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The influences of Sponge city on property value in Wuhan,China

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Summary

The fast urbanization in China and global climate change increased the urban flood exposure in Wuhan and the increased flood risk reduce the property value in serious flooding area. The central government of China promote the application of sponge city concept to reduce the urban flood risk and improve the environment in cities. The fund shortage is one of the problems facing by sponge city construction in Wuhan and how to find the funds for the sponge city construction or how to find a suitable business model has a significant role in the sponge city pilot. To test the residence's willingness to pay for sponge city, the research analyses the impacts of the construction of the sponge city on the housing value of the area that the sponge city construction covers. The research used a combined research method of survey and desk research. The questionnaires, interviews and secondary data analysis was conducted to analyse the impacts of construction of the sponge city on the housing value. The research result shows that more than half of the residence are willing to pay for sponge city but the amount they are willing to pay is limited. Compared with the ability to reduce flood risk, more residence is willing to pay for the ability to improve their living environment such as the increment of green area. It was suggested that sponge city construction could consider more multi-functional application so that the value of sponge city can be better recognised by the residence in Wuhan.

Keywords

Sponge city, Urbanization, Flood risk, Flood risk management, Property value

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Abbreviations

IHS	Institute for Housing and Urban Development
FRM	Flood risk management
SUDS	Sustainable urban drainage system
DRR	Disaster risk reduction
ATP	Adaptation tipping point
LID	Low impact development
WSC	Water sensitive city
SUDS	Sustainable urban drainage system
BMPs	Best management practices
PPP	Private-public partnership

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Chapter 1: Introduction

1.1 Background

1.1.1 The Relationship between Water and urbanization in Wuhan city

In the past 30 years, because of economic reform, the economic market grew fast and got booming in China. Urbanization, as one of most significant driving forces, contributes to the fast increase of China's economy.

In 2004, China's National government announced a national strategy called "The Rise of Central China". This strategy is aiming at helping the central part of China to accelerate a fast development and reducing the economic gap between the central region and East- Southern coastal region. Wuhan, as the largest city in Central China, benefits a lot from this national strategy.

Wuhan is the capital city of Hubei province and is locating in the middle reaches of Yangtze rivers. According to the statistic yearbook of Wuhan 2016, the city has a population of 11 million and has a land area of 8569 sq. km. In the year 2016, the GDP reaches a historically high level of 1191billion CNY. Because of the booming economy and population, the city is regarded as a super city in China and plays a leading role in the economic and social development in the region of Central China.

Urbanization is the engine of growth. (Bertinelli and Black 2004). Urbanization in China is a process that relocates people from rural to urban areas. The result of this process is that the population density in urban areas is much higher than the density in rural areas. To cover the basic living requirements for this large amount of population, the urban area accommodates up to thousands of buildings for those new immigrant living, working and having entertainments. In general terms, the more population the city has, the higher the density of the city will be. The high-density urban area will post two aspects of effects on urban water resource development and management. On the one hand, due to the high density of population, intensive social and economic activities occurred in the urban area. Those activities consume a large volume of water for living and manufacturing. Thus the need for high quality and large volumes of water is an important factor that has effects on urban planning and design. On the other hand, a city with a high density and large number of population are more vulnerable to natural disaster than ordinary cities. In recent years, due to climate change, more extreme weather has been observed and recorded by China's weather bureau (Meteorological Bureau of Shenzhen Municipality, 2014). With the spread of urban area and an increase of construction intensity, cities in China experience more flood risk exposure than ever before.

Wuhan city is a giant city with a history of more than five hundred years. Nowadays, Wuhan city is an economic, political, cultural and educational hub in the central region of China. The history of city development is also a history of how human beings fight with floods and deal with water (Wang, 2013). Similar to other urban areas globally, the impropriate ways of dealing with water results a delay response of urban problems facing by urban developer and manager. In one aspect, the Yangtze River and its biggest tributary cross at the city's geographic centre. This geographic feature means that the water level of the two rivers plays a direct influence on the whole city's safety level. In the other aspect, the rapid urbanization process filled original lakes and rivers within the city and transferred those water bodies into impenetrable concrete. Those man-made transformations significantly reduce the city's ability to absorb water and make the city easy to be flooded after a heavy rain.

For example, the South Lake area is a large residential community in Wuhan central area. This area is a small village located around the lake before 1996. Large developers in China such as Poly Real Estate Group Co and Langold Real Estate Co built numbers of residential houses in this area since 1996 and made the South Lake area becoming a newly built residential community with a population of about five hundred thousand residents (Wuhan evening news, 2013). During the process of development, part of the water body of the South lake has been filled with the land. According to the survey conducted by Chunye Environmental protection association, the water area of the South Lake reduced from 14.5 sq. Km in 1994 to 7.49 sq. Km in 2013. The water filling activity reached a peak between 2001 and 2002. During this period, 2 sq. Km of water body was filled by land (New Jing news, 2016). The activity of water filling reduced the capacity of water storage and increased the risk of flooding in the original lake area.

Figure 1 Map of Wuhan

Source: Google Maps (2017)

The principle of Wuhan city's drainage system is collecting rain-water and waste-water and discharge those two water streams into the Yangtze River. But in the flood season, the water level of the Yangtze river is sometimes more than 2 meters higher than the Wuhan city height. In this situation, water is hard to discharge into the river naturally and pumps are being widely used to remove water from the city into the river. When the amount of precipitation is larger than average, the problems of river discharge stormwater surplus often coincides, which together make flood risk particularly higher than in other periods.

1.1.2 The pilot project of sponge city in Wuhan

The sponge city is a concept of stormwater management. It is a system of infrastructures to help the city to improve the ability to absorb the disturbance and bounce back to the original state(Yu,2015). 'The general objectives of the concept entail 'restore' the city's capacity to absorb, infiltrate, store, purify, drain and manage rainwater and 'regulate' the water cycle as much as possible to mimic the natural hydrological cycle' (Zevenbergen&Boogaard,2016).

To deal with the challenges and problems resulting from urban flooding, China's central government released a policy of promoting the construction of a sponge city at the 12th Dec 2014. On 31st Dec 2014, the China's Ministry of Finance has published its policy of allowance on the construction of the sponge city (Ministry of Finance of the People's Republic of China, 2014). This policy of allowance gives a detailed description of how the central government will support the local government in the construction of the sponge city.

Shortly after China's central government released its policy of promoting the construction of the sponge city, Wuhan city has been selected as one of the first batches of pilot cities for the sponge city construction in April 2015.

Shortly after China's central government released its policy of promoting the construction of the sponge city, Wuhan city was selected as one of the first batches of pilot cities for the sponge city construction. In order to explore effective ways of constructing the sponge city, Wuhan has set up a pilot. This pilot has been started from the middle of 2015 and will end by the end of 2017.According to the working plan of Wuhan sponge city (The Office of Wuhan city government, 2014), five objectives, which are related to urban environmental conditions and improvements of waterlogging issues, have been set in city level and those objectives should be achieved and checked before the end of 2017.

Apart from the objectives, two districts have been selected as the demonstration areas in the pilot period of sponge city construction in Wuhan. The Wuhan government wishes that the experience gains in the pilot projects will be applied in the later construction period (The office of Wuhan city government, 2016). One of the demonstration districts is Qingshan district, which locates between the Yangtze river and the East Lake. The other is located at Sixin area, which is a new development area in Hanyang district. According to the requirements and plans made by the Wuhan government, these two areas should complete their construction process for sponge city before the end of the year 2017.

Figure 2 Location of sponge city area

Source: The author

1.2 Problem Statement

1.2.1 The increased exposure to urban flood

In 2016, two months after the Yangtze river entered into the flood season, a long-term continual intensive rainfall period affected the catchment of the Yangtze River (Wuhan Morning News, 2016). Wuhan, the biggest city located in the middle reaches of the Yangtze River, has been exposed to a high risk of flooding through the whole flood season. The high water level of the Yangtze River makes it hard to discharge the urban water into the Yangtze river via gravity. Because the construction of pumping stations or new drainage tubes are expensive and cannot be completed in the short term, the capacity of the city's pumping station is limited and cannot be adjusted in a short period. In July 2016, a one-week continual heavy rainfall attacked Wuhan city and the precipitation intensity reached a historically high degree. According to a media's report, more than 600mm(1.9ft) of rain has fallen in Wuhan over one week, and this precipitation level is the most ever recorded in the history of the city (Wuhan Morning News, 2016). On the morning of 6th July 2016, a major part of the city was flooded by rainwater. Roads and metro stations were inundated, and trains cancelled. Because of waterlogging within the city, two main metro lines were out of operation and thousands of cars were inundated by water and blocked on the street. This urban flooding in Wuhan has caused an economic loss of €300 million and 10 million people in the city were severely affected because of the dysfunction of the transportation system and the power supply system (Today's Sydney, 2016). It took ten days to remove flood water from more than one hundred plots in urban areas, and after two weeks, the urban operation finally returned to normal.

The heavy flooding in Wuhan in the summer of 2016 is an extreme event, but it is not a particular case in China. According to the data released by The Office of the State Flood Control and Drought Relief Headquarters (China) on 3rd July 2016, 32 million people in 26 provinces across China have been affected by severe flooding from June 2016(BBC News, 2016). Due to the high population intensity in urban areas, the flood risk exposure in cities is much higher than in rural area and the economic and social effects in large cities are more severe than in other regions. Disasters remind people to rethink the relationship between urban development and water management in urban areas.

1.2.2 The drastically drop of housing value in flooding area

Apart from the negative effects on citizen's safety level and daily life, the extreme flood event occurred in summer of 2016 also played an influence on the value of house price in Wuhan. The South Lake area is one of the urban areas, where the housing price has increased dramatically in the past ten years. In 2005, the average housing price in the South Lake area was 4 thousand CNY per sq.m.. The average housing price in this area has increased to 12 thousand CNY per sq.m. in 2015(Wu, 2015). The South Lake area is an area with serious waterlogging condition during the heavy flood event in the summer of 2016. The heavy storm on 6th July 2016 and the resulting waterlogging, caused many citizens of the community of the South lake area to have limited access to electricity and drinking water. One week later, there were still some areas inundated in the South Lake area. As a result, the housing market changed after the flood event. Before the flooding, the housing price in this area was between 12 thousand to 15 thousand CNY per sq.m. It was hard to buy a house in that area because too many potential buyers were bidding on the same house. However, after the flood event, the asking price of some houses in the south lake area dropped to 10 thousand and the agency said that the house transaction was hard to complete because of the lack of buyers after flooding (Hubei web, 2016).

1.2.3 The difficulty in construction of urban drainage system and sponge city

Because of devastating consequences made by urban floods, citizens and governments in Wuhan paid more attention to the construction process of the urban drainage system and sponge city. In June 4th 2013, Wuhan government announced that 13 billion CNY fund would be invested into urban drainage system construction in 3 years to improve the capacity of urban drainage and reduce the waterlogging situation in Wuhan (Hubei daily news, 2013). After the flood events in the summer of 2016, citizens raised questions on how the 13 billion CNY fund was spent and why the urban drainage system did not have many improvements in the past three years (Sina News, 2016). The Wuhan government explained that the amount of the 13 billion CNY came from the investment plan and only 4 billion CNY fund was actually invested into the urban drainage improvement projects. The shortage of the funds for construction was the main reason for the delay of construction of urban drainage improvement projects (21th-century economic news, 2016).

The problem of fund shortage also happened in the sponge city construction. On April 20th 2016, Wuhan government released the construction plan of the sponge city. According to the plan, 15 billion CNY fund will be invested into the construction of the sponge city in Wuhan in 2 years. The investment plan covers 389 projects in Wuhan (Wuhan urban and rural construction commission, 2016). After the news had released, Wuhan government published the notice of action plan of the sponge city construction to give specific guidance to Wuhan. In the guidance, Qingshan demonstration area has an area of 23 s.q. kilometres. There are 330 projects need to be constructed within the area according to the requirements and evaluation and the total investment for this area will reach to 13.1 billion CNY. Major projects include 41 urban roads, 260 public spaces in communities, 12 green spaces, 5 urban rivers and 12 urban drainage tubes (The office of Wuhan city government, 2016).

In the middle of 2016, half of the projects have completed the construction and the ability of flood protection have been examined after the serious urban flood happened during the summer time of 2016. However, the process of constructing the sponge city is falling behind the schedule of Wuhan government's planning in 2015. The main reason for that delay is insufficient funds required for the construction of the sponge city (21th-century economic news, 2016). In order to promote the construction of the sponge city in Wuhan, China's central government has already given 1000 million CNY to Wuhan government for project construction, but comparing the fund requirements estimated by Wuhan government, which is 15 billion CNY in two years, the subsidies amounts are far less than the requirements of funds. The notice of action plan of the sponge city construction (The Office of Wuhan city government, 2016) mentions that Wuhan city government will allocate at least 400 million CNY fund to the sponge city construction and the Qingshan and Hanyang district government will each allocate at least 100 million CNY fund to the sponge city construction. As the public willingness to pay for the sponge city is low so it is hard to finance the construction of the sponge city by means of increasing the fees for urban water (Wang, 2016). The remaining amount of fund shortage assumed to be financed by a method of private-public partnership (PPP). However, the expert said that social capital was hard to participate through ways of PPP, as there was no successful operation model in PPP to collect revenue from sponge city currently (China environmental news, 2017).

Concerning the difficulty in construction of urban drainage systems and the sponge city, how to find the funds for the sponge city construction or how to find a suitable business model has a significant role in the sponge city pilot.

To explore a better method of sponge city construction, a seminar about Wuhan sponge city was conducted on October 20th 2016. Experts from Hubei's research institution of social

science, Wuhan real estate association and China's research institution of real estate index and representatives from China's famous real estate developer such as Vanke and Beichen participated in the seminar.

1.3 Research Objectives

In the current pilot period, the funds of sponge city construction mainly come from government's grants. In the later period, the shortage of funds will become the barriers of the sponge city construction as that the amount of government's grants is far less than the requirements. The significance of finding the potential business model for sponge city construction and operation will increase over time. The objectives of the research are to analyse the impacts of the construction of the sponge city on the housing value of the area that the sponge city construction covers. If the assumption that sponge city construction can improve the property value in the area that construction covers have been verified, an effective business model can be designed accordingly.

1.4 Provisional Research Question

According to the problem statement and research objective, the main research question is:

To what extent the application of sponge city concept in urban construction will impact the residence's perception on housing value in Central area of Wuhan?

To answer the main question, there are several sub-questions of this study:

1. What is the flood risk perception of residences in Wuhan?
2. How residence in Wuhan value the different functions of sponge city?
3. Whether the residence in Wuhan are willing to pay for the sponge city through a way of housing price increase? To what degree?

1.5 Significance of the Study

1.5.1 Significance of study about water management

Facing the challenge impacted by climate change and globalization, water management has become more important than ever. Urbanization influences water flows and groundwater levels. So the method to use and to manage water is an indispensable factor that should be considered during urban development and management. Water is a necessity for people's daily life. Beyond that, water plays an important role in the Chinese culture. In the south part of China, water is a symbol of fortune. Therefore, people of the south part of China are preferring to live near water. Under this condition, the role of water management in China is multidimensional. The basic function of water management facilities is to ensure the supply of water in urban areas. Furthermore, the water management facilities should have the ability to decrease the risk and effects of floods. Last but not least, the facilities may need to provide an opportunity for people to live close to water. The three aspects of water management involve the different institutions and authorities. Hence the exploration of an effective mechanism to coordinate the different institutions and authorities to achieve a common goal has significant meaning in urban water management. The property value is a measurement of those aspects and functions of water management facilities, so the study of how water management facilities can play an influence on urban land values can provide suggestions to the urban manager about scientific urban-water using methods.

1.5.2 Significance of the study about the relationship between sponge city and housing value

The sponge city is a new concept that has been widely discussed but research into this concept is relatively new. People's understanding of the sponge city is limited. The construction of sponge city is still in a pilot period but problems of a lack of funds have become a serious barrier in its wider acceptance and implementation. So to find a business model for the sponge city seems to be an alternative option to overcome the problem of a lack of public funding. Under this condition, whether the construction of a sponge city can increase the housing value plays an important role in the success of promotion of the sponge city.

1.6 Scope and limitation

The research will cover perceptions of residence, housing and land value and transaction price in the central area of Wuhan, which includes 7 administrative districts. The peri-urban area and remaining new towns of Wuhan are excluding in the research as the urban development level in those areas is significantly different from the central area of Wuhan.

The limitations of this study are as follows:

- Wuhan is a city exposed to frequent flooding, the result of research in Wuhan is hard to generalise to other cities which experience only limited flooding;
- The pilot project of sponge city has begun in Wuhan from April 2015; It has been implemented for only two years. Hence the project is still in an early stage of development.
- The research analysis the relationship between citizen’s perception about sponge city and housing value. However, it is difficult to exclude other factors that influence housing and land values.

Chapter 2: Literature Review

This chapter reviews the concepts of urban flooding, flood risk management and sponge city concept. It presents and analyses the academic theory and concepts around those topics while highlighting on their relationships and key points in the context of this research.

2.1 The relationship between urbanization and urban flooding

During the past decades, China has made a significant achievement in the process of urbanization, the urbanization rate of China increased from 10.64% to 56.10% from 1954 to 2015 (Pan, et al., 2015). Because of the economic reform and national policy of opening-up in 1979, China has a high-speed economic growth. Thus the urbanization speed reached 0.98% per year after the national policy of opening-up (Xia, et al., 2017).

The fast urbanization rate accelerated the construction of cities in East and Middle China but brought a series of problems in the fast development process. Firstly, due to the unprecedented speed of the urbanization process, the construction speed of infrastructures is hard to catch up with the expansion and development of cities. Secondly, due to the inefficiency of experience and lack of capacity, officers in urban development and management paid more attention to the visible infrastructures e.g. transportation facilities, skyscraper and high-rise residential buildings. As a result, the construction of invisible infrastructures e.g. underground drainage systems and waste process facilities have been ignored by many cities' management (Xia, et al., 2017). Last but not least, the conflicts between increasing population and limited lands are extremely intense in many giant cities such as Beijing, Shanghai, Chongqing and Wuhan. In order to satisfy the increasing demands arisen from urbanization, many lakes within cities have been filled up by land and houses have been built on the newly made spaces. As a result, the changed hydrological regimes of the city have altered city's ability to reserve water.

