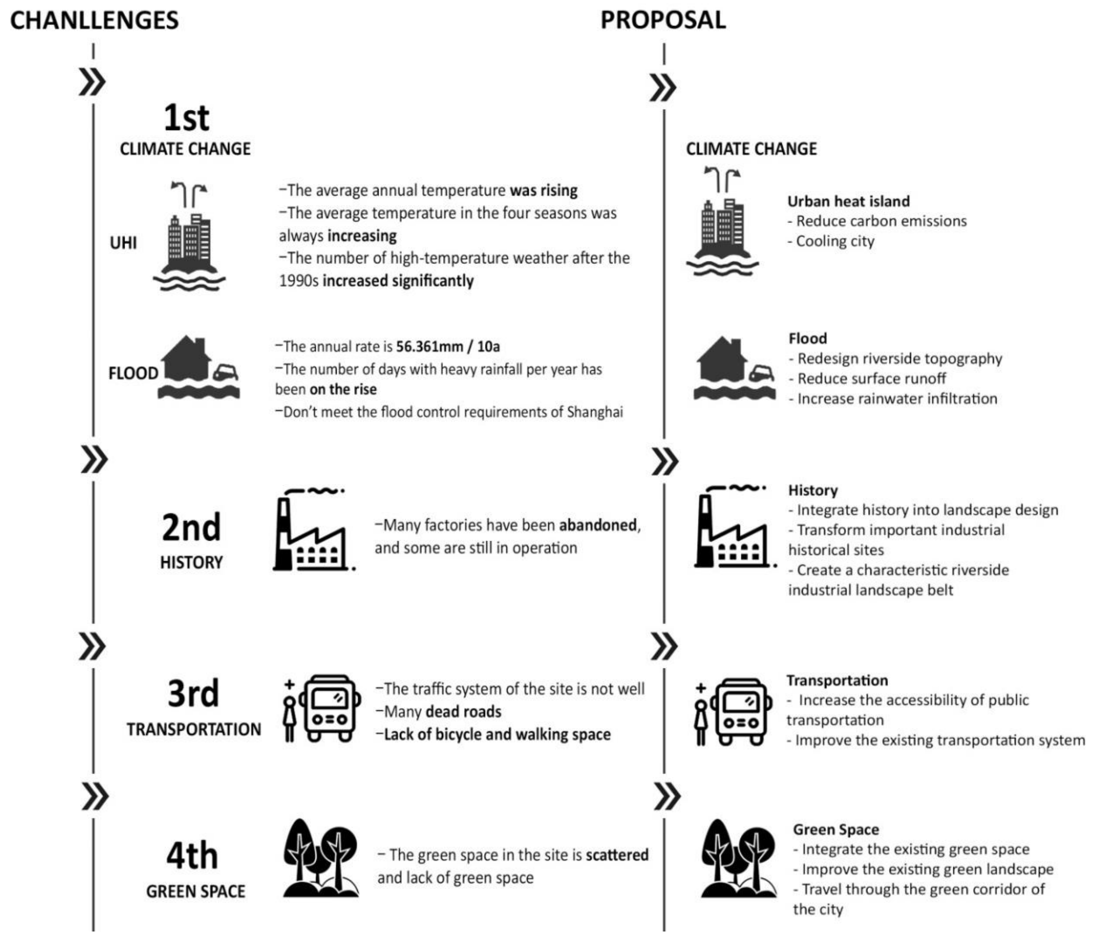


FIGURE 3.2.9: Challenges and Design Goals

(Source: Made By Authors)

3.2.4.2 Concept

According to the previous analysis, our overall design idea is to retain the operating factories and some important historical factories and relics in the site, as shown in Figure 3.2.10.For the remaining part, we divided the site into three sections. The section two has been systematically renovated, just like the picture shows, so we will not make any changes. In the first section, according to the characteristics of the site, we will design the open space with Shanghai shipyard as the main public entertainment and cultural activities, and introduce retail, commercial, cultural, catering and other functional measures. The third section of the site, according to the characteristics of the site, we plan to design a creative cultural block, continue the characteristics of the surrounding site, at the same time, with culture, exhibition, performance, leisure and art and other functions. We mainly carried out specific planning and design for the first section, which not only provided reference for the design of the third section, but also provided specific practical significance for the design of other riverside sites later.

After the completion of the design, it is hoped that a complete riverside green space can be traveled, as shown in Figure 3.2.12, to improve the overall green space quality of the city and make the city better adapt to climate change.

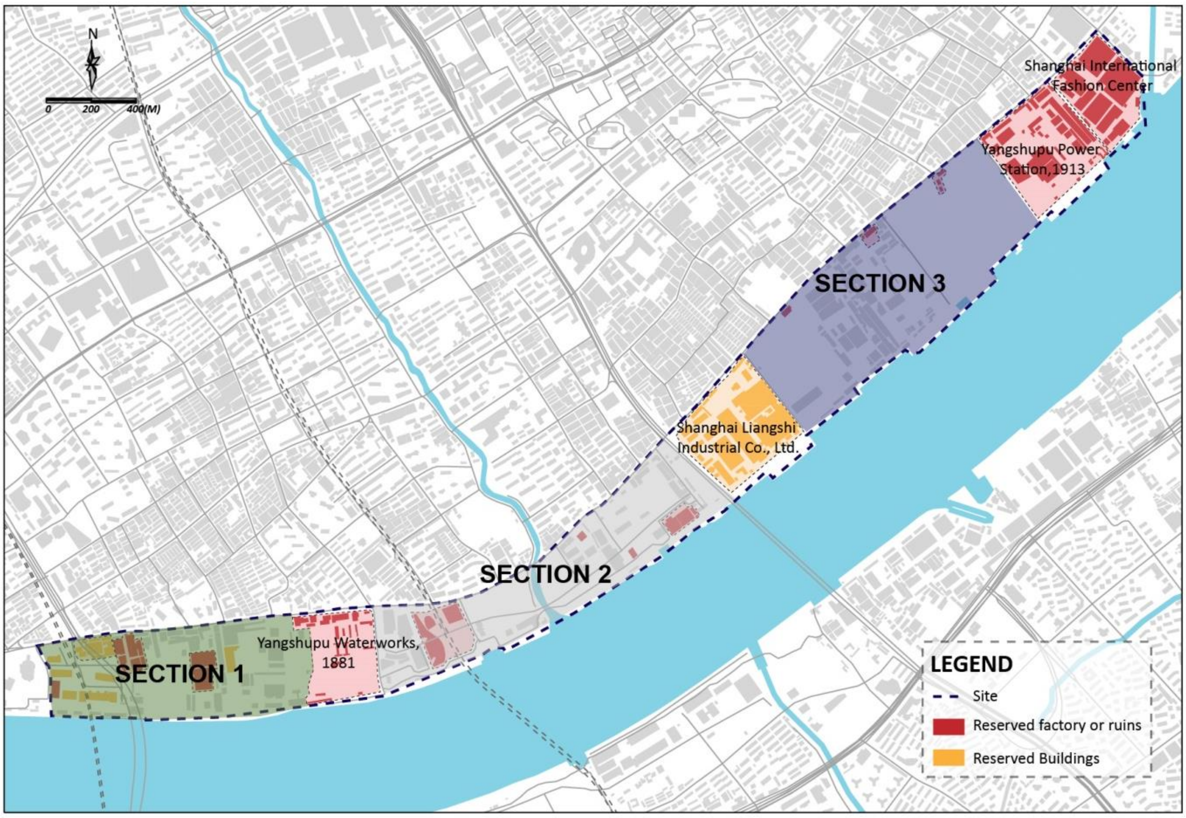


FIGURE 3.2.10: Divided into Three Sections of the Site

(Source: Made by Authors, Referred to map.baidu.com)

The Second Section Status Photo

(Source: www.gooood.cn)

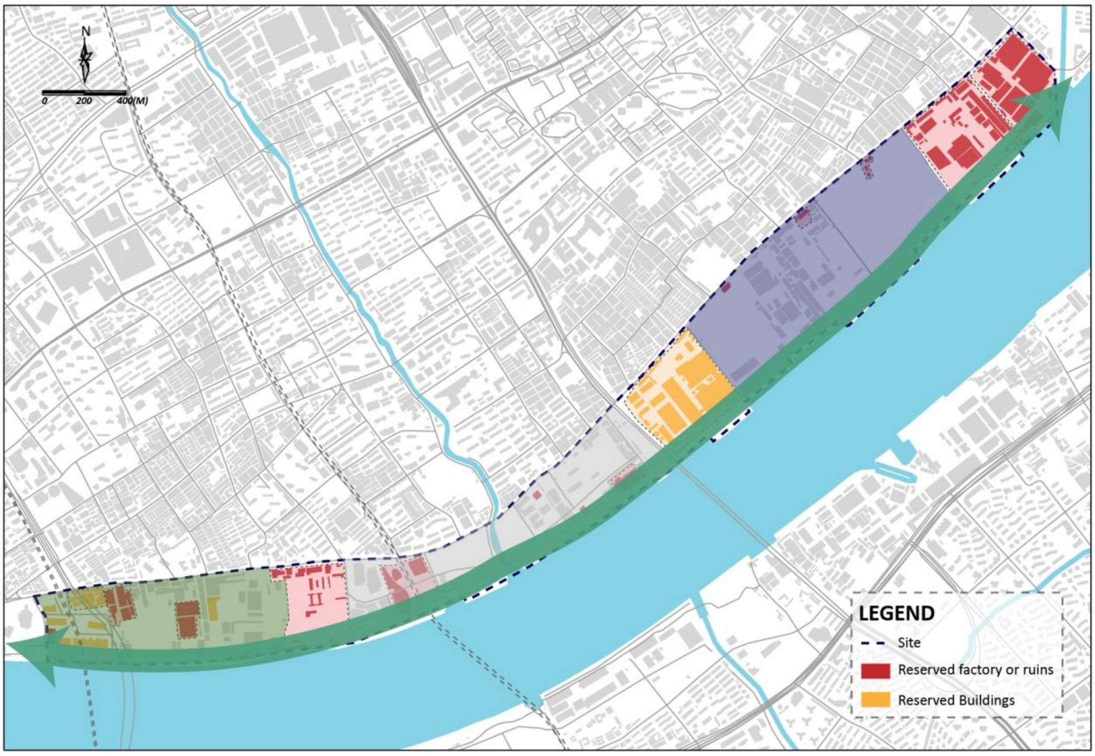


FIGURE 3.2.11: Expected Riverside Green Belt

(Source: Made by Authors, Referred to map.baidu.com)

3.2.4.2.1 Adapt to urban framework

The design of the site should first follow the urban network, as shown in Figure 3.2.12.City texture is the reflect of urban ecological and natural environmental conditions of natural systems and urban historical tradition, from the economic aspects of culture and science and technology of artificial systems, the spatial characteristics of long-term formed by the mutual fusion, is the city, the natural environment and together build the whole, the whole a city directly reflects the characteristics of the structure and type of reflects the history of the schema to the people living in it reflects the cultural characteristics of the geographical environment of the city. The urban fabric is the result of historical accumulation, and contains rich life contents in the polishing of time. Therefore, the urban fabric is the urban settlement form of human beings with certain scale and organization rules. It involves all aspects of urban life, and is closely related to urban structure, urban function and urban form. The significance of urban skin texture, formation of evolution is that it reflects a certain time space shape of collective agreement, is an area of the habit of space perception in long term, is a kind of "in" "the masses" will the grid diagram ***[https://baike.baidu.com/item/city]***.Therefore, we should show respect for the urban fabric in the design.

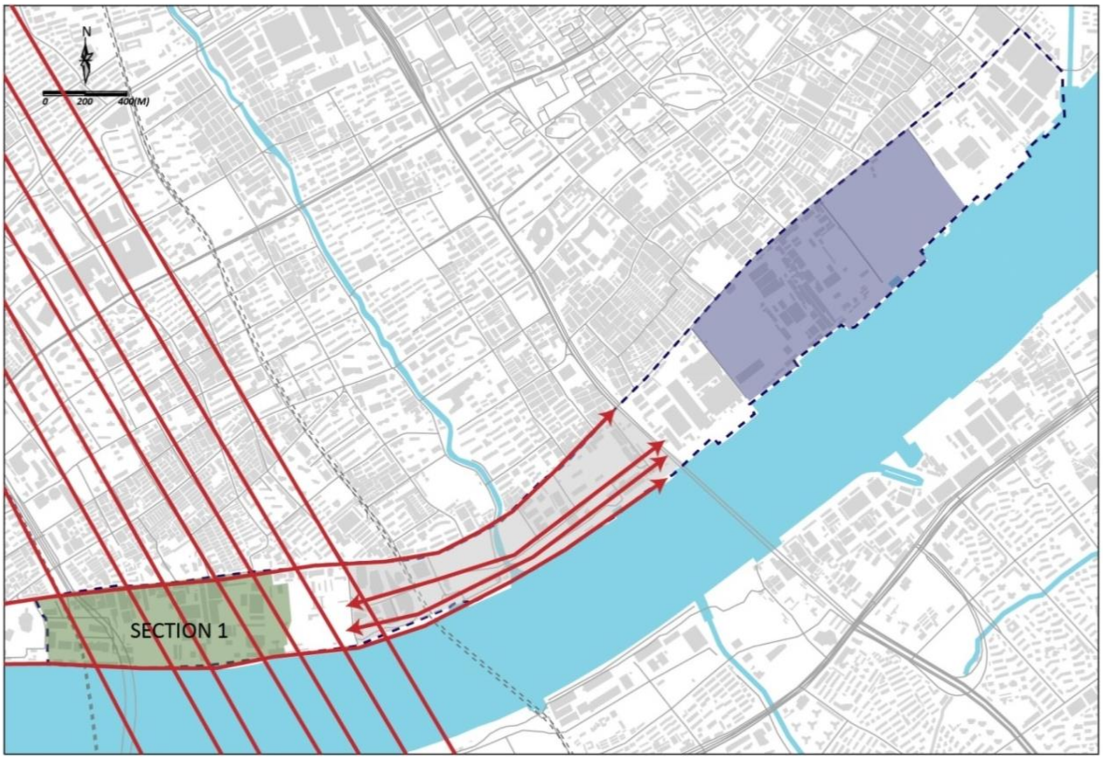


FIGURE 3.2.12: City Grid Framework around Section One

(Source: Made by Authors, Referred to map.baidu.com)

Combined with the urban texture, the design schematic diagram we proposed is shown in Figure 3.2.13. The total area of the site is 451,625 sq. The first is to expand the original riverfront road and the itinerary characteristic industrial riverfront park. The main function is to provide leisure and entertainment space, to repair the terrain, to meet the flood control requirements. And in order to mitigate and adapt to the impact of climate change, many LID measures have been designed in Riverfront Park. At the same time, we designed a Shipyard Park which is based on the History of Shanghai Shipyard to extend the riverside green space to the residential area of the city. In addition to continuing the overall urban network, it also improves the public transportation efficiency of the plot and the overall accessibility. In some newly added buildings, we also advocate the use of green buildings, green roofs or green walls, etc., to make the buildings better respond to climate change. In addition, we have retained some major buildings, renewed commemorative factories, and strengthened the characteristics of cultural buildings to enhance the characteristics of the industrial green space of the site. The site not only ensures the characteristics of the industrial site, but also makes use of the landscape characteristics around the site, taking the river view as the main landscape surface, embedding green land and city together, connecting the three levels of river, green space and city.

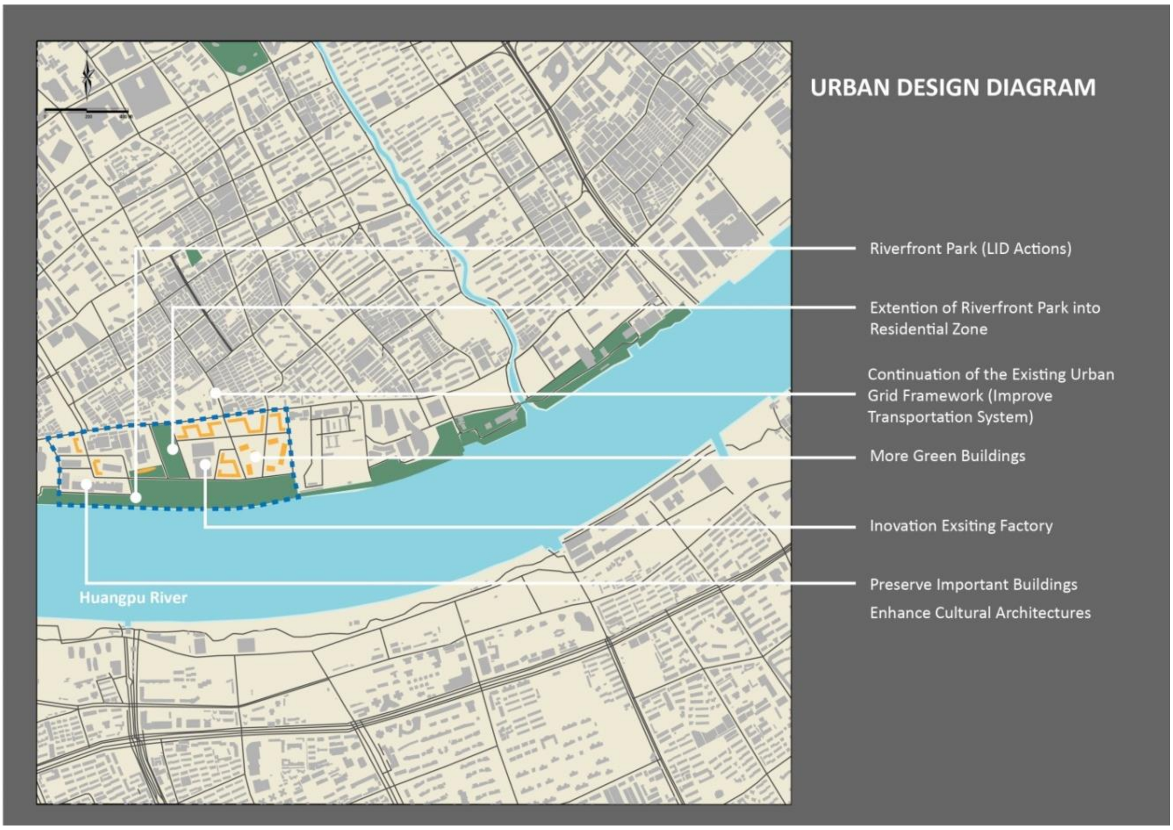


FIGURE 3.2.13: City Grid Framework around Section One

(Source: Made by Authors)

3.2.4.2.2 Organizational principles

Our overall planning and design follow 5 organization principles, as shown in Figures 3.2.14 to 3.2.18.

The first principle is to create a high-quality Riverfront Industrial Ecological Park, which adds vitality to the Huangpu Riverside landscape, while ensuring the continuation of the industrial characteristics of the site and being able to adapt to climate change.

The second principle is to create 5 new communities, each of which is closely linked to Riverfront Industrial Ecological Park. The first district is mixed with a newly built commercial street; the original factory's ferry station and ticket office are a mixed-use land. The second is that the shipyard headquarters has been left intact. The third is the transformation of the shipyard factory, which together with the planned industrial park and shipyard headquarters constitute a comprehensive industrial cultural center. The fourth area is the retail area. This area provides a new comprehensive venue for some retail businesses in the original venue. The last one is the hotel and cruise ship banquet venue. The original cruise ship banquet venue has been upgraded to make the square area occupied by the venue suitable for antique events.

The third principle is that all roads in the site are connected to the park, which improves the current situation of many dead ends in the site and enhances the connectivity of the site.

The fourth principle is to use roads to divide smaller blocks close to pedestrian scale. Make the planned community more pedestrian-oriented.

The fifth principle is to establish places of special quality near the park and in the development plot. For example, the commercial street shown in the picture is added to the mixed land. The museum is added near the shipyard industrial park. Others, such as art installations and plazas, add more iconic objects to the nature of the site.

Principle 1

FIGURE 3.2.14: The First Organization Principle

(Source: Made by Authors)

Principle 2

FIGURE 3.2.15: The Second Organization Principle

(Source: Made by Authors)

Principle 3

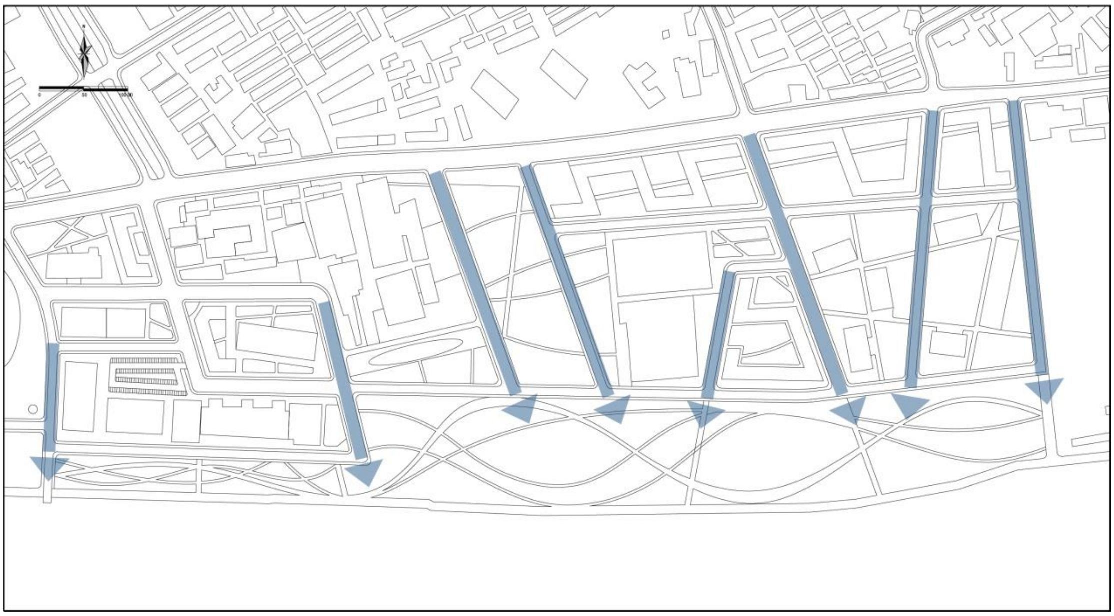


FIGURE 3.2.16: The Third Organization Principle

(Source: Made by Authors)

Principle 4

FIGURE 3.2.17: The Forth Organization Principle

(Source: Made by Authors)

Principle 5

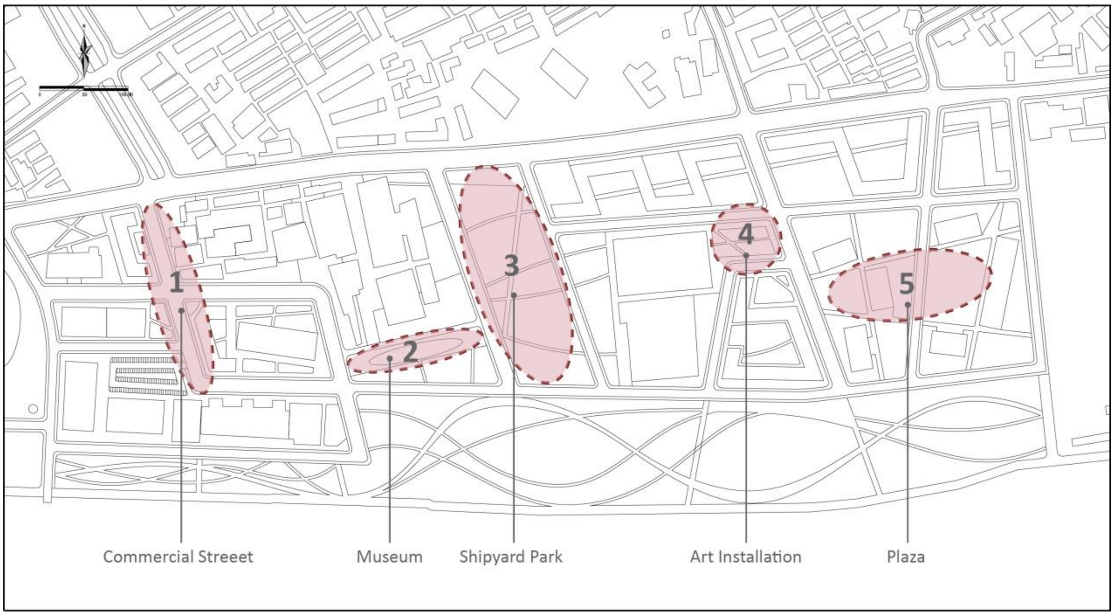


FIGURE 3.2.18: The Fifth Organization Principle

(Source: Made by Authors)

3.2.4.2.3 The master plan

Our overall design drawing is shown in Figure 3.2.19.In the picture, we mark the new buildings as red, and the white ones are the original buildings or the upgraded buildings based on the original buildings. And some important places are also marked as shown in the figure. Therefore, our design aim is to preserve the characteristics of the original site and to preserve and upgrade the important site. Then the whole area is divided organically, characteristic small blocks are rearranged, and places with special quality are added to different blocks. Finally, the road system and green space system are improved to create a high-quality Riverside Industrial Ecological Park.

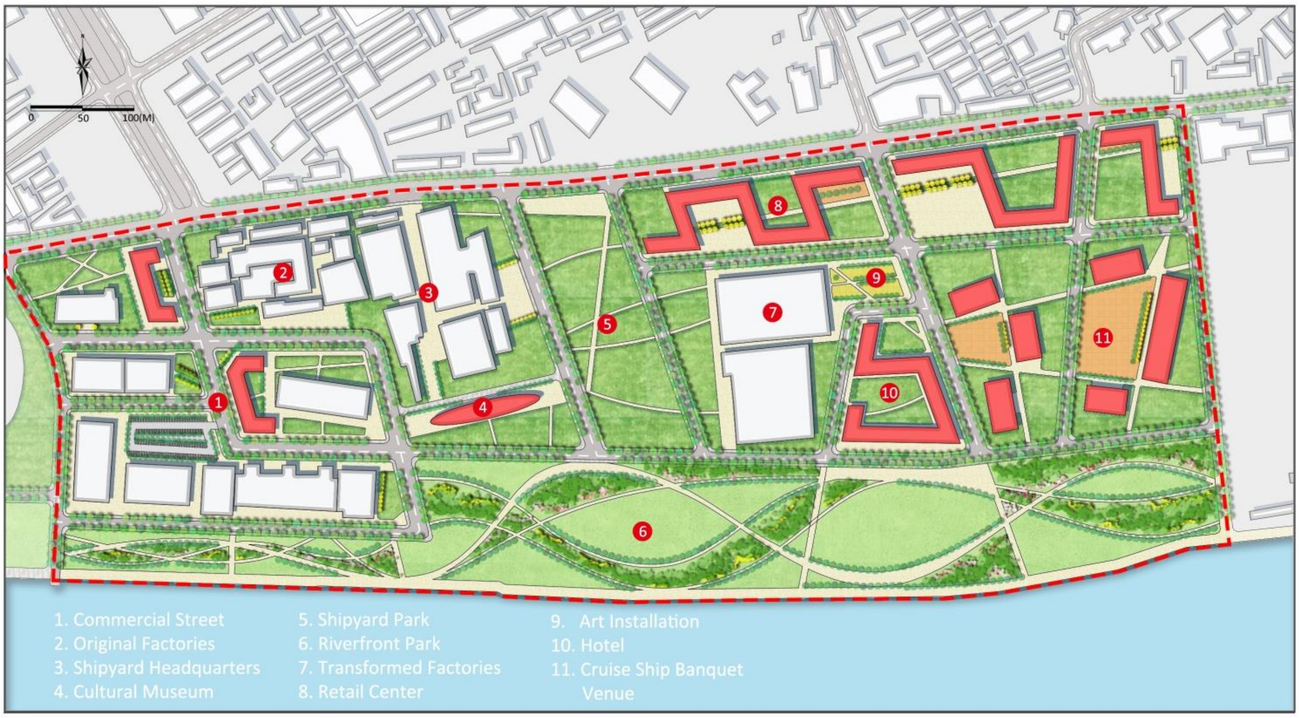


FIGURE 3.2.19: The Master Plan

(Source: Made by Authors)

In addition, according to the second principle described in the previous section, the more precise zoning of the site is shown in Figure 3.2.20.We have more precise highlighting of each site.

FIGURE 3.2.20: Key Components in Master Plan

(Source: Made by Authors)

In addition, we also marked the area of each small district area and the control height set according to different land use types, as shown in Figure 3.2.21.The height of the business district is set to the highest 120m, and the land area is also the largest. Then there is the retail area, the cruise banquet space, and the factory and shipyard headquarters. The next highest level of control is the retail area and the hotel, which is 80 meters. The height of the factory renovation area and the museum are all less than 40m.

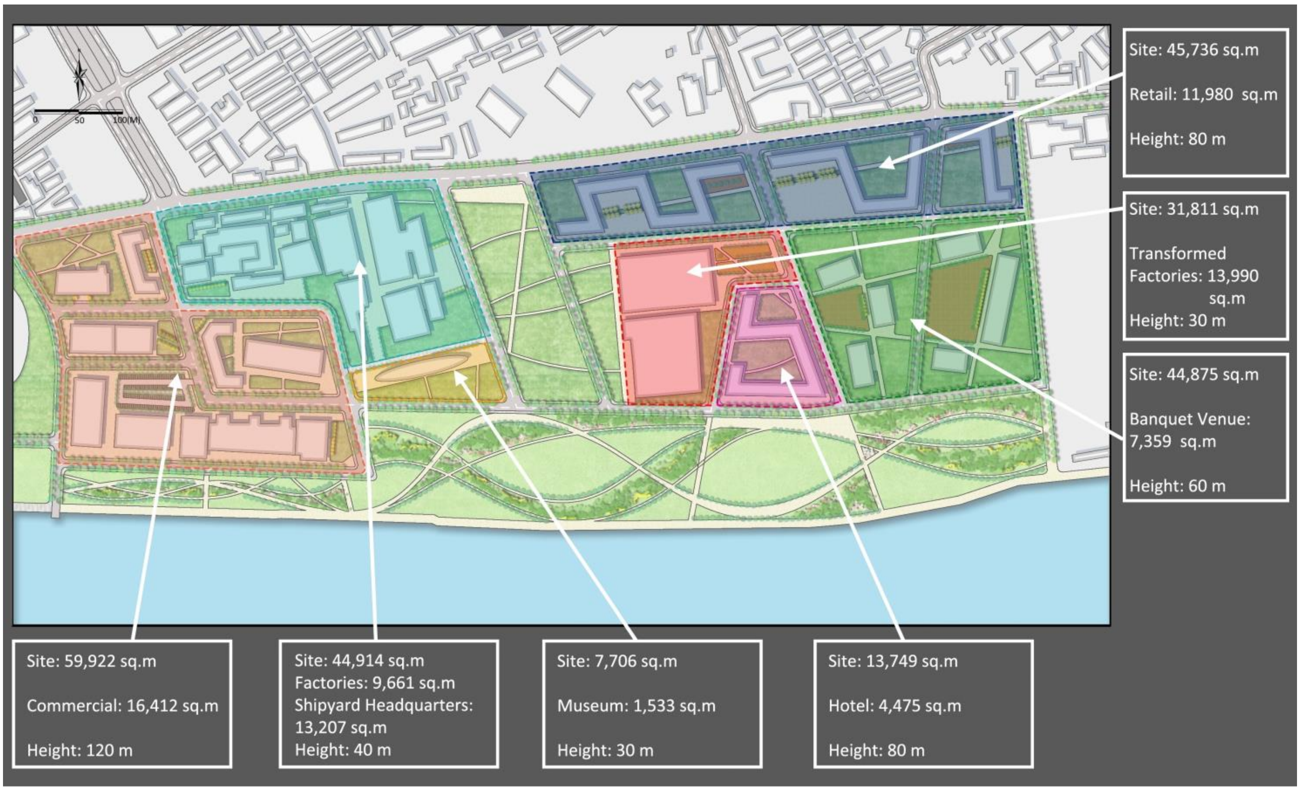


FIGURE 3.2.21: Control Height in Different Districts

(Source: Made by Authors)

3.2.4.3 Sponge system planning

We know that greenhouse gases are the main cause of climate change. In human activities, transportation is the most important source of greenhouse gases, as shown in Figure 3.2.22, accounting for 34% of emissions. Residential and industrial emissions follow. So when we design sites we need to be aware that transportation is a main carbon dioxide producer.

Sector	GHG %
Transportation	35
Residential	18
Industry	18
Tertiary	13
Other	12
Waste	4
Total	100
Total, GT CO_2	1,6

FIGURE 3.2.22: A survey on 170 cities over 100,000 inhabitants

3.2.4.3.1 Pedestrian guidance system

As shown in Figure 3.2.23, the road system design of the site. There is a 25m+ city street next to the site, and its role in the site is to undertake a large amount of traffic, and at the same time provide the main entrance for the newly designed site and also provide an entrance for the core plot. It can be seen from the cross section that there are 2 rows and 3 lanes, with a landscape separation zone in the middle and a landscape zone beside the sidewalk. The second is the 15-25m primary street, which plays a role in the city to establish the image of the main commercial street, connect the urban traffic and the main plots, and provide on-street parking. The cross section shows the width of each road. There is no partition in the middle of the tertiary street, and also there aren't on-street parking spaces. Then there are neighborhood roads 10-15 meters wide that can lead to various development plots, but there is no parking along the street. Then in Riverfront Park, there are 5-10 meter wide pedestrians and a 5-10 meter wide cycling and jogging path.

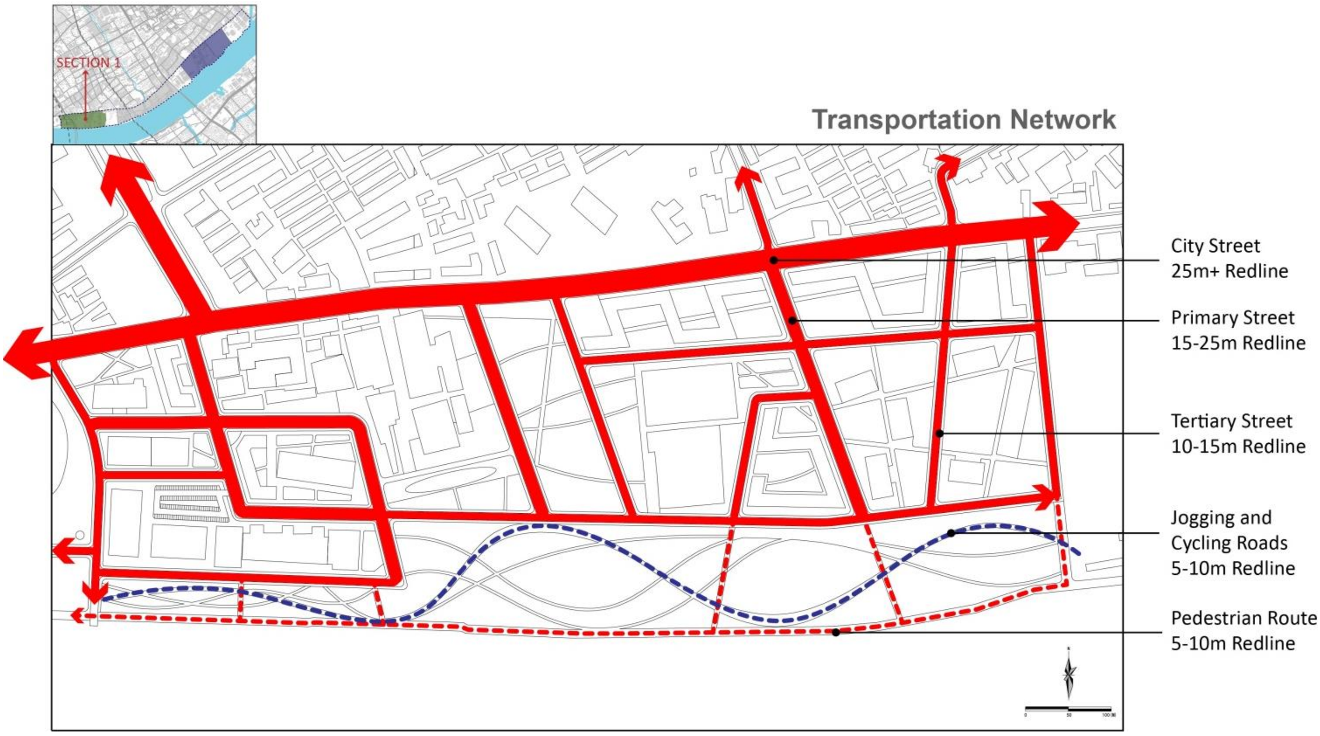


FIGURE 3.2.23: Transportation Network in Section One

(Source: Made by Authors)

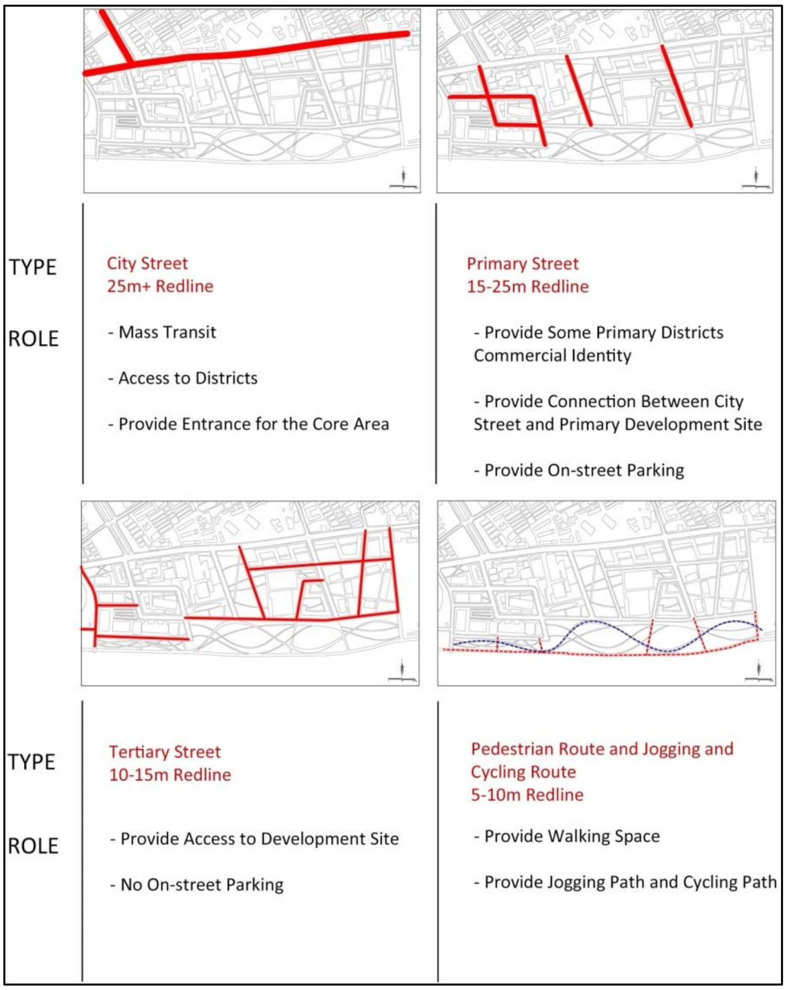
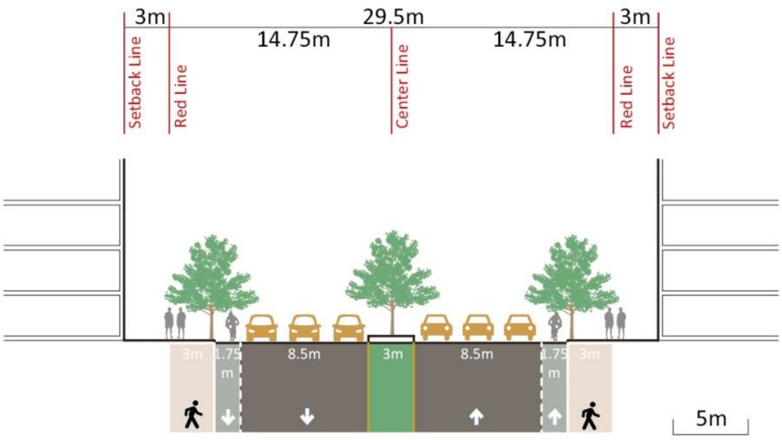


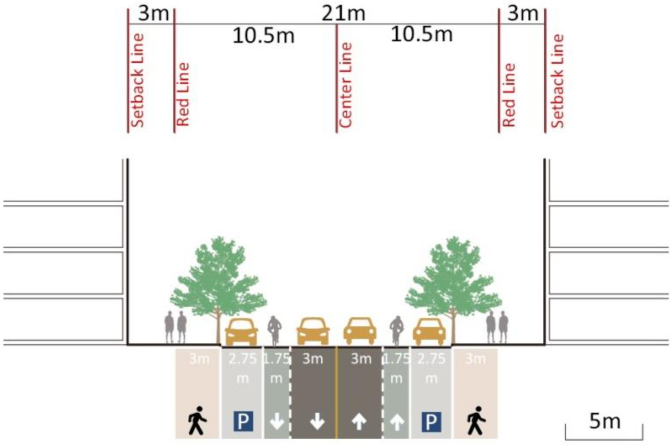
FIGURE 3.2.24: Street Types and Roles in Section One

(Source: Made by Authors)

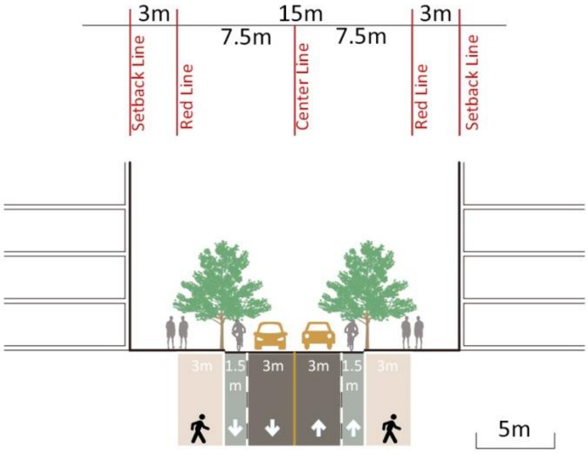
25m+ City Street



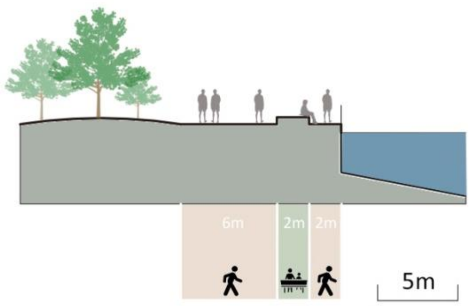
15-25m Primary Street



10-15m Tertiary Street



5-10m Pedestrian



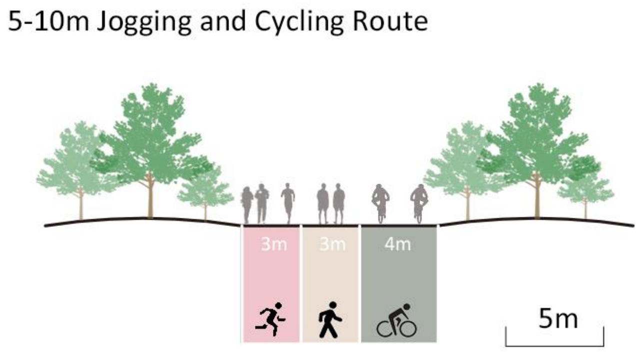


FIGURE 3.2.25: Different Street Sections

(Source: Made by Authors)

According to our previous road planning, we have planned walking space and cycling space for all roads. We encourage pedestrians to travel by public transportation, and we will also set up some bicycle stops around the site, hoping that the site can bring demonstration effect. As shown in Figure 3.2.26, it is the bicycle parking point planned in the site. Of course, we still want the whole site to be pedestrian-oriented, hoping to improve people's journey experience in the site.

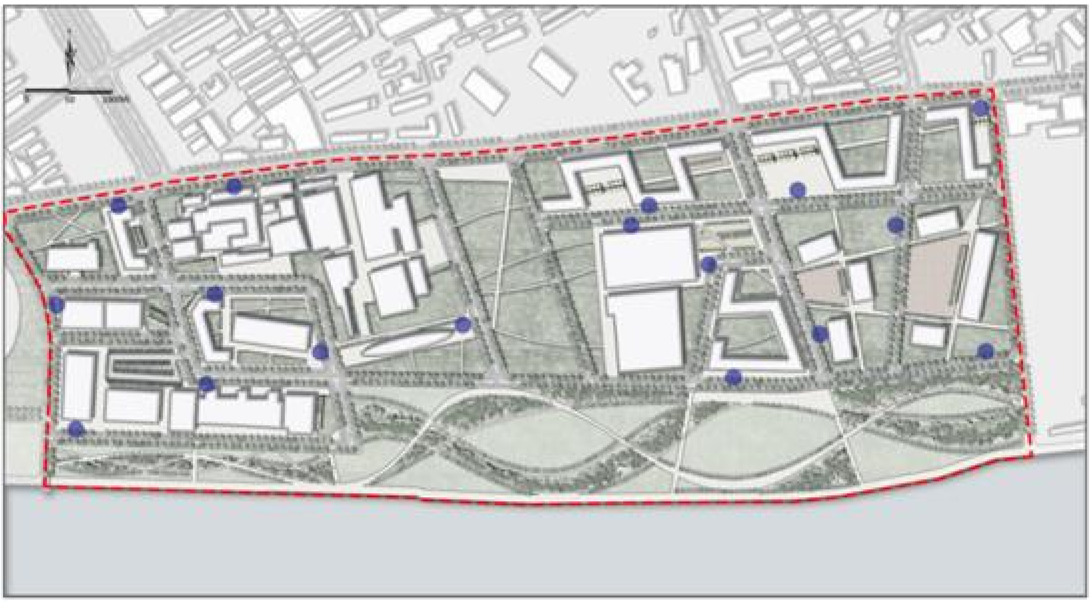


FIGURE 3.2.26: Bicycle Parking Points in Site

(Source:Made By Authors)

Walking is a choice, even if we don't always make it consciously. To create an environment that encourages people to walk more, we need to know how to influence people's choices. The choice to walk is actually influenced by many factors. Everything we experience in life is stored in the brain as information, which is interpreted in two broad ways, or "systems," and then used as a basis for our choices. The first system tends to make unconscious, emotional, quick, automatic and effortless decisions, relying on a rule of thumb based on knowledge, experience or emotion we have acquired in the past. This kind of decision requires little critical thought. The second system is rational and requires conscious reflection and a lot of effort. It helps us make more informed choices and questions the rules of thumb of the first system. In order to encourage walking, we need to fully integrate these two systems into the urban design approach***[Yang Binyuan. 2019]***.

FIGURE 3.2.27: Humanized Street

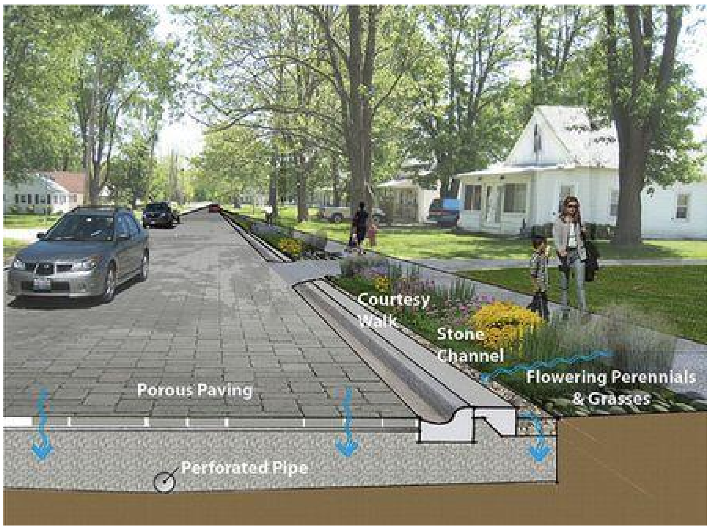
(Source: https://www.gooood.cn/towards-a-healthy-city-by-foot-felixx.htm)

The design of walking Spaces often follows a similar "mechanical" logic to that of road design. The experience of the journey was secondary to getting to the destination as quickly as possible. This repeatedly confirms our brain's preference for the first system: faster travel by car or bike. After people have adapted to the rules of the car-oriented environment, we first have to adopt humane measures in streets and public Spaces to reconnect society with walking. Improving the comfort, accessibility and feedback of walking Spaces can help design humane streets that attract people to make walking choices.

3.2.4.3.2 Permeable roads and rain garden

(1) Permeable roads

We want to use permeable surfaces for both the sidewalk and the on-street parking on the site, as shown in Figure 3.2.28.



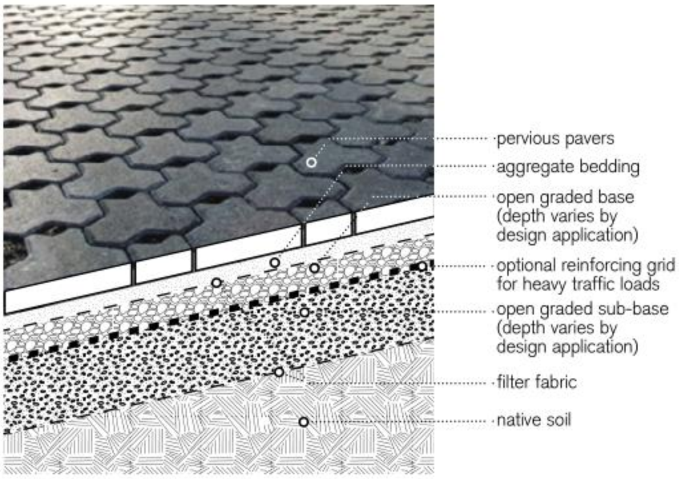


FIGURE 3.2.28: Pervious Street

(Source: https://www.epa.gov/G3/learn-about-green-streets and http://uacdc.uark.edu)

As a new type of environmental protection and ecological road, permeable road has been paid more and more attention by people, especially the industry. Permeable roads adopt ecological pavement, which can make rainwater quickly penetrate into the surface, effectively replenish groundwater, alleviate the urban heat island effect, and balance the urban ecosystem. The permeable ground can also permeate "ground air", so that the ground is warm in winter and cool in summer. The water is permeable in rainy season and the snow melts in winter, which can increase the comfort of urban living. In addition, due to the porous ground, the surface area is large, the dust has a strong adsorption, can reduce dust pollution, but also reduce noise. The characteristics of permeable roads are:

1) In rainy days, there is no water on the surface of permeable road, and the road has excellent anti-skid performance, which increases the road safety and traffic comfort

2) The use of permeable concrete pavement can reduce or cancel the setting of road drainage pipe network and reduce the overall cost of the road.

3) Permeable roads can be designed according to the surrounding environment with beautiful patterns and graphics, which have strong decorative properties.

4) Rainwater permeates through permeable concrete and is reduced to groundwater, which increases soil moisture and restores the living environment for soil microorganisms. It is eco-friendly.

5) As a new environment-friendly and ecological road material, it is in line with low-carbon construction and advocates a large number of pavement.

6) Adjusting surface problems and mitigating heat island effect.

7) Reduce the burden of urban drainage pipe network and alleviate the urban waterlogging problem.

8) The porosity of the permeable road is large, which has the effect of sound absorption and can reduce the environmental noise.

Especially in the plum rain season in Shanghai, it is easy to generate water phenomenon, resulting in traffic jams, power outages, houses flooded is an indisputable fact. Experts point out that the main reason for this situation is that China's urban roads are impervious to water.

In urban construction, many cities use cement, asphalt, concrete and other closed surface to replace the original soil surface; On the sidewalk, open parking lot, courtyard and square and other public places, also like to use neat and beautiful stone plate or cement brick laying. While improving traffic and road conditions and beautifying the environment, the closed surface also has significant adverse effects on the urban ecology and climate environment: the city becomes "artificial desert". Closed surface and high-rise buildings make the surface of modern cities gradually hardened by water-blocking materials cover, water is difficult to penetrate, precipitation soon become surface runoff, into the river or underground drainage pipes, forming the ecological "artificial desert".

The urban "heat island effect" is serious. The impervious road lacks the ability to adjust the urban surface temperature and humidity, the rain evaporates quickly, the surface is easy to dry, and the dust pollution is heavy. And the rapid evaporation of water after rain, air humidity, make people feel hot and unbearable, and then abnormal dry, urban meteorology "heat island effect".

The water table is "funnel-shaped". The impervious road blocks the groundwater recharge path. In addition, the excessive extraction of urban groundwater leads to the lower and lower urban groundwater level, this leads to land subsidence. In coastal areas, seawater irrigation will be reversed. Causing a geological "funnel-shaped" water table***[Li Yang, Liu Yinghua, Liu Zijing, Guan Yuntao 2017]***.

Cities are covered in "dead ground". The hardened impervious ground makes it difficult for the surface plants used to regulate the microclimate in cities to grow, and some trees even die and lie down because of the lack of water in their roots, thus losing their ecological role. Surface runoff has a serious impact on the quality of urban surface water. Because there is a large amount of dust and various pollutants on the urban surface, the runoff formation process, although washing the surface, quickly brings these pollutants into the urban river channels.

(2) Road greening - rain garden

For the green space on both sides of the road, we choose rain garden, as shown in picture .

Rain Garden

(Source:

https://agrilifecdn.tamu.edu/water/files/2013/02/stormwater-management-rain-gardens.pdf)

Rain gardens rely on plants and natural or engineered soil medium to retain stormwater and increase the lag time of infiltration, while remediating and filtering pollutants carried by urban runoff. Rain gardens provide a method to reuse and optimize any rain that falls, reducing or avoiding the need for additional irrigation. The structure of the rain garden is shown in Figure 3.2.29.

Water storage layer: The water storage layer is the top layer of the rainwater garden, where rainwater will collect and settle. The height of this layer is generally 10-25cm.

Mulch layer: Tree bark is often used for covering, and the depth is preferably 5-8 cm. It has the function of preserving soil moisture, and can also purify water.

Vegetation and planting soil: Planting soil layer is mainly used for filtering and adsorption. In the rain garden, the plant roots absorb the permeated pollutants from the water. It is better to choose sandy soil with a larger permeability coefficient.

Sand layer: It can prevent the soil particles from blocking the perforated pipe of the next layer, and the sand layer also has the function of ventilation.

Gravel bed: Pave with a diameter of no more than 5cm from 20-30cm.Perforated pipes can be buried in it, and the rainwater that has passed through the percolation can be collected by the pipes into nearby rivers or other drainage systems.

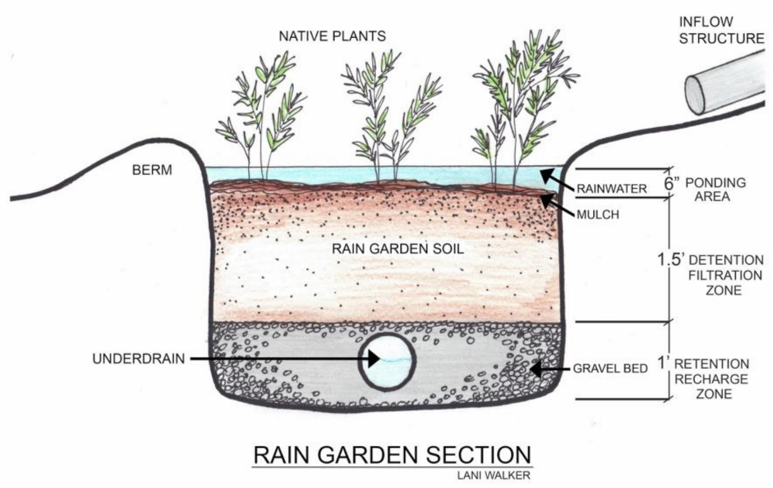


FIGURE 3.2.29: The Structure of Rain Garden

(Source: https://landscapingdigimag.com/steps-to-construct-your-own-rain-garden-at-home/)

The advantages of rain garden are: it can effectively remove suspended particles, organic pollutants, heavy metal ions, pathogens and other harmful substances in runoff; Through reasonable plant arrangement, rain garden can provide good habitat for insects and birds; The transpiration of rainwater gardens can adjust the humidity and temperature of the air in the environment and improve the microclimate environment; Rain gardens cost less to construct and are simpler to maintain and manage than lawns; Compared to the traditional lawn, rain garden can give people a new landscape perception and visual feeling***[Chen Song. 2014]***.

And the rain garden has three functions:

1. Ecological Value

Collect rainwater and rebuild the water cycle: Groundwater replenishment through retention, storage, moisturizing and infiltration functions

Purify rainwater and reduce runoff pollution: Rainwater also carries a large amount of air pollutants and surface pollutants during rainfall. Rainwater gardens can remove impurities and pollutants through infiltration, plant absorption, soil adsorption, and microbial action.

Benefits of locally mitigating urban heat islands: Rainwater gardens are often paired with carefully selected plants to alter the thermal distribution of the ground. It can reduce the ambient temperature and increase the humidity, and improve the comfort of the urban environment.

Maintain biodiversity: The rainwater garden has the natural elements of soil, plants, and rainwater, and can provide habitat for birds, insects and other animals in a local area.

2. Economic Value

Rainwater collection and utilization can reduce urban flood pressure and save the drainage pipe network load under closed roads.

The rainwater garden has a good ecological landscape effect, which can promote the economic activities of the surrounding residential, commercial, and shop activities.

The rainwater collection function of the rainwater garden can supplement urban water and greatly reduce the cost of urban water.

3. Landscape value

The rain garden maintenance costs are low; it can withstand extensive management methods and integrate itself into the natural environment.

3.2.4.3.3 Ecological parking lot

In addition to the large parking lot in the site, we can also design it as an ecological parking lot, as shown in Figure 3.2.30.Ecological parking lot refers to the open parking lot with high greening and high load. It is a kind of parking lot with the functions of permeable, purification, environmental protection and low carbon. The parking space can be combined with the surrounding concave green space, combined with the high permeability property to achieve the total runoff control and pollutant removal control index of sponge city ***[Jin Song. 2020]***.

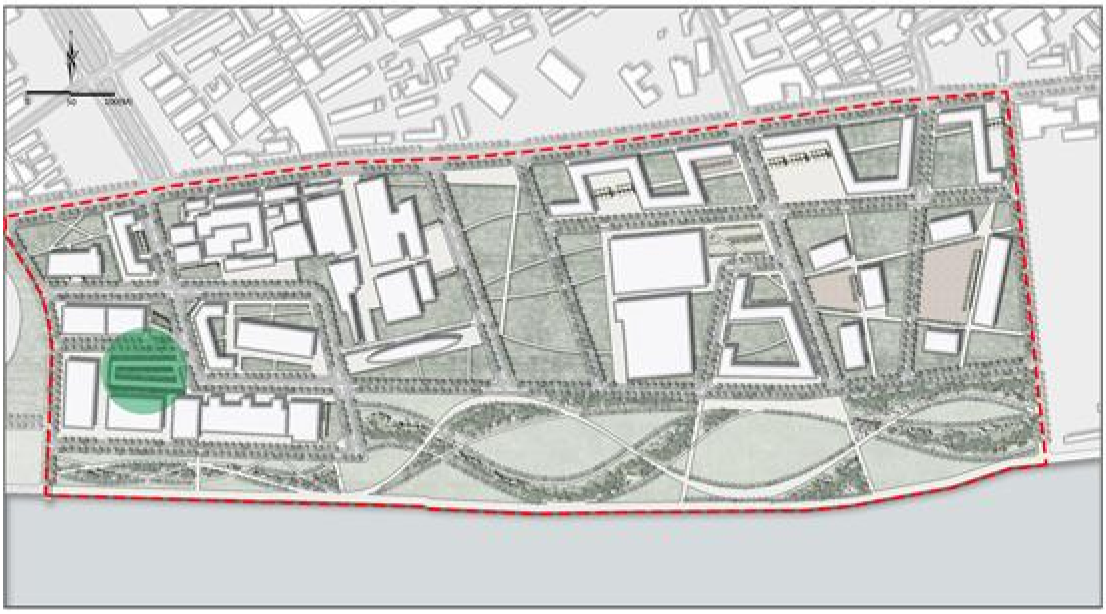


FIGURE 3.2.30: Location of Ecological Parking Lot

(Source:Made by Authors)

The layout of the ecological parking lot should be combined with the lower concave sponge facilities and overflow facilities, and the rainwater initially purified by the ecological parking lot should be naturally sloped and left to the surrounding lower concave green space for storage. When there is a certain distance between the ecological parking lot and the green space, it can be transmitted through the drainage ditch. Flat teeth or open teeth can be selected around the ecological parking lot, and a reasonably designed rainwater circulation system ***[Liu Hao. 2019]***.The layout of the ecological parking lot is shown in Figure 3.2.31.

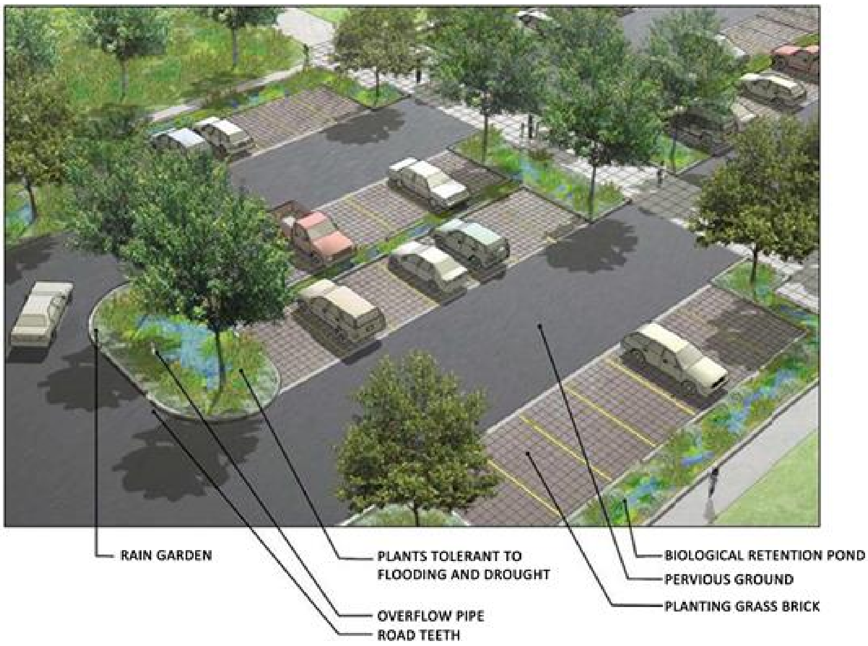


FIGURE 3.2.31: Layout of the Ecological Parking Lot

(Source: Made by Authors, Modified by Liu Hao 2019)

There are three key points in the design of ecological parking lot:

1. Planting soil mixtures consist of a specific proportion of sand, good soil, and organic matter to facilitate vigorous plant growth and infiltration of rainwater. In order to ensure the growth effect of turf, biofertilizer can be added appropriately. A certain proportion of planting soil mixed with sand can ensure the soil permeability due to construction compaction and later vehicle rolling.

2. Most surface car parks use traditional watertight asphalt paving materials. Ecological parking requires the use of a grass permeable pavement system to reduce stormwater runoff and significantly improve stormwater quality and groundwater recharge. This requires the ecological parking lot cushion structure should also use perspective materials, the bottom of the permeable concrete base and drainage gravel cushion based on the fully permeable structure. Rainwater is trapped beneath permeable roads and seeps into the soil, or it is collected for reuse by perforated blind pipes at the bottom. ***[Liu Hao. 2019]***.

3. In order to keep the ecological parking lot playing the function of sponge city efficiently, concave biorestasis facilities are usually set in the nearby green space to collect the excess rainwater runoff. In this way, the landscape optimization design is carried out on the pavement surrounding the parking lot, the rainwater runoff transmission system and the drainage system of the ecological parking lot, and the

combination of the ecological parking lot can complement each other with the landscape effect.

3.2.4.3.4 Sustainable green space

The types of green space are mainly shown in Figure 3.2.32.In addition to the main Riverfront Industrial Ecological Park and Shipyard Park & Plaza, the commercial area is mainly open space, while the area from the shipyard headquarters to the east is mainly private space, accompanied by some plazas and art installations as event viewing venues. The overall green space system design concept is to better help the site to distinguish and clarify the different special properties of each district, and more green space can create a more natural atmosphere, and better adapt to climate change.

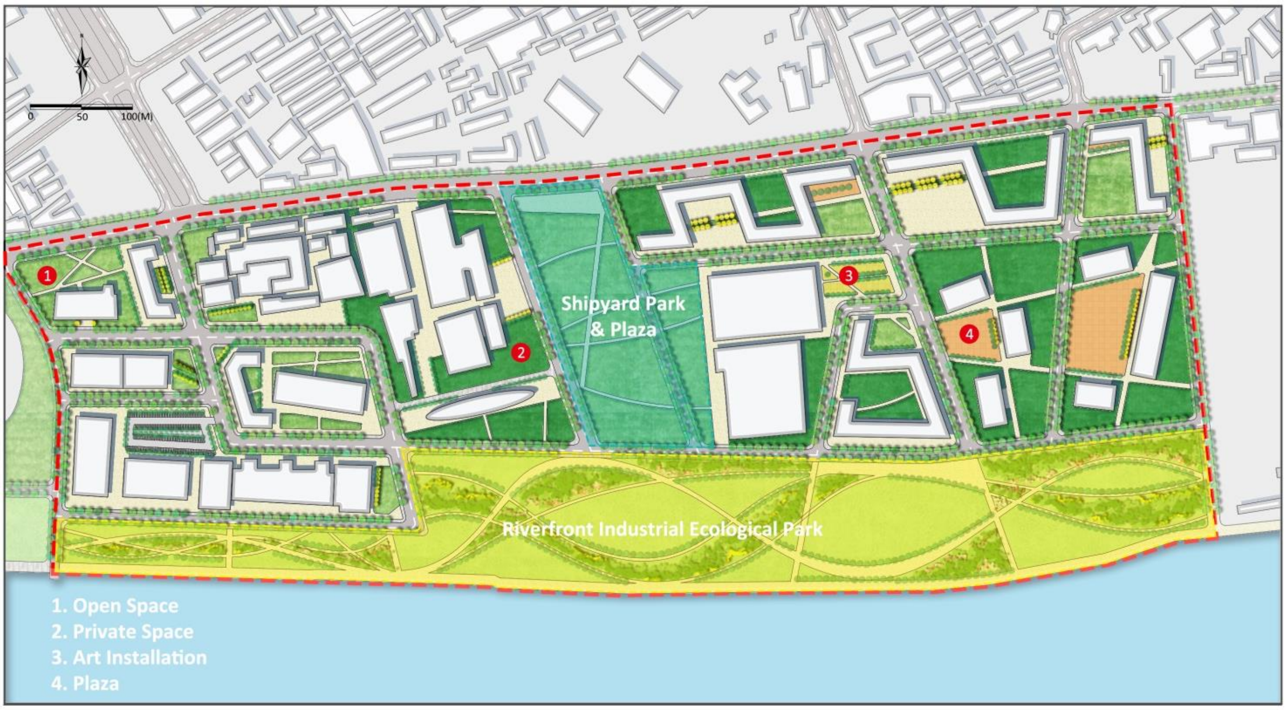
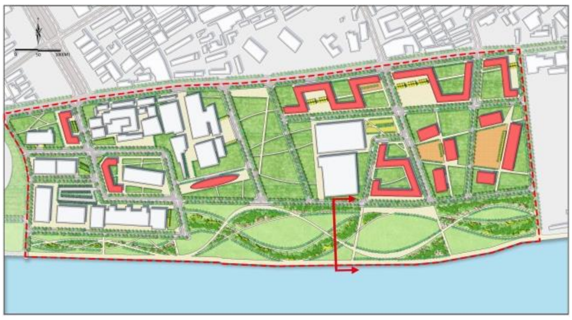


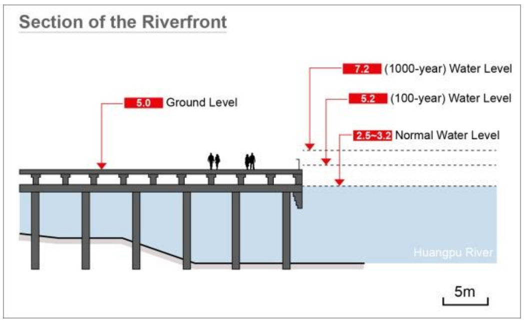
FIGURE 3.2.32: Green Space Analysis in Section One

(Source: Made by Authors)

In addition, according to our previous design goal, we hope that the Waterfront Park can meet the flood control requirement of Shanghai's water level once in a thousand years.As shown in the figure, the elevation of the ground is 5m. The normal water level of the Huangpu River is 2.5-3.2m, and the once-in-a-millennium water level is 7.2m.Therefore, according to a section in the site, we designed the newly Industrial Ecological Park to meet the flood control requirements by reshaping the terrain and raising the ground height to 7.2 meters, as shown in Figure 3.2.33.

And it plays an important role in ecological protection and social economy.In the aspect of ecological function, it mainly shows in the aspects of soil and water conservation, water quality protection and pollution control, which has obvious effect.At the same time, in terms of social economy, urban residents along the river system should be provided with places for recreation and leisure.The urban green space along the river system and the protective green belt, combined with the walking path of the road, can be used to arrange some recreation areas suitable for urban residents, as the leisure area and the transitional zone of the urban area.For the bank revetment near the river, low shrubs can be planted as the riverbank boundary, which can play a protective role on the one hand and strengthen the ecological function on the other hand.





Water Level Explanation (Left)& Location of the Section (Right)

(Source: Made by Authors)

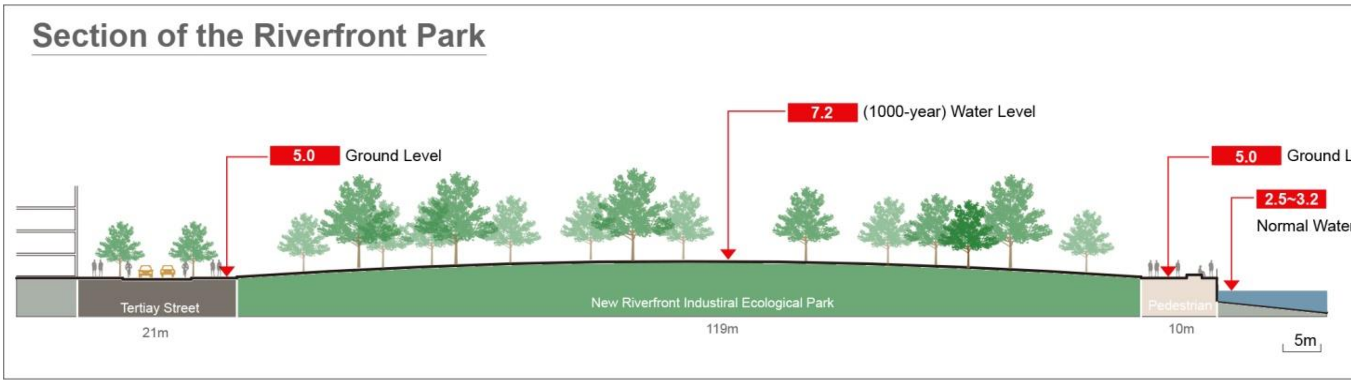


FIGURE 3.2.33: Section of the New Riverfront Park

(Source: Made by Authors)

There area two mini-parks in the site. One is the Waterfront Ecological Industrial Park; the other is the Shipyard Park. The Waterfront Park offers river views, jogging and biking, memorial industries, and many recreational functions. The shipyard park is transformed on the basis of the old shipyard to improve the quality characteristics of the block. Some LID strategies can also be adopted in parks, such as rain gardens, permeable ground, infiltration basin and other measures to help urban rainwater drainage and Infiltration.

In the waterfront ecological industrial park, in order to meet the flood control requirements, the terrain is sloping, as shown in Fig. 3.2.34. The green space between the city road and the 1000 year floodwall is designed as a rain garden which alleviating the burden of the municipal drainage network during storm，which makes the hard-concrete walls no longer a negative factor. In addition, an underground rainwater harvesting device provides irrigation water for the park. As a space for ecological education, the wooden elevated trails and platform nodes under the tree can help people understand the meaning of sponge city. In order to create a better visual corridor to the river，the planting design focuses on two levels in the vertical direction. The upper level is mainly arbor, with local species that can grow stably and resist typhoon. The understory level is a variety of Herbaceous plants, with the dynamic landscape of the river wind, which makes an interesting contrast with the heavy industry. The riprap and reed plants on the shore between the 10m walking way and the land are used to slow the impact of the water on the river bank.

Rain Garden in the Sloping Area

(Source: www.gooood.com)

Two-level Planting Design in the Sloping Area

(Source: www.gooood.com)

In addition to increasing the amount of green space within the site, the two parks also contribute to the climate of the city and its surrounding environment. And research has shown that increasing park area is one of the most effective ways to reduce the urban heat island effect.With the rapid development of urbanization, the urban heat island effect is more and more obvious. Urban heat island phenomenon leads to urban high temperature and then affects the safety and comfort of the living environment, and intensifies energy consumption and greenhouse gas emissions. Studies have shown that increasing urban park green space is one of the most effective ways to reduce the urban heat island effect. However, the cooling effect of park green space is affected by many factors of itself and environment, and the research on its mechanism is still very weak. In summer, tree communities can significantly reduce air temperature and light intensity, and increase relative humidity. Compared with the control points in the open field outside the community, the average daily cooling intensity in the plant community was 1.6-2.5℃.The humidifying strength is 2.9% ~ 5.2%.The shading rate is 61.0% ~ 96.9% ***[Yan Hai. 2014]***.At the same time, there were significant differences in the microclimate factors of different tree communities. The average daily discomfort index of the plant community was not significantly different from that of the control point, but compared with that of the control point, the community could reduce the discomfort index to a certain extent, and the reduction rate of the discomfort index was 2.5% ~ 4.3%.The correlation analysis showed that the canopy characteristics (leaf area index, canopy coverage and sky visibility factor) of the community had an important regulating effect on the microclimate factors in the community. The higher the leaf litter area index and canopy coverage, the lower the light intensity and the lower the air temperature in the community.

Large Riverfront Park Photo

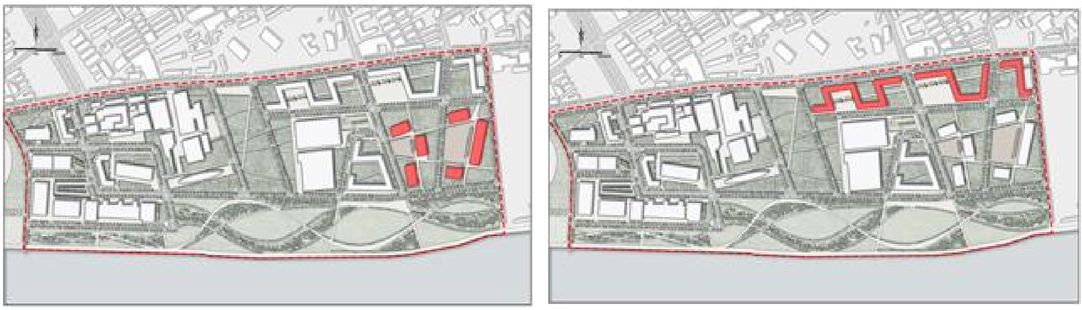
(Source: map.baidu.com)

In summer, the temperature of different underlying surfaces was significantly different, especially in the afternoon, when the road temperature was the highest, followed by the lawn and water, and the woodland temperature was the lowest. At night, however, the temperature difference between the different underlying surfaces is small, when the road surface is still the highest temperature and the lawn becomes the lowest temperature. The humidity pattern and temperature of different underlying surfaces show an opposite trend. No matter in the day or at night, the humidity of different underlying surfaces in the park is higher than that of the urban environment outside the park, forming "Wet Island of the park". However, in the afternoon, the temperature of the park's pavements and lawns may be higher than that of the nearby urban environment, creating an uncomfortable thermal environment. In the afternoon, the area ratio of woodland plays a dominant role in the park microclimate, while in the evening, the area ratio of grass has a decisive role in the park microclimate.

The park area has lower air temperature and higher relative humidity than the surrounding urban environment, especially in the middle of the night, the cooling effect of the park is most obvious, the maximum cooling intensity of 4.8℃, the average cooling intensity of 2.8℃.The observation also found that with the increase of the distance from the park boundary, the air temperature showed an upward trend, especially in the middle of the night, the temperature increased 0.20 ~ 0.31℃ with the increase of 0.1 km from the park boundary***[Yan Hai. 2014]***. This phenomenon indicates that the park also has a cooling effect on the surrounding urban environment, and this cooling effect can extend to the area beyond the park boundary 1km.The intensity and range of park cooling are affected by the surrounding urban environment. The higher the ambient urban temperature is, the greater the intensity of park cooling is. The wider the park's surroundings, the farther the park's cooling distance. Through regression analysis, it is found that air humidity and air temperature are significantly negatively correlated, indicating that evapotranspiration plays an important role in regulating the cooling effect of parks. In addition, the composition of the underlying surface around the measurement point also has an important influence on the temperature of the measurement point. The higher the vegetation coverage rate is, the lower the temperature will be; while the higher the ratio of impervious surface is, the higher the temperature will be.

3.3.4.3.5 Green building

Finally, for some new buildings in the site, we also suggest more energy saving and environmental protection measures. For example, the building in the cruise ship banquet site can adopt the green roof, while the building in the retail area can adopt the green wall, which can not only form a characteristic building, but also reduce the impact of climate.



Location of Roof Greening Building in Cruise Ship Banquet Area (Left) & Location of Green Roof Building in Retail Area (Right)

(Source: Made by Authors)

(1) Roof greening

Roof greening can be widely understood as a general term for planting trees and flowers in all kinds of ancient and modern buildings, structures, city walls, Bridges (overpasses) and other rooftops, terraces, rooftops, balconies or large artificial rockery mountains. Roof greening can increase urban green space area and improve the deteriorating human living environment space. To improve the urban high-rise buildings, improve the hard pavement of many roads to replace the natural land and plant situation; To improve the excessive deforestation of natural forests, all kinds of waste gas pollution caused by the urban heat island effect, dust storms and other hazards to human beings; It is of great significance to develop green space for human beings, build garden cities, improve people's living conditions, improve the quality of life, and beautify the urban environment and improve the ecological effect ***[Xiao Yiheng,...2016]*** .

Roof greening is not only a green space development into the air, land saving, , explore the effective way of urban space. It is also the perfect combination of architectural art and garden art, and plays an important role in protecting the urban environment and improving the quality of human settlement environment.

1. Improve the urban environment and improve the living and working environment quality of citizens;

2. Alleviate the atmospheric dust, purify the air;

3 protect the top of the building; extend the service life of roof building materials;

4. Alleviate the urban heat island effect;

5. Heat insulation; reduce the use of air conditioning, save energy;

6. Reduce urban noise;

7. Increase air humidity, purify water;

8. Improve the utilization rate of land and resources;

9. Can be planted fruits and vegetables, the formation of urban garden, orchard;

10. Simple leisure and entertainment facilities can be established according to preferences.

With the rapid development of urban construction, the problem of air pollution in cities is becoming more and more serious. At present, many urban problems exist in the vast city need to be reduced. How to expand the greening area in the limited urban space has become a new problem that people must face and reduce. The current green building is mainly reflected in the application of materials and clean energy, but the roof of building, as a very important content, has not received enough attention. In recent years, people began to discover this hidden corner -- the roof, also known as the so-called "fifth facade".

Green Roof

(Source: http://www.eee.org.cn/portal/nyxh/yhkp_details.action?id=104303&typename=kpzs&sub=1)

The urban roof occupies about 1/5 of the urban area. If it is properly improved and utilized, the urban environment and greening will be improved as a whole. At present, China is still in the development stage in the field of roof greening, which needs to be improved in terms of technology, and the management mechanism is in a state of extreme deficiency.

Roof greening reduces the ecological crisis, environmental crisis, health crisis and economic crisis that human beings are facing comprehensively.

The roof is equivalent to an artificial desert. In summer, when the sun is directly on the roof, the temperature can exceed 60 degrees Celsius, which makes it impossible for ordinary animals and plants to survive. When some drought-tolerant plants survive, due to lack of water, transpiration and photosynthesis temporarily stop, they cannot achieve the results expected by human beings. A constructed wetland on a roof can use twice as much water as an equivalent area of water, four times as much as a forest, and eight times as much as a meadow. The more water it consumes, the greater its transpiration and photosynthesis, and the greater its ability to cool, absorb carbon dioxide, and produce oxygen. Wetland is known as the "kidney of the earth". The use of "constructed wetland" to green the roof greening is equivalent to turning the desert directly into wetland, and its ecological contribution will be the largest.