Under these circumstances, it was a wide belief (Wu et al,2012; Yazdanfar and Sharma, 2015; Xia,2017) that the limited capacity of urban drainage systems is the main reason for urban flooding in China in recent years. Xia (2017) points out that the increased urban impervious area increased runoff in the urban areas. As a result, the rapid urban expansion makes it hard for the runoff water to be drained out by grey infrastructure systems. In conclusion, Xia (2017) views that the outdated grey infrastructure and low standard of urban drainage system are the major reason for the urban waterlogging phenomenon and urban floods in China's big cities. Apart from that, the author points out that the blind urbanization also caused other urban issues such as environmental pollution including air and water pollution and heat islands, high housing price, resource shortage and traffic congestion. He thinks that those issues harm human's health, social stability and economic development directly.

According to Zheng (2016), a limited capacity of urban drainage system is not the main cause of urban flooding in China. In his article, he argued that the Chinese government has already taken measures to upgrade the capacity of the drainage system and uplifted the design standard of the drainage system, but there is no obvious improvement in dealing with the urban flood. In his article, three causes have been proposed for tracing urban flooding in China. The first cause for the flooding is the loss of natural water bodies. He described the situation in Wuhan as an example. In the past 30 years, 90% of the lakes. ('a total of 228.9 km2, equivalent to 20% of its current municipal area' (Zheng, et al., 2015)) within the city were infilled. Thus the decrease in natural water bodies reduced the cities' capacities to withstand strong storms and increases the flood risks. Secondly, the urbanization enlarged impervious areas in cities thus increased the amount of water runoff and added extra burdens on urban drainage system. Last but not least, the urbanization altered the natural water system within urban area significantly, resulting in fragmentation of water system and sedimentation in urban rivers. The two results

decreased the drainage efficiency simultaneously. Apart from that, Du (2010) thinks that the social and ecological value of water has been unrecognized in urban spatial planning and development processes, resulting in the undervaluation of water bodies which has increased the likelihood of urban floods.

In conclusion, no matter whether the construction of grey infrastructure should be the main course of urban flooding, the unscientific urbanization process indeed has led directly and indirectly to the frequent urban flooding in China.

2.2 Flood risk perception

2.2.1 Termination of flood risk perception

Apart from urbanization, scholars (Chou, 2012, Lawrence, et al., 2014 and Odilon & Lokonon, 2016) also argue that climate change is another important factor that contributes to the increased occurrences of urban floods. Due to the climate change, the extreme climate events such as heavy rainfall occurred much more frequently than before. The amount of runoff water increased rapidly and exceeded the capacity of the city's drainage system. Urban floods happened as a consequence. To cope with the negative effects of flooding, a risk-based analysis is often used to evaluate causes and mitigation measurements of flood events.

Samuels & Gould (2009) give a definition of Disaster risk, which is the likelihood of a specific event or consequence to happen. When referring to flood risk, Adelekan & Asiyanbi (2016) mentioned that the technical definition of risk has its limitation, because the technical definition does not consider the social aspects of flood risk. Urban floods are events that are tightly related to residence's social life and play a significant influence on urban's historical and cultural developments. For example, when an urban flooding happens in the urban area, citizens' daily activities will be influenced by the traffic interruption and the ordinary operation of urban infrastructures will face the severe challenge. Urban drainage systems are one of the obvious examples that significant influence by the urban water cycle, and residents' safety issues and environmental health issues. In order to understand the impacts of urban floods and the response of urban residence and urban managements, a multidimensional concept called perception of risk has been introduced to describe the objective consideration of a flooding event. (Renn, 1995) In order to make it clear what the risk perception is, Adelekan & Asiyanbi (2016) gave a definition of risk perception in his article 'Flood risk perception in flood-affected communities in Lagos, Nigeria'. They described risk perception as the ability to prepare for, respond to, and recover from hazards and disasters.

2.2.2 Determinants of flood risk perception

O'Neill et al (2016) viewed that risk perception is influenced by the combination of three groups of factors, which are cognitive factors, socio-economic factors and geographical factors.

In term of cognitive factors, O'Neill et al (2016) defined it is a kind of behavioral factor that influences people's personal interpretation of experience and attitudes and responses. The author explains the difference between experience, attitudes and responses. Those previous experiences including damage experience, the ways of perceived risk being informed and likelihood to undertake action. The previous experience is a reaction to a past event and is neutral, but the attitude of flood risk is mostly negative emotion e.g. dread, worry and loss of assets. For the response aspect, the response includes both individual and public responses and them interrelated. Because of difference in acquiring the information and knowledge, the response of the individual is highly dependent on the disseminated information by public institutions. And the behavior varies from the perceived flood exposure and level of flood awareness.

In term of socioeconomic factors, Merz et al. (2010) mentioned that characteristics of educational level, income level, gender, age and tenure status have a play influence on people's risk perception.

According to O'Neill et al (2016), the three groups of factors not only influence the risk perception in a combined way, but they influence each other group. In term of socioeconomic factors, Merz, et al. (2010) mentioned that characteristics of educational level, income level, gender, age and tenure status have a play influence on people's risk perception.

2.2.3 Measurements of flood risk perception

In order to find the impacts of flood risk exposure on flood risk perception, O'Neill, et al (2016) conducted a literature review on risk perception. During the process of research, he made a comparison of measurements of risk perception between ten authors by different categories of hazard sources. The research covers 5 categories of the flood, which includes coastal flood, flash flood, hurricane flood, ice-jam flood and river flood. Although the courses and consequences of different flood categories are various, the focus aspect of measurements in each flood category are similar.

For Coastal flood, aspects such as Awareness, Likelihood, Affect (worry), Impacts (consequence), feelings of safety, Control and damage are usually used in evaluating risk perception (Kellens, et al., 2012) (Terpstra & Gutteling, 2008) (Terpstra, 2011).

For River flood, measures such as Probability, flood risk rating, return period, safety norm, damages, Likelihood and Affect are used (Botzen, et al., 2009) (Miceli, et al., 2008).

For other floods, new measures such as disruption, an index derived from cartographic perception maps and cognitive maps of historical inundations have been described as supplements for measuring the risk perception (O'Neill, et al., 2016).

Although the factors that play the influence on people's flood risk perception are different in the different category of floods, four groups of indictors of flood risk perception are mentioned by those authors in summary. The first group of factors is hydrologic regime aspect. The flood location (Distance to flooding area), risk rating, return period of floods and probability of floods are included in this group. The second group of the factor is the perceived level of flood risk. This factor refers to the degree of controllability of flooding event and the factor usually combined with the consideration of the hydrologic factors to play the influence on people's flood risk perception. The third group of the factors is the attitudes and feelings about the flood risk. The attitudes about the flood experience, the feeling of the safety during the flooding period and emotional feeling about the flood experience are belonging to this group. The fourth group of factors is the impacts of flooding. Both impacts about physical assets and impacts about people's attitude such as worries after the floods were included in this group.

2.2.4 Significance of flood risk perception

Because urban floods have a strong relevance respect to residence within the flooding area, the value of risk perception of flood-affected communities has been widely recognized and risk perception has currently viewed as 'an essential aspect of subjective risk analysis' (Adelekan & Asiyanbi, 2016, p. 448). Therefore, an understanding of flood risk perception can help urban managers conduct more effective public governance and to inform policy makers to make better decisions on urban flood management.

Lawrence et al (2014) hold the view that the way to communicate information on floods plays an influence on risk perception, and the risk perception affects the respondents of risk manager. Therefore, the risk perception plays a critical role in the success of implementation of mitigation measurements.

When discussed relationship between the understanding of risk perception and effectiveness of disaster mitigation, Fatti & Patel (2013) highlighted that understanding of risk perception does not increase the area's resilience level automatically. He admitted that residents' experience and risk perception should be taken into consideration by local governments when responding to disaster events, but factors like power distribution, competing interests and priorities also play an important role in responding to disaster events. The fact is that areas with a higher level of resilience have a higher level of knowledge of disasters and can receive more investment than the disadvantaged areas.

2.2.5 Factors affecting property value and price

2.2.5.1 Factors that play influence on property value and price

Hummel (2011) defined the property value as an estimate of what a property is worth. The value was based on people's perception so its varies person to person. He empathized the difference between the property value and the property price. The price of the property refers the transaction price of the property. The transaction price of the property plays significant influence on people's perception on property value.

Meen and Mark (1998) regard two aspects play an influence on housing price. One aspect is macroeconomic condition in the area. He concluded that the income, interest rate, credit availability, tax structure, housing supply and demographic structure are the main factors that have impacts on housing markets. The other aspect is the house conditions. The coverage rate of infrastructure, education resources, the accessibility of commercial buildings, the environmental conditions and the quality of the house will play influence on housing price in specific areas or units.

2.2.5.2 Relationship between flood risk perception and property values

The increased urban floods, a result of urbanization and climate change, has become a global issue in recent years. Researchers focused on the relationship between flood risk perception and property values have been conducted in some Europe countries such as Finland, England, and Netherlands.

In Netherlands, Danel et al (2009) used the tool of Hedonic Price Analysis to find the relationship between floods and residential property value. The research shows that floods of the Meuse river in 1993 and 1995 made a 9 percent decrease in housing price within flood affected area. And data shows that the price reduction by flood does not recover after a decade after the flood. However, the article shows another interesting finding that 'a location close to the water has an upward effect on property values of up to 3 percent' (Danel, et al., 2009, p. 563).

In England, the relationship between the impacts of flood risk and commercial property value has been researched by Bhattacharya & Lamond (2016). The article described that majority of the respondents were perceived the flood risk would have an impact on property value because the flooding has negative impacts on the utility of commercial properties. For example, people have limited access during and short after the flooding period. The reduced number of visitors causing by floods will decrease the revenue of the shopping centres. As a result, the value of those commercial properties decreased after the flood. Furthermore, comparing the results of respondents of flood experience with non-flood experience shows that respondents with flood experience give greater weight to the flood risk factor when making a business decision.

However, the case of Helsinki, Finland shows that a drop of housing price affected by flood risk can be recovered by increasing disclosure of flood risk information. (Votsis & Perrels, 2015) Votsis & Perrels (2015) observe that housing price is sensitive to flood risk. But due to

the fact that the occurrence of a flood can be projected by expert, the residence in Helsinki can take measurements and actions to reduce the negative effects of the floods. The more uncertainty of flood risk exposure, the harder for the housing price recovered after the flood events.

2.3 Flood risk management theory

2.3.1 Introduction to Flood risk management theory

The theory of flood risk management has significantly changed in the past decades, the theory has involved from a focused approach to reducing flooding to multiple scales approaches driven by a design and decision-making process. In order to have a better understanding of improvements and content of flood risk management theories, I divided the various research into two categories and illuminated them below separated.

2.3.2 The integrated approach for flood management

Urban flood management was started from the 19th century when the conception of modern urban drainage appeared. At that time, the objective of the drainage facilities was to get rid of sewage and storm water according to a specific standard (Verworn, 2002). However, due to the advanced requirement for the construction of urban drainage facilities (e.g. the assessment of hydraulic performance and pollutant emissions), the urban drainage facilities have been updated based on an integrated approach for both flood protection and ecological perception. Furthermore, because of the widely constructing of the urban drainage facilities and improved requirements by urbanization, simple structural maintenance cannot satisfy the requirements of better facility use. Therefore, an interactive way of operational management and control of urban drainage facility has been suggested by the urban manager and engineers (Verworn, 2002).

The difference between a traditional urban drainage system and an integrated approach for flood management has been explored by different scholars. Although each author has its focus and content of the integrated approach to flood management, they all share the relevance of upgrading the traditional urban drainage system with the development of urban planning and management (Verworn, 2002) (Marsalek & Chocat, 2002) (Jha, et al., 2012) (Ellis & Viavattene, 2014).

Based on the conception that the traditional urban drainage system has evolved into an integrated urban flood management system to respect to the various demands driving by urbanization, the world bank published a guide to illuminate how to conduct a better design and operation for integrated urban flood management system (Jha, et al., 2012). The integrated urban flood management system was composed by measurements of two categories: structural measures and non-structural measures. Jha et al(2012) give a definition of structural measures as ‘measures that aiming at controlling the flow of water both outside and within urban settlements’ (Jha et al., 2012, p. 33). The range of structural measures covers from the hard-engineered ways of flood management facilities (e.g. drainage pipeline) to natural buffer for flood reduction (e.g. wetlands). Although the structural measures are effective in reducing the waterlogging in flood period, the capacity of structural measures is limited and cannot extend in a short period (Jha, et al., 2012). Furthermore, the authors mentioned that the structural measures could not reduce the flood risk, they just transfer the flood risk from one location to another by redirection of water flows.

In order to deal with the limitations of structural measures, the non-structural measures have been used complementary to keep people safe from flooding. Jha, et al (2012) gave a definition of non-structural measures as ‘measures of managing risk by building the capacity of people

to cope with flooding in their environment' (Jha, et al., 2012, p. 34). The major ways of non-structural measures are planning and management of urban development (Jha, et al., 2012). The author viewed that some kinds of non-structural measures such as early warning of floods can be used as the first step to protecting people from disaster when the expensive structural measures are absent, but those non-structural measures should be used integrated with structural measures.

In conclusion, based on the definition and classification, Jha, et al(2012) viewed that the integrated approach for flood management is linking the design and operation of the flood management facilities to existing urban planning and management policy.

Ellis & Viavattene (2014) conducted research on the integrated approach and focused their research on surface water management. Within the scope of surface water management, the integrated urban drainage system combines the design and operation of drainage conveyance with urban land use, building distribution and infrastructures (e.g. roads, bridges and culverts). The integrated approach combines those separated parts of facilities and functions into a single system for any specific conditions.

2.3.3 New approaches for flood management

While the integrated approach considers both the cognitive and physical aspects of flood risk management, the approach still has its limitations in dealing with the uncertainty of the probability of flood occurrence. Due to the increased impacts made by climate change, the condition and degree of floods become much more hard to estimate by scientific methods. Even though the integrated approach combines the construction of flood management facilities with city's social development (e.g. urban planning and management), approaches that can effectively cope with the challenges arisen to deal with uncertainty is being explored by many scholars.

- **The multiple scale system-based approaches**

The proposed multiple scale system-based approach was based on the emerging concept of resilience. The new concept can 'provide guidance for an overarching approach to managing urban floods, which devise strategies to cope with change and uncertainty' (Zevenbergen et al., 2008, p. 83) .

Resilience is a concept that has involved since 1973 and is widely applied in the social domain. Gallopı́n (2006, p.298) use the definition of 'the capacity of a system to absorb disturbance and reorganize while changing so as to still retain essentially the same function, structure, identity, and feedbacks' to illustrate the concept. The concept of resilience is being used in flood management field to solve the limitation of the integrated approach for flood management by Zevenbergen (2008). The author proposed that resilient approaches can take advantage of intervention at multiple spatial levels and gave the comparison of features between the traditional approach with the resilient approach in Table 1.

Table 1 Transition from a traditional approach to (more) resilient approach: key features (Zevenbergen, et al., 2008)

Traditional	Resilient
Changes in system are stable and predictable	Changes in system are uncertain
Control changes (preserve status quo)	Sustaining and enhancing capacity to adapt to uncertainties
20-year planning timeframe	Long-term horizon (up to 100 years)
Sequential process of planning (linear)	Continuous alignment of content and process with context

Top-down strategy making	Bottom-up initiatives and top-down strategic decisions
Focus on probability reduction	Plan for less vulnerability key guiding principle
System of aims and static	System of strategic alternatives
norms and standards	Full life cycle impacts for long-lived elements of the built environment Whole system solutions

Using the practical example of Dordrecht, Zevenbergen (2008) viewed that flood resilience measures can make a contribution to urban planning objectives and provides short-term benefits by dual-use options at the same time.

- **The approach of Dynamic Adaptive Policy Pathways**

To better adapt to climate change, Kwadijk et al (2012) developed the concept of adaptation tipping point (ATP). In the field of climate change, the adaptive capacity was defined as 'ability of a system to adjust to climate change to moderate potential damages, to take advantage of opportunities, or to cope with the consequences' (Holling, 1973, p. 300). According to the adaption research, ATP was defined as 'points where the magnitude of change due to climate change or sea level rise is such that the current management strategy will no longer be able to meet the objectives' (Kwadijk, et al., 2010, p. 730). The approach was involved from the bottom-up approach and defined to find a starting point where current policy cannot cope with for the degree of climate change and an alternative strategy or measure need to be taken. The ATP approach aims at defining 'when the adaption approach and enable policy maker to plan the adaption' (Kwadijk, et al., 2010, p. 732).

Based on the research result of ATP, an approach called 'Dynamic Adaptive Policy Pathways' has been proposed for decision-making under deep uncertainty and regional changes (Haasnoot, et al., 2013). The approach is a method for designing adaptive plans and consist of two complementary approaches: 'Adaptation Pathways' and 'Adaptive Policymaking'. The 'Adaptation Pathways' approach is a dynamic improvement process for the scenario based action. Each time of action is basing on the actual scenario and the conduct of the improvement is based on the evaluation of adaptation tipping point (ATP). In general, 'the Adaptation Pathways approach presents a sequence of possible actions after a tipping point in the form of adaptation trees' (Haasnoot, et al., 2013, p. 487). The 'Adaptive Policymaking' approach is planning process for a set of actions with different vulnerabilities.

Table 2 Comparison of the approaches (Haasnoot, et al., 2013)

Aspect	Adaptive Policymaking	Adaptation Pathways
Focus	Starts from a vision of the decisionmaker and creates a plan for realizing this vision and protecting it from failure.	Explores actions for achieving objectives over time by including dynamic interaction between the system and society.
Consideration of the multiplicity of futures	Indirectly via vulnerabilities and opportunities.	Explicitly via transient scenarios.
Planning process	Comprehensive stepwise approach for designing a plan.	Short stepwise approach for designing Adaptation Pathways.
Clarity on how to design a plan	Limited; a high level framework that can be translated into a specific plan in many different ways.	Application oriented, with a clear link to the use of models to develop a specific plan.
Types of actions that can be taken	Distinguishes many different types of actions that can be taken (e.g. hedging, mitigating, and shaping).	No specific categorization of actions is used. Several actions and pathways are presented. A variety of actions are identified based on different societal perspectives.
Desirable plan	One basic plan is developed. No clear guideline on how develop the basic plan.	Several pathways are presented. Different perspectives result in different preferred pathways. No focus on how to identify promising pathways when confronted with a large number of possible actions.
Consideration of types of uncertainties	In principle, any uncertainty can be accounted for.	In principle, any uncertainty can be accounted for. Explicit attention is given to social uncertainty.
Flexibility of resulting plan	Flexibility is established through the monitoring system and associated actions.	The Adaptation Pathways map clearly specifies when a policy should be changed, and what the next action should be.
Dynamic robustness of resulting plan	Dynamic robustness results from the monitoring set up in Step IV and the actions taken in Step V.	Dynamic robustness is produced indirectly via the idea of a 'sell-by date' and the shift to another action.