(2) Green wall

A form of vertical greening in a city, a wall covered with green plants is called a green wall. Urban afforestation is divided into land afforestation and vertical afforestation, which includes roof garden, balcony afforestation and wall afforestation. "Green wall" is a form of wall greening in vertical greening. The concept is: a wall covered with climbing plants. The greatest significance in cities is generally in the building covering rate of greening effect and can also be ***[Wu Xiaoyan. 2013]***.

Green Wall

(Source: https://www.merriam-webster.com/dictionary/vertical)

The functions of the green wall are:

1. Improve microclimate and alleviate urban heat island effect

The study shows that green walls can alleviate the urban heat island effect through four mechanisms: plants shade solar radiation, which can differ 2-3℃ from the common building exterior wall; Transpiration of plants can reduce the ambient temperature. The green walls act as insulation for the building; can change the wind effect of the building.

2. Reduce noise

The leaves and stems of green-walled plants can rub sound waves against each other, effectively reducing noise.

3. Improve air quality

Studies have shown that green walls can block road dust, filter air dust and absorb heavy metal particles from the air.

4. Reduce storm runoff

Green walls absorb some of the rainwater to reduce surface runoff.

5. Enhance urban biodiversity

Green walls can improve urban biodiversity by creating habitats, food sources (e.g. wintering birds), ecological corridors, nesting sites, etc.

In addition, the green wall can also improve visual comfort, improve energy efficiency, improve human mental health, etc.

3.2.5 Conclusion

For the construction of waterfront ecological sponge park, in addition to the ecological nature of the park as a whole, the continuity between the park and the surrounding green space as well as the urban living area should also be considered. Therefore, in the site, the author has carried out a comprehensive re-planning of the whole waterfront area, creating a dynamic waterfront space. In addition to the waterfront ecological industrial park, the function and quality of the original site has been improved and planned. It is hoped that it cannot only restore the ecology and improve the climate problem, but also bring a more comfortable living environment to the residents living in and around the site.

3.3 Ecological sponge community in Jiuxing area

3.3.1.Introduction

The site is located in Jiuxing Village of Shanghai, which is located in the fringe area of urban and rural areas, southwest of Shanghai, and belongs to Qibao Town of Minhang District. The site covers an area of about 1.1 square kilometers. There are 19 village groups, 1185 households and 4,600 villagers in the village. It is close to Shanghai Hongqiao Airport and Hongqiao Railway station, and there are metro lines connect the city center and the site. **[https://baike.baidu.com/item/jiuxingvillage]**

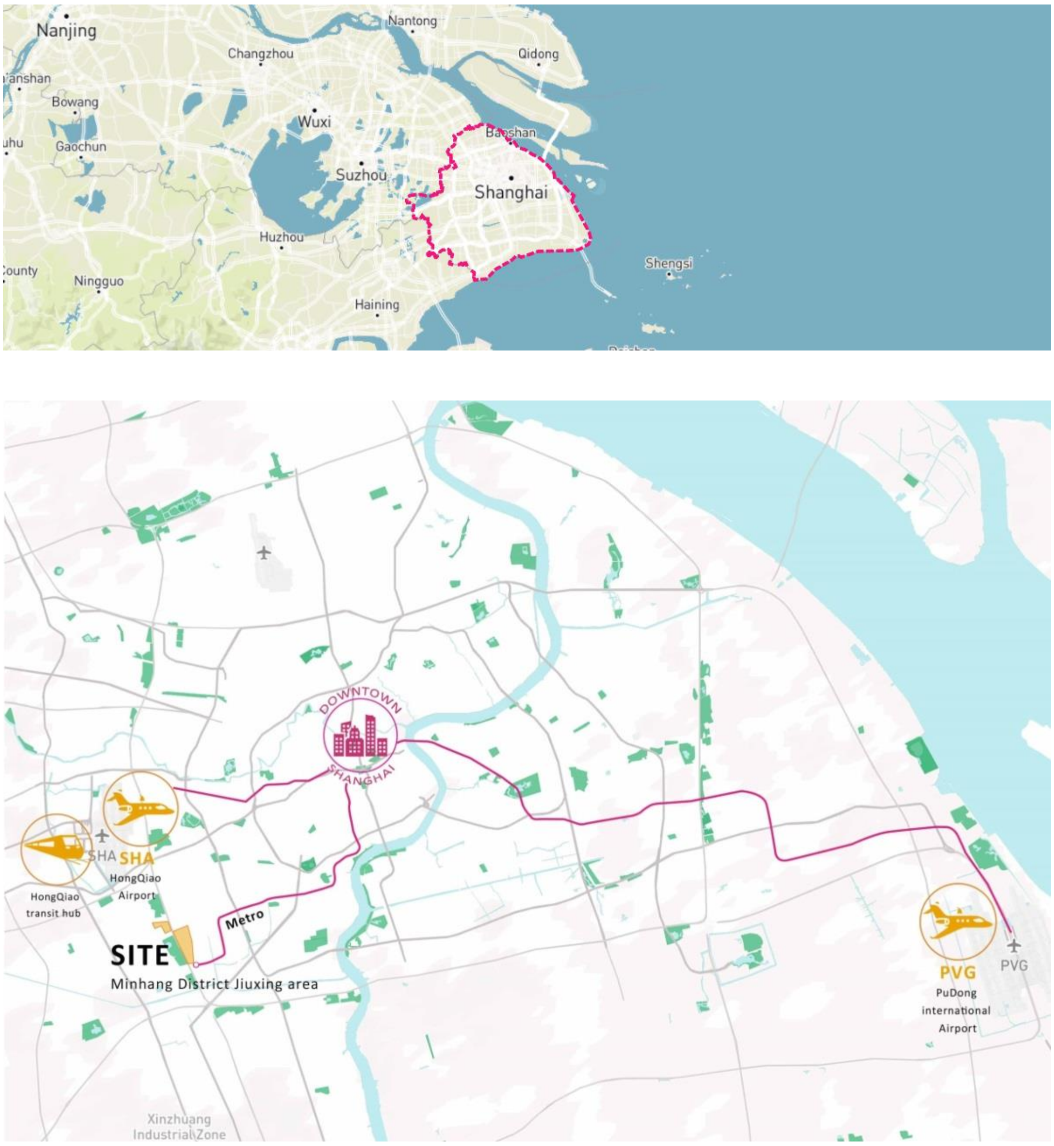


FIGURE 3.3.1Location of site

(Source: Made by author)

FIGURE 3.3.2 Current situation of Site

(Source: map.baudu.com)

3.3.2 Context analysis

3.3.2.1 Landuse analysis

The site is east of Shanghai Caohejing Hi-tech Development Zone. The west of site is Minhang Sports Park. To the north, close to Shanghai's Hongqiao transport hub, there are scattered small retails and schools within a 20-minute walk.

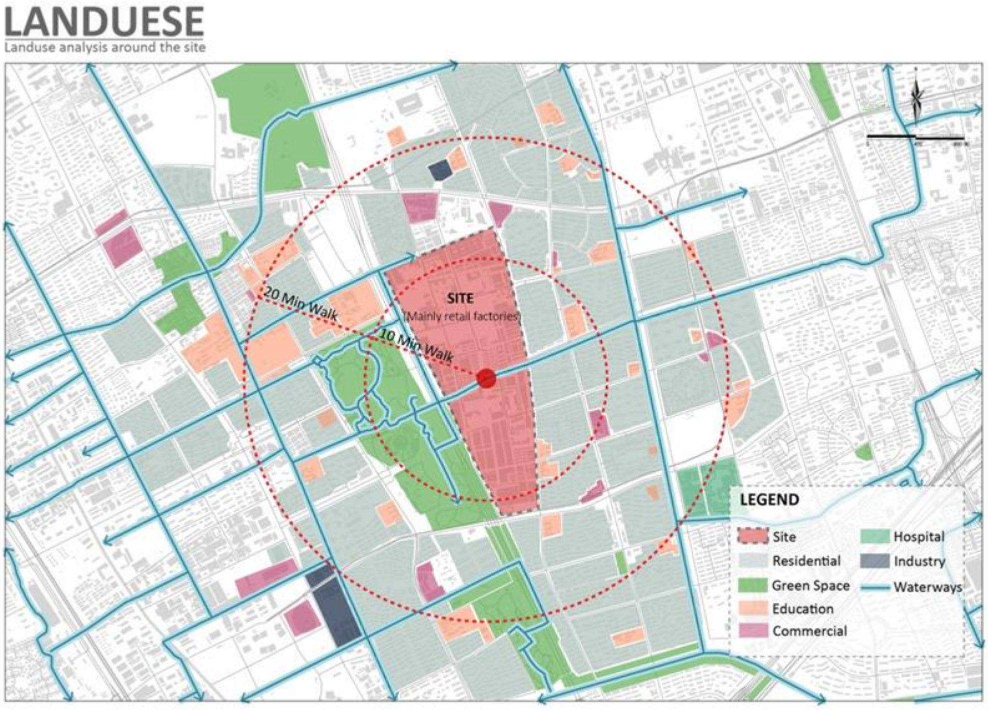


FIGURE 3.3.3 Landuse analysis

(Source: Made by author)

FIGURE.School around the site (left) & Residential area around the site (right)

(Source:map.baidu.com)

FIGURE 3.3.4 Commercial area around the site (left) & Industry area around the site (right)

(Source:map.baidu.com)

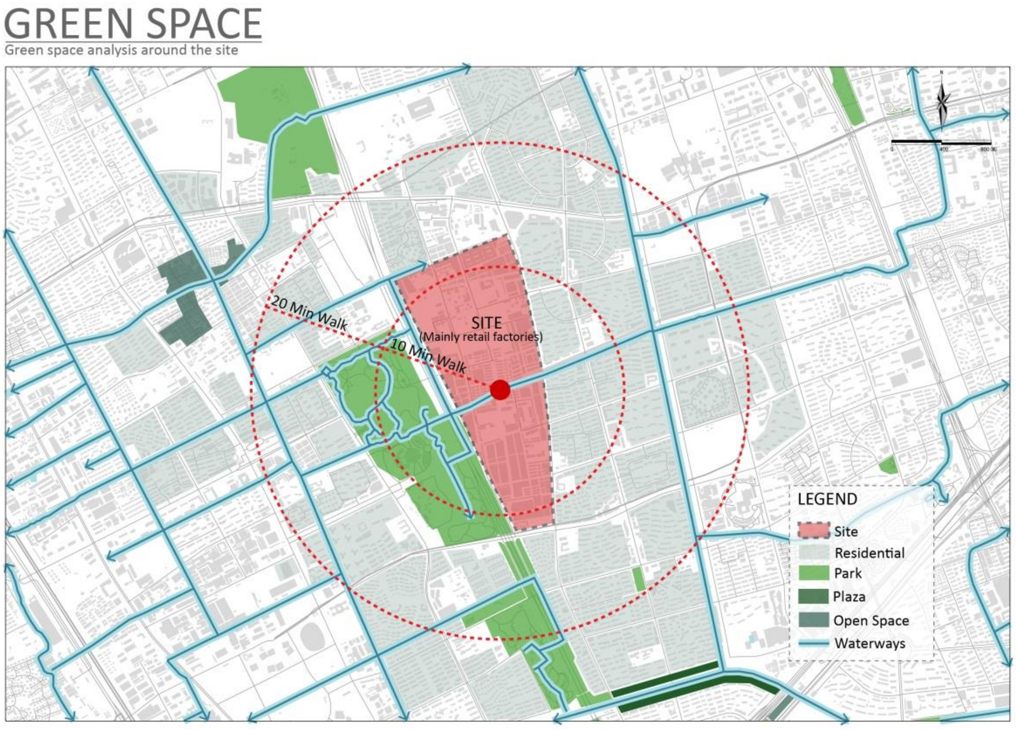


FIGURE 3.3.5 Green space analysis

(Source: Made by author)

FIGURE 3.3.6 Sports park on the west side of the site

(Source:map.baidu.com)

FIGURE 3.3.7 Shuangyong Park is on the southwest side of the site

(Source:map.baidu.com)

3.3.2.2 Transport analysis

Shanghai's urban outer ring S20 passes through the village, and it is connected to two ramp entrances of Guodai Road and Caobao Road from north to south (FIG.3.3.8). Xingzhong Road Station of Line 9 of Shanghai Rail transit, Hongxin Road Station of Line 12 to be constructed and opened to traffic, and dozens of bus lines extending in all directions are convenient and convenient with superior location. (FIG.3.3.11)

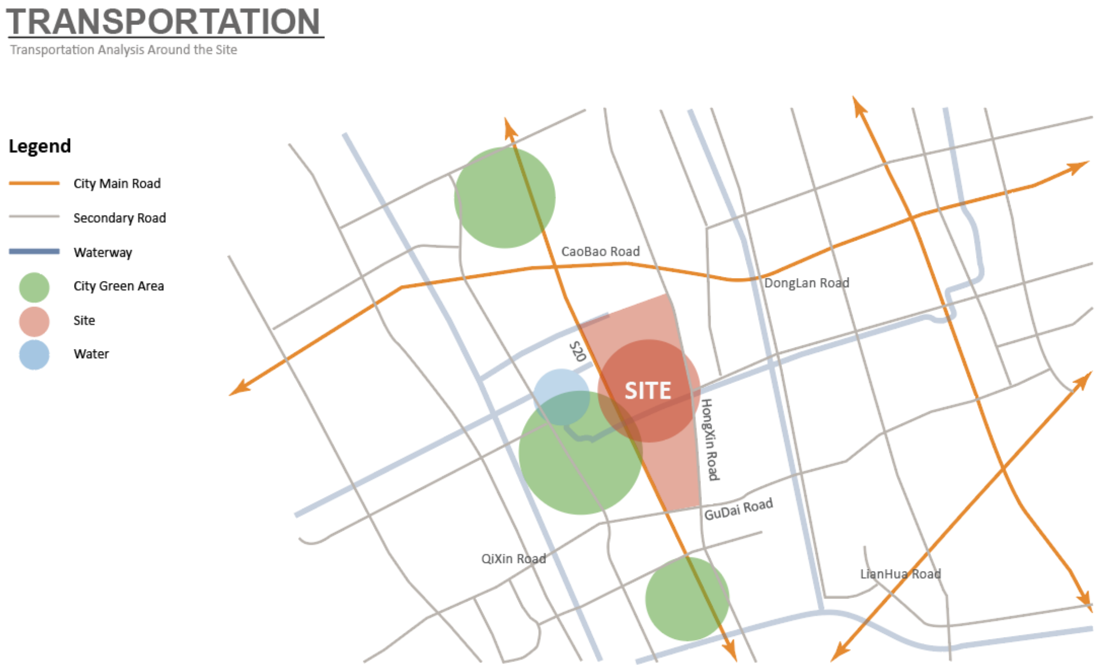


FIGURE 3.3.8 Transportation analysis

Source: Made by author

FIGURE 3.3.9 HongXin Road(Left) & GuDai Road(Right)

(Source:map.baidu.com)

FIGURE 3.3.10 S20(Left) & XinZhong Road(Right)

(Source:map.baidu.com)

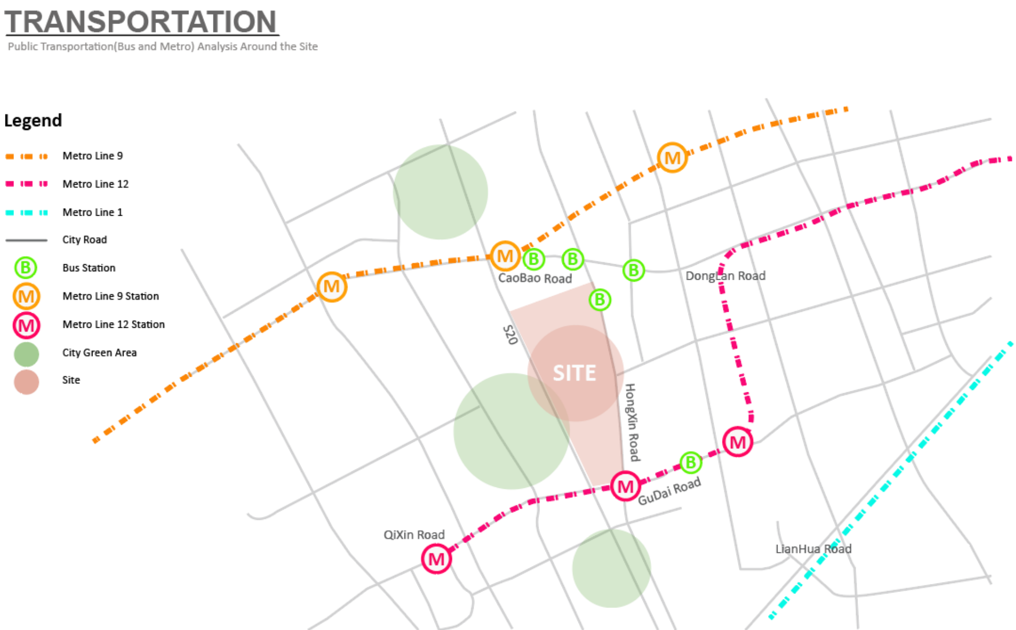


FIGURE 3.3.11 Public transportation analysis

Source: Made by author

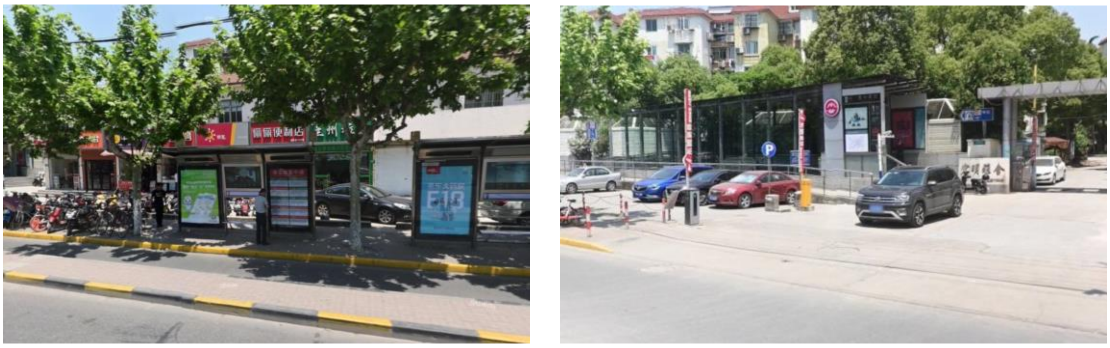


FIGURE 3.3.12 Bus Station and Metro station of XinZhong Road

(Source:map.baidu.com)

FIGURE 3.3.13 Bus Station and Metro station of GuDai Road

(Source:map.baidu.com)

3.3.3 History and development

Jiuxing Village was formerly a nine-star senior agricultural production cooperative composed of nine primary cooperatives, mainly cultivating grain, vegetables and cotton.

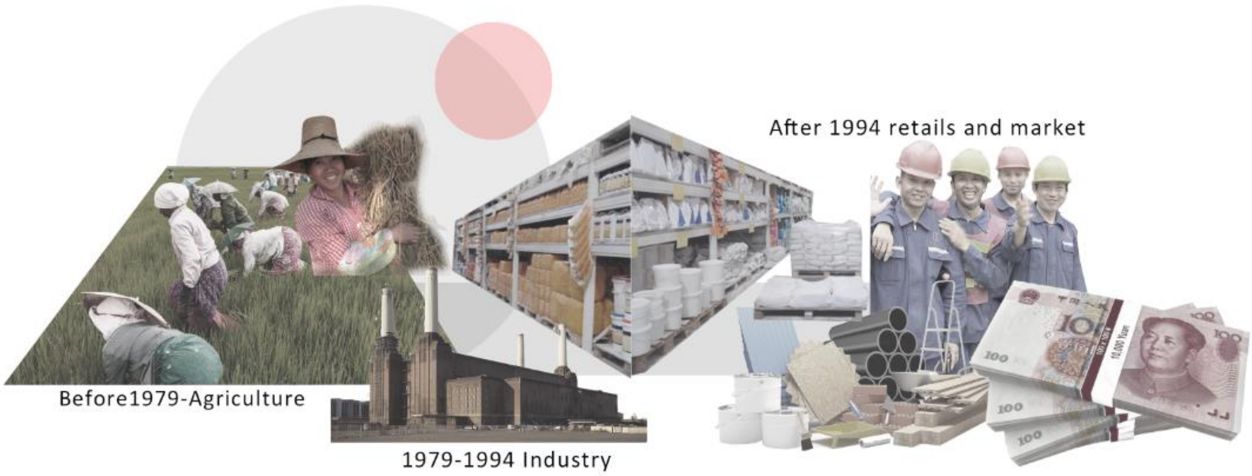


FIGURE 3.3.14 Collage of history of HongXing Country

Source: Made by author

After China's reform and opening up (1979), while engaged in agriculture, a number of factories were set up. However, due to various problems in agriculture and village-run industries, the village was in trouble in 1994. Village-run industries were deficit, many enterprises are in a state of shutdown, economy ranked second from bottom of Qibao town, the village earned 3.18 million yuan in 1994, spending 4 million yuan and liabilities of more than 17million yuan. Debt ratio as high as 84%, annual per capita income of less than 3000 yuan, a part of the retired old man did not receive a pension for 23 months. Run away 90% of the agricultural labor force in the village.

Therefore, Jiuxing Village began to turn to the modern service industry for the development of the tertiary industry, and decided to build a market based on urbanization and the actual situation of traffic, popularity and capacity of Jiuxing Village, which is located in the suburban fringe area, to meet the huge demand of building decoration formed by the rapid development of population in surrounding areas.

Since 1994, the construction of parking lots, duck farms, farmers' markets and so on. The economic strength of the village has been increasing year by year, and the per capita income has also been increasing gradually.

For more than 10 years after 1994, the economic strength has been the top 100 villages in the suburbs of Shanghai. On only 1600 acres of non-agricultural construction land, set up the comprehensive wholesale market covers an area of 1.06 million square meters, to form the agricultural and sideline products, glass, ceramics, lamp act the role ofing, furniture, hardware, steel professional area, 22 products such as goods amounted to more than 500 categories of more than 100000 in the market, the scale, in eastern China's leading nine star of the rapid growth of economic and social benefits. Take 2006 as an example (see Table 1 and Table 2) **[Zhang Benxiao, Ji Xiaolan 2010.]**

Economic indicators data (1998-2006)						
Year	Net worth(B)	The collective benefits(m)	The labor distribution(t)	Tax (m)	Net profit (m)	Welfare (m)
1998	0.064	28.84	18	29.30	17.84	1.258
1999	0.078	33.00	20	33.29	19.01	1.432
2000	0.095	48.26	21	42.01	24.81	1.675
2001	0.115	84.00	23	64.82	45.00	2.219
2002	0.166	102.00	26	80.50	56.00	3.967
2003	0.261	162.00	28	129.50	97.00	4.895
2004	0.412	246.80	31.6	220.07	155.53	5.709
2005	0.5773	331.32	35	265.37	180.35	8.524
2006	0.650	420.40	38	305.00	210.00	15.000

Turnover of Jiuxing Market(1998-2006)									
Year	1998	1999	2000	2001	2002	2003	2004	2005	2006
Billion	1.5	2.0	3.0	5.0	7.0	10.0	12.0	13.0	15.0

[Xu Fuxin，Fang Xiuren.2011]

Now market hardware, ceramic sanitary ware, lamp act the role ofing, furniture, curtain cloth art, tea, hotel supplies, decorative glass, steel, plywood, rare wood, floor, security doors, paint coating, electric appliances, PVC, stainless steel, stationery gifts, vegetable market, stone material, wire and cable, fire equipment, culture collections, annatto furniture such as 28 categories of professional products area.

The prosperity and development of the market have kept the economic growth of Jiuxing Village in double digits. The economic indicators from 1998 to 2014 are as follows: the disposable income of rural residents increased from 28.84 million yuan to 11.097 million yuan, an increase of 38 times. The tax paid increased from 11.45 million yuan to 413.64 million yuan, an increase of 36 times.

Net profit increased by 17.84 million yuan to 361.54 million yuan, increased by 20 times, 1307 mu of land MuChanZhi reached an average of 840000 yuan, income exceeding 1.1 billion, and created for 20 years of sustained growth performance, ranked fifth in the Chinese economy top village, the village influence ranking fifth, A backward village that once owed 17.8 million yuan become the no.1 Chinese market village.

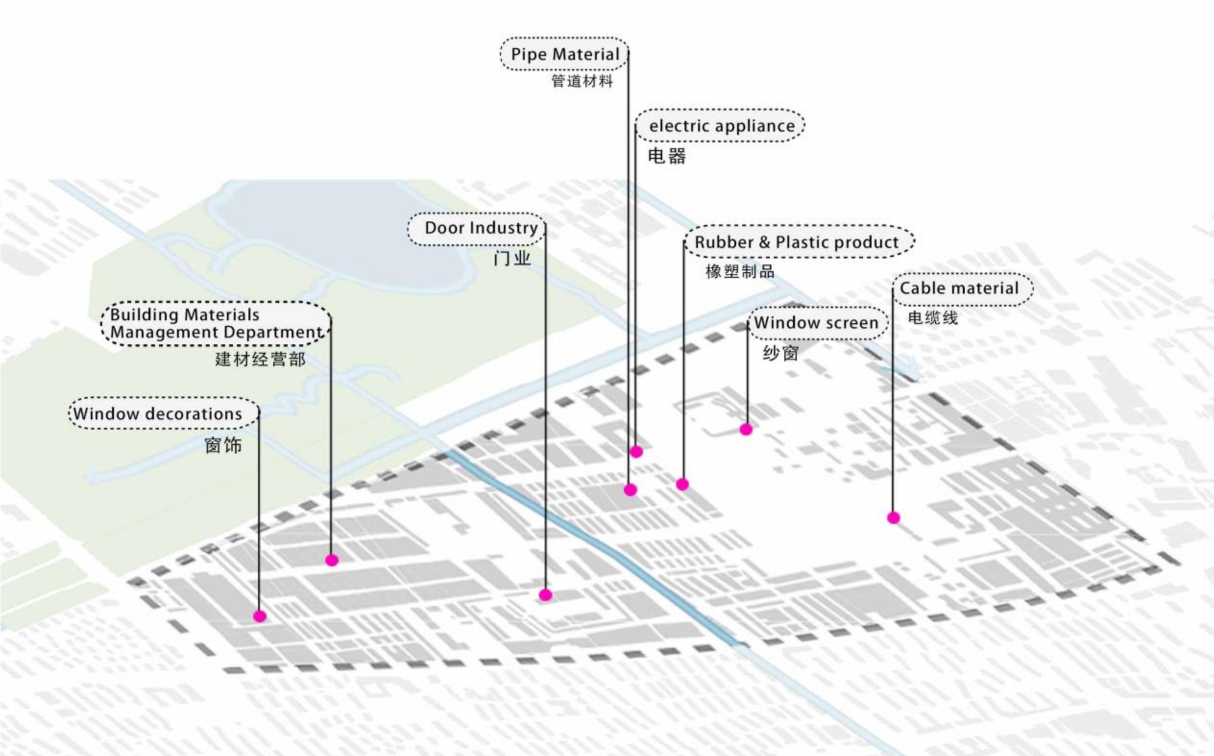


FIGURE 3.3.15 Commercial distribution

Source: Made by author

3.3.4 Strategies for coping with climate change

3.3.4.1 Challenges and goals

(1) Challenges

This community belongs to the village in the city. Due to long-term neglect of the management and maintenance of the community landscape, there are many problems in the current situation of the site

(1) Shanghai has a subtropical monsoon climate with high rainfall intensity. Due to insufficient consideration of the local climate characteristics at the beginning of the construction, there is serious accumulation of rainwater in the community in the season of concentrated rainfall.

(2) Due to too much emphasis on economic development, while ignoring the sustainable development of its own ecological environment, the ubiquitous market makes the whole region almost all hard ground and low permeability, which has no sense of beauty at all, and leads to urban heat island.

(3) There is a lack of activity space within the site. Due to the unreasonable design, the space utilization rate is low, which cannot meet the daily leisure needs of residents. The surrounding residential green space is filled with weeds and hedges and is unusable. The community garden has a single form, low use efficiency and waste of space. The number of basic public facilities is small, the project is single, the environment is not good.

(4) The space for motor vehicles and pedestrians is mixed in the site. With the rapid increase of the number of motor vehicles, there is a serious shortage of parking Spaces, which affects the community safety and air quality. Most of the roads in the community are impermeable to water, serious illegal parking, a lot of landscape is destroyed; Roadside parking tightens traffic.

(5) The plant species in the site are few and the configuration is single.

Many plants have died due to insufficient maintenance in the later period. The loess is exposed and the ecological environment of the community has been seriously damaged.

(2) Goals

Entered a stage of rapid development of urbanization, Shanghai urban construction has developed rapidly, but at the same time the urban villages as the living form of the early reform and opening up, the problem increasingly concentrated, mainly reflected in the environmental pollution, aging infrastructure, lack of supporting facilities, etc., there are some difficult to use the old district of the city renewal, but there are some temporary did not reach the standard reconstruction, the need for a comprehensive transformation, in order to improve urban residential environment.

First, it is necessary to reduce the effect of the total amount of flood and to improve the suitability of the area. Shanghai is located in the middle and lower reaches of the Yangtze River and has a subtropical monsoon climate, with abundant precipitation. Jiuxing Village lacks greenery as a whole, and the site is basically hard ground, which cannot absorb and infiltrate rainwater well, often causing urban floods. If it can increase the absorptive capacity of the land and the infiltration capacity of the soil, it has a great effect on reducing the total amount of flood and waterlogging.

In engineering construction aspect, need to create a "clear road". To strengthen the "purification" of the road surface, the precipitation through the primary purification, through the floor tile, soil, etc., to reduce the total amount of flood and waterlogging, in the case of small rainfall, can play a full role. According to the meteorological records, major urban floods occur in some drainage problem areas in Shanghai every year, which should also be taken as an important aspect of the study. If the surrounding water network is fully utilized to collect rainwater, the problem will also be well reduced.

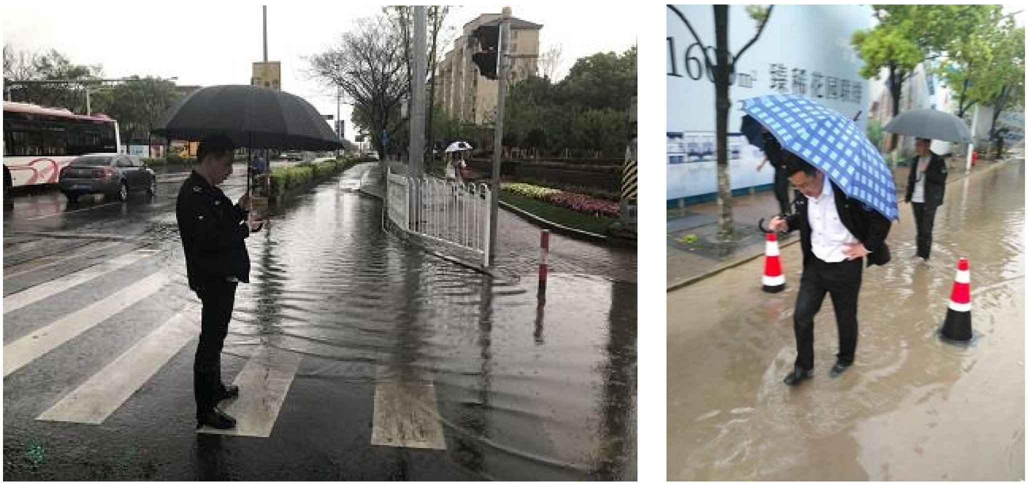



FIGURE 3.3.16 Flooding in Jiuxing Area

(Source: baidu.com)

Secondly, efficient use of water resources is the most important direction guided by the "sponge city". Then, as for the water treatment of the community, two more issues should be considered: the utilization effect after rainwater storage, and the purification treatment of rainwater. The runoff and rainwater can be introduced into the new green space and square area through organized confluence, diversion and transportation, and after pretreatment such as pollution interception.

Finally, to deal with urban construction management inner sponge, because it involves a number of appearance, so green will play a large role in the transform urban style and features, vegetation can better absorb the infiltration of surface water, also can absorb a certain amount of carbon dioxide in the air, choose the suitable for field with low maintenance costs of local tree species, reasonable planning of green space, have a great effect for the mitigation of urban heat island.

3.3.4.2 Concept

Stormwater has become a serious natural disaster in alluvial urban construction. Therefore, low-impact development is an ecological flood management method, which tends to manage rainwater in soft engineering through paper cup treatment in the site. The objective is to maintain the hydrological balance before and after the site development by means of infiltration, filtration and evaporation of rainwater. It can reduce runoff, prevent water pollution, and increase ecological diversity in the landscape.

Therefore, this project combined with the basic requirements of sponge city theory, guided by the principles of natural infiltration, natural storage and natural purification, sponge city technologies such as permeable pavement, rain pond, rain garden, grass ditch and green roof are applied. The roads and squares, residential green Spaces, parking Spaces, landscape water bodies and other areas in Jiuxing area are specifically renovated to realize the rational use of rainwater resources in the community and build an ecological, beautiful and functional friendly community environment

In-depth research of the local environment and ecology was used to support a comfortable microclimate at the neighborhood and building scales. A verdant, connected, and functional landscape network of agricultural plots, eco-corridors, and parks ensure the recharge of the region’s aquifer, while promoting walking and biking. Plazas, sidewalks and trails tie the natural landscape with civic, cultural and entertainment spaces allowing the community to connect with nature and with each other.

3.3.4.3 Sponge system planning

3.3.4.3.1 Organic open community

According to the previous analysis, Jiuxing area was an agricultural area before 1979, and until now there still has some farmers' markets. Therefore, when designing the community residential area, we should consider combining agriculture with residential green space, and continue to retain the agricultural characteristics of this area.

On the one hand, it could attract more people from the other areas, especially low-income ones. It can provide employment opportunities for them and encourage them to participate in planting activities, and living there. And from its Agricultural plots in short walking distance to residents, it will create more convenience for farmers' life.

On the other hand, compared with traditional Residential areas in China, this model can collect and utilize water resources to a greater extent. Rainwater can be used through some LID devices for re-irrigation, and meanwhile, the flood problem in rainy season can be reduced, the urban heat island effect can be alleviated, and the biodiversity of the site can be increased.

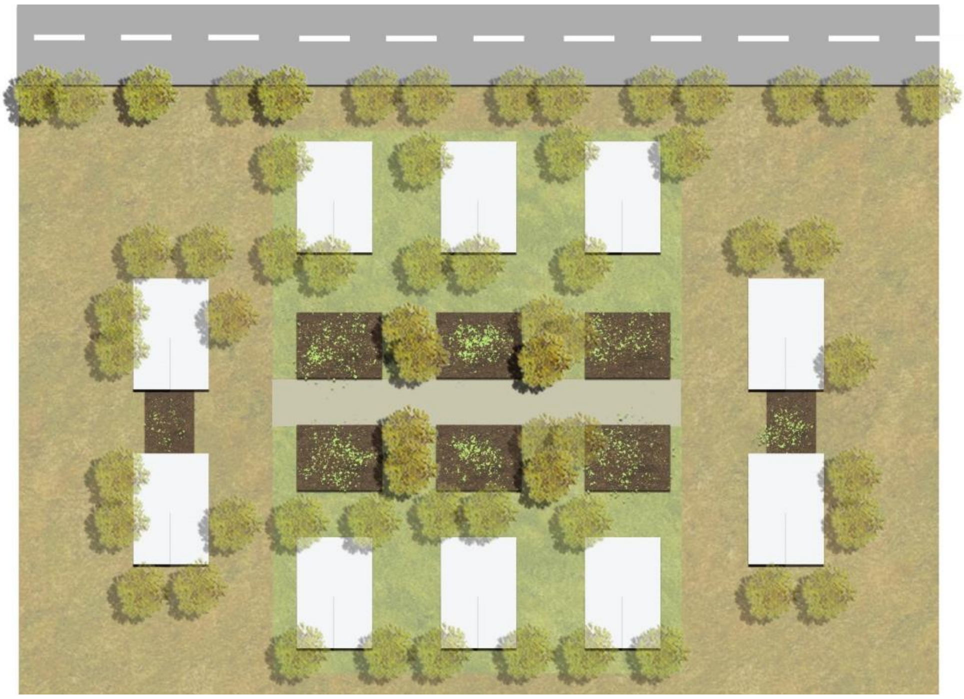


FIGURE 3.3.17 Residence area

(Source: Made by author)

This layout of the building allows the connections at the edges of the building to maximize wind capture and promote cross ventilation. (as shown in figure3.3.18)

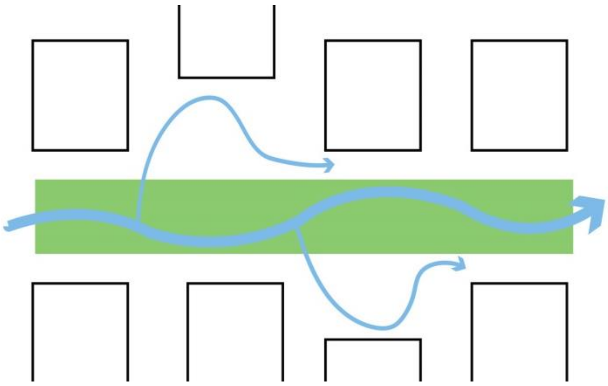


FIGURE 3.3.18 Layout of Buildings

(Source: Made by author)

In the rainy season, especially during the mold rains , the rain on the motor vehicle or the farmland, may be adopted by permeable pavement and the pavement has a small slope in order to collect rainwater (Fig3.3.19), and then through the permeable layer purification, and stored in underground cistern. The rain water on the rooftop of residential building will be collected by the roof (Fig.3.3.20), and then flow through the pipe to underground cistern storage, the water can be used to irrigate farmland in the dry season.

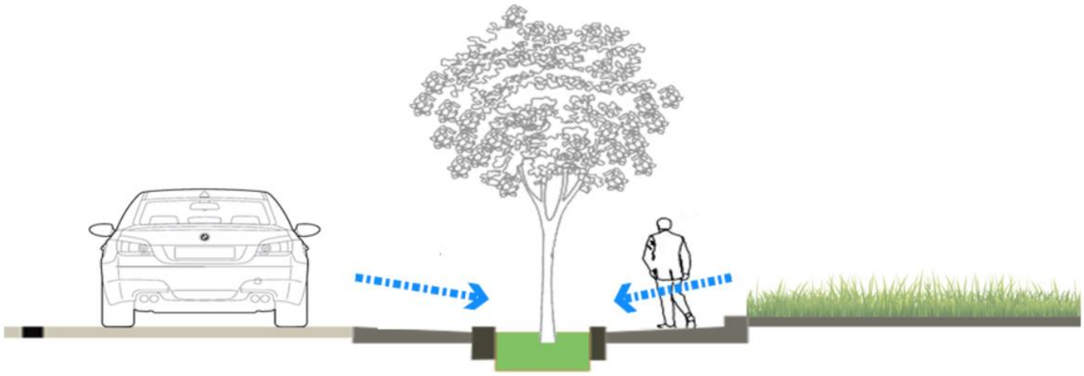


FIGURE 3.3.19 Pedestrian rain water collection

(Source: Made by author)

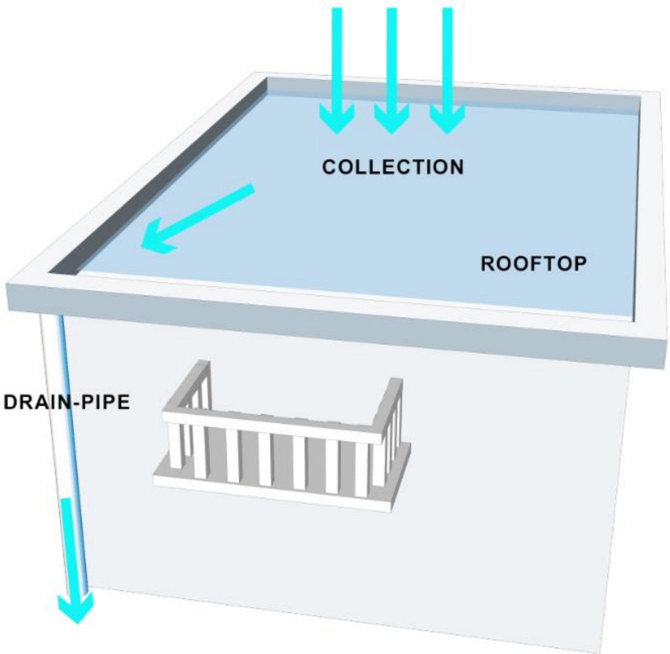


FIGURE 3.3.20 Roof rain water collection

(Source: Made by author)

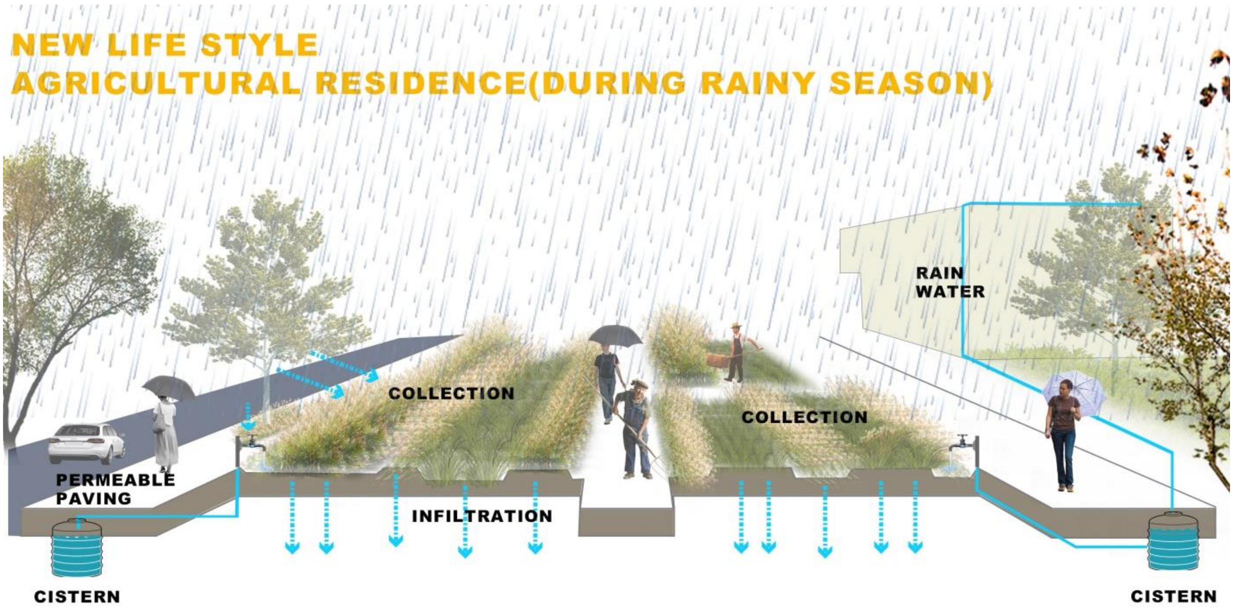


FIGURE 3.3.21 Concept during wet season

(Source: Made by author)

In the selection of crops, considering the climate of Shanghai and the influence of plum rain, flood tolerant plants are adopted, such as dates, potatoes, mung beans and so on.(Fig.3.3.22)

FIGURE 3.3.22 Crop selection

(Source: Baidu.com)

During the dry season, irrigation water is mainly stored in cistern during the rainy season, while grey water on residential buildings can continue to be collected for storage and utilization.

FIGURE 3.3.23 Concept during wet season

(Source: Made by author)

3.3.4.3.2 Permeable roads and squares

Is given priority to with conventional road system of city road, it is hard to meet people for the prevention and control of flooding, rainwater recycling, energy conservation and environmental protection needs, using Low impact development concept (LID) combination design of urban road scheme can maximum reduce the risk of urban flooding.

The previous design schemes usually only pursued the maximization of economic benefits. With the development of China's economy and society, the construction of ecological civilization has been constantly strengthened, and the requirements for environmental benefits and social benefits have become increasingly high. Therefore, urban road design schemes have changed to pursue the three goals of economy, environment and society.

LID urban roads and greening systems have many technologies and complex forms. Therefore, when planning LID design schemes, under the premise of meeting urban traffic needs and maximizing benefits, how to combine LID measures and conventional practices flexibly and orderly to obtain the optimal design scheme.

FIGURE 3.3.24 Main street of site

(Source: Made by author)

Road and square, as the activity site with a large flow of people in the community, the reconstruction of sponge landscape is an important node in the construction of sponge city.

In the renovation of the main road in the community, gravel that can filter and store rainwater is first laid on the bottom soil. When the rainwater quickly infiltrate into the soil layer, part of it will enter the underground reservoir or drainage pipe, and part of it will permeate into the underground to supplement the underground water source.

Then, in the gravel set on PP plastic aqueduct, and laid on the appropriate thickness of concrete, after concrete completely solidification, the drainage holes on the pavement are exposed and porous asphalt can continue to be laid on the pavement to make the community motorway a circulation path that can absorb water and breathe **[ying jun, qing-ping zhang. 2016].**

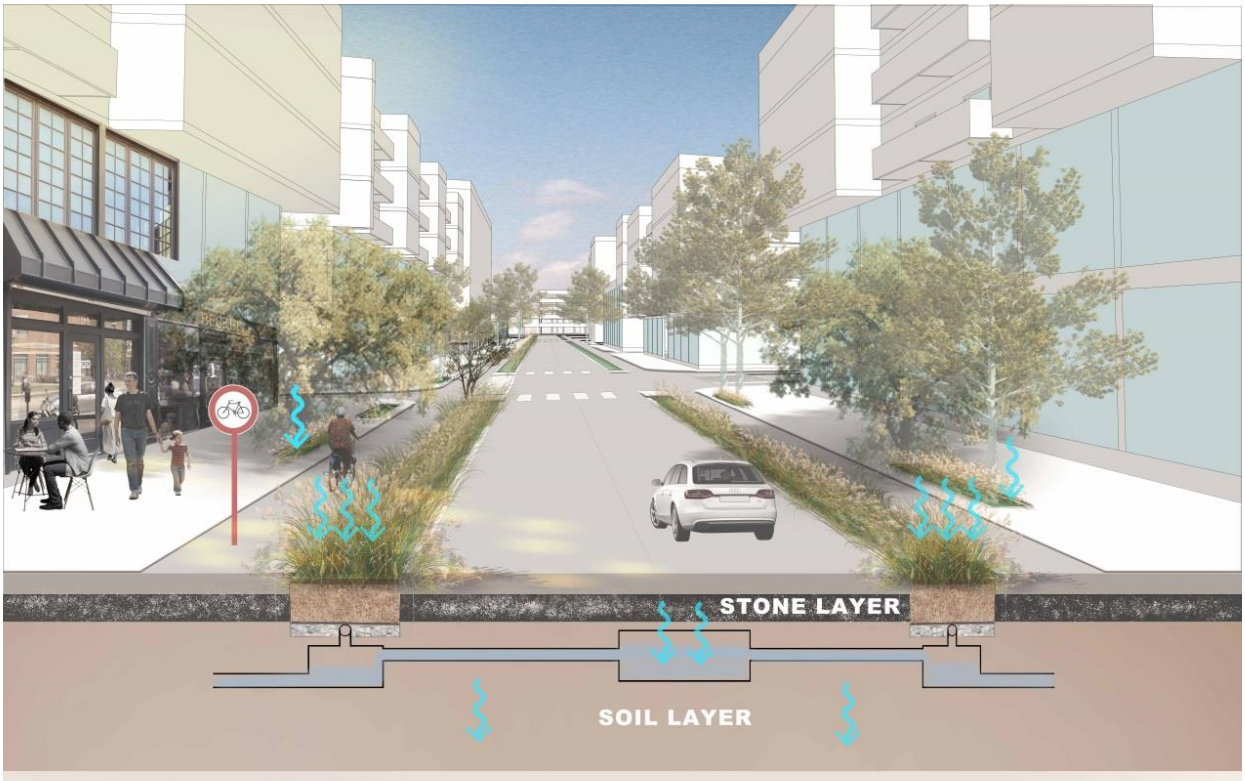


FIGURE 3.3.25 Main street of site

(Source: Made by author)

(1) Ecological bioswale

There are bioswale on both sides of the main road, planting some water-resistant shrubs or herbs, which is a long, channeled depression or trench that receives rainwater runoff (as from a parking lot) and has vegetation (such as grasses, flowering herbs, and shrubs) and organic matter (such as mulch) to slow water infiltration and filter out pollutants**.[New York Construction, 1 Nov. 2010]**

The ecological filter ditch is used to collect and treat the runoff from the surface rainwater collection. It is hoped that the treated rainwater will meet the landscape water consumption standard, so as to relieve the pressure of urban water supply and flood control. By means of rainwater collection, plant purification, filtration and storage, planting layer is added at the top of the traditional sand and stone filter bed to treat urban rainwater, so as to obtain better effluent quality, meet the commission requirements and store water.

Therefore, it plays a certain role in relieving the pressure of urban water supply, flood control, allocation of water source of drought and waterlogging, supplementing groundwater and regulating ecological microclimate. In addition, Bioswale can also make the street landscape more beautiful.

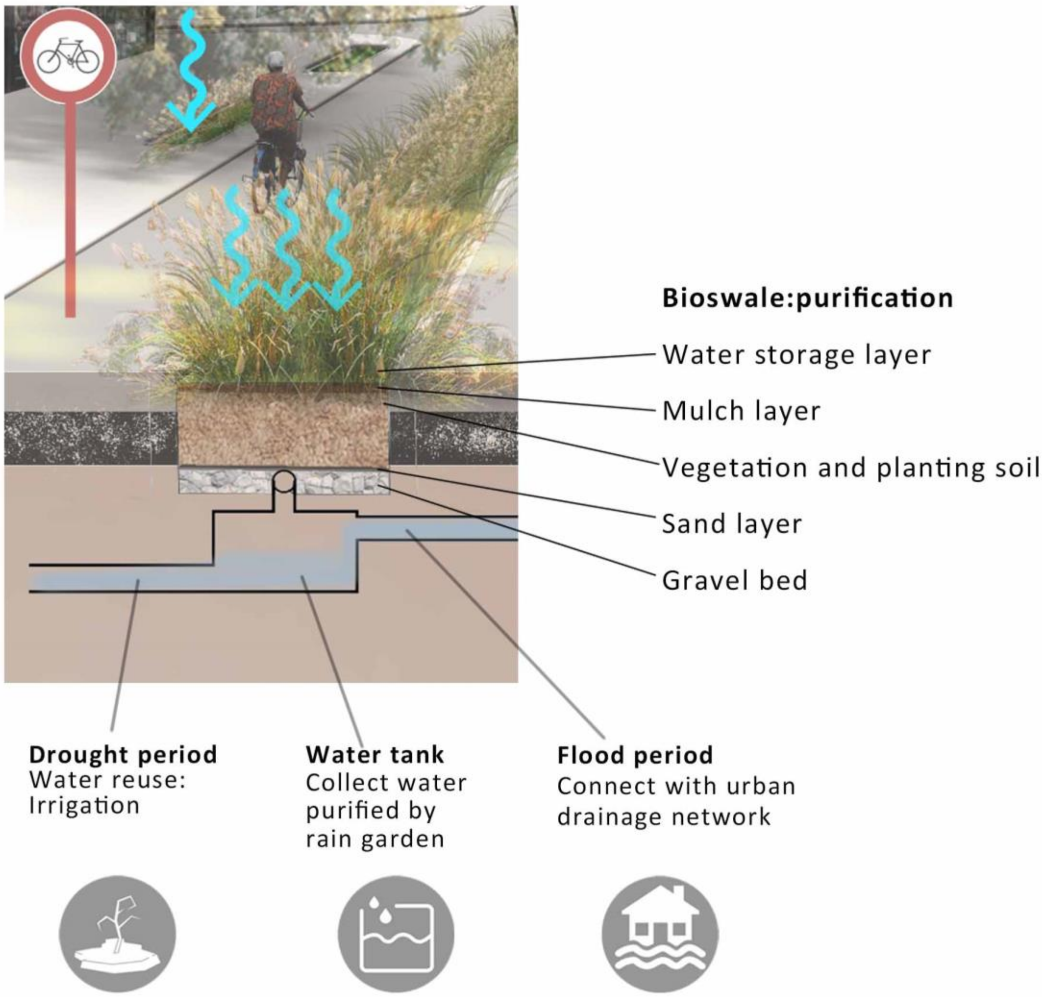


FIGURE 3.3.26 Bioswale

(Source: Made by author)

(2)Permeable pedestrian and road

For the landscape reconstruction of the square and other pedestrian , it is mainly laid with concrete pervious bricks. The permeable concrete bricks are mainly made of crushed stone and cement **[Xiao yue, zhao xiumin.2016]** It has been professionally processed and has relatively strong infiltration capacity of rainwater (FIG. 3.3.27).

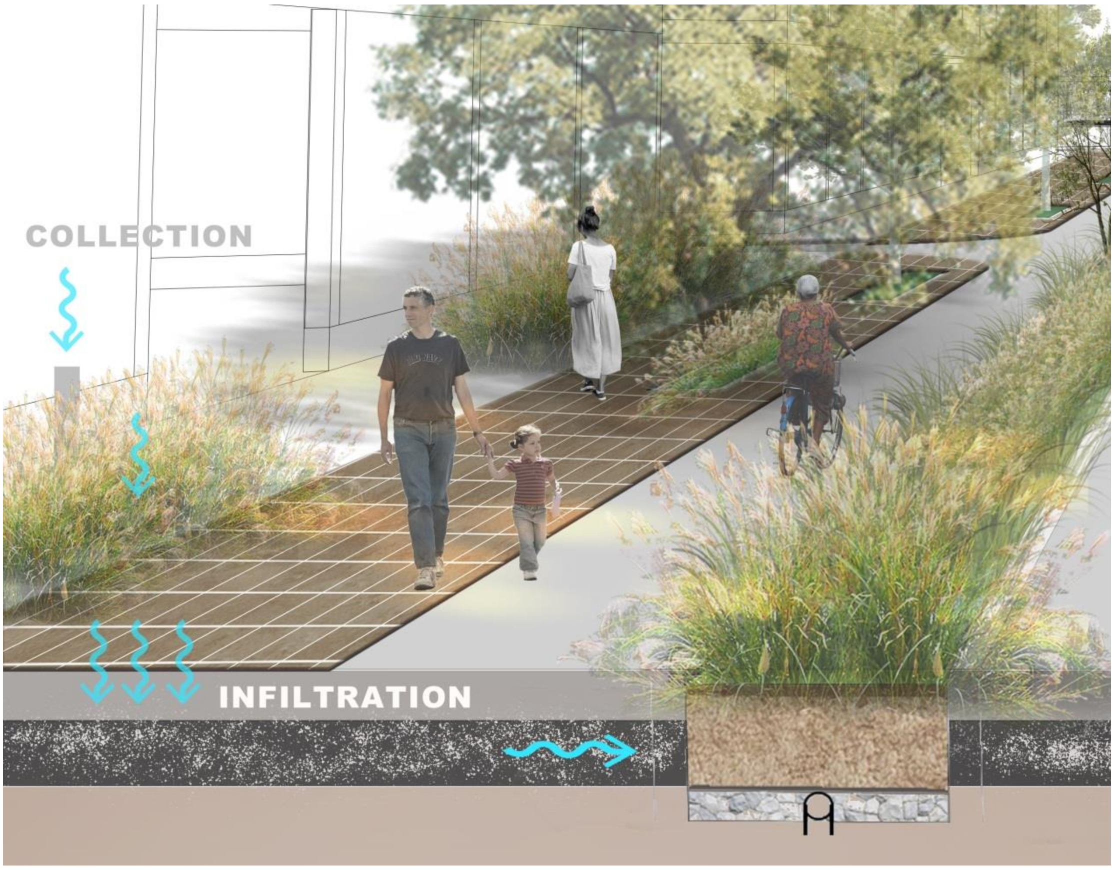


FIGURE 3.3.27 Permeable pedestrian

(Source: Made by author)

Permeable material on the pavement can not only promote the infiltration of rainwater to supplement groundwater, but also activate the surrounding soil, so that the surrounding green soil and air form natural convection. In order to enhance the aesthetic effect of the square, permeable bricks of different shapes, colors and materials are used to combine them into different patterns, so that the square is full of new vitality and vitality.

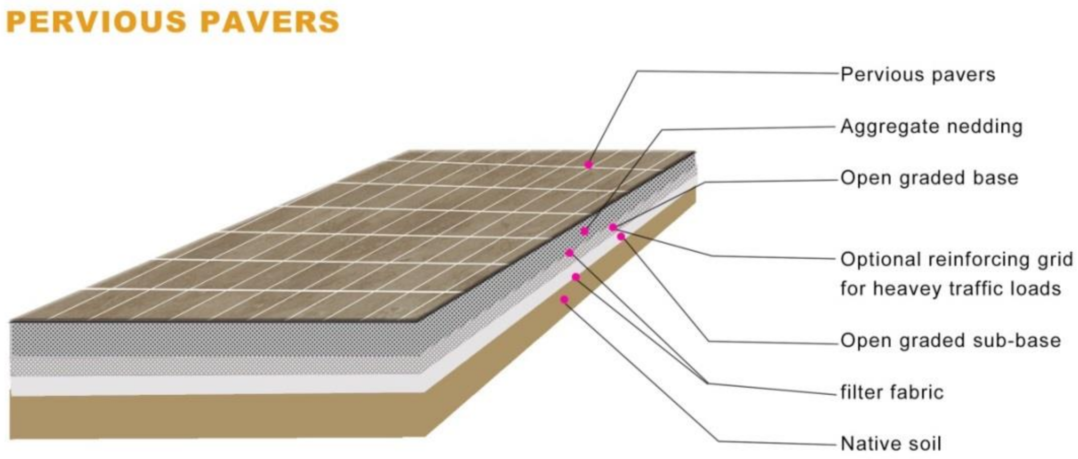


FIGURE 3.3.28 Structure of permeable pedestrian

(Made by author)

(Source: www.pinterest.com)

(3) Sponge renovation of community parking spaces

In the renovation of community parking Spaces, combined with the design concept of sponge city, in addition to meeting the basic functions of parking, a certain area of green space is set to retain the rain water of parking Spaces. Grass-planting brick has a strong compressive resistance, made of concrete, river sand and other raw materials, through high pressure brick machine vibration and pressure, good stability, and has a large green area. Therefore, the use of grass-planting bricks or grass-planting floors as the paving materials for parking Spaces can not only meet the parking needs of community residents, but also increase the green space area to ensure the natural infiltration of rainwater for parking Spaces.

FIGURE 3.3.29 Location od parking lots

(Source: Made by author)

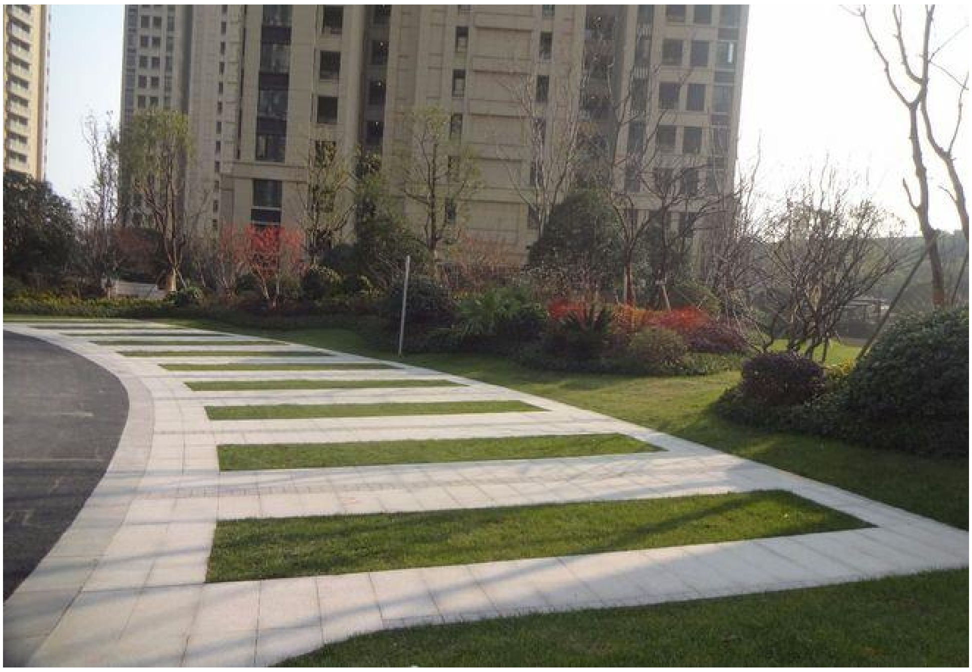


FIGURE 3.3.30 Permeable parking lots

(Source: baidu.com)

(4) Ecological Tree pool

Different from the traditional tree pool, the retained ecological tree pool can be used to collect rainwater from the open field while protecting the tree.

In the overall structure of the tree pool, its internal soil is connected, and the ground is separated by pavement to form an integrated tree pool zone, consisting of ecological growing area and ecological ecological storage area (Fig.3.3.31). The purpose of ecological growing area is to create a suitable habitat for soil community and form a good symbiotic relationship with street trees. The purpose of ecological storage area is to meet the needs of pedestrians and collect road rainwater for purification, storage and utilization. The two are interconnected and permeable to jointly create a suitable living environment for street trees. As a sponge facility in the city, the rainwater of urban roads can be regulated and absorbed to alleviate urban waterlogging.

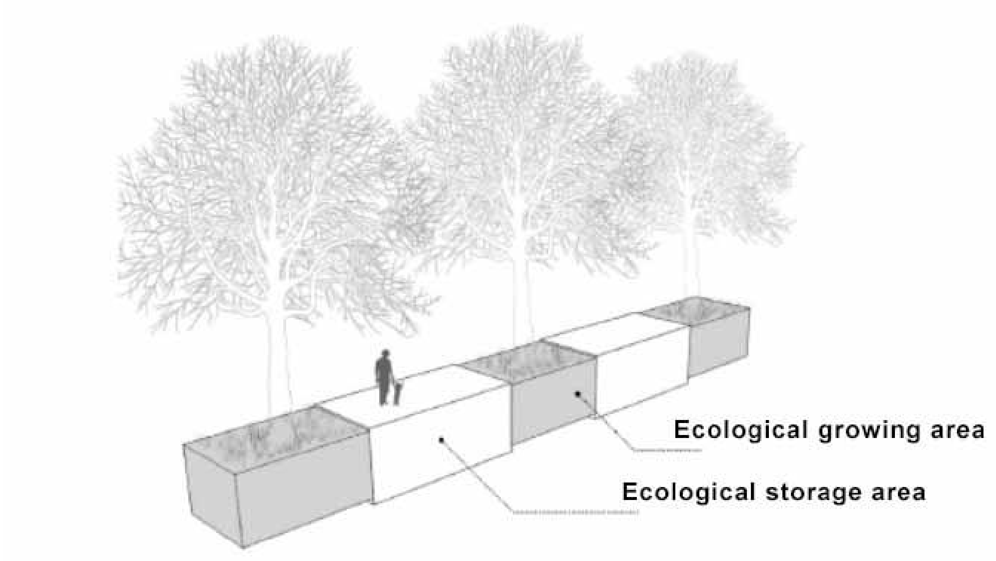


FIGURE 3.3.31 Tree pool structure diagram

(Source: baidu.com)

FIGURE 3.3.32 Section of tree pool

(Source: Made by author)

（5）Bicycle-friendly community

Public transportation or active transportation (including walking, cycling, etc.) is generally considered healthier and more sustainable than relying on private cars. Increasing bike sharing helps increase physical activity, which in turn reduces levels of obesity and cardiovascular disease, two major health threats in many developed countries. There is also considerable evidence that congestion, air pollution and energy consumption are greatly reduced when buses and active transportation replace private cars.

FIGURE 3.3.33 Bicycle system

(Source: Made by author)

3.3.4.3.3 Ecological green space

In this design, the renovation of the central park should have the following goals

1) Meet the rainwater storage target of the site

The planning and design goal of park green space based on LID is to recycle rainwater, combine rainwater utilization with the planning and design of park body, shape the park landscape and allow and utilize rainwater, and give full play to the ecological benefits of green space. Therefore, the design of park green space should first meet the site rainwater storage requirements.

2) Optimize drainage capacity of the site

If the rainwater pipe network around the park plot is relatively developed, and all rainwater in the park can be discharged into the rainwater pipe network without putting pressure on the rainwater pipe network, then the topographic design in the park can be mainly drained. The topographic design scheme should be the one with low stormwater runoff and relatively low rain-peak position.

On the contrary, if the rainwater pipe network around the site is relatively single and the instantaneous rainfall will bring great pressure to the drainage of the rainwater pipe network in the city, the vertical design of the park green space should optimize the drainage capacity as much as possible while satisfying certain storage capacity and reducing the external discharge of rainwater at the site.

3) Meet the needs of site landscape

In meet the ground line of rainwater storage function at the same time, should meet the demand of site landscape sex as far as possible, as the city park green space, provide a certain amount of view is its basic function, therefore, when the vertical design, ability of similar cases, the function of rain should try to choose landscape is better or more landscape potential retrofit scheme.

FIGURE 3.3.34 Master Plan of central park

(Source: Made by author)

Therefore, in the landscape transformation of Jiuxing Village Central Park, it is mainly transformed into rain garden or sunken green space. When it rains, the roof rainwater can flow through the ecological pool buffer, through the blind pipe into the rain garden, sunken green space or grass ditch, and can quickly collect the square and road rainwater, the excess rainwater will be discharged from the green space, to avoid excessive rain water formation waterlogging. Rainwater imported into the community green space, part of the rainwater pipe into the underground reservoir, the other part through the soil infiltration underground to supplement the underground water source. The rainwater garden is rich in wet plants, which have the function of water purification and landscape effect, and can play a good role in display and popularization of science.

While focusing on sustainability, the design of the park should be combined with residents' recreational activities. In the absence of rain, the grassy slope can also be used as a leisure site to create a vibrant community park.

FIGURE 3.3.35 central park

(Source: Made by author)

①Community landscape water sponge transformation:

Some plant roots can not only adsorb and retain granular nitrogen and phosphorus, but also secrete organic substances to promote microbial metabolism, so plants or microorganisms that can purify landscape water can be planted for water purification. The rainwater collected in the rainy water reservoir is used as the source of landscape water body, and artificial fountain, artificial spring and other dynamic measures are adopted to make the water body present dynamic aesthetic feeling. For the water with a high degree of pollution, the water body is firstly purified by chemical purification method, and then purified by plant purification method when the water body is less polluted.

As a stormwater collection facility, it can hold the peak flow of stormwater runoff for a temporary period, and then slowly drain the rainwater from the storage tank after the maximum flow drops. In this way, it can not only avoid the peak of rainwater flood and improve the utilization rate of rainwater, but also control the pollution of initial rainwater to the receiving water body, and also play a positive role in the drainage dispatching between drainage areas.

As we know from the previous article, the annual precipitation of Shanghai is more than 1100mm, which is abundant in terms of water quantity on the whole. The precipitation is mainly from June to September in summer, while other months are relatively dry season. The maximum monthly precipitation is 180mm in July, and there are also rare cases of no rain in some months.

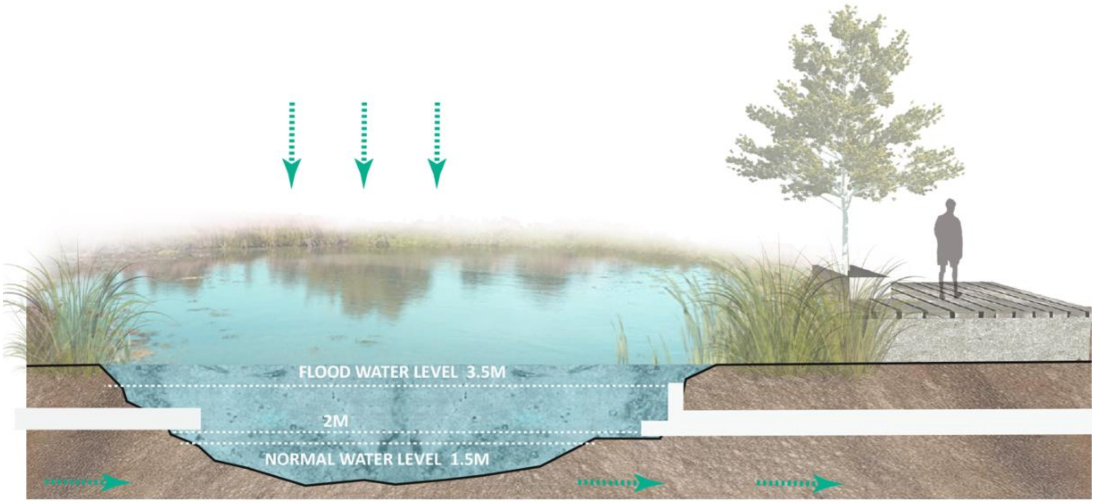


FIGURE 3.3.36 Section of retention pond

(Source: Made by author)

FIGURE 3.3.37 Retention pond

(Source: Made by author)

②The ecological corridor:

The green space of the whole site is connected by a green ecological corridor, which is also provided with walking access. Compared with the previous lifeless space, the daily activities of residents are now more closely connected with the site

Part of the green space adopts sunken green space to collect and purify water from the road or surrounding hard ground Concave green space is a kind of public green space whose elevation is lower than the surrounding road, also called low potential green space. Contrary to the "flower bed", the idea is to use the open space to accept and store rainwater, so as to reduce runoff and discharge. Generally speaking, low-potential green space has certain requirements on the depth of the depression, and its soil quality is mostly unimproved. Compared with the "line" of shallow gullies, the main "surface" can receive more rain water, and the plants inside are mostly native herbs.

The construction of more sunken green space for rainwater storage can make the surface paved into a state similar to farmland, slow down the speed of water flow and extend the storage time, so as to form a natural "reservoir" when it rains.

In this way, green space not only decompresses downstream drainage, but also revives the natural ecological cycle of the city.

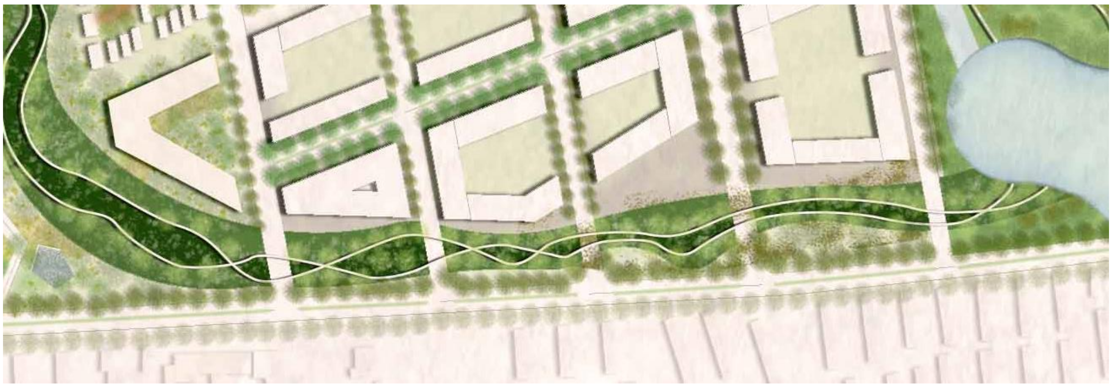


FIGURE 3.3.38 Master Plan of ecological corridor

(Source: Made by author)

FIGURE 3.3.39 Ecological corridor

(Source: Made by author)

3.3.4.3.4 Market and Commercial area

1) Open farmer market

Reserved area farmer's industry, and the modification of the farmer's market, make the whole market combined with a sustainable living community, to encourage new residents in local urban agriculture at the same time, make relevant community and agricultural functions, such as restaurants, the market is adjacent to planting channel, to create an opportunity for the future economic development and innovation.

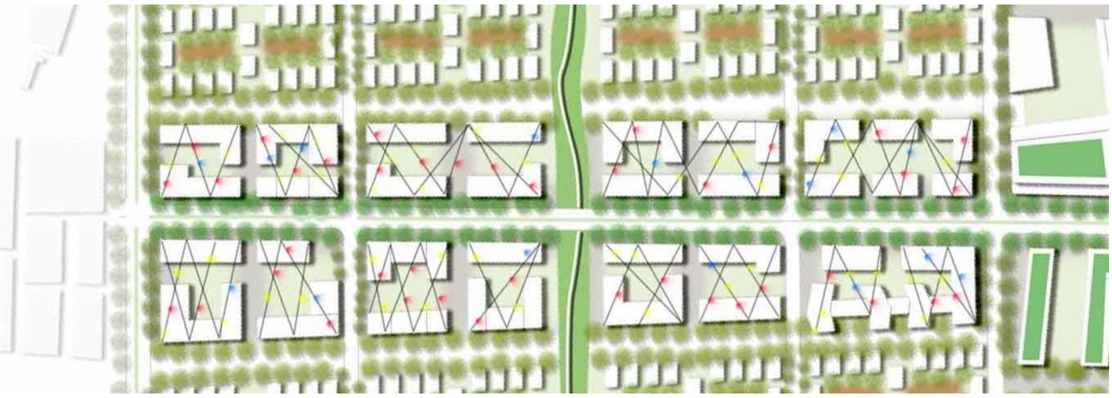


FIGURE 3.3.40 Market plan

(Source: Made by author)

FIGURE 3.3.41 Market

(Source: Made by author)

2）Commercial Area

Planning of Shanghai, near the northwest of the site has a large area, therefore in the regional planning is not considered a large shopping center, through the analysis above, In jiuxing area, the residents' income of major industry for hardware furniture decoration, etc., so commercial area planning is mainly composed of these industries, continue to make contributions to the region's most powerful economic income.

FIGURE 3.3.42 Shanghai "One zone, One belt, One core" development

(Made by author)

(Source: http://n.eastday.com/mnews/1599700400021111)

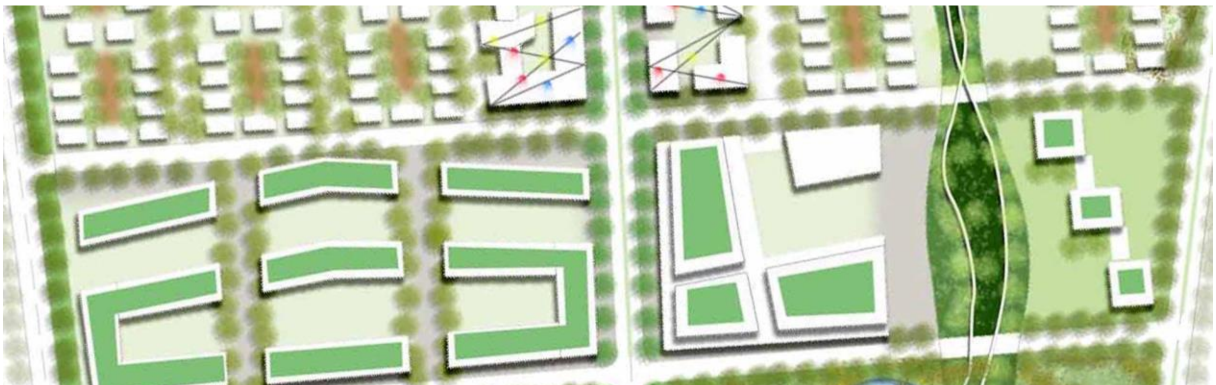


FIGURE 3.3.43 Commercial area

(Source: Made by author)

Due to the large volume of the commercial building, green roof was designed for the sustainable perspective in the commercial building. Green roof can not only create a habitat environment, also increased the human living environment of green space, reduce the urban heat island benefit, stranded in the rain, and reduce the atmospheric pollution, increase the area of the habitat, naturally will enhance the city's diversity, affect the urban ecological environment and enhance residents' quality of life of biodiversity are important factors. **(Lu Yun. 2016).**

(1) reduce the urban heat island effect

The heat island effect was proposed by the scholar Mitchell in 1961. Since urban building materials are mainly concrete, their heat conduction ability and heat storage are relatively high, which is the main reason for the temperature difference between urban and rural areas at night. And due to the lack of green shade in the day, and so on absorption of radiation heat in the day, and will the existence of a large number of concrete and other man-made building materials, so that at night time, after the surrounding air is cold, city under the influence of concrete building materials gradually release heat energy, indoor temperature and buildings around the high temperatures continue (figure 3.3.44).

FIGURE 3.3.44 Heat island effect

(Source: Made by author)

The study on the impact of urban development on climate shows that in addition to the warming of the climate, the large areas of roads, the reduction of green space and the effect of dense buildings, industrial dust, and exhaust emissions from combustion caused by urban development make the temperature difference between urban areas and rural areas obvious, especially at night.

Greening can effectively slow down the heat island effect, the use of transpiration can be natural cooling temperature, by figure, according to the city center due to less trees and vegetation, and buildings and the narrow streets of intervening hindered the flow of air, result in hot air trapped in the meantime, combined with the exhaust from cars and factories, and the release of heat exchange in air conditioning system makes the temperature of environment, it also increased the heat island effect, the influence of the temperature difference between the suburbs and downtown can be up to 10 ° C. The green vegetation that roof afforestation place increases can alleviate city heat island effect, because the moisture that plant transpiration place releases, can make the temperature of its surroundings drops, want to use asphaltene and concrete to wait for material less only, and a few roof afforestation, the temperature in the city can drop.

In addition to the above factors, the heat island effect is also closely related to the weather, climate, water resources and topography of the region. Plants play an important role in the hydrological cycle. Plants can block and adsorb filtered rainwater, soil and water conservation, and affect the surrounding humidity. Make the surrounding microclimate comfortable and suitable for human habitation. Therefore, green plants can regulate the humidity in the atmosphere and purify the air to reduce the temperature. Green roof not only improves the urban landscape, but also has an obvious effect on reducing the heat island effect.

(2) relieve urban rainwater problems

In the face of global water shortage, countries all over the world are paying attention to the collection and utilization of rainwater. At present, rainwater collection on the roofs of most buildings in China depends mainly on the roof drainage of buildings. The roof rainwater is collected in the roof gutter and then collected in the downpipe, which is discharged to the ground or drainage pipe. In many cities, old urban areas do not allow for the diversion of rainwater and sewage, which leads to overloading of drainage systems and prone to water accumulation during the rainy season. In addition, the constant exploitation of groundwater in cities, which cannot be replenished, will easily lead to surface subsidence and lead to new groundwater disasters. In nature's water cycle, 30 percent of rainwater is absorbed by plants, 30 percent by soil, and 40 percent is returned to the air by evaporation, thus reaching a balance. In cities, however, 80-100% of the ground is impermeable, resulting in only

5% of the water being absorbed by the soil, 15% returning to the air, and 75% being expelled from the hard ground. Green roof can effectively soften the hard surface of the city, accumulation of rain water, relieve the pressure on urban stormwater and flood.

The results show that 64.6% of rainwater can be intercepted by garden-style green roofs, 21.5% by simple roof greening, and on average, planting roofs can intercept 43.1% of rainwater.

(3) reducing urban air pollution

Rooftop plants can absorb carbon dioxide and sulfur compounds in the air, and plant leaves can absorb dust particles floating in the atmosphere, greatly improving the quality of urban air.