In conclusion, facing deep uncertainties and unforeseen future conditions, the traditional integrated approaches were unable to cope with the dynamic challenges. The approach named Dynamic Adaptive Policy Pathways has been used to explore an adaptive flood risk management in developed countries such as Netherlands. Although this approach needs to be further tested in more countries and regions, the result of Netherlands shows that the approach of Dynamic Adaptive Policy Pathways is promising.

However, Klijn, et al. (2015) pointed out problems of uncertainty still cannot be effectively coped by the Adaptive approach because the complexity of global economic development and geopolitical changes.

2.3.4 The application of terminology of Flood management theory

Because urban flood management theories have become increasingly complex in recent decades, the terminology describing the practice for applying those theories have become increasingly diverse consequently. There are mainly five terminologies (Water sensitive city, Sustainable urban drainage system, Best management practices, Low impact development and sponge city) have been used for the practice of urban flood management currently.

The term Best management practices (BMPs) was previously used in North American to 'describe a structured approach to prevent pollution' (Fletcher, et al., 2015, p. 529). The content of BMPs was expanded by Pollution Prevention Act (The United States of America, 1990) and consists both structural and non-structure attributes to reduce the pollutant content of rain-water.

The term Sustainable urban drainage system(SUDS) was evolved from the implementation of BMPs in the UK. The term was formed in a guidance document published in 2000 and 'consist technologies and techniques used to manage rain-water and surface water in a more sustainable way' (Fletcher, et al., 2015, p. 529).

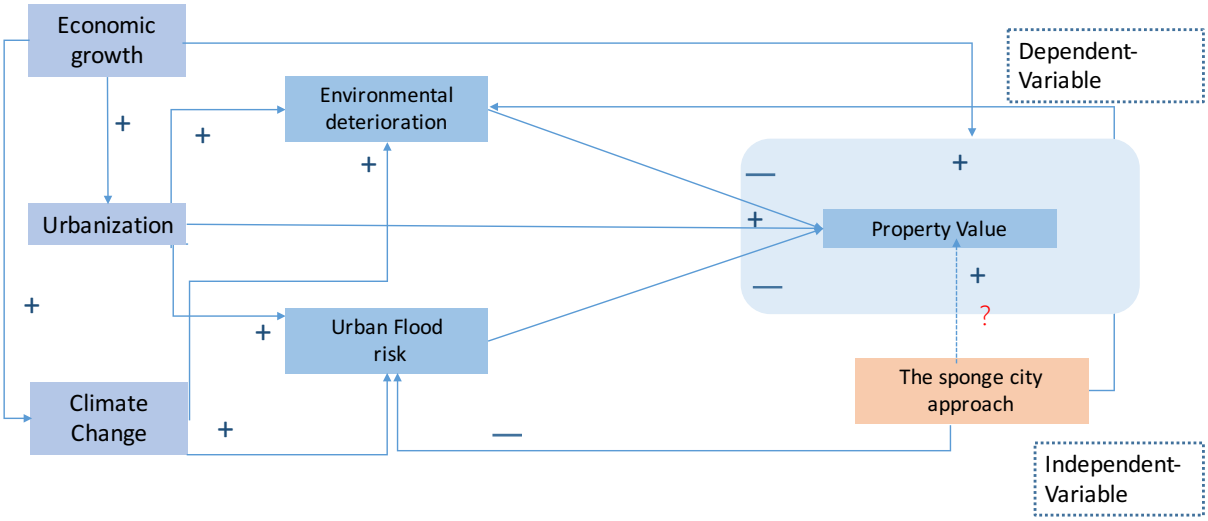
The term Water sensitive city (WSC) has been developed based upon the concept of water sensitive urban design, which has been used in Australia from the 1990s (Fletcher, et al., 2015). The WSC was defined as 'a conceptual representation for urban water systems, building on sustainable urban water planning and management practices and prioritizing liveability, sustainability and resilience in the design of its institutions and infrastructure' (Ferguson, et al., 2013, p. 33). Ferguson, et al (2013) observed that WSC is a shift from engineering approach to system approach for urban water systems, but there is a limitation in an understanding of how the strategic planning and management can use undertaken.

Unlike the BMPs, which is mainly focused on preventing pollution, the term low impact development (LID) is an approach design with nature and aims at 'minimize the cost of rain-water management' (Fletcher, et al., 2015, p. 526). The proposed of LID was to encourage the small-scale stormwater managing approaches like Bioretention and green roofs. The content of LID was being extended largely to become an option of practice used to achieve goals in sustainable urban development in North America.

The sponge city is a term to describe a condition of cities which have the ability to adapt flexibilities with the environmental changes(Zevenbergen&Boogaard,2016). The abilities include 'absorb, store, permeate and purify rainwater and make use of the stored water when needed' (Shao, et al., 2016, p. 780). The sponge city was promoted as a national strategy to solve the urban flooding by national governments of China. Sponge city offers 'a more sustainable solution to urban flooding problem than stormwater management, and more close to the eco-city and low-carbon city theory' (Yang & Lin, 2015).

2.4 Conceptual Framework

Figure 3 Conceptual Framework



Based on the literature review above, there are three concepts related to my research question: flood risk, flood risk management and property value.

The urbanization and climate change led to the increased urban flood risk. Thus the increased level of urban flood risk plays a negative influence on property value. In the meanwhile, the environmental deterioration, which is the result of urbanization, is another factor that plays a negative influence on property value. The sponge city approach is one of the flood risk management methods that been promoted by the Chinese government to reduce the urban flood risk. Whether the sponge city approach can increase the property value need to be tested by this research.

Chapter 3: Research Design and Methods

Scholars have studied the relationship between urban flood risk and housing and other properties' value (Danel et al., 2009) (Bhattacharya & Lamond, 2016) (Votsis & Perrels, 2015). These studies have been reviewed in Chapter 2. The outcomes of these studies vary widely. Nevertheless, they show that flood risk perception is influencing the housing and other property values. There is also a large body of literature exploring and elaborating on different flood risk management approaches. The sponge city approach is one of the urban flood risk management approaches, which is encouraged by the Chinese government to reduce both the urban flood risk and improve the urban environment. However, very limited research has been published on the relationship between the sponge city approach and its impact on property value.

Based on the research objective, the conceptual definitions, variables, main indicators, research strategies and specific methods for data collection and analysis are presented in Chapter 3. Reliability and validity of the resulting outcomes are also discussed at the end of this chapter.

3.1 Revised Research Question

According to the problem statement and research objective, the main research question is:

To what extent the application of sponge city concept in urban construction will impact the residence's perception on housing value in Central area of Wuhan?

To answer the main question, there are several sub-questions of this study:

1. What is the flood risk perception of residences in Wuhan?
2. How residence in Wuhan value the different functions of sponge city?
3. Whether the residence in Wuhan are willing to pay for the sponge city through a way of housing price increase? To what degree?

3.2 Selection of research area

The research area includes seven central districts in Wuhan. They are Jianghan district, Jiangan district, Qiaokou district, Hanyang district, Qiaokou district, Wuchang district, and Hongshan district. It should be noted here that Wuhan has 13 districts. The main reason that the remaining 6 districts in Wuhan are excluded from the research area, is that those remaining districts encompass large portions of newly built-up or industrial areas. The urbanization degree and the density of the population differ significantly from those central districts. According to the Wuhan statistic yearbook of 2016 (Wuhan Statistic Bureau, 2016), the population of the 7 central districts included in this study account for 57% of total population in Wuhan. Furthermore, the economic development and maturity level of the real estate market in those seven districts are different from those levels in the remaining six districts. The people's perceptions towards flood risk and housing value are different from the central area.

3.3 Operationalization: Variables, Indicators

The definition of variables related to these concepts in Table 3 can help to translate the complex concepts into measurable indicators (see Table 4). They are also instrumental to address the sub-question of this research.

Table 3 Definition of concepts and variables

Concepts	Definition	Source
Flood risk perception	The objective consideration of a flooding event	Renn, 1995
	How people prepare for, respond to and recover from flood	Adelekan & Asiyanbi,2016
Sponge city	A condition of cities which have the ability to adapt flexibilities with the environmental changes	Zevenbergen&Boogaard,2016
	A more sustainable solution to urban flooding problem than rain-water management, and more close to the eco-city and low-carbon city theory	Yang & Lin, 2015
Property Value	Property value is an estimate of what a home is worth. Property values are not the same as property prices.	Hummel, 2011
Land Value	Land value is an estimate of what a piece of land is worth.	Author

Source: The author

Table 4: Operationalisation of concepts

Concepts	Variable	Indicators
Flood risk	Flood Risk Perception	Scale of exposure to floods
		Feeling about experience of floods
		Frequency of exposure to floods
		Categories of exposure to floods
		Measurements responding to floods
		Perception about property value after floods
Flood Risk Management	The sponge city	Degree of familiar of the concept
		Degree of understanding the function of sponge city
		The increase of safety level
		The increase of Green space coverage
		The increase of public space coverage
		Public willingness to pay for sponge city
property value	Housing value	Degree of increase of housing value because of sponge city construction
	Land value	Degree of increase of land value because of sponge city construction
	Housing transaction price	Degree of increase of housing transaction price fluctuation because of sponge city construction
	Land transaction price	Degree of increase of land transaction price fluctuation because of sponge city construction

Source: The author

3.4 Research strategy

This research uses a combined strategy of survey and desk research.

3.4.1 Strategy of Survey

This survey involves 'a large-scale approach and covers a large number of variables and many respondents of study' (Thiel, 2014, p. 74). This strategy 'collects data on both factual information and perception of people through a form of standardizing measurements. Methods of questionnaires and interviews are usually used in this strategy' (Thiel, 2014, p. 74).

The reason for choosing the strategy of survey is based on the research objective, which is to test whether the implementation of the sponge city approach will increase the housing value in clearly defined urban areas that have experienced transformation into a Sponge City. According to the objective, the results of the research should have a clear answer about residence's willingness to pay for the sponge city through a way of paying for the housing premium. The willingness to pay is a subjective behavior may vary from person to person and the reasons behind residence's willingness also vary due to the different risk perception and estimation and valuation of property values.

In the strategy of survey, a questionnaire is used as the main method to explore residence's perception about flood risk, the sponge city approach and to test its influence on housing and land value in central districts of Wuhan, China. However, the method of a questionnaire has also its shortcomings. Because the questionnaire is limited choices instruments that used by the researcher, it is likely that the answer cannot cover all the possibilities and nuances. The method of interview of residences in Wuhan central districts is used as a triangulation to overcome the abovementioned shortage of the questionnaire.

Considering the fact that citizens are unable to buy land in China, there is a possibility that some of the residences in Wuhan do not have a clear perception of land value. And also because the housing and land market is a market that is heavily influenced by the government. Interviews with representatives of the public sector, such as city government and of the private sectors including developers and professional service firms and experts on sponge city approaches, are conducted to increase the reliability of the research results.

3.4.2 Strategy of desk research

The strategy of desk research is to investigate how the sponge city policy is implemented in the real transaction market of lands and houses. This strategy was used to increase the reliability of the research.

Based on the research results of the survey, the residence's perception of flood risk mitigation and property value can be understood. However, the value of a property varies according to the individual's perception. In order to overcome the difficulty in comparing the property values, the transaction price of the property has been introduced as a measurement to reflect on the property values.

Methods of content analysis and secondary data analysis are used in the strategy of desk research.

In the method of content analysis, the policy of the sponge city program will be analysed to understand the ways the government decides to implement the sponge city program in Wuhan. The policy of the sponge city program includes the Sponge City guidance customised to the context of Wuhan, the government's regulation on construction, the engineering standards

associated with the sponge city project, the incentive and rules to promote the sponge city and the sponge city planning requirements in the land parcel.

In the method of the secondary data analysis, the analysis of land transaction pricing and housing transaction pricing in the sponge city areas are conducted to test whether the sponge city program will impact the property values.

3.4.3 Summary of research strategies and methods in the table

Table 5 Summary of research strategies and methods

Strategy	Method	Research contents
Survey	Questionnaire	Residence's perceptions of sponge city and property value
	Interview	Other parties' (public sector, research institutes, developers and firms of professional services) perception of sponge city and property value
Desk research	Second data analysis	Transaction prices of houses and lands in sponge city area
	Content Analysis	Regulation and policies about sponge city

Source: The author

3.5 Data collection and analysis methods

According to the research aim and the strategies selected above, both primary data and secondary data were collected during the research process. The quantitative data was the main source of data to draw the conclusions upon and the qualitative data was collected to increase the reliability of the research. The data type and source of different strategies are listed in the table below.

Table 6 Table of data collection method

Strategy	Method	Data type		Data Source
Survey	Questionnaire	Quantitative	Primary Data	Online survey tools
	Interview (Triangulation)	Qualitative		Video chat
Desk research	Second data analysis	Quantitative	Secondary data	Secondary data from existing database
	Content Analysis (Triangulation)	Qualitative		Documents analysis

Source: The author

3.5.1 Primary Data collection method

3.5.1.1 Data collection method and instruments of questionnaire

The questionnaire was structured into five parts. The first part was to collect the basic information on socio- demographic characteristics of the respondents. The second part considered the respondents' exposure to urban floods. The third part explores the respondents' general perception of the sponge city program. The fourth part tests the respondents' perception of the positive effects brought about by the sponge city program. The last part encompasses a

summary to understand the respondents' general perception of the relationship between sponge city and property value.

The online platform called Sojump was used to conduct the questionnaire.[1] The questions were put into the platform by the researcher and the platform produced a unique URL link to the researcher. The research sent this link to the target respondents through e-mail, messages and other information sharing tools like Wechat. This method of data collection was chosen because it was cost-efficient and less time consuming than other methods such as door to door survey or street interview.

3.5.1.2 Sampling Techniques and Sample size selection

According to the Wuhan statistic yearbook of 2016 (Wuhan Statistic Bureau, 2016), the Table 7 shows the population of those 7 central districts at the end of 2015 was 4.7 million.

Table 7 Demographic data of central districts in year-end of 2015

District	population of residence (unit: thousand)	Percentage of Wuhan city	Percentage of central districts
Jiangan district	719.5	8.7%	15%
Jianhan district	486.4	5.9%	10%
Qiaokou district	526.5	6.3%	11%
Hanyang district	585.4	7.1%	12%
Wuchang district	1,056.1	12.7%	22%
Qingshan district	433.7	5.2%	9%
Hongshan district	948.8	11.4%	20%
Total	4,756.4		

Source: Wuhan statistic yearbook of 2016

Based on this figure, and using a confidence level of 95% at a confidence interval of 5, a sample size of 384 respondents would have been a representative sample to survey through a method of questionnaire.

The study used non-probability data sampling techniques. The sampling method involves a snowball method of a self-selection method conducted by respondents through voluntary participation. In order to increase the representativeness of the sample, the questionnaire was distributed to residences covering all those 7 central districts of central Wuhan. Due to the limited popularization of English, questionnaires were sent in Chinese.

3.5.1.3 Data collection methods of interview

The other data collection method of the survey strategy are in-depth, one-to-one interviews. Since the sponge city could involve many different parties and institutions, it is difficult to completely test and explain by just using collecting data from residence only. For this reason,

[1] The address of the online platform: https://www.sojump.com/

the in-depth interviews were conducted as a supplement to test and explain the residence's perception.

The interviews were conducted through Wechat video chat. The interviews were conducted with people who have a good knowledge of the sponge city. The type of interviewee covers public sector, private sector and Residences. The institutions of interviewees and number of each type were list in the Table 7 below. The notes will be written to record the opinions of those interviewees.

Table 8 List of interviewee of in-depth interview

Type of interviewee		**Number of interviewees**
Public sector	Officer from Government in Wuhan city	2
	Officer in Urban planning institution of Wuhan	1
	Expert in Sponge city	2
Private sector	Real estate developers with projects in Wuhan	2
	Professional consultants	2
Residence	Residence living in Sponge city area (Qingshan and Hanyang District)	5
	Total	14

Source: The author

3.5.2 Secondary Data collection method

The data collection method of the secondary data mainly focused on quantitative data collection and data of sponge city policy in Wuhan. There were used as a supplement to enable the researcher to have a better understanding of the sponge city project. The method of collecting quantitative data involved collecting secondary data from the existing database and government announcements. Two categories of quantitative data were collected. The data source of each category of data is shown in Table 8 below. All of the secondary data has been obtained by visiting the website of those institutions or databases. The period of all secondary data collection is from 2007 to 2017. The data size of quantitative data included house transaction price and land transaction price in 7 central districts of Wuhan.

Table 9 Secondary Data collection method and source

Data category	**Data type**	**Data content**	**Source**
Housing transaction price	Quantitative	Data about the transaction price of residential housing in Sponge city area (Qingshan District and Hanyang District)	China Index Academy
		Data about the transaction price of residential housing in non-Sponge city area (Other central districts)	
Land transaction price		Data about the transaction price of land in Sponge city area (Qingshan District and Hanyang District)	Wuhan land transaction center
		Data about the transaction price of land in non-Sponge city area (Other central districts)	

Sponge city policy	Qualitative	Guidance of sponge city in Wuhan; government's regulation on construction; The incentive rules in promoting sponge city	Committee of Wuhan Development and Reform (Government Department)
		The sponge city planning requirements in land parcel	Wuhan land transaction center

Source: The author

3.6 Validity and Reliability

3.6.1 Reliability

The reliability of this study was addressed by focusing on accuracy and consistency. The accuracy means the no distortion has taken place. Due to the nature of the test people's perception about one policy, objective attitudes varied from person to person. Three ways of improvement were conducted in this research to improve the accuracy of the research results. The first improvement concerned to carefully distinguish between residence perception on sponge city and housing value. In the questionnaire, the different functions of the sponge city approach were tested separately and the land and housing value have been divided into 6 zones, leading to an increase of the accuracy level in measuring the residence's perception. The second improvement involved 10 pilot questionnaires in testing the comprehensive level the of questionnaire. The third improvement used the secondary data to triangulate the research strategy. Those secondary data all came from official authorities and the data reliability level assumed to be high. The consistency of the research refers that same measurement will lead to similar results under similar circumstances. The research achieved a relatively high consistency level as the research conducted three methods (Questionnaire, in-depth interview and secondary data analysis) to test the relationship between sponge city and property value from different aspects. The data analysis results of those three methods are similar.

3.6.2 Validity

The validity of this study addressed both internal validity and external validity. The internal validity of this study was improved in two aspects. The first aspect was using tools of an online platform to conduct the questionnaire as the researcher cannot influence the respondents' attitude during the survey process. The second aspect is on the improvement representativeness of the sample. As the sample method was a non-probability method, the researcher sent more questionnaires than the target sample size. Hence the each of district has more than 30 respondents to complete the questionnaires. As a result, the representativeness of the sample was improved.

However, it needs to point out that the external validity of this research is limited. As people's perception of sponge city differs according to the flood risk exposure, thus the result of research in Wuhan is hard to generalize to other cities.

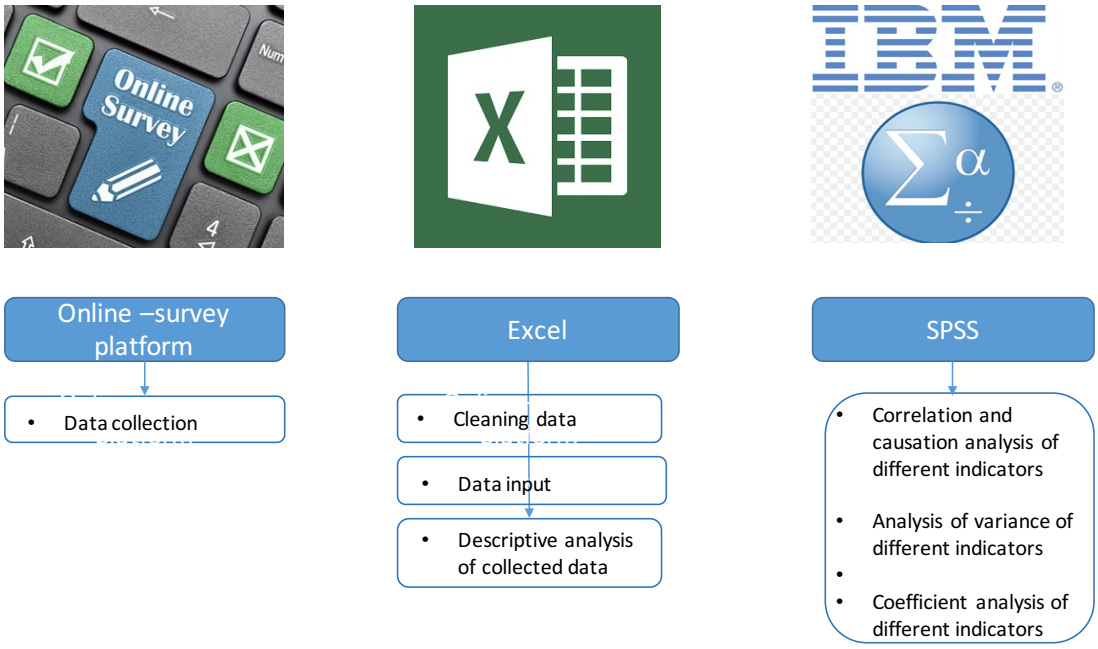
3.7 Data Analysis Methods

3.7.1 Primary data analysis methods

In this research, both quantitative and qualitative data were included in the primary data analysis methods. The quantitative data was collected from questionnaire and the data analysis process was divided into three steps. The process of data analysis began from collecting data through the online survey tool named Sojump. After the data collection, raw data were downloaded into Excel and ineffective data were removed from the data source. The ineffective data refers to data came from respondents who are not living within 7 central districts of Wuhan. Then all the effective data were put into a new Excel sheet. Descriptive analysis of effective

data was conducted. In the third step, SPSS were used to further analysis those data. Three types of analysis were conducted during the analysis process. They are Correlation and causation analysis of different indicators, Variance analysis of different indicators and Coefficient analysis of different indicators.

Figure 4 Quantitative data analysis Flowchart



Source: The author

As a supplement, qualitative data were collected during the research process through method of in-depth interviews. Three steps of analysis were conducted as follows:

- Written interview memos
- Comparing the views with the results of questionnaire analysis
- Summaries the views by group of interviewees

After each part of primary data analysis, the research will come to the following conclusions:

- The flood risk perception of residences in Wuhan.
- The extent of the different functions of sponge city was been recognized by Wuhan residences.
- The percentage of residence in Wuhan are willing to pay for the sponge city through a way of housing price increase.

3.7.2 Secondary data analysis methods

For the secondary data analysis, both housing price and the land price will be compared between sponge city area with non-sponge city area. Within the sponge city is, the data of housing price and land price before the sponge city period and after the sponge city period will be compared to explore the conclusion. After those comparisons, conclusions of two questions following should be answered:

- Whether the increasing speed of housing price and land price in sponge city area will be faster than the non-sponge city area.
- Whether the increasing speed of housing price and land price in sponge city period will be faster than before.

Content analysis of policy documents and government regulations were conducted as a supplement in this research. After the content analysis, the guidance of sponge city in Wuhan, government's regulation on construction, the engineering standard of sponge city project in Wuhan and the incentive rules in promoting sponge city will be list and summarized during the research.

Chapter 4: Research Findings

4.1 Introduction

This chapter presents the major findings resulting from data collection. It begins with a brief overview of the general condition in Wuhan city and the sponge city program in Wuhan. The research findings consist of three parts; the first part is the data analysis of questionnaires; The second part is the analysis of qualitative data based on in-depth interviews from representors of different sectors. The last part is the results of secondary data analysis, which concluding analysis of land user-right transaction prices and housing transaction prices.

4.2 The research findings of respondents of questionnaires

The questionnaires were made up of five parts; Personal information was required by the questionnaire to understand the demographic characteristics of respondents in the first part. The respondents' exposure to urban floods, the general perception of the sponge city program, the perception of the positive effects brought by the sponge city and the willingness to pay for the sponge city are four aspects that been explored by the questionnaire.

At the end of data collection period, 452 questionnaires have been collected by the author. However, there are 29 respondents do not live in the seven central districts of Wuhan, so those respondents' questionnaires were being excluded from the final data. The total valid number of respondents is 423 and the research findings of respondents of questionnaires are came from data analysis of those effective questionnaires.

4.2.1 Demographic Characteristics of Respondents

The basic demographic characteristics of respondents are shown in Table 10. The primary age range of the respondents is between 18 years old to 65 years. Most of them got a university or college degree. The respondents came from 7 central districts of Wuhan city, and the percentage of respondents from each district accounts at least 10 percent, which means that the respondents can well represent the residence in central districts of Wuhan (Table 7).

Table 10 Demographic Characteristics of Respondents

Variable	Category	Number of respondents	Percentage of respondents
Age	Below 18	1	0.2
	18-28	201	47.5
	29-35	88	20.8
	36-50	51	12.1
	51-65	80	18.9
	older than65	2	0.5
Gender	Female	250	59.1
	Male	173	40.9
Education level	Senior school or below	87	20.6
	University or college degree	224	53
	Post-graduate qualification	112	26.5

Residence location	Jianghan	54	12.8
	Jiangan	48	11.3
	Qiaokou	43	10.2
	Qingshan	43	10.2
	Wuchang	74	17.5
	Hongshan	116	27.4
	Hanyang	45	10.6

4.3.2 The respondents' exposure to urban floods

The impacts of urban floods and responses of urban residence play an important role in understanding residence's perception on urban floods (Renn, 1995). Five indicators were used to measurement residence's flood risk perception in Wuhan.

- Scale of exposure to floods

Table 11 shows the scale that respondents have exposure to urban floods during the past twenty years. The survey shows that 96.7% of the respondents have exposure to urban flood in Wuhan in either direct or indirect way, which means the residence's urban exposure level in Wuhan was extremely high. It can be seen that 44% of the respondents have exposure to urban floods and 34% of residence have limited exposure to urban floods. It means 78% of residence in total have direct exposure to flood in Wuhan. This large-scale exposure of urban floods signifies the research about urban floods has a significant meaning in city of Wuhan. There is 18.7% of respondents have claimed that they do not have a direct exposure to floods, but they observed other people's exposure to floods. This situation was assumed as an indirect way of exposure to floods.

Table 11 The respondents' exposure to urban floods

	Frequency	Percent	Cumulative Percent
Heavy exposure	186	44	44
Limited exposure	144	34	78
Observed other's exposure	79	18.7	96.7
No exposure	14	3.3	100
Total	423	100	

- Frequency of exposure to floods

Under the condition that more than 95% of the respondents has been exposed to flooding, the frequency of the respondents' exposure to urban floods varies across the different respondents. As Table 12 shows, 68.8% of the respondents who has either directly or indirectly being exposed to urban floods experienced a frequency of flood exposure of at least once a year in the past ten years.

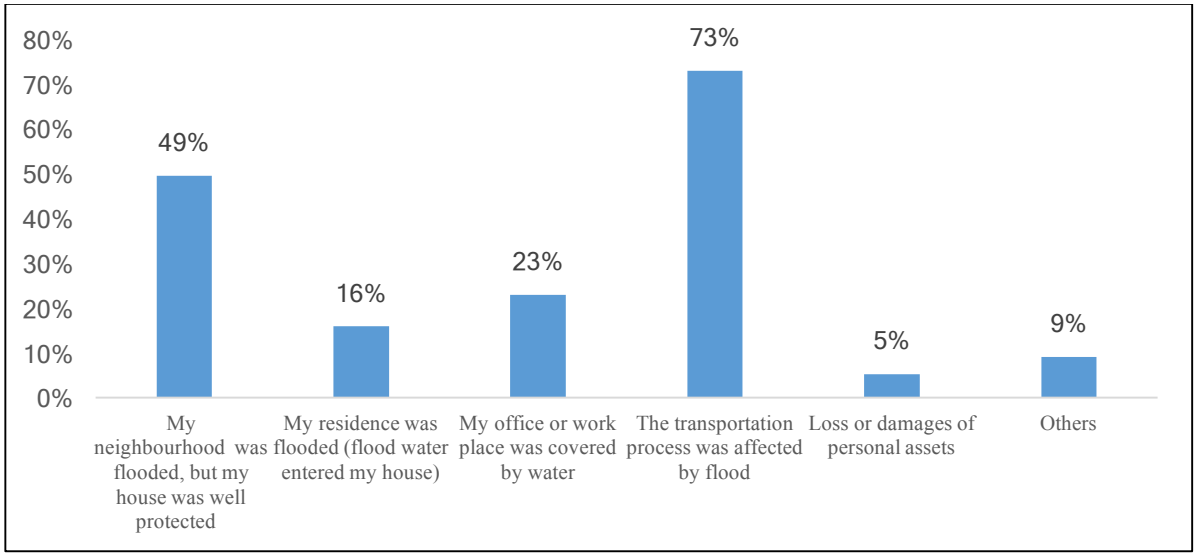
Table 12 The frequency of respondents' exposure to urban floods

	Frequency	Percent	Valid Percent
More than once a year	109	25.8	26.7
Once a year	172	40.7	42.1
Once per two years	55	13	13.4
Once per three to five years	59	13.9	14.4
Once per six to ten years	10	2.4	2.4
Less than once per ten years	4	0.9	1
Total	409	96.7	100
Missing value	14	3.3	
Total	423	100	

- Categories of flooding damages

Under such a high degree and frequency of urban floods, residence's perception about the damages of floods is different according to their situation and relation to urban floods. Chart 1 suggests that public transportation has been affected most seriously by flooding in Wuhan as 73% of respondents claimed to experience adverse flood impacts on public transportation. The second affect was flood impacts on residential buildings, as 16% respondents claimed that their houses were flooded and 49% respondents claimed that their neighbourhoods were flooded. Office buildings and other public places such as shopping centres were the third aspect that has been identified as a factor which has been affected by flooding. Only 5% of the respondents claimed to be affected by damages of moveable assets such as cars and other belongings. Unlike the infrastructures of transportation and other immovable properties such as houses and offices, movable properties can be transferred to a safe place. Thus effects made on those immovable properties (including houses, offices, work places and infrastructures for transportation) are much higher than the movable ones. Respondents also identified that floods not only have impacts on hygiene and safety issues but also destroy city's good image during and after the flood period.

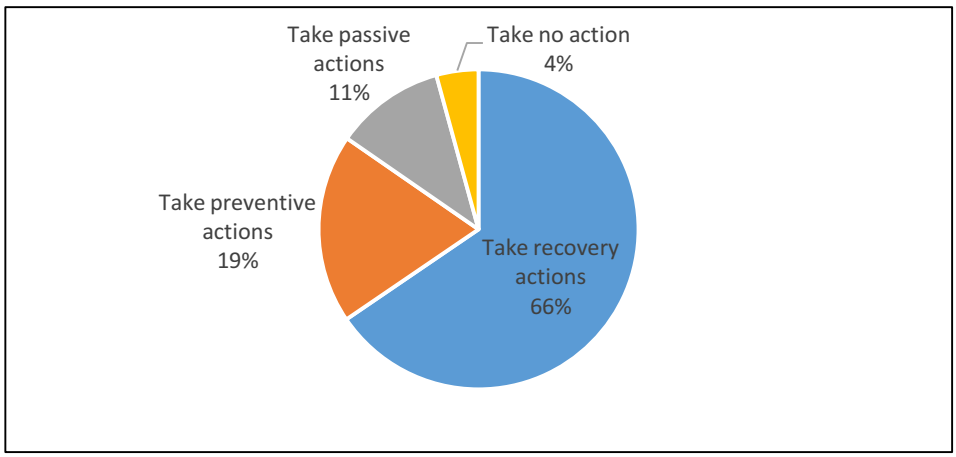
Chart 1 Categories of affects played by urban floods



- Flood resilient technologies taken by residence

Measures that residence take when responding to urban floods is another important indicator to measure the residence's perception on urban floods. The different measures they were taken reflect how they react to the floods and their willingness to reduce the potential flood next time.

Chart 2 Categories of anti-flood measures taken by residence

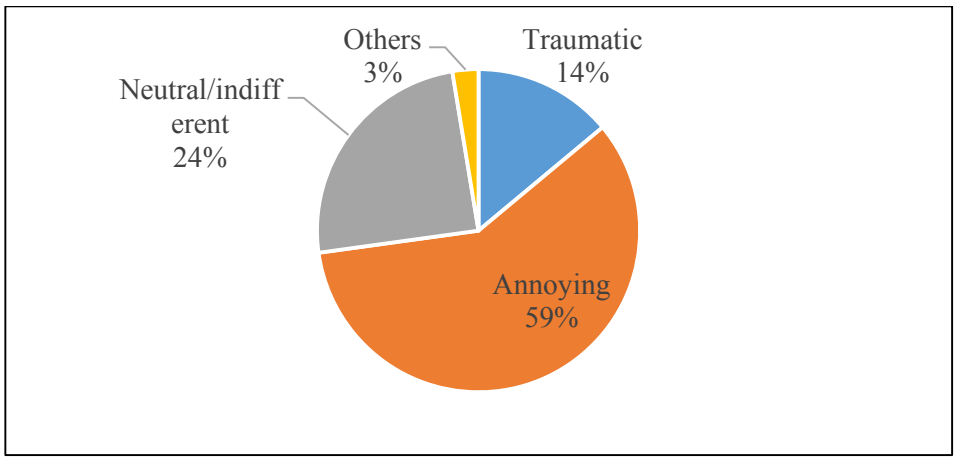


From the Chart 2, it can be seen that the 96% of respondents preferred to take some actions when anticipated and suffered from the flood risk. The most often used measurements were recovery actions such as flood resilient repairs or replacement. There are 19% of respondents claimed that they take preventive actions to protect from flooding water entering the house and protect their properties. Measures such as flood boards to close off door openings, sandbags, and remove valuable assets to dry places are usually used, but they mentioned that the effects of those measures are not obvious and the water still flows into their houses. The remaining 11% respondents claimed to have taken passive actions such as leaving the flooding room or area to protect themselves.

- Residence's perception about relationship between floods and property value

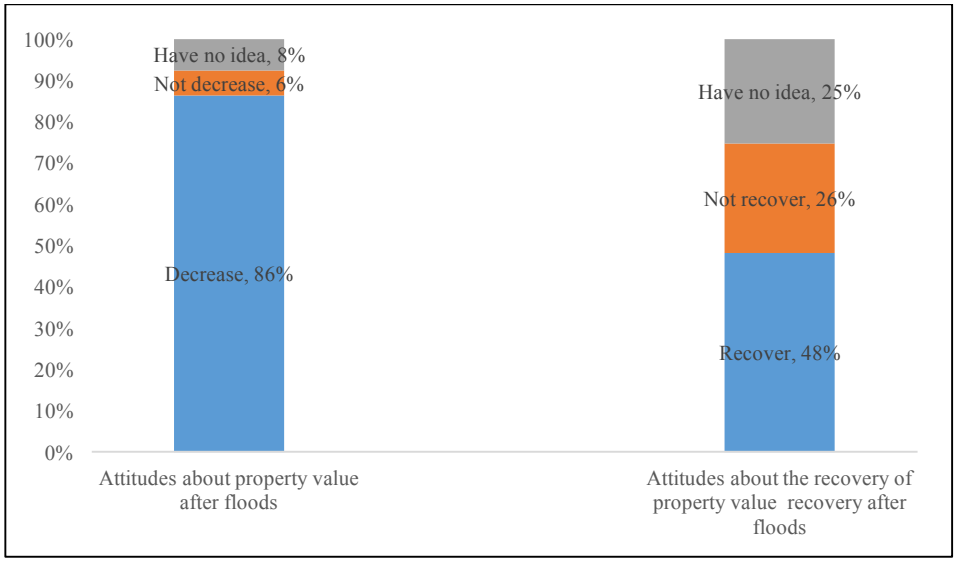
Despite the heavy exposure conditions to urban floods experienced by the respondents, most of the respondents qualified floods as annoying, which accounts for 59% of total respondents as shown in Chart 3. 14% of the respondents qualified their flood experience as traumatic and consider to move to a safe place if possible. Respondents who feel neutral or indifferent about floods accounts for 24%. During the in-depth interviews, two respondents said to hold a neutral attitude toward floods because they got used them as they happened every year and they already have a psychological expectation about the potential floods.