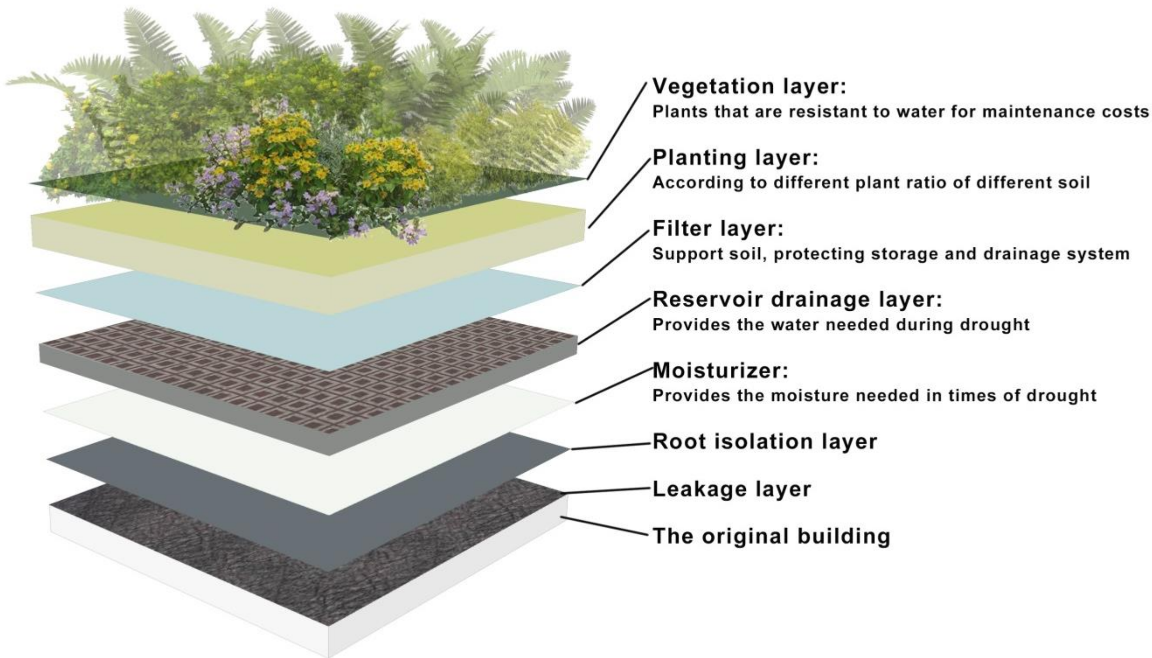


FIGURE 3.3.45 Green roof structure

(Made by author)

(Source: www.pasteurfood.com)

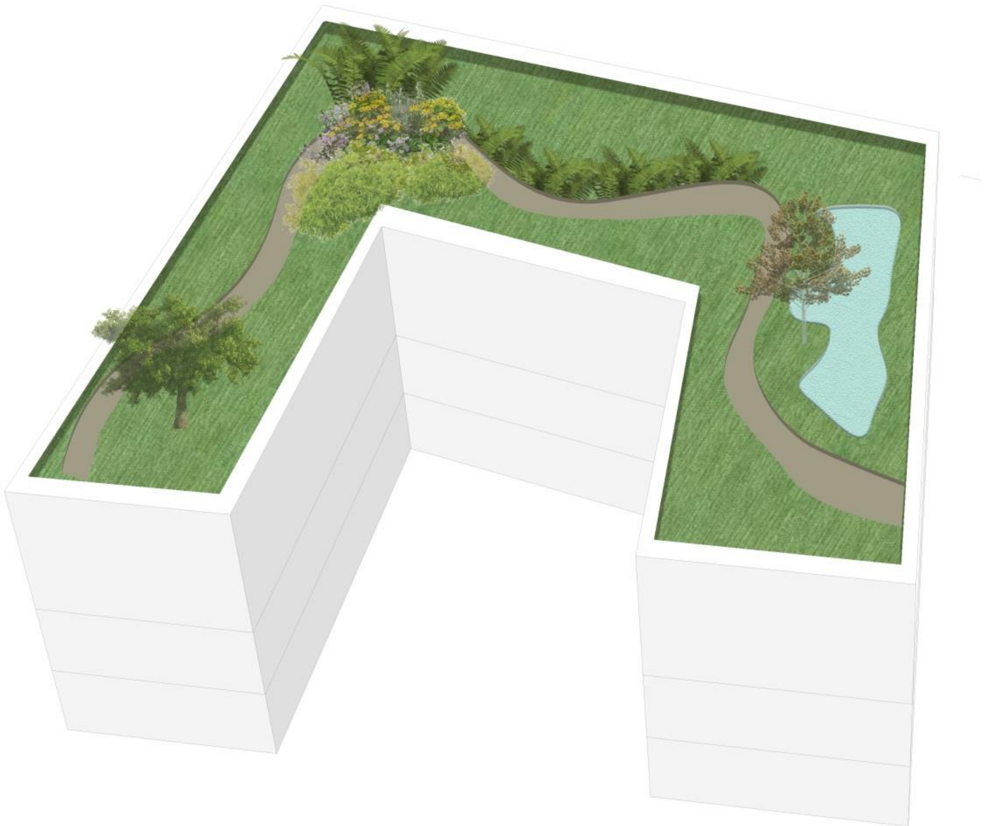


FIGURE 3.3.46 Green roof

(Source: Made by author)

3.3.4.3.5 Plant landscape planning

1) Status quo of local tree species in Shanghai

The site vegetation is selected as local tree species in Shanghai. There are 35 local tree species in Shanghai, which can be divided into 5 species: evergreen broad-leaved tree, semi-evergreen broad-leaved tree, deciduous broad-leaved tree, deciduous coniferous tree and deciduous broad-leaved small tree.

According to the application scene is divided into: Camphor, privet, Acacia, Neem , mainly used in urban parks green; In addition, there are ginkgo, maple, Beech, magnolia, camphor trees, mostly used in the road, along the river greening and commercial entertainment center. In the local climate of Shanghai, semi-evergreen broad-leaved trees have better growth performance compared with other tree species, while other tree species are more suitable for flower and fruit viewing and have higher ornamental value.

Shanghai existing 84 kinds of shrubs native tree species, most species distribution in the front room, empty, rural housing land, in addition to gold leaf privet, cuckoo, Nandina domestica Thunb can be used as a hedge or ball, other species has been well developed at present

There are 9 kinds of climbing plants in Shanghai, such as Chinese wistaria and Vines climbing plants. According to the growth habit can be divided into deciduous rattan and evergreen rattan species. These tree species are basically in the wild growing environment, but rarely used in urban greening.

2) Local tree species should be the main choice of site vegetation

① Adaptable

Native tree species are the result of long-term screening of nature, and most native tree species can adapt to various local extreme weather, such as extreme low temperature, extreme high temperature, etc.

At the same time, it also has a strong ability to resist diseases and pests, even if the attack of diseases and pests, but also through their own immune system regulation recovery. Compared with exotic tree species, it has strong resistance and higher ecological value. Using native tree species in greening project can not only improve the community environment, but also promote the production development of local nursery stock.

②Easy to manage

Native tree species are abundant in resources, which are convenient for introduction, cultivation and domestication. Related technologies are also relatively mature, and the cost of planting is relatively low. In addition, native tree species have a high survival rate, can be extensive management, do not need to invest too much manpower and material resources can maintain the long-term stability of tree species structure.

③ It has cultural regional characteristics

Like urban landmark buildings, native tree species are highly identifiable and can be used as an important symbol of a city. People can identify the city by native tree species and associate the local landscape characteristics. For example, the cherry blossom in Japan, the red maple in Canada, the redwood in The United States, the Phoenix wood in Xiamen, and the red leaves of The Fragrant Hills in Beijing are all important symbols of a country or region.

3）Park green space not only has the function of visiting and resting, but also has the function of renewing and protecting plant species. Native tree species can play the function of biological purification and provide abundant species resources for urban parks and green space.

Therefore, metasequoia, Magnolia grandiflora, camphor tree, cypress for evergreen species, Chinese rose, michelia alba, weeping willow for deciduous tree species. The choice of road tree is mainly good water resistance, easy to grow and maintain, Smoke-resistant, harmful gas-resistant, so choose zelkova schneideriana, Osmanthus, Albizzia julibrissin ， Magnolia grandiflora as the road tree species.

CENTRAL PARK	SPECIES
Evergreen species	Metasequoia,
	Magnolia grandiflora,
	camphor tree
	Cypress
Deciduous species	Chinese rose
	Michelia alba
	Weeping willow

STREET	SPECIES
	zelkova schneideriana
	Osmanthus
	Albizzia julibrissin

	Magnolia grandiflora

FIGURE 3.3.47 Vegetation distribution

(Source: Made by author)

3.3.5 Conclusion

FIGURE 3.3.48 Master plan

(Source: Made by author)

The design of the project from housing, market, business, entertainment and other different functions to consolidate the integrity of the community, the increase of employment opportunities, the diversity of living patterns, so as to become a more sustainable development of the model of the community, for the local residents living environment and quality of life has a positive impact.

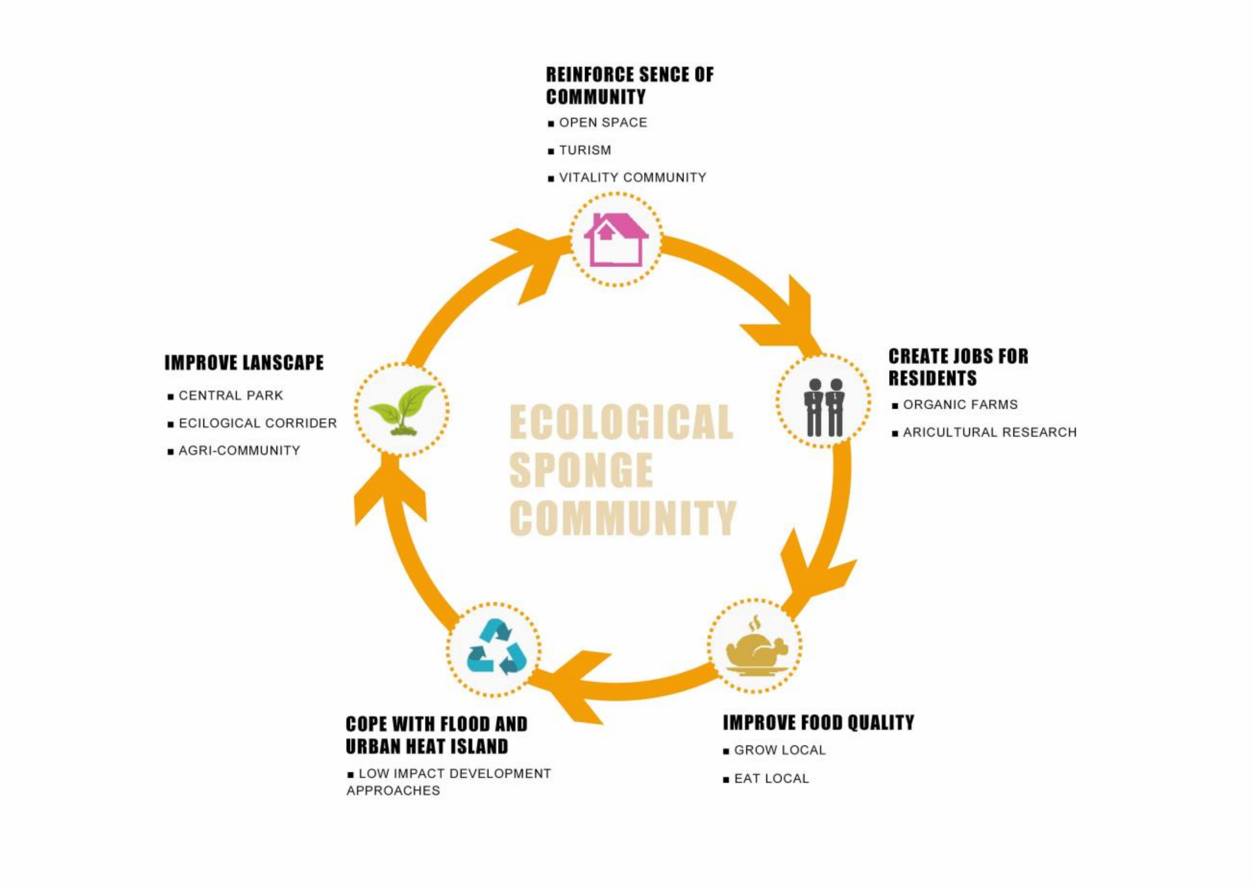


FIGURE 3.3.49 Result of ecological sponge community

(Source: Made by author)

3.4 Ecological country park beside the Hongqiao Airport

3.4.1 Introduction

It is one of 16 pilot sponge cities planned by Shanghai. The site is located to the west of Hongqiao Hub in Minhang District of Shanghai, 19km from downtown Shanghai, and takes 52 minutes by public transportation.

The airport is tourists' first impression of a city, which is equivalent to a 'city name card'. In addition, there are Shanghai National Convention and Exhibition Center, which integrates convention and exhibition, commercial office, shopping and entertainment, and Hongqiao CBD. Therefore, we hope to build this city into a country ecological park providing leisure places for surrounding residents and tourists. **[https://baike.baidu.com/item]**

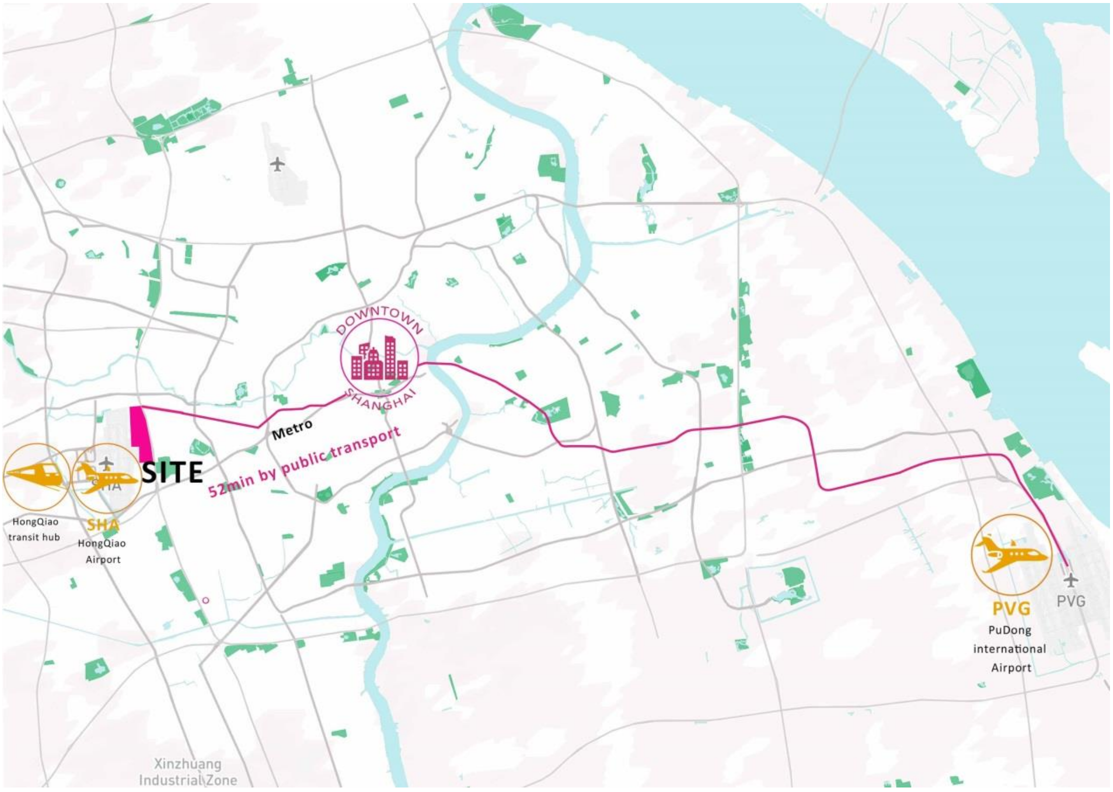


FIGURE 3.4.1 Location of site

Source: Made by author

FIGURE 3.4.2 Location of site

(Source: map.baudu.com)

FIGURE 3.4.3 HongQiao Hub

(Source: https://baike.baidu.com/pic)

3.4.2 Context analysis

3.4.2.1 Landuse analysis

As can be seen from the figure3.4.4, the site is adjacent to Hongqiao transportation hub, and the surrounding land is mainly for living.

On the west side of the site are Hongqiao Transportation Hub, Hongqiao CBD and Shanghai National Convention and Exhibition Center. Hongqiao transportation hub is composed of Hongqiao airport, Hongqiao railway station, Hongqiao maglev station, east-west transportation center, urban rail transit and so on. As one of the international hub portals, it has made outstanding contributions to the development of Shanghai and even the Yangtze River Delta region. With the gradual operation of Hongqiao Business District and National Convention and Exhibition Center, the passenger flow of Hongqiao transportation hub is increasing day by day.

The site is residential to the east and commercial to the north. Shanghai Zoological park is located in the southeast of the site. It was founded in 1954 and formerly known as Xijiao Park.Shanghai Zoo is a large national zoo. It covers an area of 743,000 square meters and has more than 400 kinds of animals on display, with a total area of 47,237 square meters. It is one of the top ten zoos in China and the second largest city zoo in China**. [https://baike.baidu.com/item/Shanghai zoological park]**

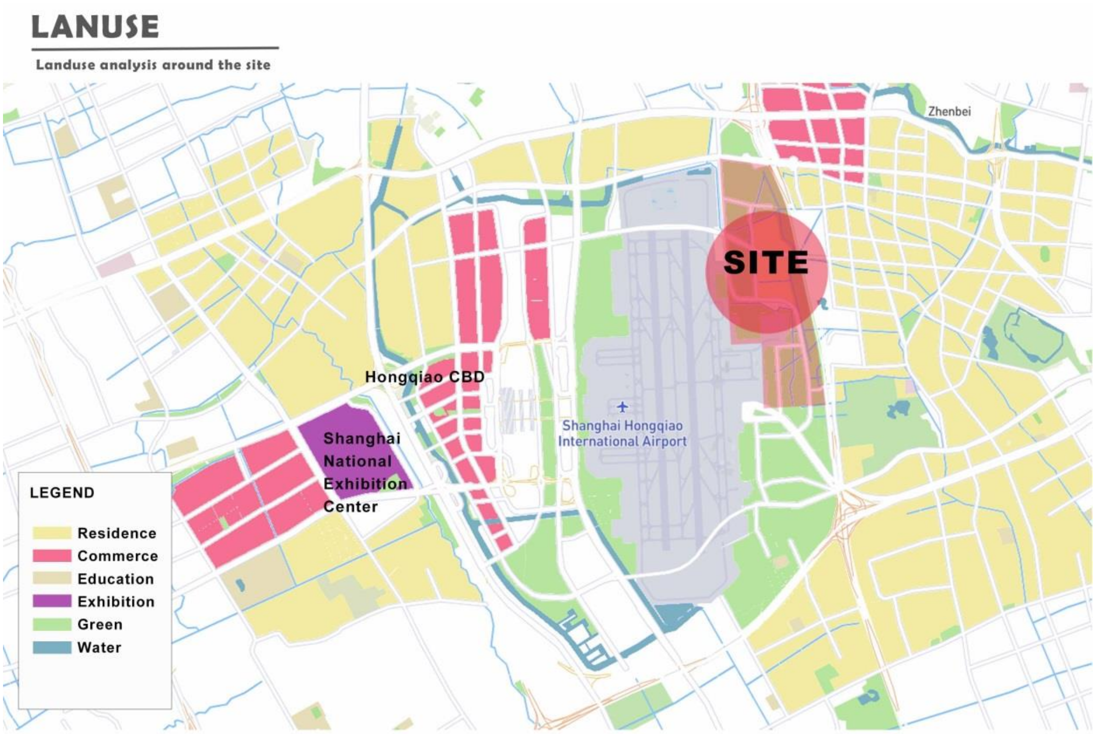


FIGURE 3.4.4 Landuse analysis

Source: Made by author

FIGURE 3.4.5 Hongqiao International Airport(Left) & HongQiao railway station(Right)

(Source: baidu.com)

FIGURE 3.4.6 HongQiao CBD(Left)&Shanghai International Exhibition Centre(Right)

(Source: baidu.com)

As can be seen from the green space analysis diagram, the green space around the site takes up a small proportion. (Fig3.4.7) Apart from some green space around the airport, the larger green space near the site is Shanghai Zoo.

Therefore, the green space park system is not perfect, the per capita park green space area is less.

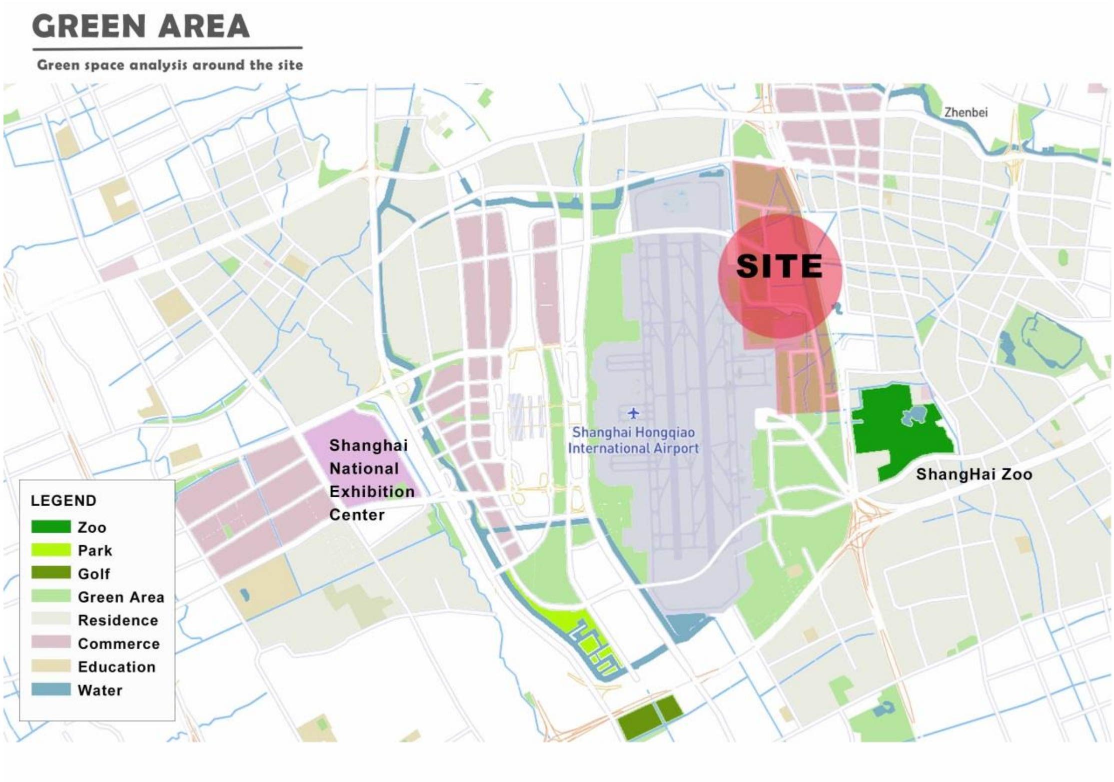


FIGURE 3.4.7: Green space analysis

Source: Made by author

FIGURE 3.4.8 ShangHai Zoological park (Left)&HuaXiang Park(Right)

(Source:map.baidu.com)

3.4.2.2 Transport analysis

Shanghai's urban outer ring S20 passes through the village, and it is connected to two ramp entrances of Guodai Road and Caobao Road from north to south (Fig.3.4.9). Xingzhong Road Station of Line 9 of Shanghai Rail transit, Hongxin Road

Station of Line 12 to be constructed and opened to traffic, and dozens of bus lines extending in all directions are convenient and convenient with superior location. (Fig.3.4.12)

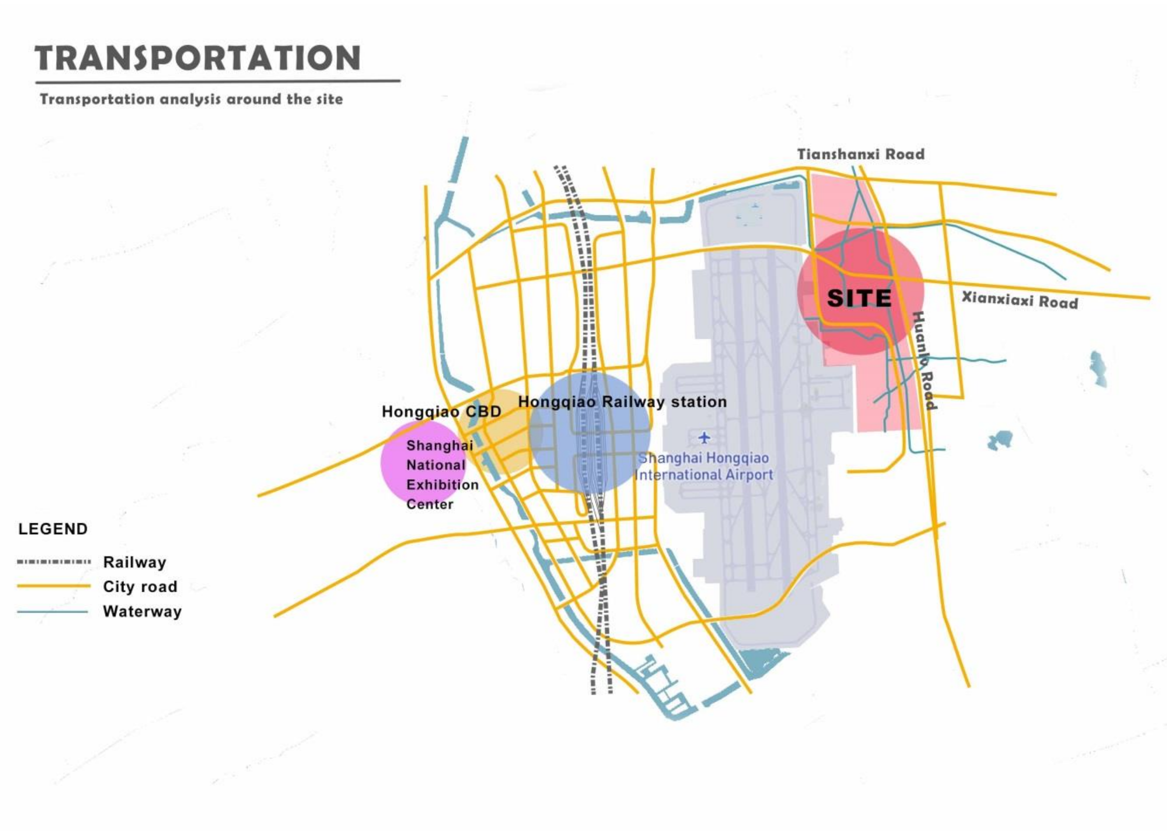


FIGURE 3.4.9 Transportation analysis

Source: Made by author

FIGURE 3.4.10 TianShan xi Road (Left) &S20 (Huanlv Road)(Right)

(Source:map.baidu.com)

FIGURE 3.4.11 XianxiaXi Road

(Source:map.baidu.com)

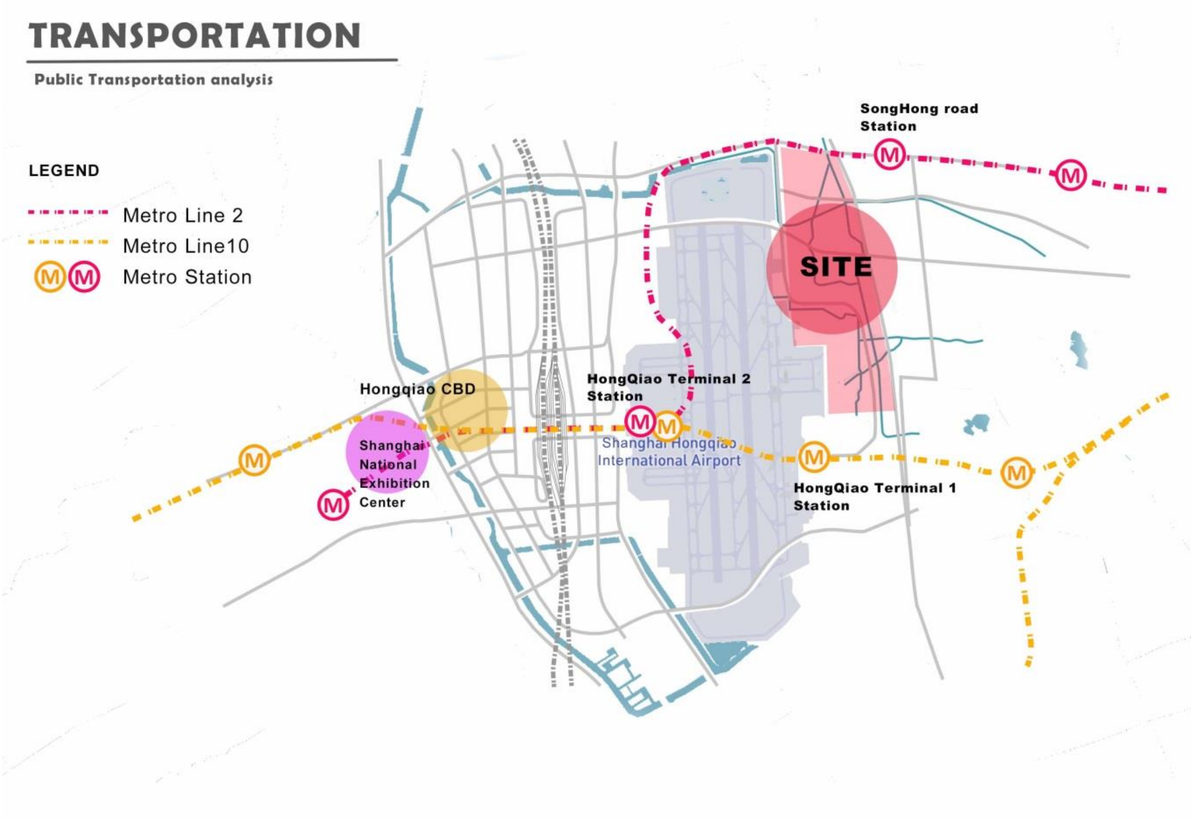


FIGURE 3.4.12 Public transportation analysis

Source: Made by author

FIGURE 3.4.13 Songhong rpad Metro station(Left)& Shanghai Zoo Metro station(Right)

(Source:map.baidu.com)

3.4.3 History and development

Shanghai Hongqiao transportation hub is the Shanghai Yangtze river delta, facing the whole country and the window of the world, the great Hongqiao state exhibition center from Hongqiao transportation hub is only 2 km, from the subway line 2 Xu hengjing station can very quick arrived in Hongqiao railway station, Hongqiao international airport, Shanghai free trade zone, Pudong international airport, which can realize arrive in two hours in major cities throughout the Yangtze river delta.

Stage1:

In 2003, the Beijing-Shanghai high-speed railway was listed in China's first national high-speed railway project plan. In 2004, the Ministry of Railways of China negotiated with Shanghai Municipal Government on the site selection of Shanghai high-speed railway station. The three main and passenger stations originally determined by the Shanghai General Plan (2001 edition) constitute the overall layout of Shanghai railway passenger transport hubs. However, due to the changes in the layout of Pudong Railway station and Pudong bus Station, and the insufficient Shanghai Railway Station and Shanghai South Railway Station to assume the functions of large hubs, it is necessary to re-select the appropriate high-speed railway sites. The Ministry of Railways first proposed to build a high-speed railway station around the then Qibao Station. However, after careful study, Shanghai considers it inappropriate to build a high-speed railway station near Qibao Station, mainly because the urban spatial pattern of Shanghai and the transportation framework inside and outside the city are not suitable, and the land conditions of Qibao town can not meet the requirements of the hub.

In 2006, Shanghai decided to build Hongqiao Comprehensive Transportation

Hub on the west side of Hongqiao Airport, which will combine Hongqiao new terminal building, Beijing-Shanghai high-speed rail transit, Yangtze River Delta high-speed intercity line and city bus system **(Xu Yisong, Yao Kai, Huang Jianzhong, 2008).** In 2010, Hongqiao Hub was officially put into use.In the early stage of the completion of the hub, the functional development of surrounding cities was relatively slow. At this stage, Hongqiao paid more attention to how to reduce the problem of fast link with the central city. The construction of transportation supporting facilities such as Metro Line 2 and Line 10, Songze Viaduct and Shanghai-Chongqing Expressway was the key point in this stage.

Stage 2:

Urban functions gradually import, form important for the growth of lead in the west of Shanghai, in 2008, the Shanghai municipal party committee and municipal government will make the construction of the hongqiao business district strategic decision, synchronization in the development of the transport hub and the combination of urban land use planning study **[Zheng degao, Cai Zhen, 2008]** the cultivation and construction of urban function is after 2013, as the core to start construction, hongqiao area began to import the urban functions, gradually formed the international fortune 500 companies and business functions of the corporate headquarters agglomeration of Yangtze river delta, and form a complete set of residential, public service facilities have been put into use,It also brought in jobs and a rapid inflow of permanent residents.

In this period, because the urban function is still being cultivated and the traffic function is not perfect, the contradiction between the two has not really appeared. It is worth noting that during this period, the Ministry of Commerce proposed to build a National Convention and Exhibition Center in Hongqiao, which once caused a great controversy because of the problem of traffic bearing and supporting capacity. At this time, the contradiction between regional functions and urban and traffic functions began to appear. However, in the long run, with the opening of the 2018 Expo, we will see more benefits than disadvantages of the exhibition center on the development of Hongqiao hub area.

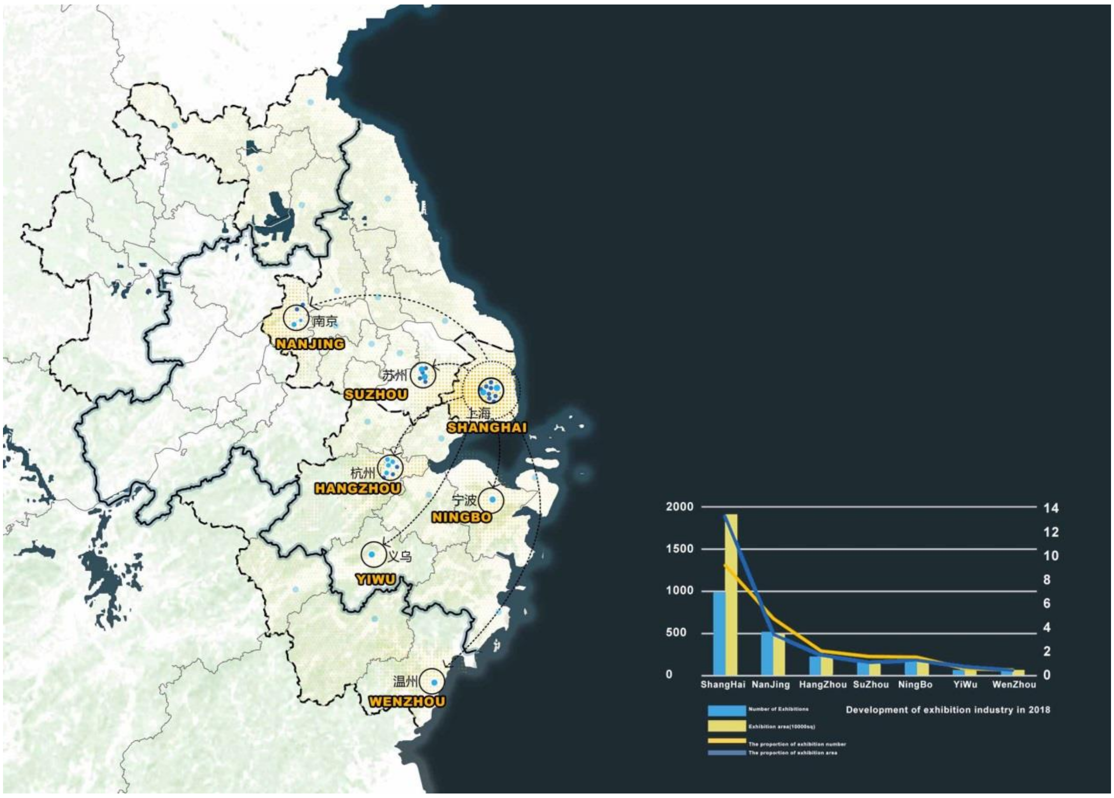


FIGURE 3.4.14 Exhibition industry

(Source: Made by author)

stage 3:

The integration of the Yangtze River Delta has entered a new period. The introduction of regional functions and the promotion of the integration of the Yangtze River Delta as an international open hub of Hongqiao has become a national strategy, marking that regional integration has entered a new period. Meanwhile, the convening of the 2018 Import Expo is a landmark node for the development of Hongqiao hub region.

It has become an important measure to implement the national strategy of the integrated development of the Yangtze River Delta to build Hongqiao International Open Hub and further enhance the hub function of serving the Yangtze River Delta and connecting the world. Hongqiao district area function has developed rapidly, in international and regional headquarters to gather at the same time, further derived from the Yangtze river delta international trade exhibition center, the Yangtze river delta electric business center platform and a series of regional function, meanwhile hongqiao also built with new hongqiao international medical center, as a representative of the service area of the public service facilities. At the same time, Hongqiao has also built public service facilities in the service area represented by the New Hongqiao International Medical Center. The agglomeration of regional business functions, functional platforms and public facilities greatly improves the regional radiation function of Hongqiao hub area. However, the rapid agglomeration of regional functions and the interweaving of relatively mature transportation and urban functions make the development contradiction of Hongqiao hub area increasingly prominent.

FIGURE 3.4.15 Collage of history of Hongqiao Transportation Hub

(Source: Made by author)

3.4.4 Strategies for coping with climate change

3.4.4.1 Challenges and goals

In the past five years, the total amount of commercial office buildings around Hongqiao Hub has been transferred to about 7 million m^2, nearly 60% of the total planned commercial buildings, and the urban function development is dominated by commercial office buildings. The rapid transfer of land brings insufficient preparation for the spatial support of major regional functional projects, and it is also difficult to adjust the functions in the future. Especially around the convention and exhibition center, with the entry of the expo, a number of related industries have been derived, and new requirements have been put forward in terms of supporting services. However, the problem of lack of development space around the center is serious, and the conflict between urban functions and regional functions in the demand for development space has become a reality.

The lack of agglomeration space supports the functional development of the surrounding areas of Hongqiao, which is very unfavorable to play the role of radiation service to the Yangtze River Delta. Hongqiao, on the other hand, there is a special phenomenon of "enclave economy", is apart from the incomplete statistics, the Yangtze river delta around a dozen cities in Hongqiao purchased the building property, but its function level is low, how their own investment promotion platform for the city, taking up Hongqiao limited space resources, failed to fully embody the hongqiao area function of radiation. The third reason is the challenge of urban space quality brought about by the multi-population agglomeration from the region.

In recent years, the cultivation of urban functions in Hongqiao mainly focuses on the industrial functions mainly focused on commerce and business, while the supply of urban supporting functions such as housing, public facilities and public space is seriously insufficient. At present, 450,000 permanent residents have gathered in Hongqiao hub area, but only 15% of the employed people live locally. The separation between jobs and housing is a prominent problem. In terms of public services, there is a single public activity center dominated by the core area, and there is a lack of regional centers and community centers for local services. Public service facilities such as culture, education and sports are mainly district-level facilities and lack of high-grade facilities. The green space park system is not good, the per capita park green space is only $7m^2$/ person. The urban service function of Hongqiao not only needs to meet the demand of the permanent resident population, but also needs to respond to the future employment population of about 700,000-750,000 people, the daily average exhibition crowd of 80,000-100,000 people and a large number of regional hub commuters. Therefore, higher standards must be put forward in the planning and construction.

3.4.4.2 Concept

Therefore, on the existing basis, a country park is planned and designed on the east side of the airport. On the one hand, it can improve the surrounding environment of the site, increase the green area, and alleviate problems such as flood and urban heat island.

On the other hand, the establishment of the country park can attract tourists to come to the exhibition or play, making this area not only an exhibition area, a business area, but also a place to spend 24 hours with their families.

Principles for sponge reconstruction of country parks：

(1) parallel principle of ecology, landscape and engineering

City park in the process of sponge reformed to follow the principle of ecology, landscape and engineering in parallel, the construction of country park sponge system to maintain the ecological balance, strengthen the sponge effect of country park, the landscape level to sponge facilities for landscape, with the normal function of the sponge both landscape beautification effect at the same time, improve the quality of park space vision, and create a charming landscape.**[Wang Haitao, Chen Zhaoxia, Wang Zhinan, Ding Chao, Chengyu.2016.]** The harmony and unity of ecology, landscape and engineering should be achieved in the sponging transformation of

(2) Planning guiding principle

Urban parks, as an important carrier of "sponge" in a region, should also follow the guiding principle of planning to integrate the sponge ecosystem of country parks into the overall urban construction, so as to ensure the orderly conduct of sponging reconstruction in the planning and construction.

(3) The principle of adapting measures to local conditions

Adhere to the principle of sponging transformation according to local conditions, conduct a detailed analysis of the location, natural environment and hydrogeological conditions of the urban park, summarize and formulate the objectives of sponging transformation, so as to ensure that it can achieve organic unity with the urban construction system.***[Li Yongchang. 2016.]***

Shanghai belongs to the coastal zone, the cold air from the north and the warm and wet air from the ocean alternately affect the weather in Shanghai all the year round. This has brought abundant precipitation to Shanghai, whose annual average precipitation can reach 1200 mm, with an average rainfall day of 135 days. Moreover, the precipitation in flood season is concentrated, more than half of the annual precipitation. In addition, Shanghai is crisscrossed by rivers in the city, which is prone to disasters under the influence of heavy precipitation in flood season. If the typhoon hits again, the precipitation will be difficult to be timely channelled, and urban waterlogging is easy to form. Especially in recent years, the abnormal global climate change and the frequent occurrence of extreme heavy rainfall have caused great pressure on Shanghai's urban drainage system. So in the new round of urban planning, urban greening industry to carry out "sponge city" construction requirements, pay attention to the water rate, green land area and height control, scientific layout, through the roof greening, recessed greenbelt, biological detention ponds, rain garden, permeable pavement combination of measures, such as increase the natural repair capacity of water ecosystem and the level of disaster prevention and mitigation, and realize the rain deposits of natural, natural, natural purification of virtuous circle.

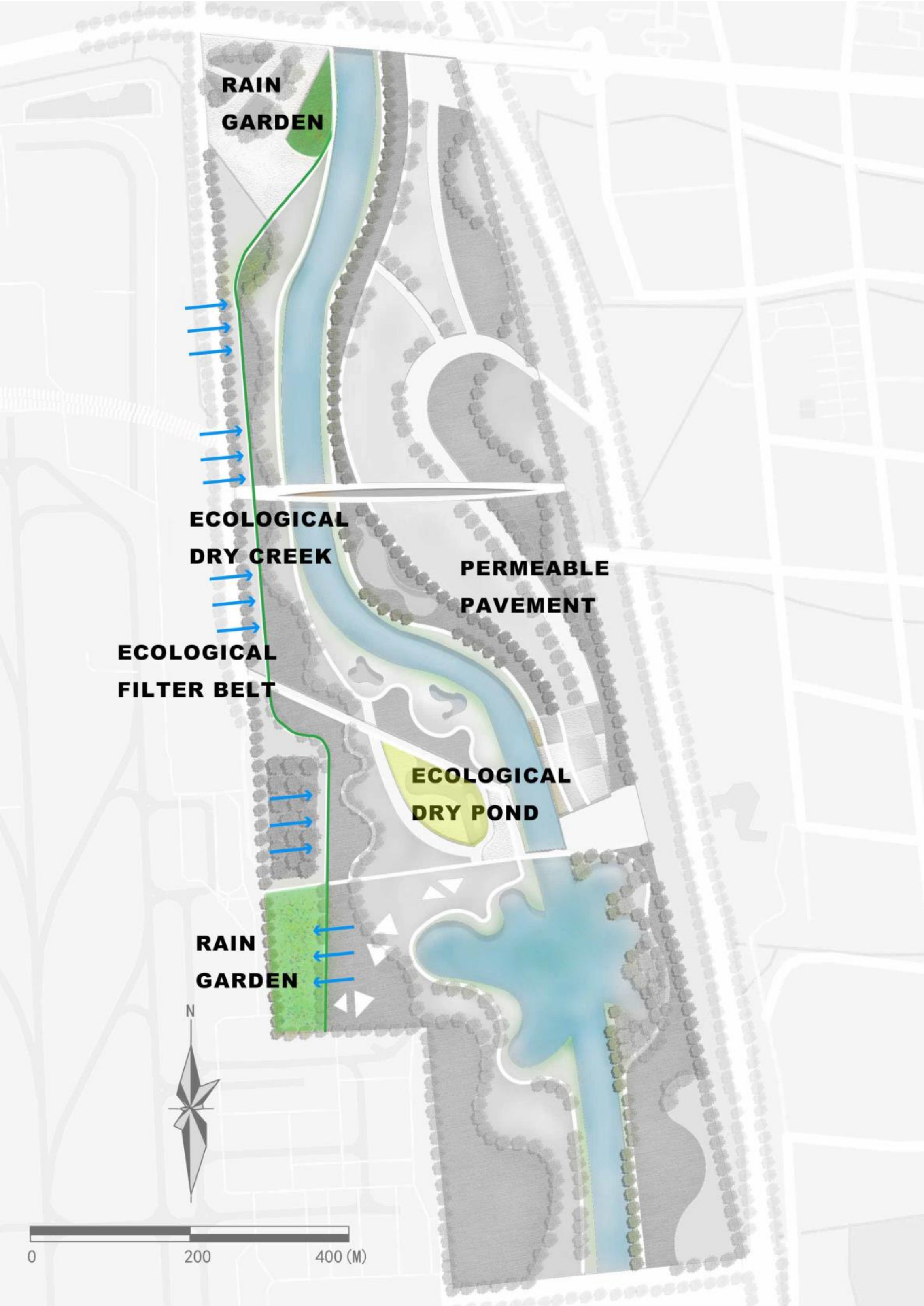


FIGURE 3.4.16 LID design

Source: Made by author

3.4.4.3 Sponge system planning

3.4.4.3.1 Ecological dry creek

(1)The use of ecological dry creek

At the bottom of dry stream, the pattern of pebbles scoured by natural mountain valley stream is simulated, pebbles of different sizes are laid in scattered points, and suitable plants are arranged. When it rains, the rainwater from the green space, the retention belt and the planting ditch flows into the ecological dry brook, which becomes a trickle through the dry brook, slowing down the flow speed, intercepting the suspended matter, absorbing, penetrating and purifying the water quality. The rainwater is stored and utilized in the rainwater garden which is located around the ecological dry creek.

Through the height difference, the rainwater on the western road and even the hard ground of the airport is guided and stored, and after infiltration and purification, it is recycled as the water source for on-site irrigation, so as to achieve the goal of effective utilization of rainwater. The whole project introduces the concept of sponge, based on the "ecological dry creek", and integrates the dry creek spongy body into this space to collect the slope rainwater, so that the rainwater has a certain buffer space.

Through the construction of ecological dry creek, two kinds of landscape effects of water storage and dry water are realized. Water storage period: natural stream landscape, gentle running water, water depth of 30~50 cm; In dry season: white pebbles at the bottom of the pool are exposed, and colorful flower are inlaid, creating a unique beauty of "Dry Creek".***[Zhangqing.2019.]***

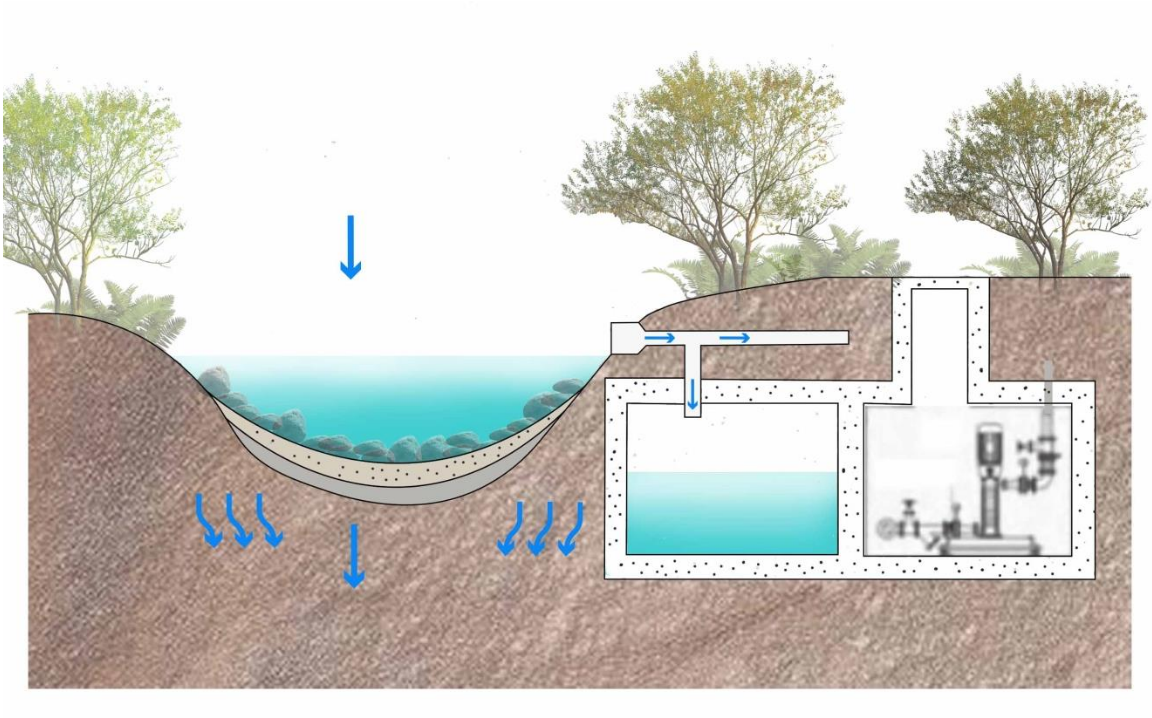


FIGURE 3.4.17 Structure of ecological dry creek

(Made by author)

(Source: Zhangqingping.2019.)

(2) The implementation steps

Slope: after the original hard pool is broken, the ecological revetment of dry stream is recommended to slope 1:2 in the case of natural slope release. In consideration of the visitors' hydrophilic experience, there are no railings on the shore, so the water depth should not be greater than 70 cm in accordance with the Park Design Code. In the actual construction, because the bottom of the pool often has a filter layer, and the situation of stacking stone, the total thickness of the two needs to be subtracted, and considering that the bottom of the original pool still needs to be broken, the actual excavation depth is best around 120 cm. After laying stone, the elevation of stone surface layer and revetment is controlled at about 50 cm.

Infiltration: after the earth excavation is completed, layer by layer filtration structures are laid from the bottom of creek, which are respectively permeable layer, filter layer and drainage layer. The permeable layer is laid with gravel and fine sand with a thickness of 10 cm from bottom to top. The filter layer is composed of non-woven fabric. The gravel with a thickness of 10 cm is placed under the drainage layer first, and the brook pit stone with a thickness of 10 ~30 cm is laid above. After the rainwater falls, it collects in the dry stream and becomes turbidity. After the filtration and purification of the aforementioned layers, the rainwater seeps into the ground and becomes clean water.

Water overflow: the overflow outlet is set 10~15 cm away from the elevation of the revetment. It is used to adjust the highest water level in the pool. When there is heavy precipitation, the water in the dry stream is too much, and the water is full from the overflow. Through the diversion device of the overflow outlet, part of the water is discharged to the embedded reservoir, and the other part is discharged to the municipal drainage pipe network. Combined with the road network transformation around the youth small garden pool, the setting of Hanxi overflow outlet on the one hand avoids the surrounding garden road and green land water due to excessive rainfall; On the other hand, it explores the use of rainwater collection devices to collect rainwater into underground reservoirs, and then carry out necessary filtration and purification. The obtained water can be directly used as the water source in the youth small garden, and the automatic irrigation facilities can fine spray and water the green plants.**[Baidubaike.com]**

FIGURE 3.4.18 Store water period

(Source: https://m.sohu.com/sa/141974299_278819)

FIGURE 3.4.19 Low water period

(Source: https://m.sohu.com/sa/141974299_278819)

(3) Vegetation choice

Considering the landscape effect of rain season and dry season is the key to master the landscape design of ecological dry stream plants and the key to the success of dry stream landscape is the selection and arrangement of planted plants.

The following principles should be followed in the selection:

a.the local plants should be selected first. The local plants have the characteristics of high survival rate, fast growth and low maintenance cost, and can quickly form scenery. The local plants can ensure the stability of Hanxi small ecology.

b.Choose plants with strong roots, the roots of such plants can grow underground to very deep soil, the soil range reached by its roots will be loose, improving the infiltration ability of rain.

c.The selection of resistant plants, not only to take into account the rainy season, the rain on the plant roots soaked root rot;

d.We should also consider that plants have strong adaptability to drought and less rain environment.

e.The plants with good landscaping effect are selected

To sum up, the ecological dry brook construction, wood selection of Chinese scholartree, podocarpus macrophyllus, red maple and so on. Bush and grass use Orychophragmus violaceus, Ajania pallasiana, maiden grass, Iris tectorum and so on.

3.4.4.3.2 Ecological filter belt

The ecological filter belt (Fig3.4.20&3.4.21) is a sponge facility with a certain slope and not parallel to the permeable surface layer, which can convert the collected rainwater runoff into multiple layers of rainwater runoff and play the effect of runoff buffering. Filter zones use plants for runoff energy reduction and rainwater filtration, which greatly reduces the risk of blockage of drainage networks or silting in receiving bodies of water. When the rainwater runoff does not enter the filter zone, the horizontal diverter is used to shunt the rainwater and make it enter the filter zone evenly. After entering the filter zone, the rainwater runoff is treated by other sponge facilities such as planting ditch. The width of the drainage area is not more than 45 meters, and the transverse slope is less than 2%, so that it can exert its maximum filtration effect.

For a slightly steeper slope, the ladder-type horizontal diversion facility can be used for processing. The filter belt should not be built in a place where building materials are piled or other areas that may disrupt surface soil activities. It should be built in a place with sufficient sunlight. The filter belt should be kept dry during the interval between rainfall to prevent root rot or growth retardation caused by high humidity.

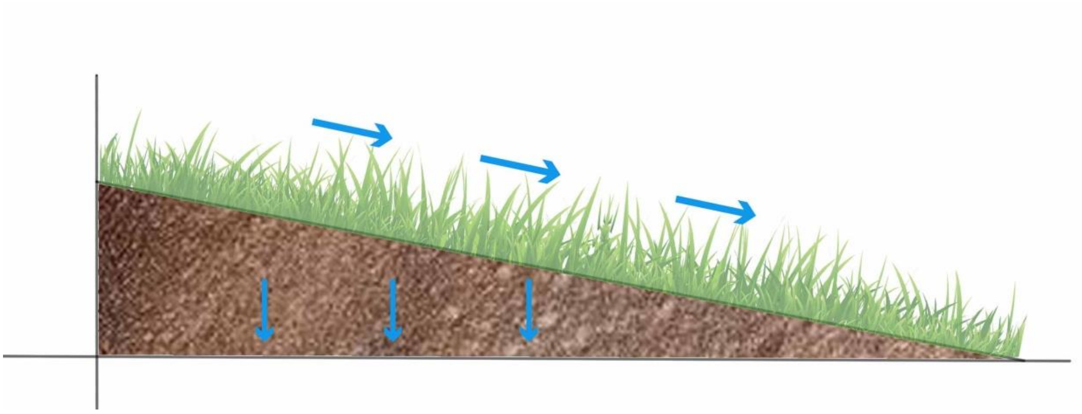


FIGURE 3.4.20 Section1 of Ecological filter belt

(Source: Made by author)

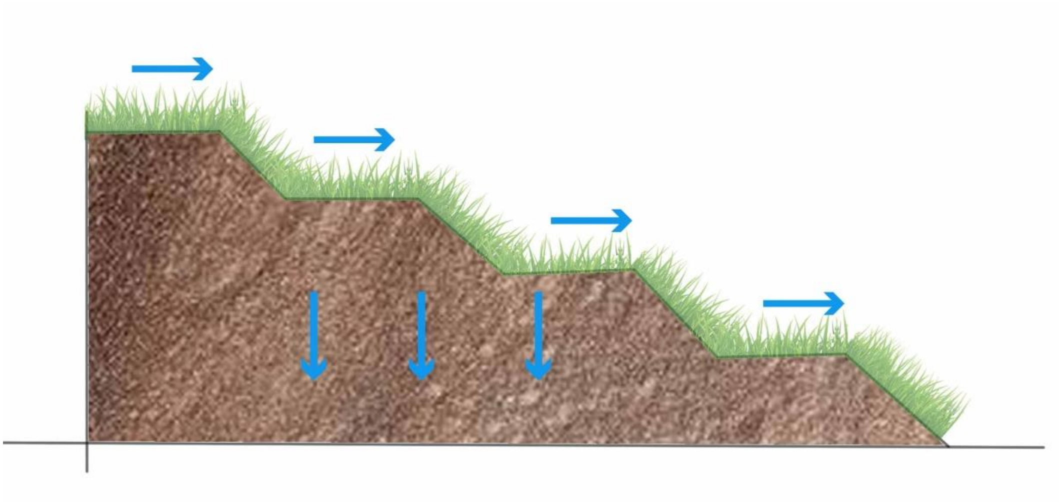


FIGURE 3.4.21 Section2 of e Ecological filter belt

(Source: Made by author)

Vegetation retention zone with a certain width and slope can remove sediments, nutrients, organic matter and other substances in surface runoff and seepage through filtration, retention and absorption, so as to reduce the concentration and toxicity of pollutants entering the water body. It is the first barrier to intercept and purify rainwater in sponge green space. **[Housing and Urban-Rural Development Department of Jiangsu Province.2018.].**

3.4.2.3 Rain garden

Uncontrolled rainstorm runoff hindered urban residents' normal life． As a typical ecological infrastructure for rainstorm treatment，rain garden is an important means of urban water management．

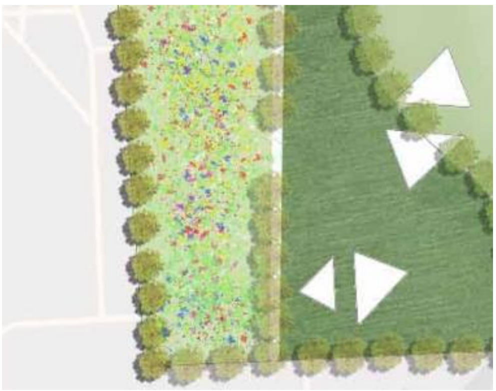


FIGURE 3.4.22 Rain garden in site

(Source: Made by author)

According to the different flooding conditions of the planting area in the rain garden, the planting area of the rain garden can be divided into the storage area, the buffer area and the edge area. The planting of the plants in these three areas should fully take into account the characteristics of different plants' tolerance to flooding and drought.

The requirement of submerging-resistance, pollution-resistance and purification ability of plant species in the water storage area is the highest, and at the same time, it is also required to have a certain early-tolerance ability in drought conditions without rainy season.

The buffer zone has a fixed volume of water storage, which requires the inundation tolerance of plants, drought tolerance and rainwater scouring resistance of plants.

The marginal area has no water storage capacity, and the plant species need to have strong early-tolerant ability, so there is no special requirement for the submerging-resistant ability of the plants. The early-tolerant plants can be selected to connect with the surrounding plant landscape.

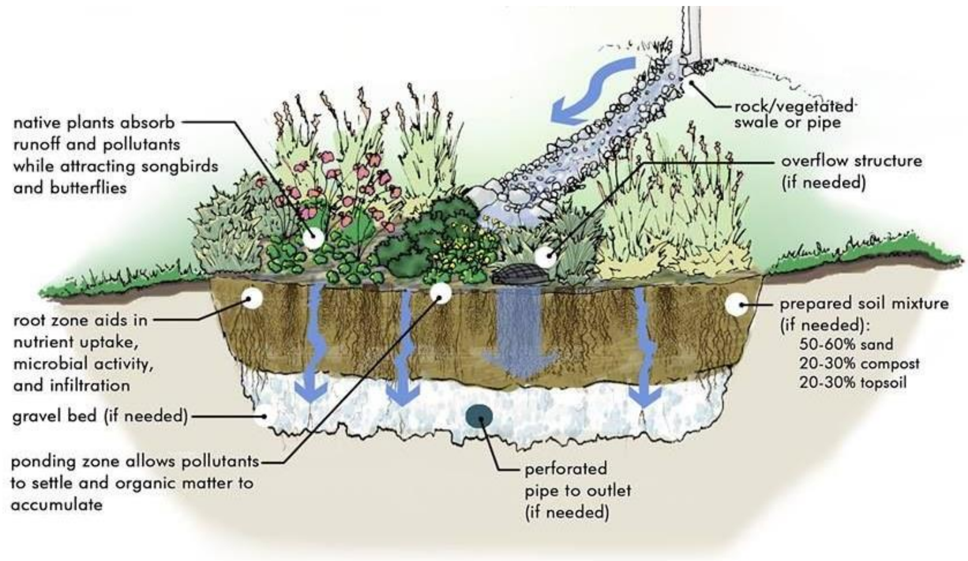


FIGURE 3.4.23 Rain garden in site

(Source:https://i.pinimg.com/originals/8a/e7/9d/8ae79dd6ff7e8269dd6944f4a2e4d95

4.jpg)

When planting plants, it is necessary to consider the matching of flowering date, color, shape, texture and season, so as to plant trees, shrubs and grass in layers to ensure the ornamental value of the rain garden.

(1). Priority should be given to native plants and exotic species

Rain garden generally choose water resistance, good moisture resistance, and plants beautiful shape of trees as common plants, easy to shape the landscape and management and maintenance.

(2). Choose plants with developed roots, luxuriant stems and leaves and strong purification ability

There are three main mechanisms for the degradation and removal of pollutants in rainwater. One is the absorption and utilization of nitrogen, phosphorus and other substances through photosynthesis. Second, oxygen is transferred to the substrate through the root system, and micro-processing units are formed around the root system to intersect the aerobic and hypoxic zones, so that aerobic, hypoxic and anaerobic microorganisms are in their proper position. The third is the interception and adsorption of plant roots to pollutants, especially heavy metals.

(3). Choose plants that can withstand both waterlogging and drought

Because the amount of water in the rain garden is closely related to rainfall, and there is an alternating phenomenon of full water period and dry water period, the plants planted should not only adapt to the aquatic environment, but also have a certain ability to resist early. So plants with strong roots, fast growth and large stems and leaves function better

(4). Choose plants that can be planted with each other to improve decontamination and appreciation

The reasonable combination of different plants can improve the water purification capacity. Plants with strong root oxygenation and weak root oxygenation can be mixed planted to form a compound plant bed, creating an environment where aerobic microzones and hypoxic microzones co-exist, thus conducive to the degradation of total nitrogen. Evergreen and deciduous herbs can be mixed to improve the water purification capacity of the garden in winter. Herbaceous plants and woody plants can be planted together to improve the structure of plant communities and ornamental.

(5). Use scented plants

Aromatic plants help to attract insects such as bees and butterflies, creating a better landscape effect.

FIGURE 3.4.24 Rain garden

(Source: Made by author)

3.4.4.3.4 Ecological dry pond

FIGURE 3.4.25 Ecological dry pond in site

(Source: Made by author)

FIGURE 3.4.26 Ecological dry pond in site

(Source: www.yl1001.com)

3.4.4.3.5 Planting grass ditch

Planting grass ditch are made at the junctions between green space and hard pavement. The trenches are 1.8-3.0m in width, and the cross-section form is inverted parabolic line shape. The bottom width is 0.3-1.2m; 15 to 30 cm deep. ***[Baidubaike.com]***

The groove shape is smooth and natural, along the hard pavement edge in and out of the green space, in order to meet the functionality, but also increase its landscape, interesting. The main function of the planting ditch is to prevent rain erosion, carrying soil pollution of the road surface, square; The second is to collect and transmit rainwater, and plant ground cover in shallow gullies on the surface, and use the plants and soil in the gullies to infiltrate, intercept and purify rainwater runoff.

Planting grass ditch (Fig3.4.27) is an open green rainwater transmission channel covered with turf, which acts as infiltration, filtration, buffer and retention of rainwater during the transmission of rainwater runoff from upstream to downstream. As an alternative to the traditional grey concrete runoff ditch, it has many advantages, such as effectively reducing the peak discharge, postponing the peak and retaining the sediment. When the sandbank is combined with the underground drainage ditch, the grass ditch can also effectively retain the rainwater and increase the infiltration of rainwater. It is a kind of high efficiency rainwater runoff transmission facilities, because of the variety of grass planting, grass planting ditch can play its due effect of "sponge" but also provides people with different aesthetic taste, for the park a variety of creatures to provide a variety of living environment.

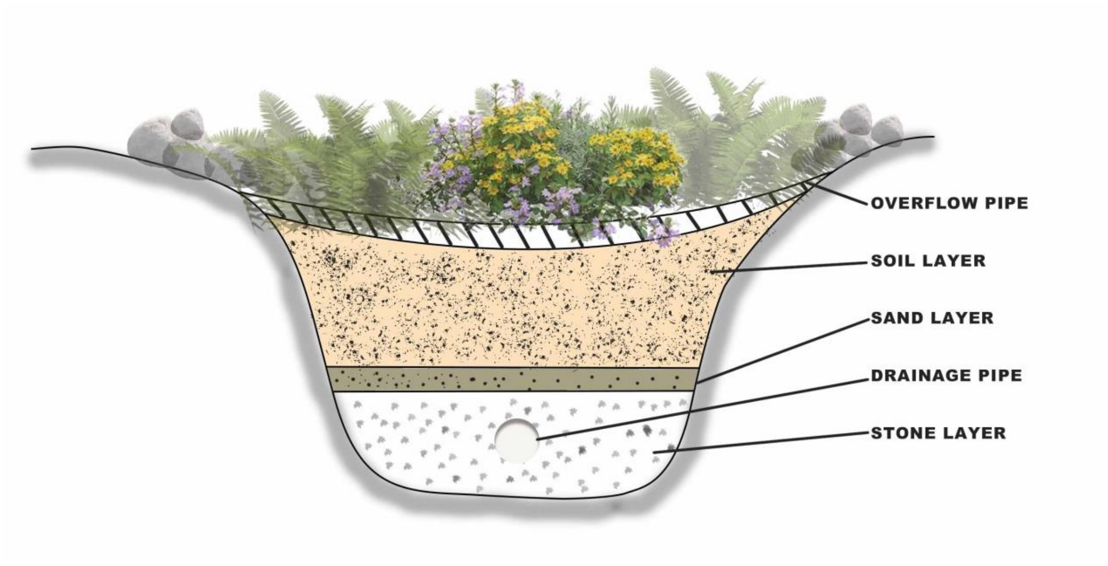


FIGURE 3.4.27 Section of Planting grass ditch

Made by author

(Source:https://bbs.tianya.cn/m/post-worldlook-1643785-2.shtml)

FIGURE 3.4.28 Planting grass ditch

(Source: www.elalt.com)

3.4.4.3.6 Permeable pavement

The entire park is paved with permeable roads. Pervious paving (Fig3.4.29) is used as an alternative to hardened pavement paving, allowing rainwater to infiltrate to underground, supporting pedestrian and vehicular passage for visitors.

Generally permeable pavements contain a base pad composed of coarse aggregate for rainwater storage. Some foundation layers are composed of soil, gravel, and sand to increase stormwater storage and infiltration rate. Permeable pavement can remove precipitation and other pollutants in rainwater, disperse rainwater runoff, reduce flow and recharge groundwater. There are various types of permeable pavement, such as prefabricated modules, site pouring, permeable asphalt, gravel pavement, etc. The light-colored permeable pavement system with high reflectivity can also reduce the urban heat island effect to a certain extent, which conforms to the concept of sponge city.

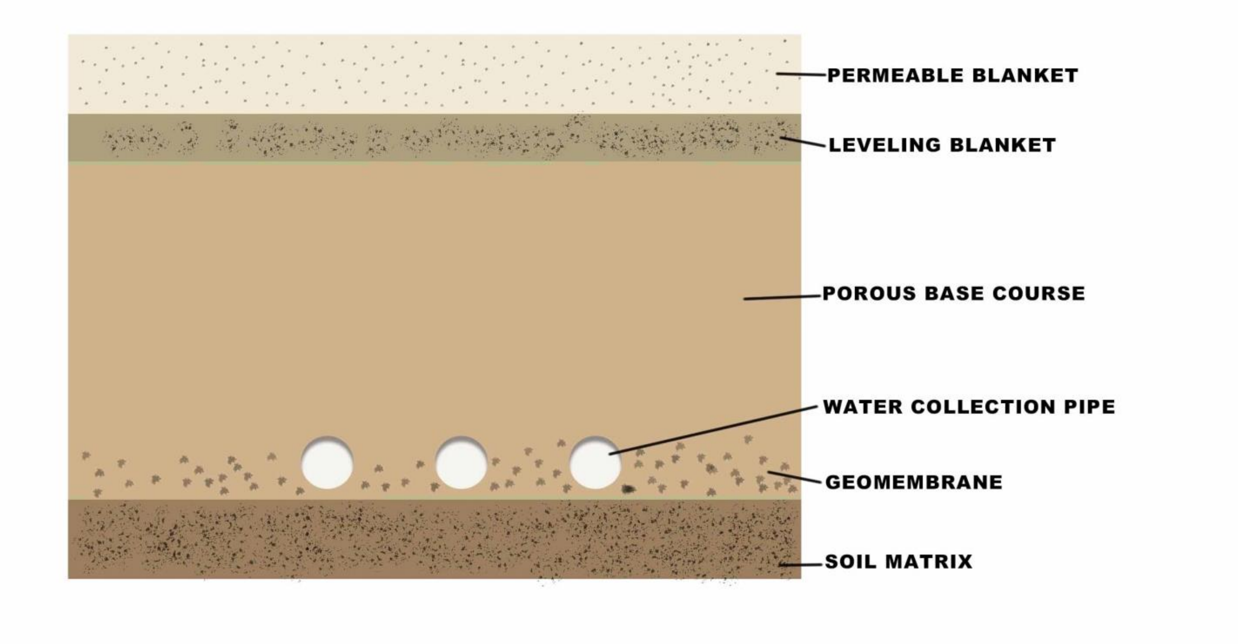


FIGURE 3.4.29 Section of permeable pavement of park

(Source: Made by author)

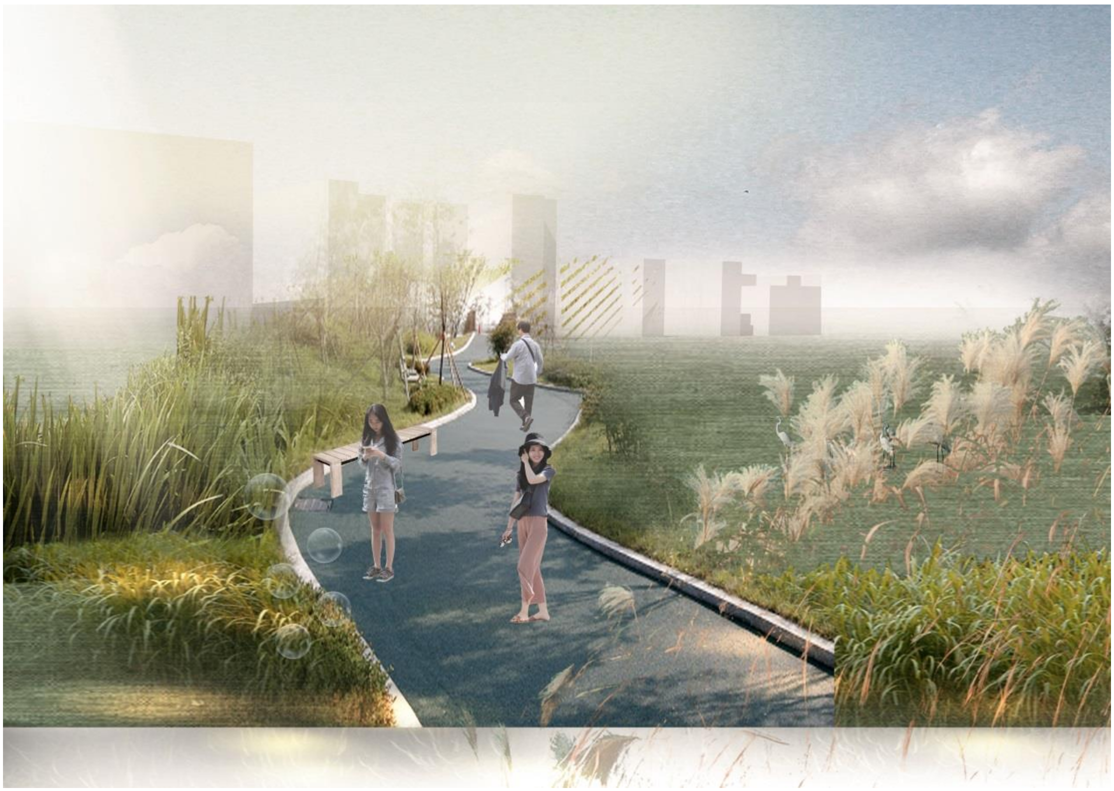


FIGURE 3.4.30 Permeable pavement of park

(Source: Made by author)

3.4.5 Conclusion

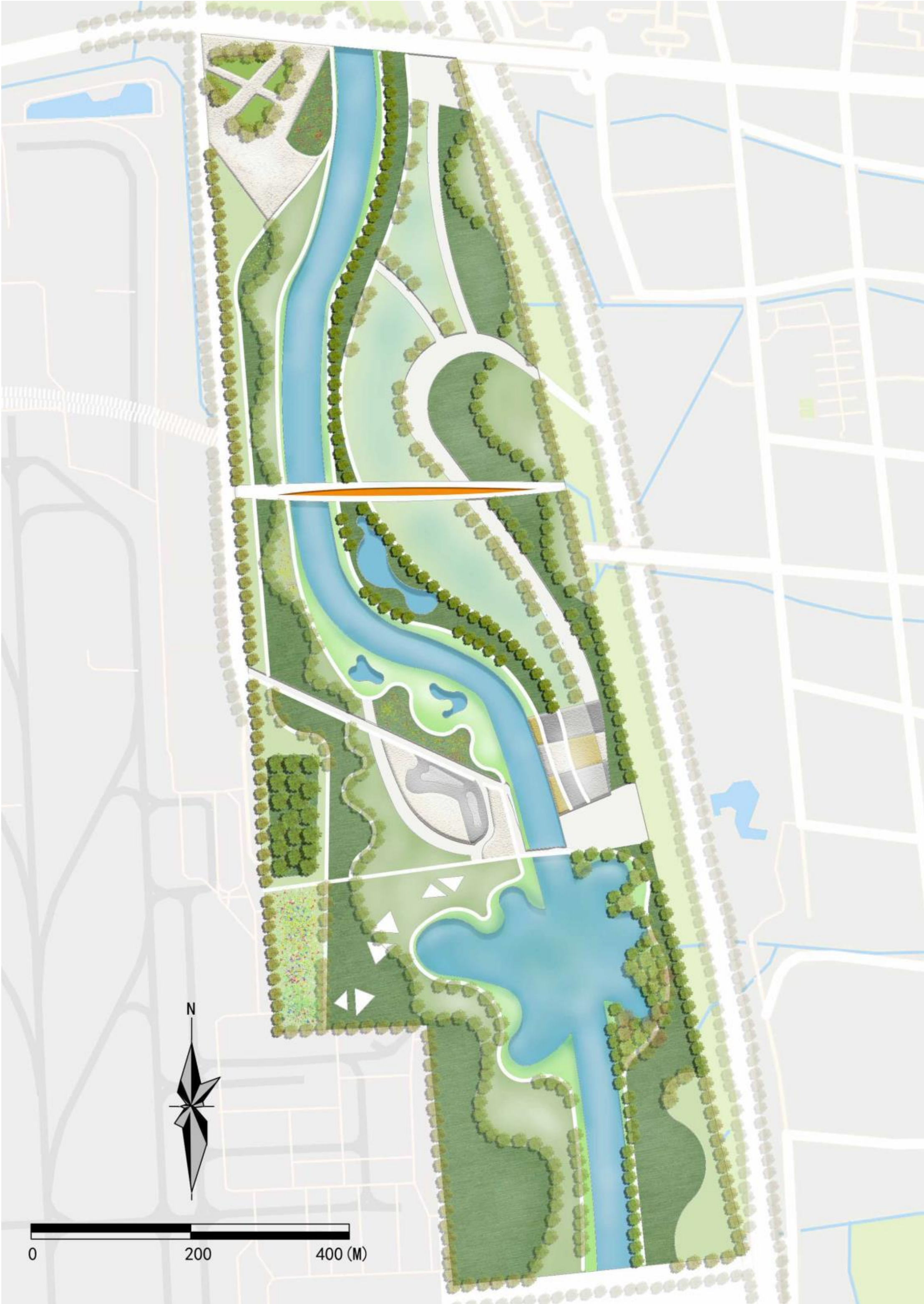


FIGURE 3.4.31 Master plan

Source: Made by author

FIGURE 3.4.32 Bridge1 of site

(Sourcw: Made by author)

FIGURE 3.4.33 Bridge2of site

(Source: Made by author)

With the large-scale urbanization process in China, urban problems such as heat island effect, urban water shortage and "sailing on the road" prevail, and the construction concept of "sponge city" arises at the historic moment.

In this project, park green space, as the spongy body of urban construction, has gradually abandoned the traditional construction mode of garden green space. Ecological measures such as planting ditches, ecological dry streams, rain gardens, and small and micro wetlands have been given priority to reduce the rainwater runoff, and the methods of "slow drainage and slow release" and "dispersing the source" have been adopted to alleviate the urban rainwater problems.

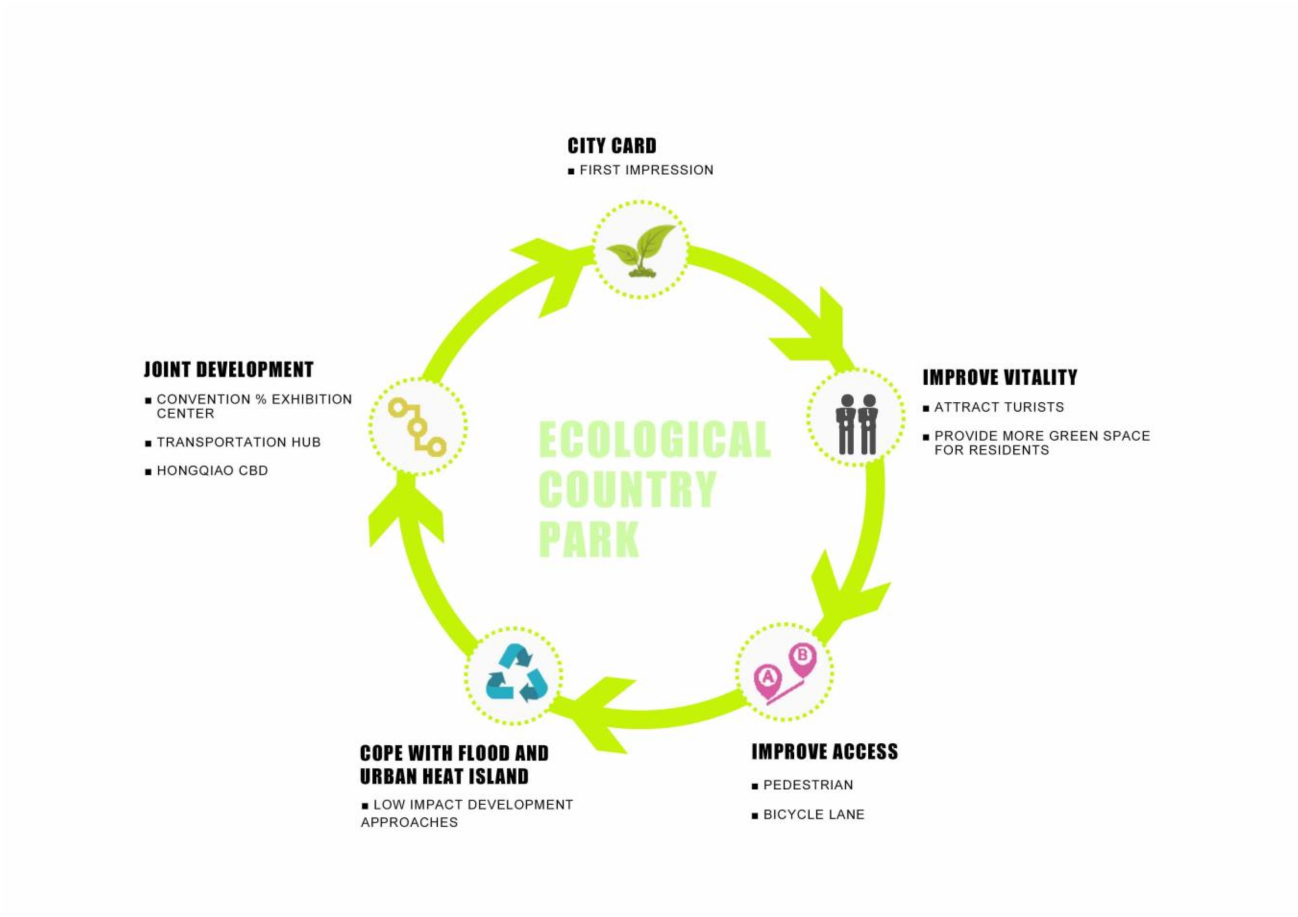


FIGURE 3.4.34 Result of exological country park

(Source: Made by author)

3.5 Ecological wetland sponge park in Fengxian area

3.5.1 Introduction

We chose Fish of Shanghai in Fengxian District of Shanghai as the forth design site. The specific location of the site legal person is shown in Figure 3.5.1. The site reaches Jinhui Port in the east, Punan Canal in the south, Jinhai Highway in the west, and Hangnan Highway in the north. The site is far away from downtown Shanghai, roughly south of Shanghai. Fengxian District, under Shanghai City, is located in the southeast of the Yangtze River Delta. It is 42 km from the People's Square in the center of Shanghai and 30 km from Pudong International Airport. It has a 13.7 km long riverfront and 31.6 km coastline. The administrative area of the region covers an area of 720.44 square kilometers. As of 2017, Fengxian District has 8 towns and 3 sub-districts under its jurisdiction, with a total resident population of 1.1553 million.