Chart 3 Residence's attitude about experience of floods



When considering the value of flooded properties, a comparison was made in Chart 4 to show the respondents' perception of the value of the flooded properties. Related to the value of property in the flooded area, 86% of respondents think that the property value will decrease if the property has been exposed to flooding during the flooding period. However, 48% of respondents think the value of property can recover after the floods when anti-flooding measurements will be taken. 25% of respondents indicated that the value cannot recover after the floods.

Chart 4 Residence's attitude about property values after floods



4.3.3 The respondents' perception about sponge city and its functions

- The respondents' perception about sponge city

Although water and water management is an important part of the urban construction, sponge city is a new concept that emerged in China for only five years (Ministry of Finance of the People's Republic of China, 2014). In the working plan of Wuhan sponge city (The Office of Wuhan city government, 2014), the promotion of sponge city program is part of the work that needs to be conducted during the pilot period. As the sponge city construction in Wuhan covers a large area of the city, the public understanding plays an important role in sponge city construction because the wide perception of sponge city's benefits can help the projects delivered more smoothly.

Although the sponge city concept is a new concept, 34% of the respondents in Wuhan central area knows what the sponge city is and 32.2% of the respondents only heard about the concept but have no idea of what it means. The survey shows that only 33.8% of respondents never heard nor understand what the sponge city is. The public awareness about sponge city construction in Wuhan is also in mediate level. The survey shows that 44% of respondents knows that Wuhan is currently implementing the sponge city concept in construction activities.

Table 13 The respondents' perception about sponge city

		Frequency	Percent	Cumulative Percent
Concept of sponge city	Know	144	34	34
	Do not know	143	33.8	67.8
	Heard, but have no idea of what does it mean	136	32.2	100
Sponge city in Wuhan	Yes	186	44	44
	No	237	56	100

- The respondents' perception about functions of sponge city

During the survey process, the concept of sponge city and its main functions and benefits to the city has been introduced to all the respondents. After the introduction, 68.1% of respondents believe that the construction of sponge city can effectively reduce the negative effects made by floods on residence's property or houses. 5.7% of respondents does not believe that the construction of sponge city can reduce those negative effects. The remaining 26.2% of the respondents have no idea of what the actual objectives and effects of the sponge city construction are and have the opinion that the results should be checked after the construction has been completed.

To find the factors that play an influence on the residence's perception about the functions of the sponge city, logistic regression analysis was used to define the relationship between the residence's flood exposure and the perception on sponge city in Wuhan.

Basing on the literature review of water management theory, local people's flood risk perception plays the influence on people's recognition of water management tools. According to O'Neill, et al. (2016) research, four factors (residence locations, the frequency of exposure to floods, attitude about the experience of floods and perception about sponge city concept) was tested by the regression model. The assumption was made those four factors will capture the variables required to assess the residence's perception on the sponge city's function. The results in Table 14 show that the significant level of the factors 'attitude about the experience of floods' and 'perception about sponge city concept' is under 0.05. Hence, the data analysis supports the assumption that attitude about the experience of floods and the understanding level of sponge city concept has a significant impact on the residence's perception of the sponge city's function. The data analysis does not support the assumption that residence location and frequency of exposure to floods have an influence on the residence's perception of sponge city's function.

Table 14 Multinomial logistic regression model results of perception of sponge city's function

Likelihood Ratio Tests				
Factors	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Residence locations	415.987	2.876	2	0.237
Frequency of exposure to floods	413.614	0.503	2	0.777
Perception about sponge city concept	423.595	10.485	2	0.005
Attitude about experience of floods	444.288	31.178	8	0.000

The Multinomial logistic regression model results of Parameter can be interpreted into two steps. The first step is to select the effective variables according to the result. The regression model takes the assumption that the dependent was influenced by the independent variable when significant level of those two variables are under 0.05. The second step is interpreted the relationship between those two variables basing on the B value. The higher absolute value of the B value means the stronger relationship between the two variables. The positive B value represents a positive correlation between the two variables and the negative B value represents a negative correlation between the two variables.

The table 15 shows how each independent variable of attitudes about the experience of floods plays an influence on the residence's perception on the sponge city's function. The independent variables (the attitude about the flood experience) have a significant influence on the residence's perception on the sponge city's function. The relationship between the (attitude about the) flood experience and the perception on the sponge city's function can be defined by the coefficient (B value). It means the stronger the emotion (ranging from traumatic to neutral) of the residence about the flood experience, the higher the degree of recognition the residence gives to the sponge city.

A similar relationship has been analysed between the level of understanding of the sponge city concept and the residence's perception on the sponge city's function. From Table 16 it can be seen that the better the understanding of the sponge city concept, the higher the degree of recognition of the sponge city's function.

Table 15 Multinomial logistic regression model results of Parameter estimate of flood experience

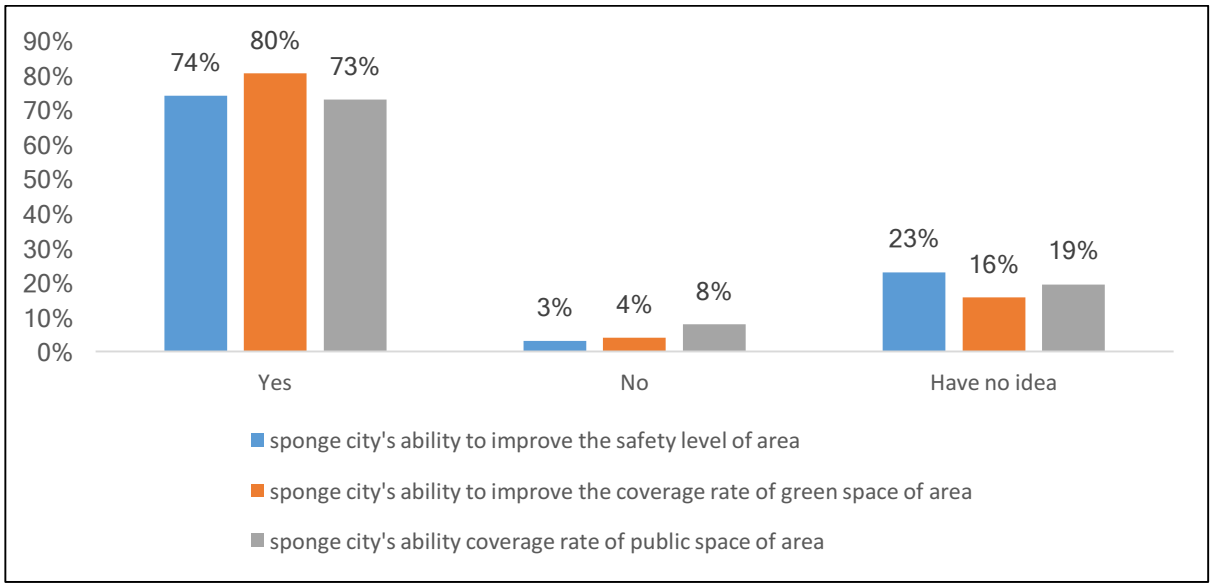
Parameter Estimates									
14. Do you think that the construction of the sponge city can effectively reduce the negative effects made by floods on your property/house?[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence	
								Lower Bound	Upper Bound
Yes	[6. How do you feel about the experience of these floods?=1]	1.075	0.310	12.050	1	0.001	2.929	1.597	5.372
	[6. How do you feel about the experience of these floods?=2]	1.010	0.147	47.125	1	0.000	2.746	2.058	3.664
	[6. How do you feel about the experience of these floods?=3]	0.833	0.219	14.505	1	0.000	2.300	1.498	3.531
	[6. How do you feel about the experience of these floods?=4]	0.223	0.671	0.111	1	0.739	1.250	0.336	4.655
No	[6. How do you feel about the experience of these floods?=1]	-1.253	0.567	4.883	1	0.027	0.286	0.094	0.868
	[6. How do you feel about the experience of these floods?=2]	-1.578	0.305	26.840	1	0.000	0.206	0.114	0.375
	[6. How do you feel about the experience of these floods?=3]	-1.792	0.483	13.759	1	0.000	0.167	0.065	0.430
	[6. How do you feel about the experience of these floods?=4]	-0.693	0.866	0.641	1	0.423	0.500	0.092	2.730

Table 16 Multinomial logistic regression model results of Parameter estimate of understanding of sponge city concept

Parameter Estimates									
14. Do you think that the construction of the sponge city can effectively reduce the negative effects made by		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence	
								Lower Bound	Upper Bound
Yes	[12.Do you know the concept of the sponge city?=1]	1.897	0.253	56.333	1	0.000	6.667	4.062	10.941
	[12.Do you know the concept of the sponge city?=2]	0.375	0.175	4.576	1	0.032	1.455	1.032	2.050
	[12.Do you know the concept of the sponge city?=3]	0.840	0.194	18.715	1	0.000	2.316	1.583	3.388
No	[12.Do you know the concept of the sponge city?=1]	-1.099	0.471	5.431	1	0.020	0.333	0.132	0.840
	[12.Do you know the concept of the sponge city?=2]	-1.928	0.378	25.958	1	0.000	0.145	0.069	0.305
	[12.Do you know the concept of the sponge city?=3]	-1.335	0.355	14.109	1	0.000	0.263	0.131	0.528

According to the literature review, the sponge city concept seems to be a more sustainable solution to resolve the urban flooding problem in general than the traditional stormwater management method, and is more close to the eco-city and low-carbon city theory (Yang & Lin, 2015). The benefits of the sponge city construction are on three main aspects: a reduction of flood risk, an improvement of the coverage rate of green space and an improvement of the coverage rate of public space.

Chart 5 Residence's perception on different functions of sponge city



The survey shows that most of the residences recognise well the sponge city's ability to improve the coverage rate of green space. 80% of respondents believe that the sponge city construction can improve the coverage rate of green space in the area the construction covers. The degree of recognition of improving the environment exceeds its ability to improve the flood safety level, which is 74%. Compared to the respondents have no idea on its ability to improvements, respondents who have no idea about the sponge city's ability to reduce the flood risk achieved 23%, which is the highest among the three indicators. This data shows that about one-fifth of the respondents has no idea about its actual effects on reducing the city's flood risk. Apart from that, 8% of respondents think that the sponge city construction cannot improve the coverage rate of public space. They do not know how the sponge city construction can improve the coverage rate of public space and do not recognize the relation between sponge city and public space. The result shows that the level of understanding of the respondents of the applications of the sponge city construction is still limited.

4.3.4 The respondents' willingness to pay for sponge city

The residence's willingness to pay is an objective perception that varies from person to person due to different personal value system. One of the factors that plays an influence on the residence's willingness to pay is how the residences perceive the property value fluctuations due to the construction of the sponge city.

- The respondents' perception of property value increased by sponge city

To explore which factors can play an influence on respondent's perception of property values movements, Chi-square tests were used to test the assumptions. Five factors (Residence locations, the frequency of exposure to floods, attitude about the experience of floods, perception about sponge city concept and perception about Flood's influence on house value) have been used as explanatory variables for the property values movements because of sponge city. The result in Table 17 shows that Pearson values of significant level of house value

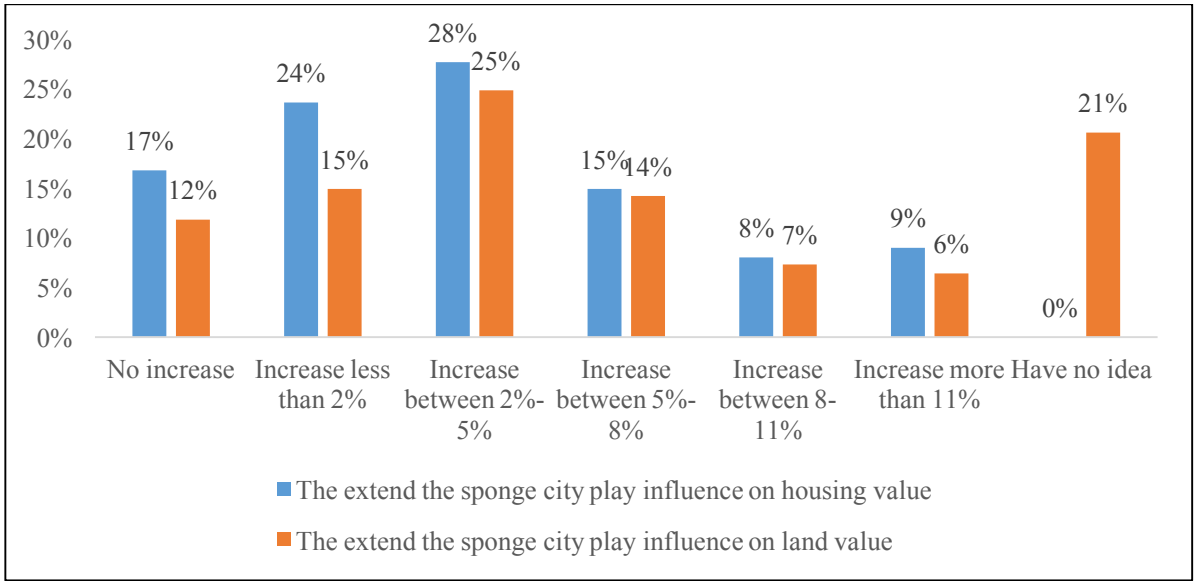
movement and land value movement are both under 0.05. It means respondents perception difference in the relation between flood risk exposure and property value has a strong relation to their perception difference in the relation between sponge city construction and property values. In a word, respondents who believe the floods will make an influence on property values also think the sponge city will make an impact on property values.

Table 17 Chi-Square Tests of property value movements between flood exposure and sponge city construction

		Value	df	Asymptotic Significance (2-sided)
House value movement	Pearson Chi-Square	18.585	10	0.046
	Likelihood Ratio	17.844	10	0.058
	Linear-by-Linear Association	0.458	1	0.498
	N of Valid Cases	423		
Land value movement	Pearson Chi-Square	24.036	12	0.02
	Likelihood Ratio	24.854	12	0.016
	Linear-by-Linear Association	0.281	1	0.596
	N of Valid Cases	423		

When testing respondents' perception about the extent that sponge city plays influence on housing value and land value, the result shows that 17% of respondents think that sponge city construction cannot increase the house value and 12% of respondents think that sponge city construction cannot increase the land value. As shown in Chart 6, the majority of respondents think that sponge city construction can increase the property values. There is 52% of respondents thinking the range of house value increasing is less than 5% of the original house value, and percentage for this range of land value increase is 40%. In China, the residence does not have the ability to participate in the land transaction of renting land or buying land user-right, so the perception of land value is not as ordinary as the perception of house value. As a result, 21% of respondents choose the choice of have no idea.

Chart 6 The extent that sponge city play influence on housing value and land value



In summary, the data shows that respondents who were sensitive to flood risk exposure and property value are likely to recognize the value of sponge city by means of property value increases. There is 83% of respondents thinks the sponge city construction can increase the

house value of the area that construction covers and there are 67% of respondents think the sponge city construction can increase the land value of the area that construction covers. The major of respondents who think the sponge city construction can increase the property value viewed the range of the increase will be less than 5% of the property's original value.

- The respondents' willingness to pay a house price increase for sponge city

In order to have a solid understanding of respondents' willingness to pay for the sponge city, a correlation test was conducted to test the correlation between respondents' perception of house value increase and their willingness to pay. The result in Table 18 shows that the Significant level of the correlation is below 0.01, which means the correlation level of these two variables has its meaning. The Pearson correlation value of these two variables is 0.443, which means the degree of the correlation between these two variables is middle and positive in the statistic.

Table 18 Result of correlation test between house value increase and willing to pay

Correlations

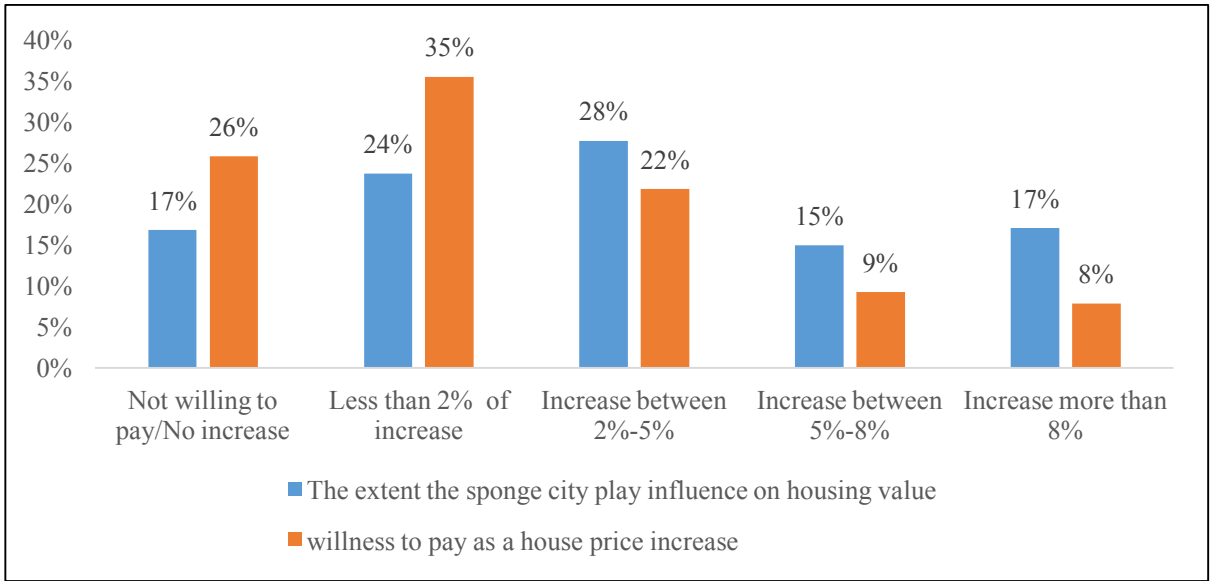
House value increase as the result of the sponge city construction	Pearson Correlation	1	.443**
	Sig. (2-tailed)		.000
	N	423	423
willing to pay an extra cost for the sponge city construction	Pearson Correlation	.443**	1
	Sig. (2-tailed)	.000	
	N	423	423

**. Correlation is significant at the 0.01 level (2-tailed).

The data result of the survey investigates the respondents' willingness to pay for the sponge city in the way of house price increase. The Chart 7compared the data results of willingness to pay with the data results of respondents' perception of housing value increased by the influence of sponge city.