The Fish of Shanghai, also known as "Jinhai Lake", is the core landscape lake of Nanqiao New Town, Fengxian District, Shanghai. Covering 8.74 square kilometers, it will be the third largest artificial lake in Shanghai, second only to Dishui Lake. The Fish of Shanghai (Jinhai Lake) Scenic Area is an artificial lake shaped like a goldfish with the technique of earth sculpture. The average water depth is 3.5 meters, and the lake is fish-shaped, with Jinhui Port and Punan Canal forming the peripheral water system, forming a circular channel with the fish body as the center. After the completion of the Shanghai Fish (Jinhai Lake) water system will connect the Huangpu River and the East China Sea, become the symbol of Fengxian District. The Shanghai Metro Line 5 extension will also have a Jinhai Lake station.

"Fish of Shanghai" is located in the northeast of Nanqiao New Town, Fengxian District, Shanghai, covering an area of 8.74 square kilometers. The construction site reaches to Jinhui Port in the east, Punan Canal in the south, Jinhai Road in the west and Tuanan Road in the north. In terms of the design scheme, the structure of "Fish of Shanghai" integrates fashion elements. The land is sculpted into the shape of fish. Three lakes, including fish body, fish tail and fish fin, form the body water body. In the future, it will be built into a sports and water sports park with yacht culture as the core, and become the landscape center and tourism distribution service center of Nanqiao New Town.

Although the main roads in the area are still lined with sheltered forests and idyllic scenery, with the official start of the project, there will be high-quality residential buildings and various resorts, picnic bays, ecological islands in the middle of the lake, yacht culture center, waterfront commercial street and five-star spa hotel.

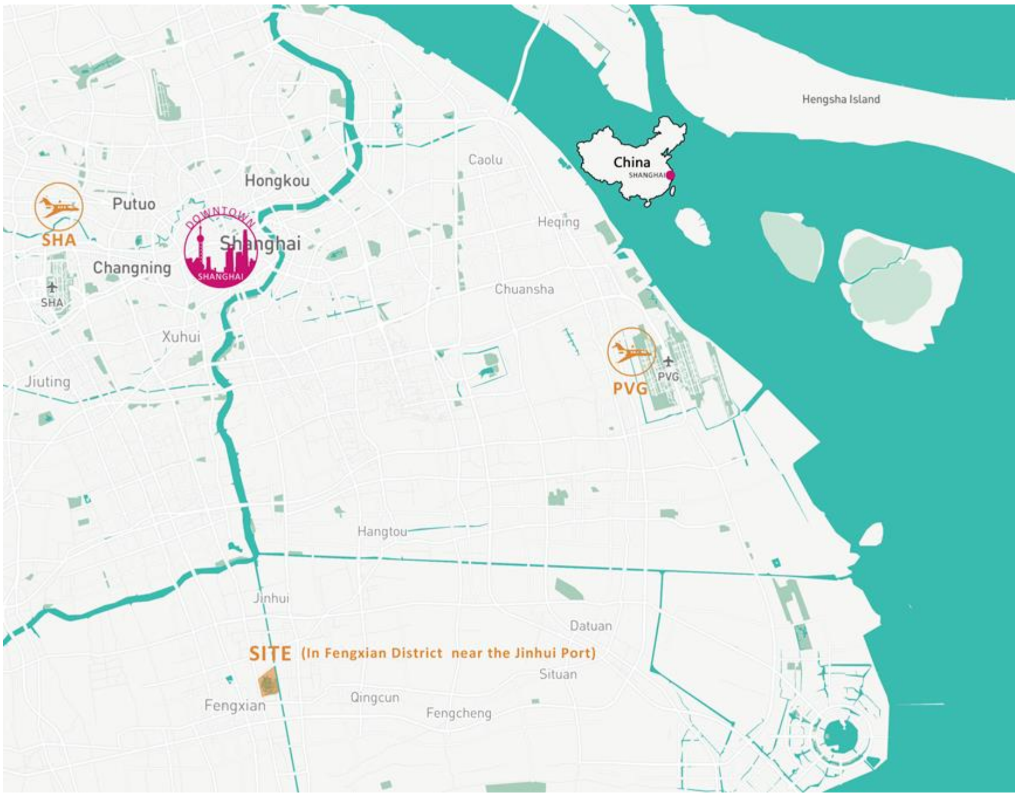


FIGURE 3.5.1: Site Location Map in Shanghai

(Source: Made by Authors, Referred to https://mapbox.com)

The Satellite of “Fish of Shanghai”

(Source: Made by Author, Referred to map.baidu.com)

3.5.2 Context analysis

3.5.2.1 Land use analysis

From Figure 3.5.2, we can find that there are many types of sites and surrounding land use. The land use type around the site is mainly residential area and some ecological woodland, which is a relatively natural area. As the site was originally in the city center, development was slow. There are also schools, businesses, hospitals and cultural Spaces scattered around the site.

Art space is Shanghai Nine Trees Art Center, Nine Trees Future Art Center, also known as "Nine Trees", located in the central ecological woodland of Fengxian District, Shanghai. In October 2019, Nine Trees officially opened to the public. This A-level comprehensive theater integrating forest, architecture, water system, culture and art has become a new artistic landmark in the cultural center of "South Shanghai" ***[https://sh100.online.sh.cn/content/2021-01/12/content_9700965.htm]***.

The Fengpu Four Seasons Ecological Park around the site covers an area of 180,000 square meters. It is also the largest park in Fengxian District that is open to the outside world for free, with a green coverage rate of more than 70%.Four Seasons Ecological Park tries to imitate a park with exotic scenery. The park is divided into 11 parks within a garden, among which six parks are open to the public, including Islamic Garden, Sculpture Garden, French Garden, Modern Garden, Rare Species Garden and Water Garden ***[https://baike.baidu.com/item/ Fengpu Four Seasons Ecological Park /2807686]***.

LAND USE

Land use analysis around the site

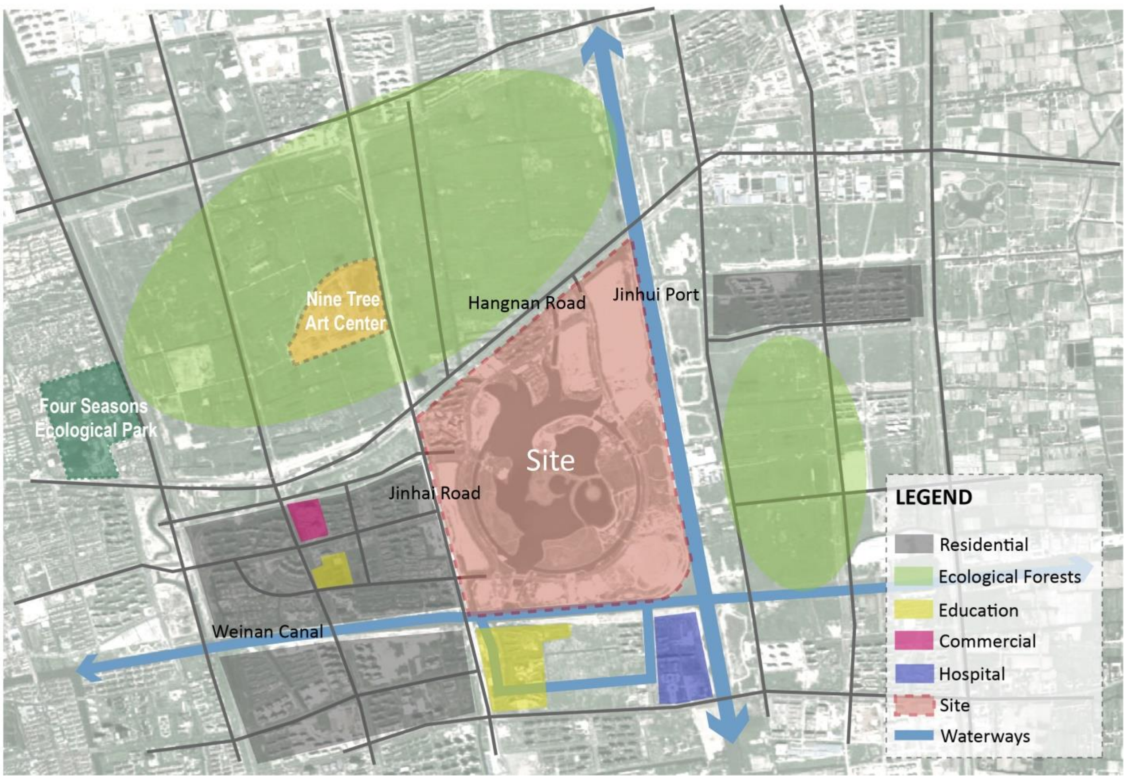
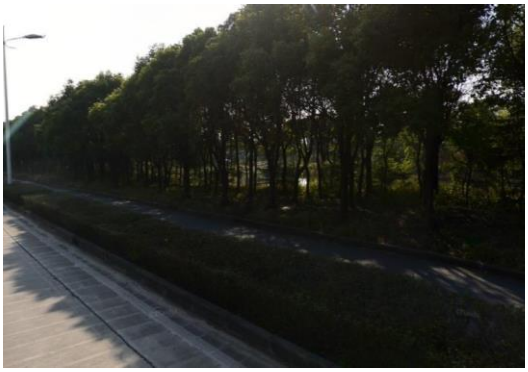


FIGURE 3.5.2: Land Use Analysis about the Site

(Source: Made by Authors, Referred to map.baidu.com)

Commercial Area around the Site (Left) & Residential Area around the Site (Right)

(Source: map.baidu.com)

School around the Site (Left) & Ecological Forests around the Site (Right)

(Source: map.baidu.com)


Shanghai Nine Trees Art Center (Left) & Fengpu Four Seasons Ecological Park (Right)

(Source: map.baidu.com)

3.5.2.2 Transport analysis

The traffic around the site is shown in Figure 3.5.3.The site is surrounded by Jinhui Port and Weinan Canal, surrounded by about 7 main urban roads and multi-day secondary roads. In addition, there is a highway near the site. The site is located in the suburb which is far away from the city center, so there is more green space around it. Some important traffic nodes, such as Hangnan Road and Jinhai Road, are also attached in the picture below for your reference.

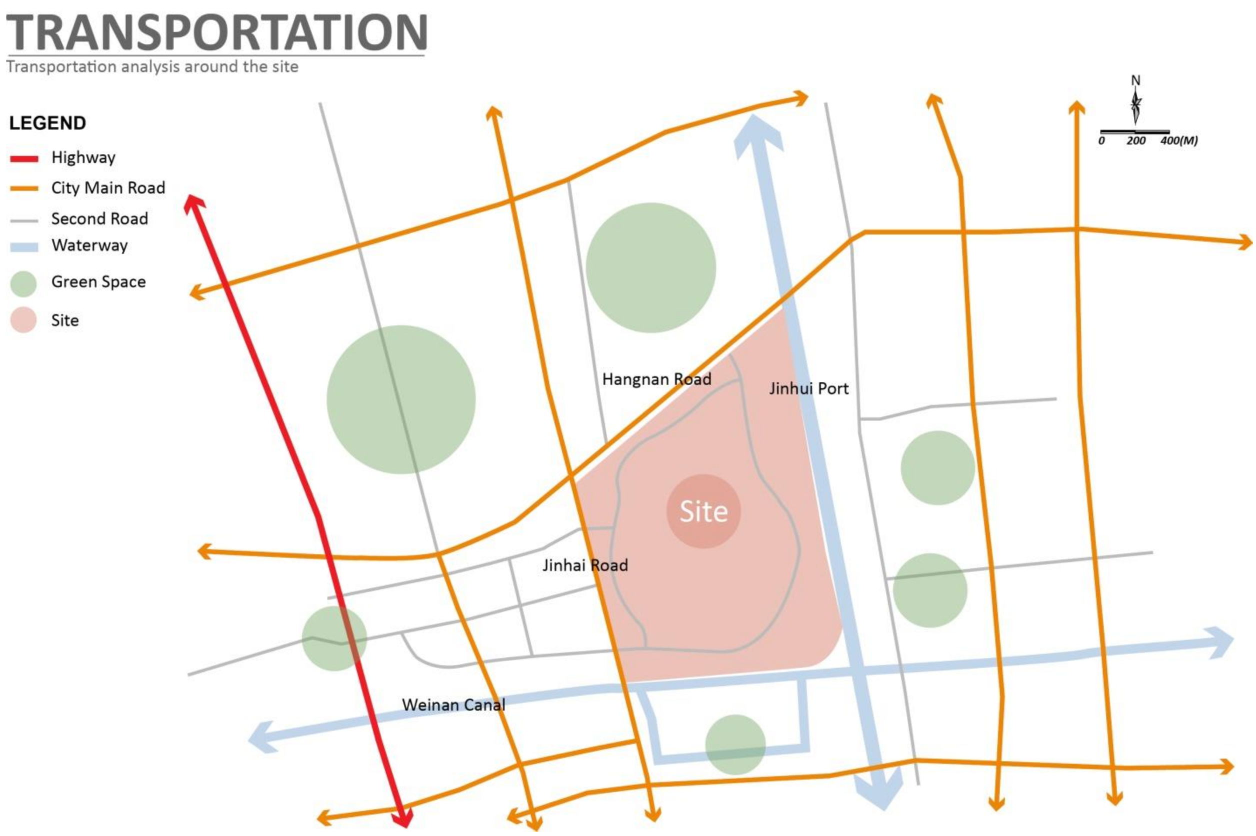


FIGURE 3.5.3: Transportation Analysis about the Site

(Source: Made by Authors, Referred to map.baidu.com)

Jinhai Road (Left) & Hangnan Road (Right)

(Source:map.baidu.com)

Weinan Canal (Left) & Jinhui Road (Right)

(Source:map.baidu.com)

After that, we also analyzed the public transportation around the site. There is Metro Line 5 around the site, which leads directly to the site, and there are two stations close to the site. In addition, as shown in Figure 3.5.4 and the photos near the site, we can see that there are many bus stops and routes near the site, such as Route 11, Route 2 and Route 21, etc. In addition, there is a special tourist line inside the site. So public transportation is very convenient.

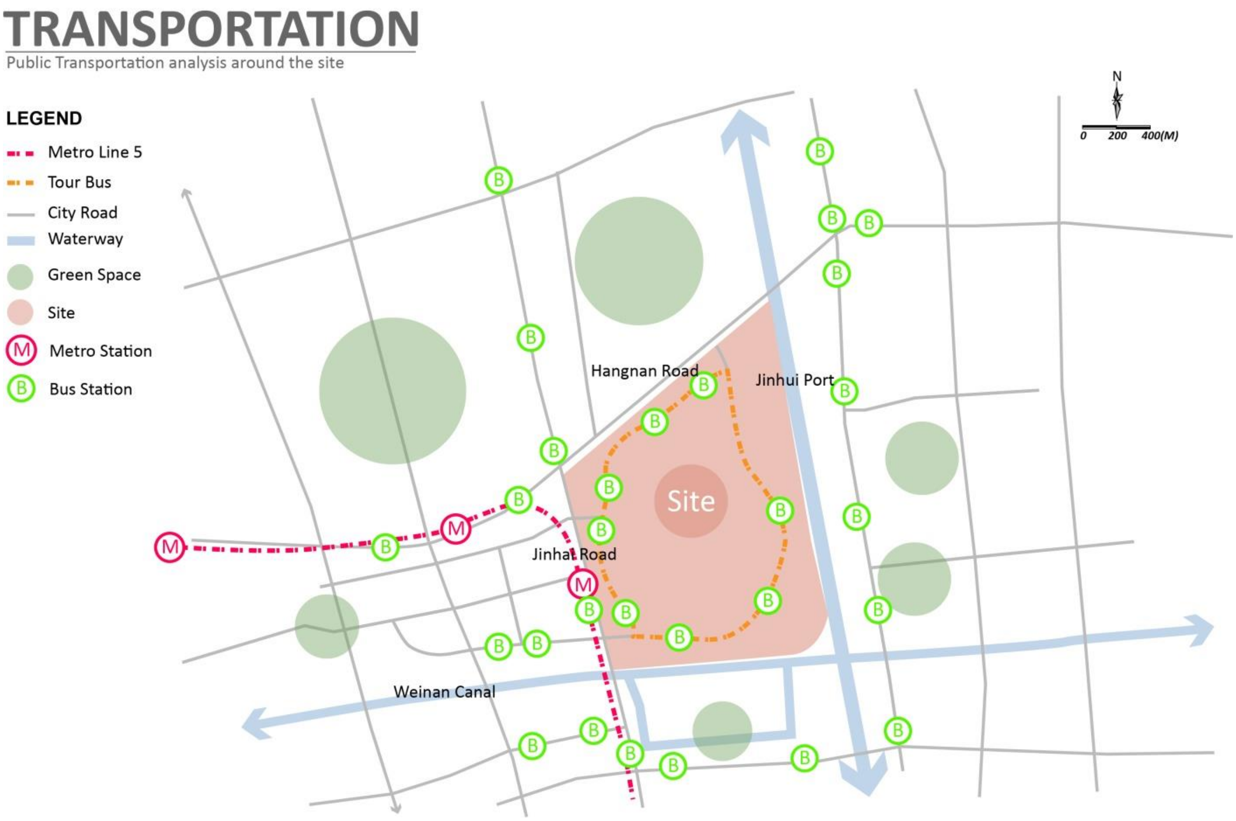


FIGURE 3.5.4: Public Transportation Analysis (Bus and Metro) about the Site

(Source: Made by Authors, Referred to map.baidu.com)

Bus Station and Metro Station around the Site

(Source: map.baidu.com)

3.5.2.3 Site project distribution analysis

In addition to analyzing the current situation around the site, we also analyzed the distribution of projects inside the site, as shown in Fig. 3.5.5.As we can see, the part adjacent to the lake is mainly composed of some hotels, a sea of flowers, a museum and a sculpture art park and a Nianfeng Park. The outer ring is composed of three main parks, namely, the green space next to the subway station, the Bubble Park and the Youth Art Park. On the north side of the site, there are some residential areas. The whole division of labor and the project in the site are clear and reasonable, in line with the site's goal - to become the new town landscape center and tourism distribution service center.

An Aerial View of "Fish of Shanghai"

(Source: map.google.com)

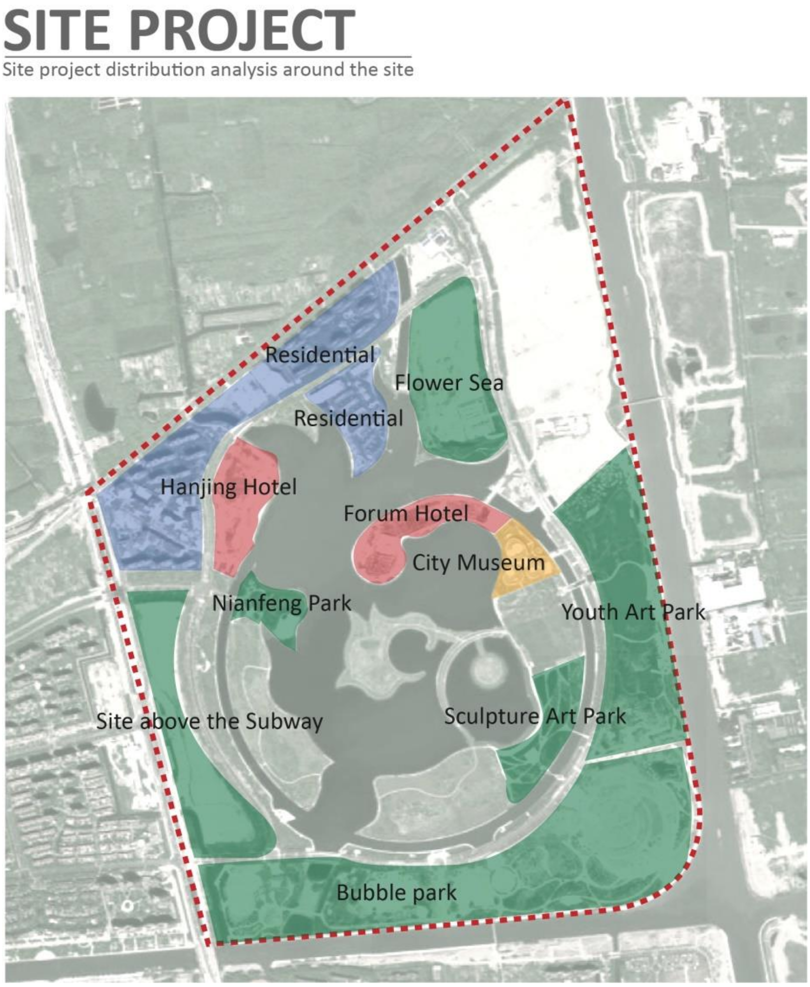


FIGURE 3.5.5: Site Project Distribution Analysis in the Site

(Source: Made by Authors, Referred to map.baidu.com)

3.5.3 History and development

Before 2008, Shanghai Fish belonged to the area around Shanghai Nanqiao. It was just an empty wasteland with no urban atmosphere. As shown in Figure 3.5.6, we can clearly see from the satellite image the process of Shanghai Fish transforming from wasteland to the present tourism lake.

FIGURE 3.5.6: The Evolution Process of "Shanghai Fish" Satellite Image

(Source: Made by Authors, Referred to https://www.sohu.com/a/421681798_100020747)

The wasteland was chosen by designer Larry Hibbs after a field trip. "Fish of Shanghai" was inspired by the Chinese word for "fish" and the place's original name, “Longtan Village”. He used the technique of earth sculpture to carve out the goldfish shaped Jinhai Lake, and outlined the functions of different areas with the beautiful and tortuous shoreline, on which he built this landmark urban facility facing the future.

Now, the "Fish of Shanghai" jumps above the core landscape of Jinhai Lake and becomes the core landscape lake of Fengxian New Town. Covering 8.74 square kilometers, it is the largest artificial lake in Shanghai.

Photo of "Shanghai Fish"

(Source: Made by Authors, Referred to https://www.sohu.com/a/421681798_100020747)

3.5.4 Strategies for coping with climate change

3.5.4.1 Challenges and goals

Based on the previous climate analysis in Chapter 3.5.2 and the site analysis in the first section of this chapter, we summarize the challenges facing the site into the following parts:

1. Firstly, it is the challenge brought by climate change. The main climate problems facing the site are urban heat island effect and urban flood disaster. Heat island effect: The mean annual temperature was rising, and the climate tendency Rate is 0.382°C / 10a; based on the seasonal temperature variation characteristic analysis, we know the average temperature in the four seasons was always increasing; the number of high-temperature weather after the 1990s increased significantly. In terms of flood, from the annual precipitation of Shanghai we found the annual rate is 56.361mm / 10a; the number of days with rainfall over 50mm, and it can be seen that the number of days with heavy rainfall per year has been on the rise in the past 59 years. In addition, due to the riverside, the current site does not meet the flood control requirements of Shanghai.

2. Secondly, in this newly designed site, the site has a construction goal, which is to become the landscape center of the new town and the tourism distribution and service center. Therefore, the design needs to conform to and enhance the design characteristics of the site.

Therefore, our design goal is mainly aimed at these two aspects:

By building an ecological wetland park to reduce the climate problem, it can also strengthen the characteristics of the site, and build a certain scale ecological wetland park with tourism and leisure facilities, for people to travel, leisure and entertainment .

Ecological Wetland Park is based on good ecological environment of wetland and diversified wetland landscape resources, which can play a core role in ecological regulation. It not only plays the basic function of development and protection of biodiversity, but also plays the extension function of conservation ecology, ecological conservation and protection of sponge ecology, such as water and soil conservation, reducing soil erosion, reducing environmental pollution, mitigating greenhouse effect and providing areas for wildlife migration and habitat.

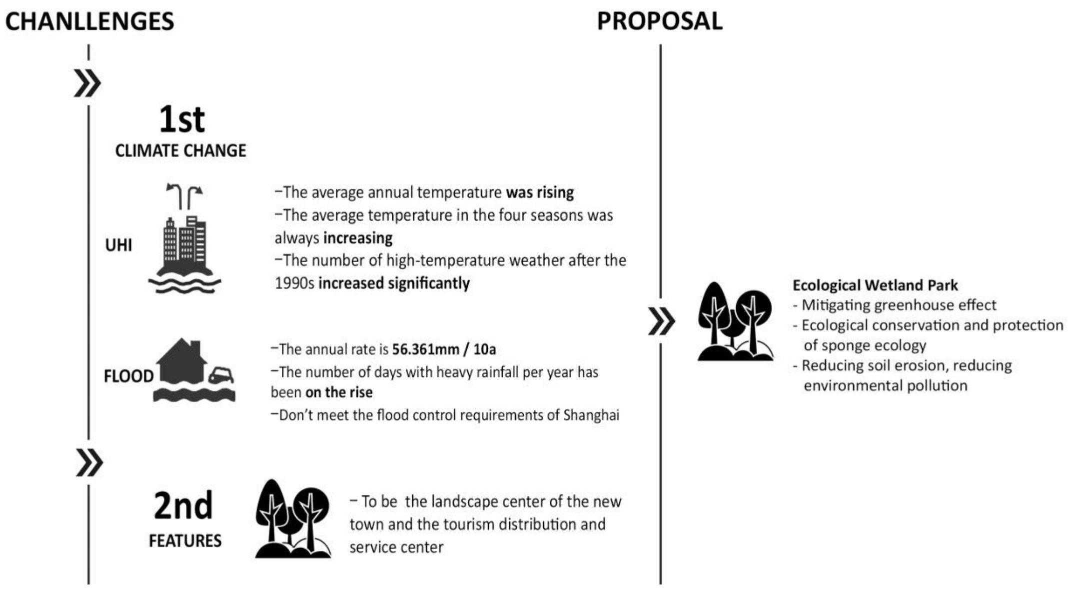


FIGURE 3.5.7: Challenges and Design Goals

(Source: Made by Authors)

3.5.4.2 Concept

As Shanghai continues to expand at a breakneck pace, much rural land has been converted to urban use. Decades of industrial development have seriously damaged the entire environmental system, leaving little wildlife and a poor biophysical environment. The canopy coverage of the entire Shanghai metropolitan area is only 10%, much lower than the average of Chinese cities (25%).A series of biological surveys published recently showed a significant decline in biodiversity and richness for all the groups studied. The amphibian diversity in Shanghai decreased from 14 species to 4 species. Bird diversity in urban areas was 63% lower than in historical surveys. Plant diversity has also plummeted. The urgency of landscape restoration in Shanghai is self-evident, which has become an important driving factor in the design strategy of this new ecological wetland park.

According to the previous analysis, the author hopes to transform the challenges into opportunities and inject vitality into this newly planned site through the ecological wetland park. Therefore, as shown in Fig. 3.5.8, we chose one of the unplanned green Spaces as the pilot area in the "Fish of Shanghai". It is hoped that this ecological wetland park can not only reduce the climate problem, but also strengthen the characteristics of the whole Jinhai Lake tourist area.

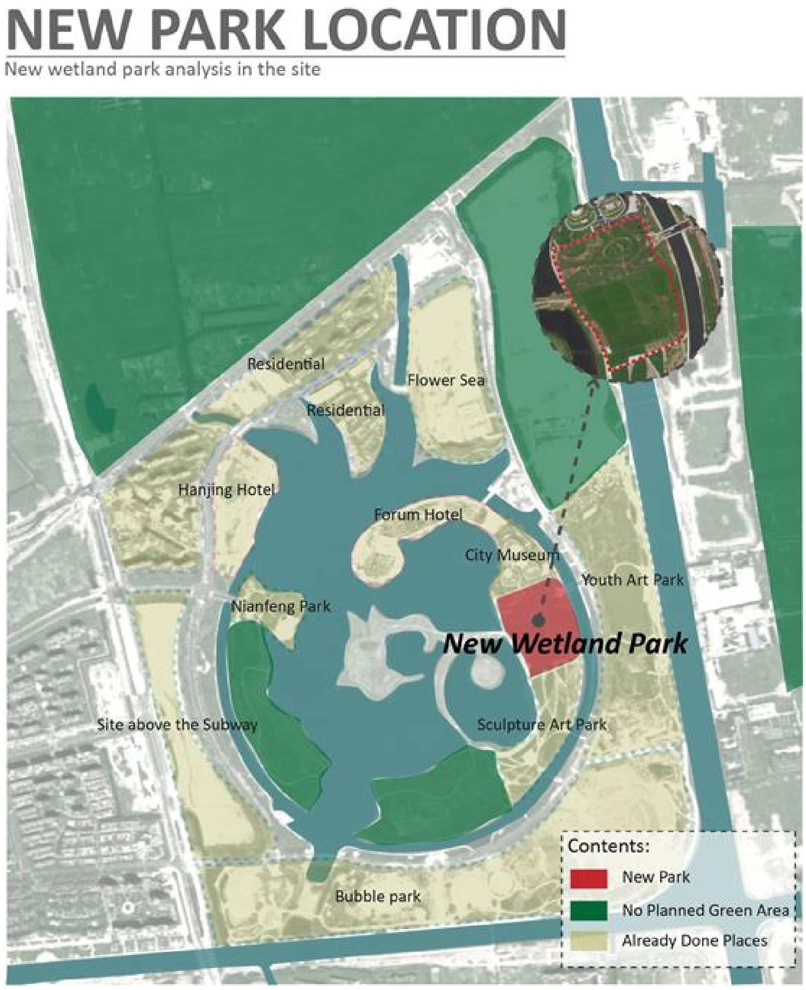


FIGURE 3.5.8: New Wetland Park Location in "Shanghai Fish"

(Source: Made by Authors, Referred to map.baidu.com)

Figure 3.5.9 shows the hope that this new park will slowly radiate to other unplanned areas, gradually increase the ecological diversity near Jinhai Lake, restore the environment and reduce the climate problem.

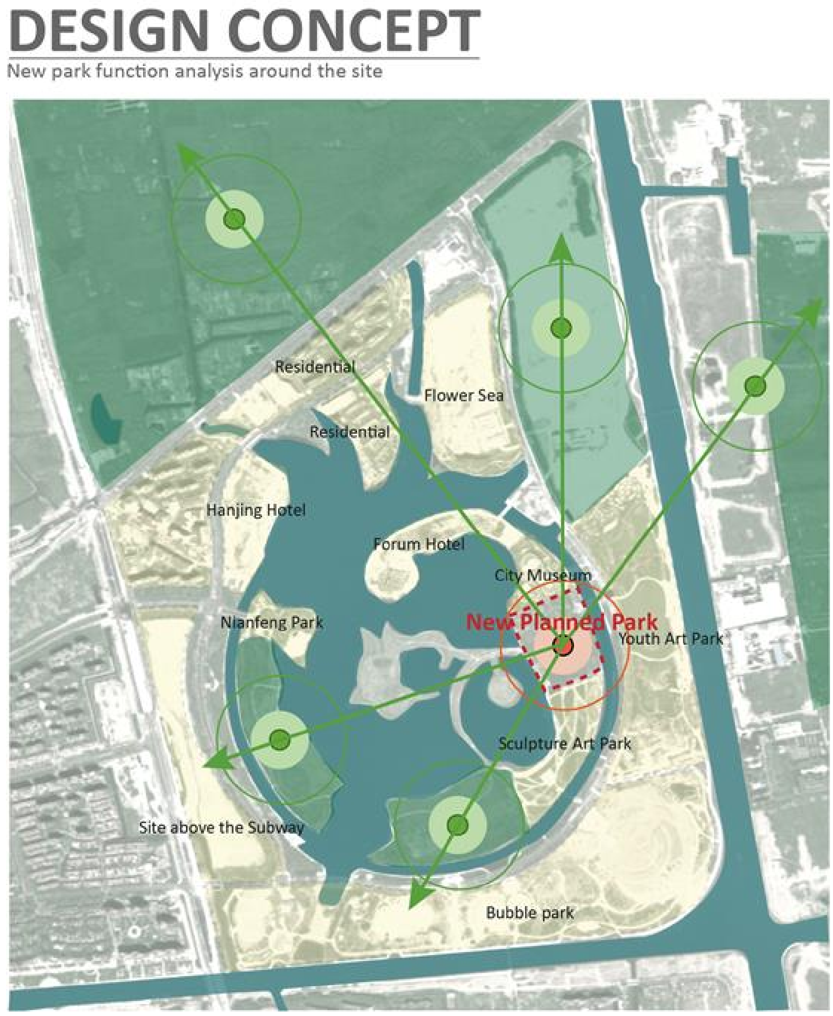


FIGURE 3.5.9: New Wetland Park Function Analysis around "Shanghai Fish"

(Source: Made by Authors, Referred to map.baidu.com)

3.5.4.2.1 Design Principles

The overall landscape design of Jinhai Lake Ecological Wetland Park, including landscape form, ecosystem function, ecology, beauty and participation, is the basic goal of the constructed wetland landscape design. Therefore, the ecological wetland park landscape design, in addition to follow the general principles of landscape design, there are special technical requirements and environmental design principles.

1. Basic Principles

The basic design principles of Jinhai Lake Ecological Wetland Park are ecology, science and technology and safety. The ecological principle is to maintain the integrity, continuity and relevance of wetland ecosystem; The principle of science and technology is to follow the principles and requirements of ecology and adopt appropriate ecological and environmental technology. The safety principle is to consider the ecological safety of wetlands and the safety of people.

2 Morphological Designs

Although the ecological wetland park is designed artificially, it should imitate the natural state as far as possible in the form, so as to adapt to the shape and distribution pattern of wetland biological system, and take the overall harmony as the purpose. Planar form should keep natural bending as far as possible, and at the same time, with the terrain and function, it should be put in order to conform to the principles of unity and harmony and natural balance in aesthetic law, and avoid regular layout.

3. Principle of recyclable design

The principle of resource recycling in the design of ecological wetland park is mainly reflected in the recycling of water resources. The collection, introduction, treatment and reuse of rainwater and sewage have clear design principles and ideas, to ensure that this idea can be put into practice in the design process, the final completion of the architecture of the recyclable system, to ensure the complete embodiment of the recyclable principle.

4 Principles of planting wetland plants

In ecological wetland park plant planting design, the design of fully considering the different terrain and the corresponding habitat types, according to the ecological habit and the growth rule of plants, according to a type of water plants (including wet and marsh), floating leaf type plants, floating plants and submerged plants are classified, and the ecological principle, principle of biological diversity, the sustainable development principle, the principle of adjust measures to local conditions, overall coordination principle, the principle of landscape character, rural related and comprehensive for planting design principles ***[Liu Biyun. 2010]***, rationally allocate trees, shrubs, vines and herbaceous plants according to local conditions, so that different plants can grow and develop normally, give full play to the landscape and ecological benefits of individual plants, populations and communities, and form a stable ecosystem with certain levels, thickness and colors.

3.5.4.2.2 The master plan

The graphic design of the entire wetland park is manifested in spatial contrasts of light and dark, as well as sparse and dense contrasts. The plane presents the contrast of light and dark in the north-south direction, and the sparse and dense contrast in the east-west direction. The various scenic spots in the park are connected and corresponded. In this small-scale space, the internal structure is clear.

The entire master plan is shown in Figure 3.5.10. The wet area of the whole park is mainly composed of the undercurrent wetland lake area and the main landscape area. Each lake area has several islands arranged according to its nature, forming the characteristics of a wetland park in which water quality changes with water level and landscape is purified with water quality. In addition, due to the characteristics of the entire site, it is necessary to provide visitors with a place for leisure and entertainment. Therefore, the main line of the park and the environmental protection water system have a series of main attractions-viewing platform, wetland flower sea, water theater, seal carving garden, etc. . The venue has rich activities and various forms, but it is far away from the wetland and the activities are relatively quiet. You can quietly watch the wetland.

FIGURE 3.5.10: The Master Plan

(Source: Made by Authors)

1. Main landscape lake area

The water area of the scenic spot is 7797sq, and the island area is about 730sq, including the center of the river bed, the shallow wetlands on both sides, etc., as shown in Figure 3.5.11. The main lake is distributed on both sides of the river wetland in the 200m section at the beginning, and it mainly plays the role of water volume regulation, water quality adjustment, and uniform water distribution for the subsequent artificial undercurrent wetland, ensuring enhanced purification and landscape effects. There is also a traditional green belt around the lake.The main scenic spots include: aquatic plant field, willow forest area, water scenery and wild interest, Begonia quiet path and other 4 scenic spots.

FIGURE 3.5.11: Main landscape lake area

(Source: Made by Authors)

1) Aquatic plant fields

A variety of aquatic plants are planted in shallow wetlands to display floating and happy water plants, such as lotus, calamus, iris, day lilies, water lilies, lily, green onion with variegated leaves, etc., forming an aquatic flower viewing area. A variety of aquatic flowers bloom in different seasons, presenting a colorful wetland landscape to visitors, as shown in Picture 3.5.12.

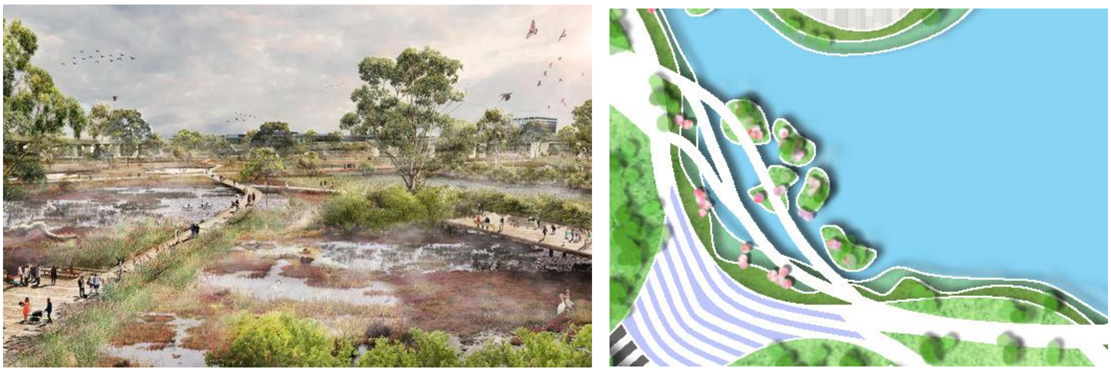


FIGURE 3.5.12: Renderings and Location

(Source: archidaily.com & Made by Authors)

2) Willow forest area

Weeping willows are planted between the islands and the shoreline, and peach trees are planted between them. In the water, aquatic plants and water-loving plants with bright colors are extended in the fields. Boating on the surface of the lake swept by light winds, the soft branches of weeping willows are swaying and floating, showing a very beautiful artistic concept, as shown in Picture 3.5.13.

FIGURE 3.5.13: Renderings and Location

(Source: archidaily.com & Made by Authors)

3) Wild water features

Floating plants are planted along the shoreline of the lake in the main landscape. Various plants are interwoven and spread at the boundary between the water and the land, and the land and water are integrated. When viewed from a distance, clouds cover the lake, which makes people relaxed and happy, as shown in Fig. 3.5.14.