The data shows that 26% of respondents are not willing to pay for the sponge city in a way of house price increase, although 17% of respondents think there is no value increase for the sponge city construction. That is to say, there is 9% of respondents recognise that the sponge city construction can improve the house value but they are not willing to pay for the value increase. For the range of increase,35% of respondents claimed that the range of paying extra for the sponge city is less than 2% of the house price. By contrast, 22% of respondents claimed that the range of paying extra for the sponge city is between 2% and 5% of the house price, which is 6% less than respondents' perception of house value increase. For the data, we can find that the range of respondents' willingness to pay for the sponge is less than the range of respondents' perception about house value increase. In a word, some of the respondents recognised the value increase by the sponge city, but the amount of their willingness to pay is part of the value increase.

Chart 7 The respondents' willingness to pay extra for sponge city



Basing on the result of correlation test between these two variables, a regression test was conducted the explore the specific relationship between these two variables. Two assumptions were made for the test. The first assumption is that the dependent variable is the house value increase and the predictors are the respondents' willingness to pay an extra cost for the sponge city. The second assumption is that the respondents' willingness to pay is been used as a constant scale indicator instead of category indicator.

Table 19 Result of regression test between house value increase and willing to pay

ANOVAa

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	181.363	1	181.363	102.679	.000b
	Residual	743.615	421	1.766		
	Total	924.979	422			

a. Dependent Variable: House value increase as the result of the sponge city construction b. Predictors: (Constant), willing to pay an extra cost for the sponge city construction

Coefficientsa

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
	Willing to pay an extra cost for the sponge city construction	.480	.047	.443	10.133	.000

Dependent Variable: House value increase as the result of the sponge city construction

The result in table 14 shows that the Significant level of the regression test is below 0.01, which means the result of the test can be reliable at 95% confidence level. The Beta value of the unstandardized Coefficients is 0.480, which means the portion of the dependent variable's influence on the predictor is 0.480. The result of the regression test means that every 1% of the respondents' perception of house value increase will lead to the 0.480% of the respondents' willingness to pay for the sponge city. In a word, if the respondents view that the house value was increased by 1% as a result of sponge city construction, they are willing to pay 0.48% of the increase for sponge city construction.

4.4 The research findings of respondents of in-depth interviews

The research findings of questionnaires above have already shown the residence's perception about flood exposure, sponge city and their willingness to pay for the sponge city. However, the quantitative data can only reflect the residence's perception about that issue, the reasons behind the data and the results are hard to explore by the questionnaires. In order to explore the causations and considerations behind the data, qualitative research of depth-interviews was conducted to explain and support the research findings of questionnaires.

4.4.1 The introduction of in-depth interviews and interviewees

The in-depth interview was focused on the three research questions above. The first question was talked about residence's flood risk exposure in Wuhan and how the risk exposure plays influence on their lives and city operation and management. The second question was talked about their perception about sponge city and its different functions. The logic relationship behind the perceptions was explored during the interviews. The last question was talked about the residence's willing to pay for the sponge city in a way of house price increase.

During the data collection period, 14 interviewees from different types of sectors have given their opinions about sponge city. For the public sector, officers from the government, officer in Urban planning institution and experts in sponge city were interviewed. For the private sector, real estate developers and professional consultants were interviewed. Five residences who conducted the questionnaires were also interviewed for an explanation of their choice in the survey.

4.4.2 The residence's exposure to urban floods

All the interviewees viewed that flood risk perception of residence in Wuhan is at a relatively high-level compared to other big cities in China. Apart from the urban flood, the river flood occurs every year, and it plays a threaten on the city's safety level. For the recent five years, the occurrence of urban floods increased to at least once per year. However, the degree of flooding varies in those last years. The negative effects made by urban floods on different aspects of their lives, but generally speaking that the public areas such as commercial centers, roads and public transportation system suffer most in flood.

The interviewee from Wuhan Metro Group mentioned that large amounts of financial and physical losses occurred during and after the flooding period due to the urban floods. The flooding water entering into the main subway stations last year and one of their subline were out of operations for one hour because of waterlogging in their hub stations such as Wuchang train station. Although they have put sandbags in front of the stations before the flooding, the water still flowed into their stations. After the flooding, they used traditional measures such as pumps to remove the water and reduce the negative effects. Each time after the flooding, they have to spend extra cost to repair their equipment which was destroyed by flooding water. Up to now, there is no effective way to prevent from flooding every summer time.

The interviewee from Wuhan city government mentioned that due to the high water level of Yangtze river, flood risk is not only a city level risk but a regional level risk. Areas along the Yangtze rivers strongly related to each other. Reducing flooding risk has high priority level within administrative affairs. Because of the frequently occurred flood, governments in both city level and districts level formed anti-flooding committees to fight against flooding risk once the weather bureau published alarms in the summer season.

The interviewees from developers conducting commercial operation mentioned that the flooding has a direct influence on their operation of commercial centers and office buildings. The flooding made the most serious influence on open areas such as commercial blocks and outdoor streets, but those damages are easy to recover. Undergrounds parking lots suffer most, and the damages on those parking cars made an adverse impact on their brand. The potential tenants cared that whether the commercial operator has sufficient measurements to reduce the flood risk. Apart from that, the safety level was an important factor that has been considered when deciding to buy or rent the property; As an operator, they have taken preventive actions such as preparing for sandbags and backup power generator sets to reduce the influence made by floods. However, they mentioned that the water flowed from the public areas such as roads, so it is hard for them to reduce the risk from source.

In the aspect of land acquired, the interviewees from developers said they would avoid the areas of South Lake and Guanggu when their companies were acquiring lands. These two areas have the most serious waterlogging situation during the flooding period and they thought the situation is hard to improve in a short period.

The interviewees from urbanisation-related consulting firms and construction institutions mentioned that the high level of flood risk exposure had played an influence on their current works. Because of the high exposure level in Wuhan, measures of improvements have been conducted continually. However, the city is in a fast developing and constructing period, to coordinate the construction requirements for some public infrastructures, part of underground drainage pipelines have been temporarily out of service or reduced its volume of discharge. Those facts exacerbated the flood risk level in the city and the problem is hard to solve under current urban development pace.

The residences said their attitudes and perception about floods changed in recent years. In the year 2008, heavy floods occurred in the major part of South China, they viewed the urban flood as the result of a huge disaster event due to climate change. However, the frequency of urban floods increased from every five to eight years per time to once or twice a year since the year 2012. They expect that urban floods are highly possible to occur in the summertime. The feeling about the experience of floods changing from traumatic to annoying or indifferent gradually due to the changing of floods expectations. One of the residence mentioned specifically on his measurements on reducing the negative effects by floods. Because his car was damaged by water on the roads, these damages were not covered by the ordinary car insurance, so he has to spend a large amount of money to repair his car. After that year he bought extra car insurance for the flooding damaged since 2012; When talking about the government's response to the urban flood, one residence said that it is government's responsibility to reduce the flood risk because the most serious waterlogging was on the roads and subways. He thinks the flooding was due to the poor quality of public construction projects.

In summary, the flood risk exposure in Wuhan is in a wide scale of residences in Wuhan. Most interviewees reported that urban floods have play influence on their daily life in a direct or

indirect way. The high frequency of floods and less effective ways of anti-flood measurements, the tolerance level about the urban floods is relatively high.

4.4.3 The residence's perception about sponge city and its functions

Unlike the perception level of urban flood risk, the perception about sponge city varies person to person. The interviewees who work in urban planning and water management area have a better understanding, others such as developers and residences have limited knowledge about sponge city and its functions.

An interviewee who works in Wuhan Urban planning institution said because of heavy flooding, water management becomes an important factor when conducting urban planning. Due to that Wuhan has been selected as the pilot project of sponge city construction, applying the sponge city concept into the urban design becomes a compulsory requirement to follow in every project locates in Wuhan from the year 2017. Apart from the sponge city, Wuhan government promote other water management concepts such as 'management four rivers together' and "providing more room for the river". Those projects' aim is reducing the flooding risk by effectively managing the rivers within the city. Their work usually combines the requirements of project 'Dealing four rivers together' with sponge city concept. However, during this work process, the sponge city is not possible to apply in all areas. In fact, whether the land should have sponge city planning depends on its geography and environmental conditions. If the land has the condition to satisfy the sponge city requirements, the requirements and regulations will be written on the instructions of the land parcel.

When talking about the value of different functions of sponge city, the interviewee who works in Wuhan Urban planning institution said the values for residence are different according to their different degree of flood risk exposure. For areas with the serious waterlogging condition, the function of safety improvement was being valued most; For other area, residences care more about environmental improvements and more public spaces.

An interviewee from Metro Group mentioned that the function of sponge city was not recognised in corporate level. According to the working plan of Wuhan sponge city (The Office of Wuhan city government, 2014), the Wuhan Metro Group was one of the major institution responsible for the construction of the sponge city in Wuhan. However, the group does not participate in any of the sponge city construction till now. The first reason is that the group lacks basic knowledge of sponge city concept. The Metro Group knew that the construction of sponge city may help them decrease the loss during the flood period, but due to the limited knowledge about the sponge city, the risk of participating in sponge city construction is too high to bear. In practice, because of plenty of subway lines construction, the corporate was running under a deficit. As a result, the group do not have the fund for the construction of sponge city.

When talking about the value of different functions of sponge city, the interviewee from the Metro Group holds the view that the value of functions varies by season; During the rainy season, the function of safety improvements will be valued most by residence. During spring and winter, the function of environmental improvements will be valued most because of the air-pollution problems in these two seasons.

In the views of officers in Wuhan government, the residence's recognition about the value of sponge city will increase after the promotion and pilot period. They valued the function of safety improvements because it represented the basic ability of urban management. But the residence may care more about the environmental issues.

The interviewees from developers hold the views that developers and the residences will have the different attitudes on the function of sponge city. Firstly, two respondents from developers

mentioned that the reason that they began to study the content of sponge city is they found there is a compulsory requirement of sponge city construction on the instructions of the land parcel land. In order to estimate the influence of the new instructions, they have to explore the content of sponge city and calculate how the new instruction will play an influence on their construction costs of that land parcel. As a real estate developer, she valued the function of environmental improvements most. And also value the benefits of increasing public space; she thought that these two aspects are easy to be seen by their clients, and they are more willing to pay things for which they can see and feel directly; But as a residence, she valued the function of safety improvements most. The improvement of the safe level will reduce my loss during the flooding season. For example, her car was broken on the road last year, and she spends a lot to repair it because ordinary insurance did not cover flooding.

As the professional in the water management sector, the experts and consultants have a much solid understanding about the residence's perception about the sponge city. The consultants emphasised that urban floods had played significant influence on urban design and construction in recent years; In the past, people thought the water management is the responsibility of water management authorises. Nowadays, people began to recognised its importance in the whole urban construction. The increasing exposure of urban floods also pushed the consultants to consider how to design and management for water in the urban design process. However, it is hard for both developers and residences to recognise its value in water management currently. They take granted for that these factors have been considered for the government. The concept of sponge city has been applying to their projects a lot, but the residence cannot combine those applications to sponge city. For example, the permeable parking lots, the green roofs and manual waterways have already been used in real estate developments. But both the residence and some of the developers do not know those constructions can be used or adjusted to reduce the flood risk. In practice, the construction of sponge city should be combined with the urban landscape and environmental conditions. The developers are more willing to spend costs on those two aspects. In a professional aspect, the function of safety improvements should be given priority. However, the function of environmental improvements and increasing public space are more valuable to the residence.

The residence said that they either heard the concept of sponge city in local news after the flooding last year or seen from the poster within communities. They have a general perception about sponge city. They described the sponge city as an improvement to current urban construction and its aim was to reduce the flooding risk in their communities. The residence who had the negative experience of flood shown high anticipation about the functions of sponge city. The residence has less exposure to floods value more about the functions of environmental improvements than the reducing of flooding risk. Two of the residence both mentioned that he cannot connect the benefits of sponge city to the increased public space. One of them viewed the construction will reduce the area of public space in his neighbourhood as the construction will be built on public lands such as the square or other entertainment places.

In summary, the understanding of sponge city varies case by case. Most interviewee's degree of understanding is at a limited level. Except for the experts in related areas, other interviewees heard the concept of sponge city, but they do not know how the concept can be used or combined with urban developments. After an explanation to the interviewees, they got a better understanding of the sponge city content. Basing on the new level of understanding, they majorly recognized the functions of reducing the flooding risk level and improvement of green space coverage. But the priority sequence of different functions still varied person to person according to their various backgrounds.

4.4.4 The residence's willingness to pay for sponge city

10 of the 14 interviewees thought the residence are willing to pay for the sponge city constructions through a way of housing price increase. The interviewees who hold the view that residence is willing to pay thought that the sponge city can not only increase the safe level or reduce the flooding but also improve their living environment. But the reason they thought why the residence is willing to pay is different.

The developers' view was that they would transfer the costs for sponge city to potential house buyers regardless of their willingness to pay. The current real estate market is seller's market, and the developers hold the right of defining the price. In practice, they will try to reduce the extra costs by sponge city construction and add the amount of cost in the sales price. The potential buyers will pay the cost for sponge city finally. In another aspect, their research and design department is studying the content of sponge city currently. They want to use the sponge city as a highlight for their products and make more price premium by the concept of sponge cities such as green roofs or more open space for communities. The interviewee said at least half of the residence are willing to pay for the better quality of the houses. The key factor that determines the residences' willingness to pay is to help them find a connection between sponge city construction and better living environment. They estimated that the willingness to pay for the reducing of flood risk might not reliable in non-serious flooding area, but the willingness to pay for the green environment and public spaces will be strong for most of the residence. But when talking about the land value movement due to sponge city, the interviewees from the developer viewed the current practice of transferring the construction responsibility to the developers made the value increment process postponed. In theory, the sponge city can improve the land value, and increment of land value can be transferred to property value. However, the current practice is transferring the construction duty to developers, so the land value does not have any increment. After the construction by the developers, the value increment can be achieved.

The experts and consultants have the similar points about the residences' willingness to pay for sponge city. They mentioned that the Wuhan housing market is booming. Because the increasing requirements for housing investment, the demand for housing cannot be satisfied by the current supply. To control the house price at a stable level, the government use the price limitation policy on house transaction. However, this policy pushes the developers reducing their supply further because they think the price was being underestimated by the limitation currently. The situation makes the residence even hard to buy a house. Therefore, the potential buyers have to pay more money for the houses. The interviewee said the issue in current market condition is not whether the residence is willing to pay for the sponge city because the most serious issue is whether they are able to buy a house. Under this situation, they increment of price for sponge city will be neglected by the residence. In theory, the sponge city construction has a lot of benefits to the residence, so these two-year is the best time for promoting sponge city in new houses as the increment cost is easy to digest through the house price increments. However, the experts mentioned that the major responsibility of sponge city construction should not belong to the developers. It is government's role to take the major responsibility for the sponge city constructions. The residence has already paid taxes and other fees for the infrastructure, which includes the sponge city construction. When talking about the property value increment by sponge city, the consultants' view is the sponge city construction can increase both the land value and house value. The increment range of land value is large than the range of house value. The reason for their opinion is the improvement of safety level and green area coverage is taking place at the regional level rather than house unit. The total construction area can get benefits of the sponge city, and the degree

of the benefits are similar regardless of quality and type of the house. So they thought the sponge city could play a direct influence on land values and an indirect influence on house values.

The interviewee from Urban planning institutions said he was not willing to pay for the sponge city. He explained that the construction cost should be bored by the municipal construction cost and local taxes. As that sponge city is part of the urban infrastructures and residences have already paid taxes for those costs, so there is no reason to ask the residence to pay for the construction. Apart from that, he mentioned that the sponge city should take advantage of technologies and skills updated. The principle of sponge city is a low-impact development, so the constructor should consider more on the aspect that how to use the scientific design and new technologies to reduce the cost.

The interviewee from the government explained the consideration from the government on this issue. They are glad to hear the statics result that more than 50% of respondents are willing to pay for the sponge city, but the cost for sponge city should distribute by various participants. In the current period, the investment for the sponge city mainly spent by the government's grants. However, the total cost should not solely rely on government's grants. The subsidies proving by central and local governments is a way of promotion, and the social capital should participate in the construction of sponge city and take the major role in the later period. Because the sponge city can make real benefits on residence's life, they are willing to pay for it. But the propose of promoting the sponge city construction is encouraging smart development during the urbanization process. The smart development requires different institutions to participate, and the power of the social capital can be used to improve the efficiency and the problem of lack of funding.

Comparing to the non-sponge city area, the residences are willing to pay a bitter more for safety level or better environment. The willingness to pay for the sponge city is paying for better quality of houses. But they also mentioned that the most important factor for housing price is the location and investment value for the houses. When the residence answered the questionnaire, they do not calculate the range of increment. They just have a 'feeling' about the range of the value increment and the feeling about the increment is not high. The residence who has no idea of land value because they seldom pay attention to land value. They think the value increased for the property will be larger than for land. The amount they are willing to pay for the sponge city will less than the range of value increased.

In summary, the value increment of land value and house value due to the sponge city have been confirmed by most of the interviewees. In current market condition, the residence's bargaining power is weak, so they have to pay for the extra costs due to the construction of sponge city. In actual, they are willing to pay for part of the value increment as the improvement of the better living conditions. That better living condition includes the reduction of flooding risk but most residences cared more about the improvement of environments of their neighbourhoods. However, the professionals mentioned that the residence's contribution should not be regarded as the main source of the construction funds. Governments and social capital should take the leading role in the sponge city constructions.

4.5 The research findings of secondary data analysis

The research findings of analysis about data of land transaction price and house transaction price were described in this part. The movement of land transaction price and house transaction price were compared between the sponge city area and non-sponge city area in Wuhan to find how the announcement and the construction of sponge city can play an influence on the transaction price.

4.5.1 The data analysis result of land transaction price

In China, the land was owned by the country, and the land transaction price refers to the transaction price of land with a marketable granted private use rights for a term 70 years. 'The Land Management Law of 1986/88 legalized private use rights to publicly owned land in China. And then the Interim Regulations on Allocation and Granting of Urban State-Owned Land Use Rights of 1990 defined urban land rights as (a) unmarketable allocated rights available for public use and (b) marketable granted private use rights for a term 70 years' (World Bank and The people's republic of China development research center of the state council, July 2014, P.25). After the regulations, China's urban land markets was created the land use right began to able to transact in the local land markets (World Bank and The people's republic of China development research center of the state council, July 2014).

The author collected data of all the successfully transaction residential use land, which are locating in seven central districts of Wuhan from the year 2007 to April 2017 from Wuhan land transaction center. Those 152 land transactions were list in Annex 3 for reference. According to the land's location, those transactions were divided into seven groups, and each group represent one of the central district transactions. Because the size of lands is different, the unit price per square meter was used to represent the land transaction price of each land. Table 20 was the annual average unit land transaction price for each district in Wuhan from 2007 to April 2017. However, each land transaction price was specific to the land characteristics and the data was not in a continual condition for analysis. For example, in the year 2009, no land transaction achieved in Jianghan District, Jiangan District, Hongshan District, Qingshan District and Hanyang District. Apart from that, the movements of each district's land transaction price were so fluctuated that no effective comparison result can be found from those data.

Table 20 Annual average unit land transaction price for each central district in Wuhan

Districts		2007	2008	2009	2010	2011
Qiaokou		2,863	2,331	2,342	4,150	-
Wuchang		3,115	2,286	3,237	2,864	2,322
Jiangan		3,738	3,188	-	1,884	3,116
Jianghan		3,070	3,226	-	-	7,800
Hongshan		2,490	1,357	-	1,620	3,097
Qingshan(Sponge city pilot)		3,415	-	-	-	1,002
Hanyang (sponge city pilot)		2,431	1,730	-	1,351	3,971
Districts	2012	2013	2014	2015	2016	2017
Qiaokou	2,046	-	2,354	4,288	-	10,555
Wuchang	3,077	1,003	-	2,178	-	-
Jiangan	1,843	1,979	2,565	-	3,136	9,886
Jianghan	-	-	-	3,418	-	15,184
Hongshan	2,353	2,014	-	4,956	2,587	-
Qingshan(Sponge city)	-	-	2,289	4,258	-	-
Hanyang (Sponge city)	2,169	-	2,946	2,901	3,536	8,457

4.5.2 The data analysis result of house transaction price

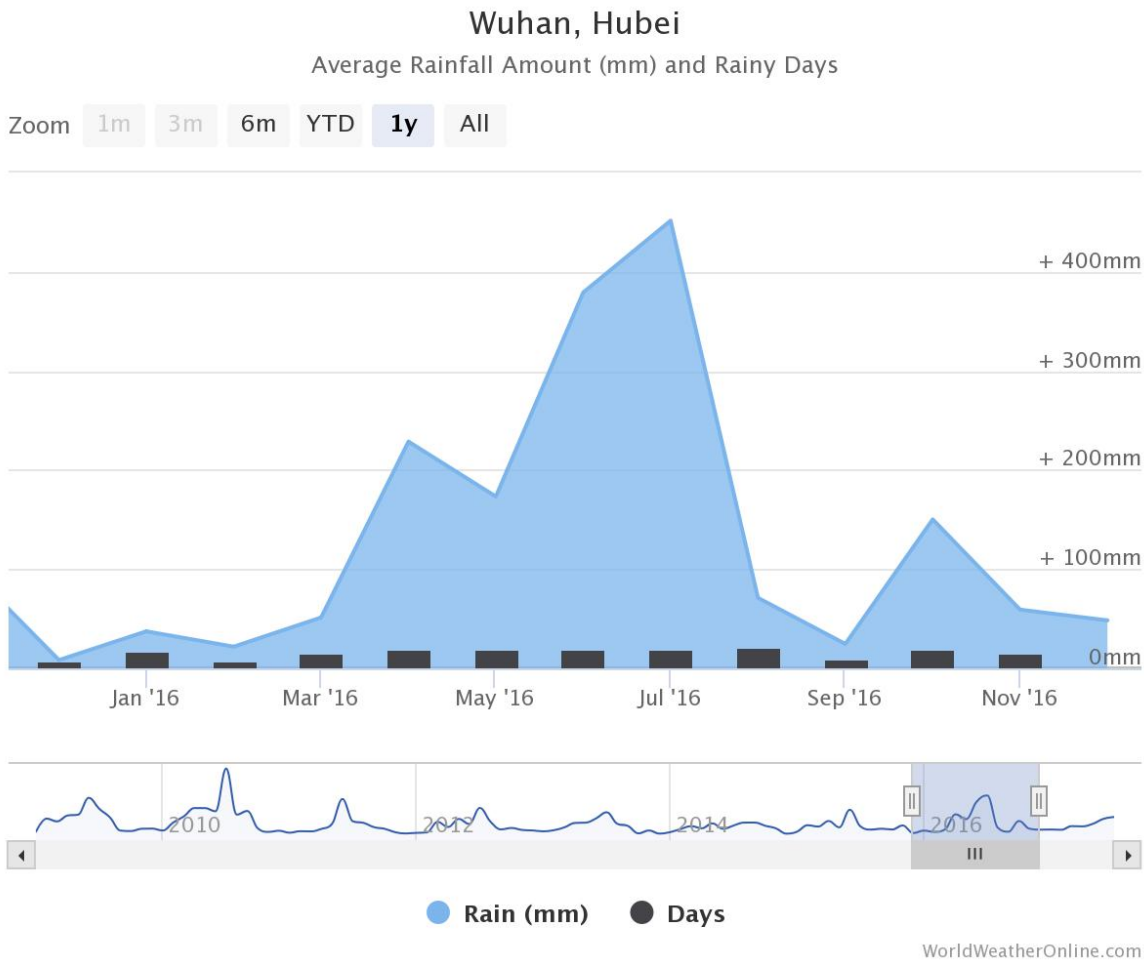
Similar to the land transaction price, the author has collected the monthly and annually transaction price of residential houses in seven central districts of Wuhan from the database of China Index Academy. The residential house transaction data in Wuhan is available from January 2011 to June 2017. Those data have been used to compare between different areas and different periods in order to find the relationship between house price and the flood risk level. The residential house transaction price refers to the unit price of the successful transacted house

that has been registered in Wuhan Real estate transaction center. The date recording for transaction is the registering date. The unit of the price is CNY per square meter.

4.5.2.1 The relationship between flooding event and house price

Wuhan is located in Central China and has features of a subtropical monsoon climate and the summer season is from June to September. During those months, the rainfall amount usually varies between 200mm to 300mm per month, and the rainfall amount is larger than in the remaining months of the year. (World weather online, 2017) From Figure 5 it can be seen that in 2016, the rainfall is significantly larger between June to August than in the other months.

Figure 5 The monthly rainfall amount of 2016 in Wuhan



Source: World weather online

In July 2016, a one-week continuous heavy rainfall attacked Wuhan city, and the precipitation intensity reached a historically high degree. The heavy rainfall caused a lot of waterlogging within the city. The data from Table 21 shows that the height of the residential house transaction price in most of the districts was lowered in July. Only two districts got a residential house transaction price increase, and those two districts are all sponge city construction areas. It is plausible that the flooding reduced the value of some residential houses with serious flooding conditions, therefore the district's monthly average house transaction price dropped in July.

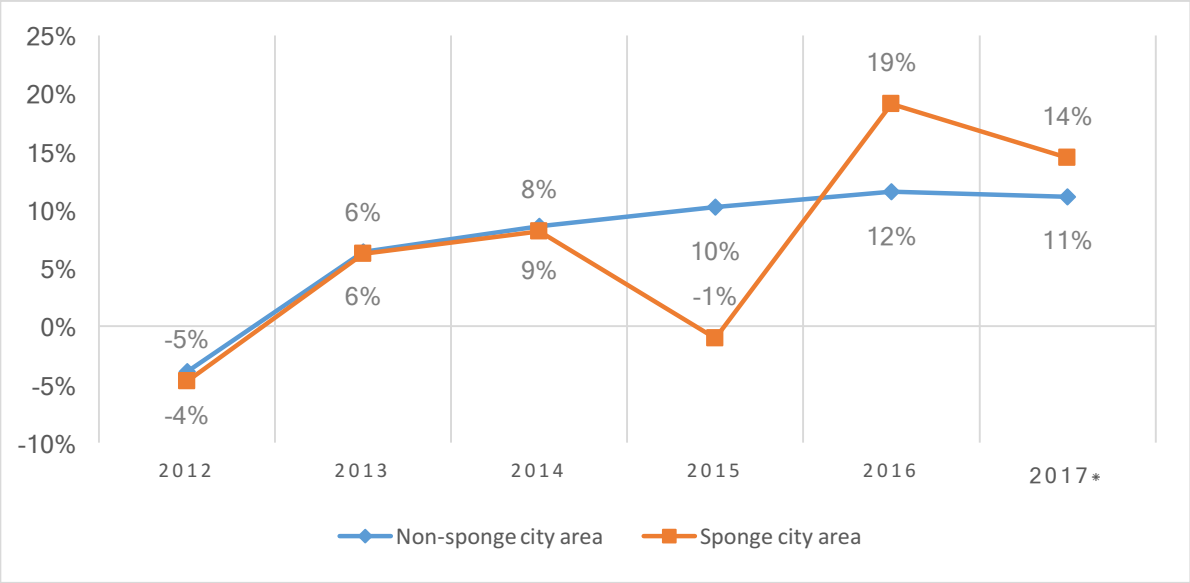
Table 21 Monthly residential house transaction price movements of 2016 for each central district in Wuhan

Districts	1	2	3	4	5	6
Qiaokou	16%	-10%	0%	-5%	0%	9%
Wuchang	3%	2%	0%	6%	2%	3%
Jiangan	-1%	6%	2%	-2%	6%	2%
Jianghan	11%	-2%	-5%	16%	-10%	-8%
Hongshan	-1%	1%	7%	1%	3%	10%
Qingshan(Sponge city pilot)	16%	-9%	-2%	5%	1%	10%
Hanyang (sponge city pilot)	-2%	0%	2%	7%	0%	0%
Districts	7	8	9	10	7	12
Qiaokou	-3%	3%	2%	2%	-3%	-3%
Wuchang	-4%	1%	5%	-36%	-4%	6%
Jiangan	-8%	9%	39%	-16%	-8%	-5%
Jianghan	-5%	15%	3%	-8%	-5%	-31%
Hongshan	-10%	-7%	26%	-8%	-10%	-12%
Qingshan(Sponge city)	6%	-5%	13%	3%	6%	-15%
Hanyang (Sponge city)	4%	3%	4%	9%	4%	11%

4.5.2.2 The comparison between sponge city area and non-sponge city area

Wuhan city has been selected as one of the first batches of pilot cities for the sponge city construction in the April 2015. The working plan of Wuhan sponge city (The Office of Wuhan city government, 2014) was released in October 2015, and the intensive constructions began after the work plan. Chart 8 shows the movement of the annual average unit house transaction price. The non-sponge city area covers five districts, which are Jianghan District, Jiangan District, Hongshan District, Wuchang District and Qiaokou District. The sponge city area includes two districts, which are Hanyang District and Qingshan District. There is no obvious difference in movements of average unit house transaction price between sponge city areas and non-sponge city areas from 2012 to 2014. In 2015, the average unit house transaction price of sponge city area dropped 1% because of the suddenly large house supply in Qingshan District. In the past five years, the average number of house supply is 2300 houses per year but the supply in 2015 is 6900 houses. The increased supply made the average unit house transaction price of Qingshan Districts to decrease from 9520 yuan per square meter to 8743 yuan per square meter. Due to the incentive policy to real estate market, Wuhan's house transaction price increased significantly in 2016 and in the first half of 2017. It is obvious that the average increment of the unit house transaction price in sponge city areas is higher than in non-sponge city area. It is reasonable to conclude that the sponge city construction has an influence on the increment of house transaction price.

Chart 8 Annual average unit house transaction price in Wuhan central areas



Chapter 5: Conclusions and recommendations

5.1 Restatement of study purpose and background information

With the influence of climate change and fast urbanization process, urban floods have become a serious problem in China's big cities such as in Wuhan. In order to optimize the urbanization process and reduce the flood risk in the city, China's central government promotes the sponge city construction for better water management in urban areas. Wuhan has been selected to serve as the pilot city for the sponge city program (also refer to as 'construction'). However, the fund provided by the central government is much lower than the actual investment needed for the sponge city construction. The challenge to overcome this fund shortage is one of the biggest of the sponge city program. The application of the PPP model is regarded as the major way to bridge this financial gap. Apart from the technical skills and knowledge for the sponge city construction, exploring a successful business model in PPP to collect revenues from sponge city plays a key role in the sponge city program. The objective of this research is to test whether the construction of the sponge city program will increase the housing value in the area that the sponge city construction covers.

5.2 Research Conclusions

5.2.1 Flood risk perception of residences in Wuhan

In the research about the relationship between flood risk perception and property value, Researcher Danel et al. (2009), Bhattacharya & Lamond (2016) and Votsis & Perrels (2015) mentioned that residence's flood risk perception plays an influence on the house value in cities of The Netherlands, England and Finland. In this research, residence's flood risk perception has been measured using five indicators: Scale of exposure to floods, Frequency of exposure to floods, Categories of flooding damages, Anti-flood measures and residence's attitude about flood experience and property value after floods.

The residence's exposure scale of urban floods has been extremely large as 96.7% of the residences have exposure to urban flood in Wuhan in either a direct or an indirect way. Apart from the scale of exposure, the frequency of exposure to floods is also high as 69% of the residences claim that they suffer from urban floods at least once per year. The public transportation systems and roads suffer most by floods and flooding of houses ranks as the second. The major measurements taken for the floods are recovery actions. Personal preventive actions have been taken by 19% of the residences, albeit that they claim that these actions have limited effects to prevent flooding. Compared with the large-scale and high frequency of urban floods exposure, the residences' attitude toward floods experience is calm. Only 14% of the respondents feel traumatic about their flood experience and most residence's feeling is classified as annoying. The research shows that flooding will reduce the property value in residence's perception as 86% of the respondents think that the property value will decrease if the property has been flooded during the flooding period. However, 48% of respondents think that the value of property can recover after the floods when flood proofing measurements have been taken.

In summary, the high flood risk exposure and limited anti-flood measurements in Wuhan result that the house value is sensitive to residences' perception on urban floods.

5.2.2 The respondents' perception about sponge city and its functions

According to the literature review, the sponge city concept seems to be a more sustainable solution to resolve the urban flooding problem in general than the traditional stormwater management method, and is more close to the eco-city and low-carbon city theory (Yang &

Lin, 2015). The research result shows that three aspects of sponge city benefits in theory were been recognised by most of the residence.

Although sponge city is a relatively academic concept in urban water management, more than 66% of the residences are familiar with the sponge city concept. Half of those residence only heard of the concept, hence they have a limited understanding of its meaning. After a short introduction of the sponge city content, 68.1% of the residences recognise its function on effective urban water management. Past flood experience and the level of understanding of the sponge city concept are the two factors that have an influence on the residence's perception on the value of functions of sponge city. The stronger the emotional impact that residences experience during and after a flood, the more they recognize the relevance of the sponge city concept. And also the better they understand the sponge city concept, the more they recognize degree the relevance of the sponge city concept.

A reduction of flood risk, the improvement of the coverage rate of green space and the improvement of the coverage rate of public space are the three main benefits that are being delivered by the sponge city construction. More than 70% of the residences recognize those functions of the sponge city. The sponge city's ability to improve the coverage rate of green space of area has been valued most by the residences as they assume that adding green space could improve their living quality the whole year through. The sponge city's ability to improve the safety level of the area has been valued most by the residences who suffered a lot from flooding. However, there is still one fifth of the respondents who has reservations about its actual effects on reducing city's flood risk. Most of the reservation is about the sponge city's ability to improve the coverage rate of public space. The reason is that some residence does not know how the sponge city construction can improve the coverage rate of public space and they do not see a relation between the sponge city and public space.

In summary, the respondents' perception about sponge city is in a limited level. Residences have heard about the concept of sponge city, but their understanding of its contents is limited. Although the sponge city is aim is to improve urban water management, residences care more about its secondary function of improving their living environment.

5.2.3 The respondents' willingness to pay for sponge city

The residence's exposure to flood and sensitivity level of property value play an influence on their perception of property value which is increased by the sponge city concept. 83% of the residences think that the sponge city construction increases the house value of the area that the construction covers and 67% of residences think that the sponge city construction increases the land value of the area that construction covers. The majority of the respondents who think that the sponge city construction increases the property value viewed that the range of the increase will be less than 5% of the property's original value.

The residence's willingness to pay is not weak. Although 76% of the residence are willing to pay for the sponge city through an increase of the housing price, the amount they are willing to pay for half of them is less than 2% of the house price. The regression model estimates that the residence's willingness to pay for the sponge city is 48% of the value increment after the sponge city construction. The degree of willingness to pay is related to the real estate market in Wuhan. The current booming house transaction market in Wuhan reduces the residence's bargaining power. Therefore, the residence's willingness to pay is relatively strong. It is highly plausible that the residence's willingness to pay will decrease due to a changing of the real estate market in the future. The actual transaction data supports the assumption that flood events have a negative influence on the house price. From the actual transaction data, it is reasonable to infer that the sponge city construction contributes to the increment of the house

transaction price, but to what degree of the sponge city construction increases the house transaction price is hard to estimate.

In summary, most of the residence are willing to pay for the sponge city through a way of house price increase, but the amount they are willing to pay is at a limited level.

5.2.4 The extent that sponge city concepts play impacts on residence's perception of housing value

According to the theory of factors influenced the property value and price, the living quality and environment is factors that play the influence on housing price in specific area or units (Meen & Mark, 1998). The research result supports the theory of factors influenced the property value and price.

Based on the research data, 83% of residence thinks the sponge city construction can increase the house value of the area that construction covers. The sponge city concepts play impacts on residence's perception of housing value in two aspects. The first aspect is basing on the residence's sensitive level of their perception of flood risk. From the data analysis, we can find that the exposure level of residence plays an influence on residence's perception about flood risk. For the residence who are sensitive to the flood risk, they have the perception that the property values have the strong relationship to flood risk level. The higher level of residences' sensitivity about the flood risk, the more possibility that those residences think the housing value will increase by the sponge city construction. The other aspect is basing on the residence's recognition of benefits of sponge city construction. The attitudes about floods and the understanding of the sponge city concept are the two factors that play influence the degree of recognition the residence gives to the sponge city. The benefit of improving their living environment was being valued most by the residence in Wuhan. The reason that the residence thinks the sponge city construction can increase the housing value of the area that sponge city construction covers is the sponge city construction can increase the green space coverage and create more public space in their communities. Those increments will contribute to the increment of housing value.