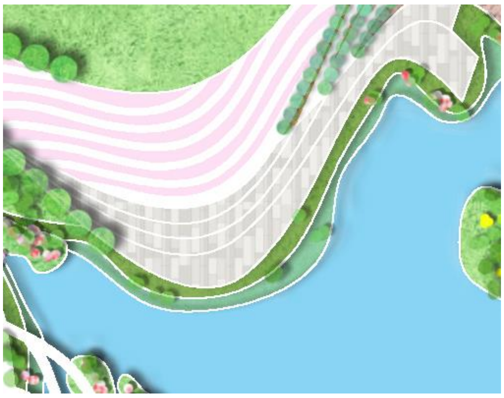


FIGURE 3.5.14: Renderings and Location

(Source: archidaily.com & Made by Authors)

4) Quiet path of Begonia

Begonia is planted along the line of this area. When the begonia blossoms in April, the petals sprinkle on the bay, and visitors can find their way to enjoy the quiet and deep landscape, as shown in Fig. 3.5.15.

FIGURE 3.5.15: Renderings and Location

(Source: archidaily.com & Made by Authors)

2. Undercurrent wetland lake area

The area of the scenic area is 4,825 square meters, and the island area is about 320 square meters. Located after the main landscape lake scenic area, the effluent of the main landscape lake can be further purified to form a natural ecological landscape wetland system with low maintenance and rich biodiversity. Several islands in the lake are habitat islands for birds, as shown in Fig. 3.5.16.The main scenic spots in the scenic area are the winding calamus area, the flying bird area and the lotus scenery.

FIGURE 3.5.16: Undercurrent wetland lake area

(Source: Made by Authors)

5) Winding calamus area

Various calamus, such as broadleaf cattail, golden leaf cattail, flowered cattail and California court calamus are widely planted along the edge of artificial subsurface flow wetland and land shoreline, interplanting flowered green, yellow calamus and flowered reed to form a lush belt of water-happy plants along the shoreline, as shown in Fig. 3.5.17.

FIGURE 3.5.17: Renderings and Location

(Source: archidaily.com & Made by Authors)

6) Birds district

This scenic spot is located in the artificial subsurface flow wetland in the middle of five islands, is a pure ecological protection zone, prohibited visitors to enter, the island planting mainly consider the needs of birds, most of the birds like to use berry plants. Shallow wetlands are set along the shoreline of the island, which is convenient for birds to forage and attract birds to live and multiply here, as shown in Fig.3.5.18.


FIGURE 3.5.18: Renderings and Location

(Source: archidaily.com & Made by Authors)

7) Lotus scenery

Lotus and lotus are planted on the opposite side of the sculpture. In summer, you can enjoy the lotus leaves and lotus flowers in the sky during the day, and taste the fragrance of lotus at night, as shown in Picture 3.5.19.

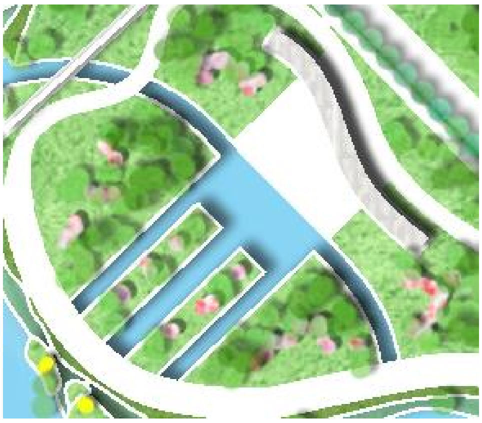
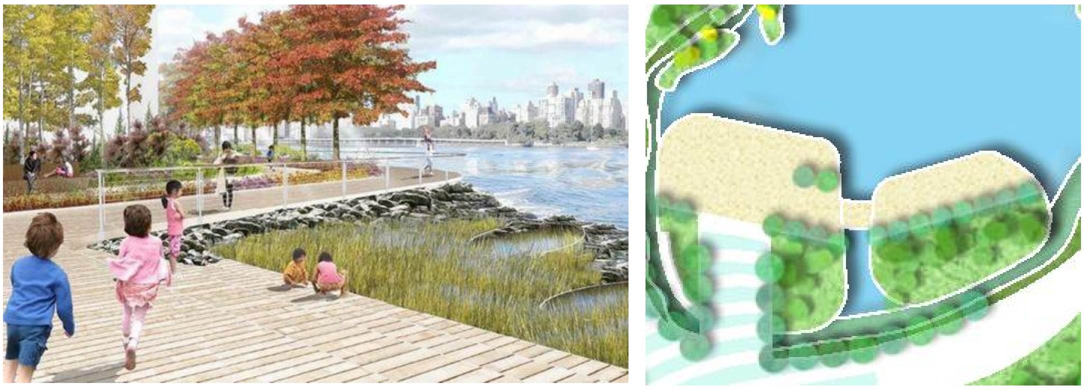



FIGURE 3.5.19: Renderings and Location

(Source: archidaily.com & Made by Authors)

3. Leisure and entertainment area

In addition to wetland landscape, the site also set up some recreational landscape for tourists. The total area of the site is 46,720sq. The area of the lake is about 126,22sq. In addition, there is another 340,98sq.The main landscape includes viewing platform, carved garden, wetland Flower Sea, water-friendly theater and some waterfront strolling space. The specific renderings are shown below.

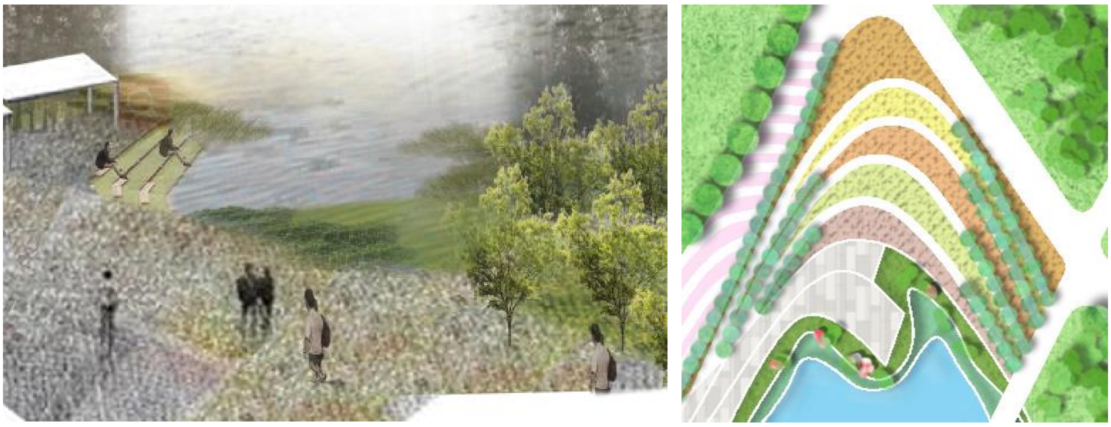


Renderings and Location of Viewing Platform

(Source: archidaily.com & Made by Authors)

Renderings and Location of Carved Garden

(Source: Made by Authors)



Renderings and Location of Wetland Flower Sea

(Source: archidaily.com & Made by Authors)

Renderings and Location of Water-friendly Theater

(Source: archidaily.com & Made by Authors)

Renderings and Location of Waterfront Strolling Space

(Source: Made by Authors)

3.5.4.2.3 Analysis of tour routes and nodes

The overall traffic analysis is shown in Figure 3.5.20, in which there are 5 main entrances and exits to meet the flow of people in different directions. The width of the road in the site is mainly between 1.5 meters and 6 meters, which can meet the main pedestrian space, as well as the passage of tour cars.

FIGUR E 3.5.20: Overall Transportation Analysis of Park

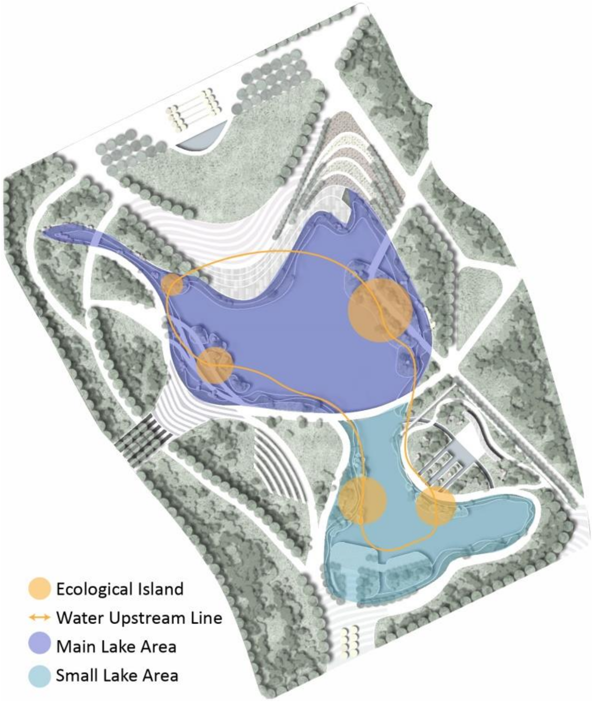
(Source: Made by Authors)

Thus, as shown in Figure 3.5.21, there are two main road types. The main tour road is about 6 meters wide and can be passed by a number of small tour cars. It is mainly distributed in the peripheral area away from the lake and has a good view of some scenic spots. The whole park is still more supportive of walking, which is also in response to climate change. The secondary road is between 1.5 and 3 meters wide and provides walking access to the main observation points, but does not take one to some of the important ecological islands.

FIGUR E 3.5.21: Specific Roadways Analysis

(Source: Made by Authors)

In addition to the traffic, we also analyzed the landscape of the lake, as shown in Figure 3.5.22.It can be seen that we have the main lake and the secondary lake, which, as mentioned before, serve the main landscape lake area and the subsurface wetland area respectively. The small water surface contrasts with the large open water surface. Moreover, the design of our island is also in line with the flow of the lake, with the temperament of Chinese classical garden.



FIGUR E 3.5.22: Lake Area Analysis

(Source: Made by Authors)

Finally, we also analyze the overall landscape nodes, as shown in Fig. 3.5.23.The Park has a north-south main axis, which contrasts the dark wetland space with the bright and spacious lawn space. The east-west landscape nodes also echo each other, the line of sight is interacted with each other, and the density is compared.

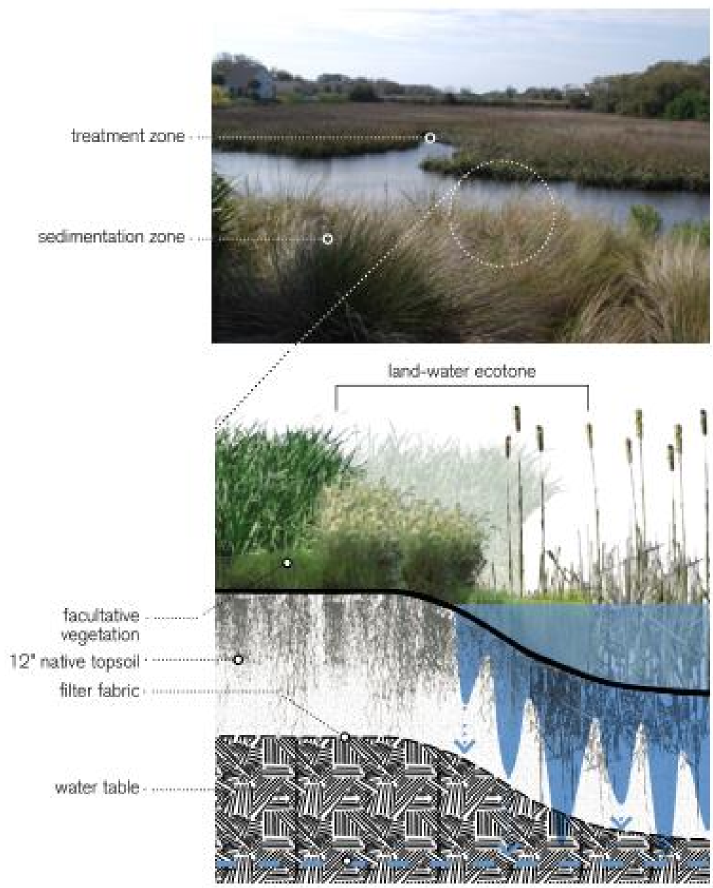
FIGUR E 3.5.23: Landscape Node Analysis

(Source: Made by Authors)

3.5.4.3 Sponge system planning

Constructed wetlands are artificial marshes or swamps with permanent standing water that offer a full range of ecosystem services to treat polluted storm water. Considered to be a comprehensive treatment system, constructed wetlands, like infiltration basins, require intrinsic hydrogeological properties to reproduce natural watershed functioning. As with other infiltration systems, pre-treatment systems upstream help to remove sediment that may clog a wetland system, resulting in eutrophication or an oxygen deprived system.

Constructed wetlands are land rich bio filters and differ from retention ponds in their shallower depths, greater vegetation coverage, and extensive wildlife habitat. They require relatively large contributing drainage areas to maintain a shallow permanent pool. Minimum contributing drainage area should be at least 10 acres, although pocket wetlands may be appropriate for smaller sites if sufficient water flow is available***[http://uacdc.uark.edu]***.



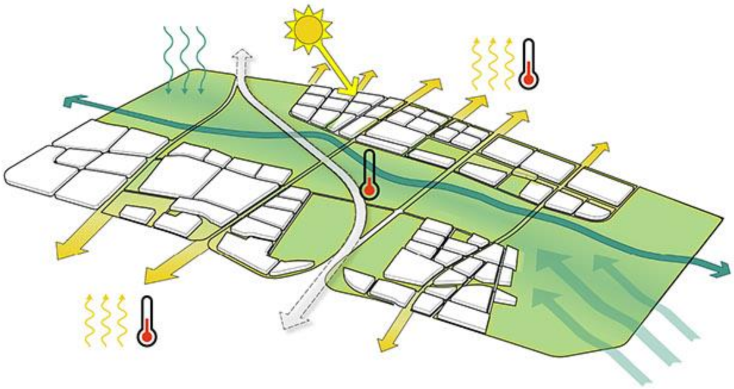
FIGUR E 3.5.24: Section of Constructed Wetland

(Source: http://uacdc.uark.edu)

3.5.4.3.1 Urban heat island effect

The main reason for the decrease of urban wetland area is that urban expansion, construction of buildings and traffic facilities occupy the urban wetland, and the shortage of urban water resources and the shortage of water supply cause the drying up and degradation of urban wetland. Rapid urbanization reduces the area of urban wetland, destroys the habitat, and aggravates the pollution, which greatly reduces the ecological and social service functions of urban wetland. The decrease of urban wetland area and the lack of water supply lead to the decrease of the role of urban wetland in regulating local climate and alleviating urban heat island effect. The destruction of urban wetland habitat and the blind introduction of some alien species lead to the invasion of alien species to wetland habitat, which reduces the survival rate of native species and increases the difficulty of urban wetland protection and restoration. Serious siltation and aging of urban wetlands such as rivers, lakes and sea lead to greatly reduced flood control and drainage capacity of urban wetlands. Urban wetland water environment pollution is serious, eutrophication, dirty and black, emitting many unpleasant smells, leading to a large number of urban wetland organisms die, biological species greatly reduced, human leisure, entertainment, living away from such an environment, the social service function of the wetland is greatly reduced.

The type, nature and structure of urban underlying surface are the direct causes of urban heat island effect. The main types of urban underlying surface features include buildings, roads, water bodies and vegetation. Buildings and roads are composed of sand, stone, brick, steel and other mixtures. Their heat capacity is low, easy to absorb a lot of thermal radiation, temperature rise faster than vegetation and water, buildings and roads can make their surface temperature 10-21 ℃ higher than the ambient temperature by absorbing solar radiation. A large number of high-rise buildings reduce wind speed and increase the difficulty of heat level exchange. The greater the density of urban buildings, the greater the intensity of heat island.



FIGUR E 3.5.25: Urban Temperature Map

(Source: Made by Authors, Referred to www.gooood.cn)

(1) Influence of urban wetland on urban heat island effect

In the summer of 2000, there was a continuous hot weather in northern China, according to experts ***[Jiang Weiguo,...2007]***.It can be seen that there is a certain correlation between wetland and temperature, climate and heat island effect. Urban wetland is the basic element of urban ecological environment, is an indispensable part of building a harmonious and healthy urban living environment, and is an important measure to purify the atmosphere, protect the environment and beautify the city. The large area of urban wetland has a good regulating effect on the temperature and humidity in different parts of the city.

1. Absorption of greenhouse gases emitted by urban heat island effect process

In the process of anthropogenic heat emission, a large number of air pollutants are produced, such as carbon monoxide, carbon dioxide, methane and so on. These three pollutants are all based on carbon and are the main substances of greenhouse effect. Urban wetlands can absorb carbon monoxide, carbon dioxide and methane from the air, thus storing a large amount of carbon, which can greatly reduce air pollution and slow down the greenhouse effect pace. About 4, 50 of the world's wetlands organic carbon x109t, covers an area of 1 m soil carbon ball land 1/3 of the total reserves, the equivalent of 4 to 0% of the total atmospheric carbon dioxide, wetland carbon library for sable and maintain a climate play an important role, strengthen wetland protection and wetland restoration, can alleviate caused by elevated atmospheric co2 concentration of global climate change ***[Jiang Weiguo,...2007]***.

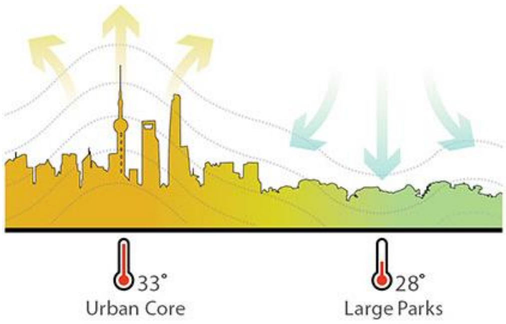
2. Cooling and humidifying and improving urban microclimate

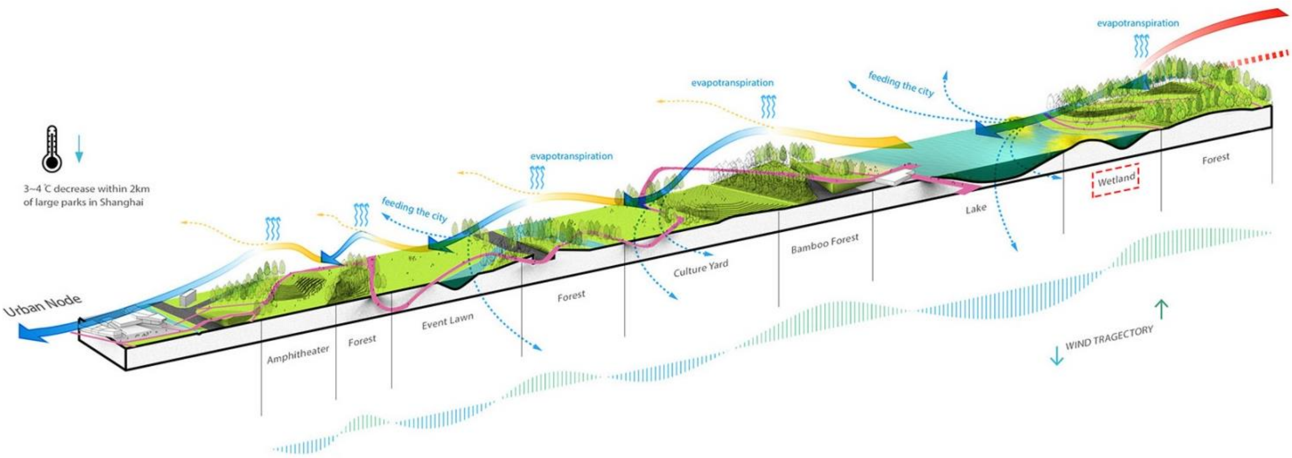
The cooling and humidifying effects of urban wetlands vary due to different natural environment conditions, wetland types, wetland area and abundant water resources. The same city is observed at different times, and the results vary greatly. The specific heat of wetland is much greater than that of dry land of the same area, which can play a role in temperature regulation. It can absorb excess heat in extremely hot weather, but it will not be too cold in winter. Retrieval of land surface temperature in Beijing from 2000-05-05-19 LANDSATETM remote sensing images***[Xu Zhendong. 2003]***. The results show that the temperature of urban wetland is about 20 ℃, which is the lowest area of urban temperature. The temperature at the distance from Kunming Lake in the Summer Palace is about 23 ℃, 24.2 ℃, 25.6 ℃ and 37 ℃, respectively. It shows that the closer to the wetland center, the lower the temperature, which has a significant cooling effect on the surrounding environment of the wetland. Wetland water through evaporation and diffusion function sends out into the air, increase air humidity and moisture content, and the wetland water by osmosis, increase soil moisture and plant roots to absorb moisture in the soil, through foliar transpiration will moisture in the form of gas emission to the atmosphere, take away the heat and increase the humidity of the air weeks surround environment, therefore, wetland weeks often produce around every morning mist. The cooling and humidification effect of wetland directly or indirectly affects the surrounding environment and climate, which is conducive to improving the microclimate in local urban areas and eliminating the urban heat island effect.

(2) Comfortable microclimate around the site

Although our first design site is small, we hope to gradually restore the ecological wetland, restore the ecological diversity and alleviate the urban heat island effect in the planned site through the slow development later.

The climatic conditions were carefully simulated during the design process to maximize thermal comfort and air quality through topographic modification, planting strategies and calculated spatial synergies. This includes the alternating appearance of forest canopy and water body, hoping to promote the natural cooling of the whole site and make the site pleasant all year round. Based on a large body of published scientific data, the design of the microclimate in the project quantifies the social and ecological benefits that ecosystem services will deliver in the overall planning. It is estimated that at least thousands of trees will be planted in the wetland park, which will bring real microclimate benefits to the whole site and effectively reduce pollution. Moreover, the Wetland Park is located in Jinhai Lake. Existing data show that, thanks to the construction of microclimate, the temperature of the whole fish in Shanghai is 3~7℃ lower than that in the downtown area of Shanghai, which will be a great blessing for the citizens in the heat wave，like the Figure 3.5.26 showing. The relatively deep lake in the park also takes advantage of its upwind position to promote heat transfer and evaporation cooling, bringing pleasant breezes throughout the park.





FIGUR E 3.5.26: Schematic Diagram of Park Alleviating Urban Microclimate

(Source: Made by Authors, Referred to Xu Zhendong 2003)

3.5.4.3.2 Wetland Park and Sponge City

We mentioned earlier that Shanghai is building a sponge city. The construction of "sponge city" can effectively improve the resilience of the city to the flood disaster, and at the same time can reduce the difficulty and working pressure of the urban drainage system and sewer system, which has obvious benefits to the urban construction. Especially in cities like Shanghai, which are prone to flooding during the summer months. Therefore, based on the construction concept of "sponge city", we discuss the effect of urban wetland landscape on it.

(1) Significance of urban wetland landscape to urban construction

1. Accumulation of precipitation

Wetland ecosystem plays an important role in urban water system. Its hydrogeological characteristics are distinct and it can store a lot of water. It can effectively purify the water quality of precipitation and surface runoff, and collect and store the purified water, so as to provide the possibility for the future use of water resources, provide sufficient water for people's production and life, and reduce the accumulation of precipitation and surface runoff on the surface. Wetland ecosystems are cities

As an important part of water source, it can transform problems such as flood disaster into water resources accumulation, which can not only reduce the damage and impact of flood disaster on the city itself, but also store enough water resources for the city as much as possible, providing more abundant water resources for people's production and life in the future. The accumulation and precipitation function of urban wetland ecosystem can also adjust the urban ecological balance, ensure that the water resources in the city match the water resources in the surrounding areas, and protect the stability of the ecosystem, which is of great significance to urban construction and ecological protection.

2. Regulation of Runoff

In most of the current urban construction, drainage problem is a relatively important topic. Due to the imperfect design of drainage system and sewer system; cities are vulnerable to the disturbance of heavy rainfall. In the case of heavy rainfall, cities cannot discharge the ground runoff well, and a large amount of water on roads will restrict citizens' travel, or even threaten their travel safety. And the existence of urban wetland ecosystem can be in

In the case of a large amount of precipitation, the ground runoff can be effectively adjusted to collect, purify and store more ground runoff, so as to avoid the impact of a large amount of water on the travel convenience and travel safety of citizens. At the same time, the wetland system can reduce the working pressure of the urban drainage system and sewer system, and the urban wetland ecosystem can help the drainage system deal with part of the drainage work and drege the surface runoff ***[Deng Chaoxian,...2020]***.

3. Precipitation purification

The traditional urban construction often focuses on the economic construction. The urbanization process promotes the urban construction, but causes the urban pollution and endangers the production and life of citizens and their health. Precipitation often contains a small amount of toxic substances or heavy metal substances, the existence of these substances lead to precipitation and surface runoff cannot be directly used in urban production and life. However, the urban wetland ecosystem can purify the accumulated precipitation and ground runoff water resources through microorganisms and soil, remove the toxic substances and heavy metals, and block the pollutants, so as to obtain relatively pure and usable water resources and store them for future urban production and living.

(2) Landscape optimization strategy of Jinhai Lake Wetland Park under the concept of sponge city

1. Optimizing strategies for wetland park landscape under drought and flood conditions

First, the revetment flood control safety principle. In the planning and design of the wetland park, flood control safety should be fully considered, which involves the design of water storage and drainage and revetment in the wetland. Non-standard revetment design will cause more serious losses, therefore, planners and designers should fully consider the structure and material of the revetment.

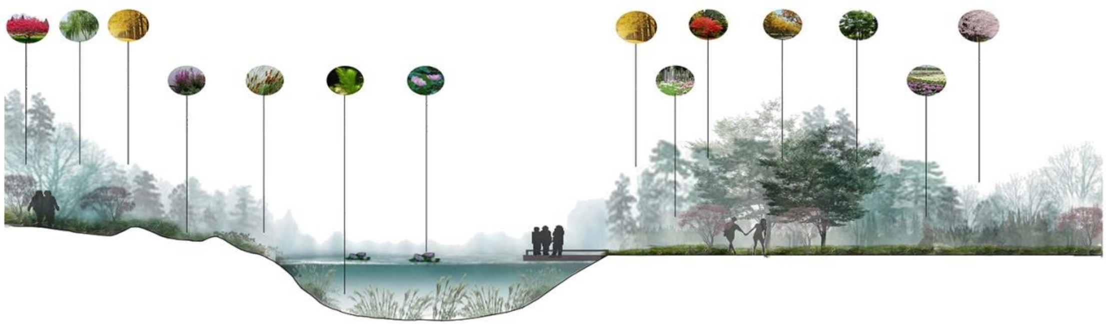
Second, road optimization. Jinhai Lake Ecological Wetland Park road should be organized confluence and transfer of water flow. To optimize and transform the existing hardened road, the drainage and seepage of the main road surface should be carried out in an ecological way at first. The rainwater from the road surface first flows into the sponging construction technical facilities in the green space on both sides of the road, and then passes through the overflow discharge system and other technical facilities in the facilities. The facilities in the green space on both sides of the road should take necessary anti-seepage measures to prevent the damage caused by rainwater infiltration to the roadbed. The green area of the road should be maintained, and the original topographic features should be used to create the concave green space in the slope position.

2. Landscape ecological optimization strategy

First, we will adhere to the principle of ecological protection. Ecological protection is the key element of landscape planning. For the construction of Wetland Park, it is necessary to protect its ecological environment and make it play the role of urban green lung and sponge system. Ecological protection should not only protect the environmental resources within the region, but also pay attention to the local cultural environment. When choosing design materials, consider local materials. Water sensitive areas, or ecologically fragile areas, need to be protected.

Second, the park green space optimization. The important carrier of the sponge construction of the wetland park is the green space system, which should absorb the runoff, rainwater and river water, and at the same time systematically realize the functions of confluence, transfer, purification, treatment of rainwater, storage and regulation of water system. The wetland green space should be reformed, water regulation facilities should be added in appropriate areas of the green space, and rainwater storage and collection should be utilized and combined with the landscape. At the same time, the vegetation buffer area is increased to effectively regulate the surrounding area and reduce the risk of waterlogging ***[Jin Na. 2020]***.

The third is the optimization design of the water revetment. Ecological revetment can control runoff pollution, strengthen riverbank line and protect internal and external water system through soil precipitation and aquatic plant purification. Plant configuration should be established under the special condition of bank slope stability. According to the change of water level, plants suitable for growth should be selected, with emphasis on naturalness and ecology, as shown in Fig. 3.5.27.



FIGUR E 3.5.27: Site Revetment Design

(Source: Made by Authors)

The fourth is the use of aquatic plants and animals to optimize water quality. In addition to aquatic plants can optimize the water quality, according to the climate conditions and water quality conditions of Shanghai, fish, amphibians or plankton can be put into the water to optimize the water quality, which can enrich the water space and prevent the water ecological environment problems caused by algae growth.

3. Landscape security optimization strategy

The revetment is shown in Figure 3.5.28, in sponge city idea, on the basis of water moorings in the optimal design of the security, revetment design should adopt the design approach of terracing, which can effectively flood prevention, prevent flood season to immerse to wetland park, and terracing the wetland park can let people under the influence of different water level in the wetland park for a walk, watch and play. The design of the trail also needs to consider the corresponding safety factors. The optimization of the trail should adopt the seepage design method, which can avoid the formation of rainwater pools, and does not damage and limit the growth of plants, and will effectively prevent people from slipping on the way of sightseeing. The aquatic plants in the water area should not be too luxuriant, and the plants with lower growth height should be selected.

FIGURE 3.5.28: Site Revetment Design

(Source: Made by Authors)

4. Optimization strategy of supporting facilities for landscape planning of Wetland Park

The park is equipped with park management and service facilities. Visitor service centers and security facilities are set up at the two main entrances to provide visitors with guided Tours and security services. In addition to strengthening the infrastructure of the wetland park, the original dining space and the paving facilities of the rest booths and the square layout system should be managed and optimized in an orderly way to enhance the tourist experience. To sum up, the sponge in the concept of urban optimization was studied for the ecological wetland park, combined with the present situation of the Jinhai lake ecological wetland park, in line with the principles of ecological protection, low impact, low development, the optimization of water revetment design, aquatic animals and plants, sponge swim trails, vegetation buffer, sightseeing zone for promoting at the same time, top ecological wetland park facilities, perfect beach makes the symbiotic and harmonious development of the new urban ecological wetland park ***[Jin Na. 2020]***.

3.5.5 Conclusion

For the construction of ecological wetland park, the author should consider the original characteristics of the site while considering the restoration of ecological wetland. Because the site is located in the scenic area, in order to better enhance the viewing effect of the scenic area, the wetland park also added some leisure and entertainment functions. The newly built wetland park is only a small part of the park. The author hopes that through the good effects brought by the park, the surrounding environment will gradually be influenced to a more ecological and sustainable landscape development.

4.Conclusion and outlook

4.1 Conclusion

Based on the analysis of the research and practice status at China and abroad, four different types of areas in Shanghai were selected as examples to carry out multi-level sponge reconstruction, waterlogging prevention and control, urban heat island, and site optimization design strategies were proposed, and LID setting and layout plan was obtained.

Leading to the following conclusions:

(1)Low Impact Development (LID), as a natural, aesthetic and low-cost urban rainwater management method, plays a significant role in controlling rainwater runoff. Many years ago, developed countries such as Europe and the United States applied low-impact development measures to urban stormwater management practices and achieved remarkable results. Due to the late start, the relevant research on the application of low-impact development mode to rainwater collection and utilization in China is still in the exploratory stage, and the functions of urban park green space designed are not comprehensive. Based on this, this study puts forward an urban planning and design method based on the concept of Low Impact Development (LID). By selecting four different types of sites, according to different environments and backgrounds, the sites renewal strategy system of waterlogging area is to transform multi-level sponge park. For example, the sponge community control mainly focuses on the sponge reconstruction of open space, the sponge corridor control mainly takes the river bank and the green ecological area as the medium, and the sponge patch control mainly focuses on the smaller spongy bodies such as urban wetland and urban green space. Through the analysis of the current layout and status quo of the sponge base in the city, on the basis of the protection of the current situation, the corridor connects the sponge ecology, water body and green space pattern in each region, so as to build a global, all-round and multi-layer green ecological system, so as to reconstruct the ecological pattern.

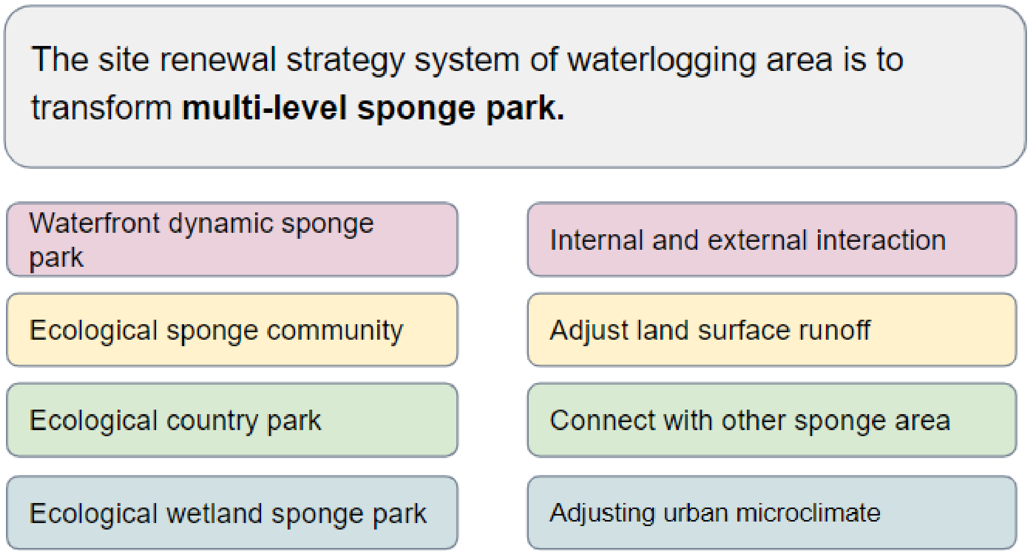


FIGURE 4.1.1: Multi-level sponge park

(Source: Made by Authors)

This method attaches importance to improving the rainwater management functions of urban parks through environment reconstruction, and takes rainwater resource utilization and reduction of urban rainwater runoff as the planning and design objectives. In order to reach sponge city's main goal, which is to make the city "resilient" to environmental changes and natural disasters, including the protection of the original water ecosystem; Restoration of damaged water ecosystems; Low impact development; Through a variety of low-impact measures and system combinations, effectively reduce surface water runoff and reduce the impact of heavy rain on urban operation **[Qiu Baoxing. 2015]**

(2)Through the research on the concept and technical methods of low-impact development, this paper try to make a series of field data analysis, combined with the actual situation and the summary of theoretical practice in the domestic and overseas. Thus, the design strategy of urban park green space under the background of LID is obtained. In the process of site reconstruction and design, reasonable allocation should be carried out according to different planning and design requirements, so as to realize the control of rainwater in urban park green space. Compared with the traditional urban park green space planning and design, its landscape effect is more natural, the construction cost is lower, and the system function is more comprehensive.

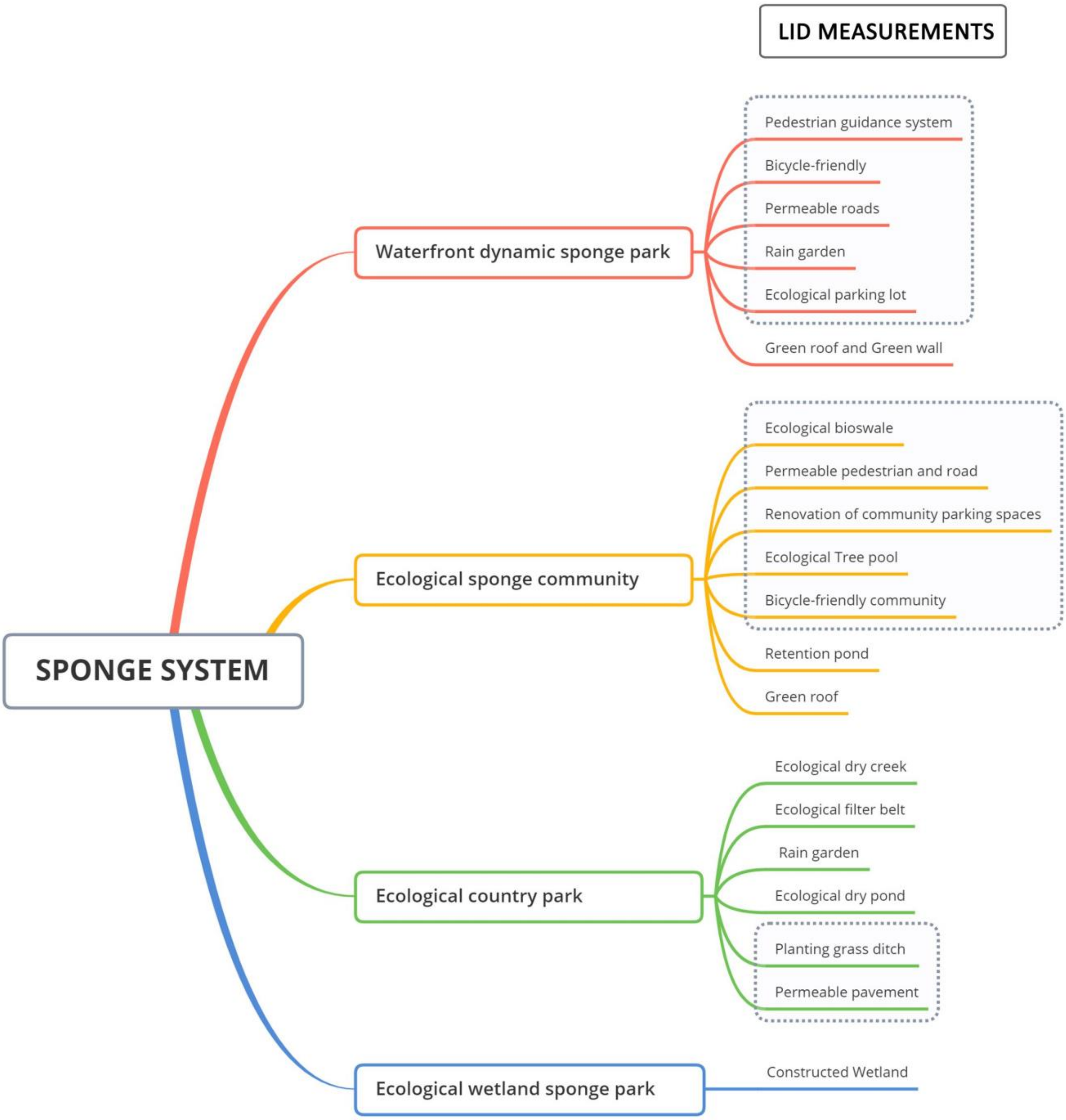


FIGURE 4.1.2: LID measurements

(Source: Made by Authors)

（3）About waterlogging prevention and control system construction. The layout of a single LID facility has negative effects such as poor effect and poor stability. Multiple LID facilities are used to improve the effect of retention and storage. Compared with the rainstorm intensity with high return period, LID facilities with low intensity have more obvious and stable effects. In the reconstruction or layout of LID facilities, more considerations should be given to local geographical and economic factors, and LID facilities should be selected according to local conditions to avoid the cost waste caused by a large number of stacking. At the same time, the special planning of sponge cities in various regions should be combined with theory and practice to conduct a deeper discussion.

4.2 Outlook

Urban design based on the concept of Low Impact Development (LID) aims to carry out sponge reconstruction design through different type urban areas. Enhance the stormwater treatment capacity of the site, restore the natural water circulation system and minimize the impact of human activities on the water system by minimizing the impact of the site and the environment. However, the pilot sponge construction planned for Shanghai is scattered and only a part of urban green space, and China has not yet formed a relatively complete urban sponge system, so the positive impact on the whole urban hydrological system and urban heat island is not obvious.

Therefore, it is expected that the application of low-impact development techniques in the design field. The rainwater capacity of urban parks is presented in digital form in a more scientific and targeted way. In order to expand the scope to the green space system of the whole city, it requires a more reasonable and complete green space system construction, and connects the scattered green space with green belts, so that the urban park can harmoniously integrate into the urban green ecological network. At the same time, it is necessary to combine urban sponge reconstruction with other design directions of park green space to achieve better design effect. More importantly, the concept of low-impact development will be comprehensively applied to the whole green ecological system, and the green system of the whole city will be used as a place for rainwater retention, infiltration and accumulation, so as to effectively alleviate the rainwater problem in the city.

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