For the degree of sponge city concepts play impacts on housing value, the major of residence who think the sponge city constructions can increase the housing value viewed the range of the increase will be less than 5% of the houses' original value. The data analysis of house transaction price proved that the residence not only has perception on house value increment by sponge city constructions but also paid more money for purchasing the houses in sponge city area.

5.3 Recommendations

Although more than half of the residence is willing to pay for the sponge city concept, the residences value more the environmental improvements than a reduction of the flood risk. So the first recommendation is that designers of sponge city should consider more multi-functional uses of water management facilities. Related to the residence's willingness to pay, it is concluded that residences are more willing to pay for a green area or public area within the community. Related to land use, the multi-functional water management facilities can save the place for land.

The second recommendation is that the sponge city concept should have a stronger connection with the urban plan. In the pilot period, the sponge city construction has been conducted by the water management authority in Wuhan. The authority conducts the construction according to their criterion, which is unpublicized. The project-based way of sponge city construction makes the sponge city pilot in Wuhan spread widely in a larger area and lack of system planning in

general. In a later period, urban design institutions should participate in the design of the sponge city in an early stage of the development process so that the sponge city can be better combined with urban design and development. Operation and maintenance of the sponge city projects should be taken more into considerations.

Last but not least, PPP has been considered as an important funding source of the sponge city. In the current period, the government plays a leading role in the sponge city construction process. The section of construction projects is administrative. The promotion of the PPP model and participation of social capital require a market-oriented way of construction and better feasibility studies of the sponge city construction. More professional institutions should have the opportunity to participate in those processes.

5.4 Limitations and further researches

5.4.1 The limitation of the research

- Limitation of literature review of sponge city construction

It is only two years after the sponge city has been promoted in China, and no existing system of sponge city has been completed in China's city. The existing research of sponge city is focusing on the engineering aspect, the public researches about the social aspect of sponge city construction are in a limited amount. Therefore, the conclusions of research have a weak connection to the literature review.

- The ineffective land use right transaction data

Relocation the original residence to a new place is a complex process in China's big cities such as Wuhan. And according to the rules in China, the land use right transaction can happen only after the relocation completed. As a result, the average amount of residential land use right transaction in Wuhan is about 30 per year. Those transactions distributed unevenly so it is likely that no land use right transaction occurred in some districts. The land use right transactions that the author collected and analysed are ineffective to make any conclusion about sponge city's influence on land use right transaction price.

- The specific analysis between the flood risk level and property value

Due to the data accessibility, the specific analysis between an area's flood risk level and property value is unable to conduct. And the factors that play an influence on property value are various and integrated to each other, so it is hard to exclude the other factors that can play an impact on property value. Therefore, the relationship between the reduction of flood risk and increment of property value has not been defined and explained clearly.

5.4.2 Further researches

The research's conclusion that more than half of the residence are willing to pay for sponge city through a way of house price increase makes it possible for the social capital participating and taking an important role in sponge city constructions. The next step for the research is to explore the specific business model for sponge city construction and operation. During the exploring process, the specialization and cooperation ways among the different institutions and player need to define and communicate. Apart from that, how the sponge city construction can be used to combine with the urban development and management and improve urban lives in China are worth to study in the further.

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Annex 1: Research Instruments

Questionnaire for public perception of the sponge city
(Applicable within Wuhan area)

Personal information

1. What's your age currently?
- Below 18
- 18-30
- 31-45
- 46-55
- 56-65
- Above 65

2. What's your gender?
- female
- male

3. Which is your education level?
- Senior school or below
- University or college degree
- Post-graduate qualification

4. Which of district that your current residence locates in?
- Jianghan
- Jiangan
- Qiaokou
- Qingshan
- Wuchang
- Hongshan
- Hanyang
- Donghu Hi-tech development zone
- Wuhan economic development zone
- Others

Exposure to urban floods

5. Do you ever have exposure to urban floods in the past twenty years in Wuhan?

- Heavy exposure (once a year or more)
- Limited exposure (less than once a year)
- Observed other's exposure
- No exposure

6. Which kinds of affects the urban floods had played on you and your asset?

- My neighbourhood was flooded, but my house was well protected
- My residence was flooded (flood water entered my house)
- My office or work place was covered by water
- The transportation process was affected by flood
- Loss or damages of personal assets
- Others affects made by floods

7. How do you feel about the experience of these floods?

- Traumatic (e.g. if possible would change the residence for a safe and flood free one)
- Annoying
- Neutral/indifferent

8. What's the frequency that your house has been affected by urban floods (in the past 10 years)?

- More than once a year
- Once a year
- Once per two years
- Once per three to five years
- Once per six to ten years
- Less than once per ten years

9. Which kind of measurements below that do you prefer to take when responded to flooding?

- Take recovery actions: flood resilient repair/replace/ cleaning/
- Take preventive actions to protect from flooding water entering the house (such as flood boards to close the door(s), sand bags, remove valuable assets to dry place)
- Leave the house

- Take no action (Except for cleaning the house after the flood)

10. Do you think the property value of areas that heavily affected by urban floods will decrease after the urban floods?

- Yes
- No
- I don't know

11. Do you think the government had taken effective measurements to reduce the effects played by the flood?

- Yes
- No
- I don't know

General perception of the sponge city program

12. Do you know the concept of the sponge city?

- Yes
- No
- Heard, but have no idea of what does it mean

'The general objectives of the concept entail 'restore' the city's capacity to absorb, infiltrate, store, purify, drain and manage rainwater and 'regulate' the water cycle as much as possible to mimic the natural hydrological cycle.' (Zevenbergen&Boogaard,2016)

13. Do you know that Wuhan government has conducted the construction of the sponge city?

- Yes
- No

14. Do you think that the construction of the sponge city can effectively reduce the negative effects made by floods on your property/house?

- Yes
- No
- I don't know

15. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?

- Increased less than 2% of the house value
- Increased the house value from 2% to 4.9%
- Increased the house value from 5% to 7.9%
- Increased the house value from 8% to 10.9%
- Increased more than 11% of the house value
- Make no effect on house value

16. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?

- Increased less than 2% of the land value
- Increased the land value from 2% to 4.9%
- Increased the land value from 5% to 7.9%
- Increased the land value from 8% to 10.9%
- Increased more than 11% of the land value
- Make no effect on land value
- I have no idea on this issue

Perception of the positive effects brought by the sponge city program

17. Do you think that the construction of the sponge city can effectively improve the safety level of the area that the construction covers?

- Yes
- No
- I don’t know

18. To what extent you think the increasing level of safety (reduction of impact/consequences) at the household level, which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?

- Increased less than 2% of the house value
- Increased the house value from 2% to 4.9%
- Increased the house value from 5% to 7.9%
- Increased the house value from 8% to 10.9%
- Increased more than 11% of the house value

- Make no effect on house value

19. To what extent you think the increasing level of safety (reduction of impact/consequences) at the household level, which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?

- Increased less than 2% of the land value
- Increased the land value from 2% to 4.9%
- Increased the land value from 5% to 7.9%
- Increased the land value from 8% to 10.9%
- Increased more than 11% of the land value
- Make no effect on land value
- I have no idea on this issue

20. Do you think that the construction of the sponge city can effectively improve the coverage rate of green space of area that the construction covers?

- Yes
- No
- I don’t know

21. To what extent you think the improvement of the coverage rate of green space, which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?

- Increased less than 2% of the house value
- Increased the house value from 2% to 4.9%
- Increased the house value from 5% to 7.9%
- Increased the house value from 8% to 10.9%
- Increased more than 11% of the house value
- Make no effect on house value

22. To what extent you think the improvement of the coverage rate of green space, which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?

- Increased less than 2% of the land value
- Increased the land value from 2% to 4.9%
- Increased the land value from 5% to 7.9%
- Increased the land value from 8% to 10.9%

- Increased more than 11% of the land value
- Make no effect on land value
- I have no idea on this issue

23. Do you think that the construction of the sponge city can effectively improve the coverage rate of public space of area that the construction covers?

- Yes
- No
- I don’t know

24. To what extent you think the improvement of the coverage rate of public space, which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?

- Increased less than 2% of the house value
- Increased the house value from 2% to 4.9%
- Increased the house value from 5% to 7.9%
- Increased the house value from 8% to 10.9%
- Increased more than 11% of the house value
- Make no effect on house value

25. To what extent you think the improvement of the coverage rate of public space, which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?

- Increased less than 2% of the land value
- Increased the land value from 2% to 4.9%
- Increased the land value from 5% to 7.9%
- Increased the land value from 8% to 10.9%
- Increased more than 11% of the land value
- Make no effect on land value
- I have no idea on this issue

Summary

26. Compared with houses that do not construct under the sponge city concept, whether you will prefer to buy the houses that constructed under the sponge city concept? (Under the assumption that other factors are similar?)

- Yes
- No
- I don’t know

27. To what extent you are willing to pay an extra cost for the construction of the sponge city in the area that your targeting house locates?

- Not pay any more for the sponge city
- Pay less than the 2%
- Pay the extra cost from 2% to 4.9%
- Pay the extra cost from 5% to 7.9%
- Pay the extra cost from 8% to 10.9%
- Pay more than 11% of the extra cost

Annex 2: Data of analysis of regression test between the property value movement of willingness to pay due to the sponge city

			10. Do you think the property value of areas that heavily affected by urban floods will decrease after the urban floods?			
			Yes	No	Have no idea	Total
16.To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?	Make no effect on value	Count	38	3	9	50
		% within 16.To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?	76.0%	6.0%	18.0%	100.0%
	Increased less than 2% of the value	Count	57	5	1	63
		% within 16.To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?	90.5%	7.9%	1.6%	100.0%
	Increased the value from 2% to 4.9%	Count	94	7	4	105
		% within 16.To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?	89.5%	6.7%	3.8%	100.0%
	Increased the value from 5% to 7.9%	Count	52	4	4	60
		% within 16.To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?	86.7%	6.7%	6.7%	100.0%
	Increased the value from 8% to 10.9%	Count	29	1	1	31
		% within 16.To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?	93.5%	3.2%	3.2%	100.0%
	Increased more than 11% of the value	Count	25	2	0	27
		% within 16.To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land	92.6%	7.4%	0.0%	100.0%

		value of areas that the construction covers?				
	I have no idea on this issue	Count	70	4	13	87
		% within 16.To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?	80.5%	4.6%	14.9%	100.0%
Total		Count	365	26	32	423
		% within 16.To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the land value of areas that the construction covers?	86.3%	6.1%	7.6%	100.0%

			10. Do you think the property value of areas that heavily affected by urban floods will decrease after the urban floods?			
			Yes	No	Have no idea	Total
15. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?	Make no effect on value	Count	55	5	11	71
		% within 15. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?	77.5%	7.0%	15.5%	100.0%
	Increased less than 2% of the value	Count	85	9	6	100
		% within 15. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?	85.0%	9.0%	6.0%	100.0%
	Increased the value from 2% to 4.9%	Count	109	3	5	117
		% within 15. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?	93.2%	2.6%	4.3%	100.0%
	Increased the value from 5% to 7.9%	Count	58	2	3	63
		% within 15. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?	92.1%	3.2%	4.8%	100.0%
		Count	29	3	2	34

	Increased the value from 8% to 10.9%	% within 15. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?	85.3%	8.8%	5.9%	100.0%
	Increased more than 11% of the value	Count	29	4	5	38
		% within 15. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?	76.3%	10.5%	13.2%	100.0%
Total		Count	365	26	32	423
		% within 15. To what extent you think a reduction of flood risk (change of occurrence), which is the result of the construction of the sponge city, will increase the residential value of areas that the construction covers?	86.3%	6.1%	7.6%	100.0%

Annex 3: List of land (for living or mixed use) transaction item in Wuhan from 2007 to April 2017

No.	Name of land	Year of n	Land code	Buyer	Total price (00,000)	Unit price (Yuan/㎡)
1	汉阳区十里铺村 A/B 地块	2007	P(2007)051	湖北十里投资发展股份有限公司	34,900	1,551
2	洪山区和平大洲村	2007	P(2007)058	武汉开来房地产开发有限公司	6,300	2,070
3	汉阳区铁桥村 A/B/C/D/E/F 地块	2007	P(2007)050	武汉铁桥房地产开发有限公司	37,100	1,708
4	胜 利 街 3 1 0 号	2007	P(2007)054	武汉九通置业有限公司	4,100	3,254
5	汉阳区鹦鹉村 A 地块	2007	P(2007)052	武汉中盛房地产开发有限责任公司	38,100	2,216
6	洪山区团结村 K-1/K-2/K-3/K-4/K-5/K-6	2007	P(2007)049	福星惠誉房地产有限公司	137,800	2,337
7	杨园街纺机路 29 号	2007	P(2007)053	武汉德润物业发展有限公司	45,900	2,399
8	江汉区复兴村 57 号	2007	P(2007)056	湖北楚天房地产开发有限责任公司	20,900	2,407
9	汉阳区新五里地区	2007	P(2007)059	武汉新城国际博览中心有限公司	197,000	1,624
10	汉阳区新五里地区	2007	P(2007)061	武汉新城国际博览中心有限公司	173,800	2,784
11	汉阳区新五里地区	2007	P(2007)060	武汉新城国际博览中心有限公司	192,400	2,033
12	汉阳区汉阳大道以南、汉桥路以西	2007	P(2007)045	武汉兆麟房地产开发有限公司	11,210	2,507
13	青山区工人村 11 村 272 号	2007	P(2007)041	湖北世纪东方房地产开发有限公司	6,750	1,507
14	武昌区彭刘杨路 239 号	2007	P(2007)046	武汉江腾房地产开发有限公司	4,350	2,286
15	江岸区金桥大道竹叶山钢才市场 A/B 地块	2007	P(2007)047	武汉竹叶山集团股份有限公司	13,820	2,284
16	武昌区中北路与北环西路交汇处 A/B 地块	2007	P(2007)044	武汉洪顶置业有限公司	33,200	6,982
17	桥口区建一路 2 号	2007	P(2007)039	武汉融侨房地产开发有限公司	77,200	5,009
18	江汉区常青路与青年路交汇处(共 6 块地)	2007	P(2007)036	华润置地(武汉)实业有限公司	269,200	6,208
19	汉阳区汉阳大道、鹦鹉大道、拦江路及北城路、南城路围合区域	2007	P(2007)038	湖北福星惠誉置业有限公司	122,500	3,567
20	江汉区解放大道 1409 号	2007	P(2007)029	湖北南国创新置业有限公司	26,450	2,085
21	青山区第 45 街坊	2007	P(2007)028	湖北世纪东方房地产开发有限公司	3,200	3,854
22	青山区第 40 街坊	2007	P(2007)027	湖北世纪东方房地产开发有限公司	7,360	4,971
23	洪山区关山街彭王村	2007	P(2007)030	武汉招银物业有限公司	15,210	1,805
24	青山区武汉科技大学内 A/B/C 地块	2007	P(2007)033	武汉高建建筑安装工程公司	13,290	3,326
25	硚口区简易路 126 号	2007	P(2007)031	湖北昌泰房地产开发有限公司	8,900	1,607
26	江汉区马场角路与马场一路交汇处	2007	P(2007)026	武汉万科天诚房地产有限公司	19,070	5,287
27	江岸区京汉大道义和巷	2007	P(2007)020 号	金地集团武汉房地产开发有限公司	48,850	6,879
28	洪山区珞瑜路 95 号	2007	P(2007)021	武汉东谷房地产开发有限公司	50,020	4,358
29	江岸区胜利街 315 号	2007	P(2007)018	武汉合记置业有限公司	6,530	2,532
30	洪山乡姚家岭村	2007	P(2007)017	湖北华中房地产开发有限公司	10,280	1,879
31	民权路与花楼街交汇处、友谊路与民主二街交汇处、前进二路与自治街交汇处	2007	P(2007)014	武汉市江汉区房地产公司	38,000	2,331
32	江汉区贺家墩村	2007	P(2007)015	武汉王家墩城建开发有限公司	56,500	1,905
33	江汉区站前北路特 1 号	2007	P(2007)011	湖北京华房地产开发有限公司	3,500	1,263
34	武昌区武泰闸片	2007	P(2007)009	武汉银沁商贸有限责任公司	2,820	2,425
35	武昌区杨园街铁机路 5、7 号	2007	P(2007)010	重庆润隆实业有限公司	162,100	3,405

36	汉阳区月湖桥西侧	2007	P(2007)008	华润置地(武汉)有限公司	135,300	3,887
37	武昌区联盟路 61 号	2007	P(2007)007	武汉天佳大自然环保科技发展有限责任公司	7,010	2,234
38	武昌区中南街民主路 624 号	2007	P(2007)002	华润置地(武汉)有限公司	15,500	3,759
39	硚口区沿河大道与武胜路交汇处	2007	P(2007)005	武汉华通置业发展有限公司	112,000	2,184
40	桥口区宗关街一号	2007	P(2007)001	武汉市桥房集团有限责任公司	9,920	2,654
41	武昌区中南街武珞路 336 号	2007	P(2007)006	武汉市海鼎置业有限责任公司	27,350	2,593
42	武昌区武泰闸片	2007	P(2007)004	湖北省世纪东方房地产开发有限公司	3,100	1,951
43	武昌区中南路街夏家村	2008	P(2008)026 号	武汉市洪山区江宏房地产开发公司	1,000	2,126
44	江岸区万隆经济实验区 C8 区	2008	P(2008)029 号	新八建设集团有限公司	2,670	1,522
45	硚口区长丰乡长丰垸	2008	P(2008)024 号	武汉佳联房地产开发有限公司	2,110	1,748
46	洪山区雄楚大道与丁字桥路交汇处	2008	P(2008)030 号	武汉光谷联合股份有限公司	15,400	1,357
47	武昌区徐家棚街武车五村 108 号	2008	P(2008)018 号	湖北宏鑫房地产开发有限公司	610	2,629
48	桥口区汉宜路 10 号	2008	P(2008)019 号	武汉华汉投资管理有限公司	14,950	2,914
49	汉阳区墨水湖北路以北、马池湖路以东	2008	P(2008)013 号	湖北新长江置业有限公司	5,660	2,300
50	江岸区二七街赵家条 319 号	2008	P(2008)021 号	湖北省铁路公司	19,950	2,685
51	汉阳区十升小路以东	2008	P(2008)003 号	湖北十里投资发展股份有限公司	3,210	1,928
52	江岸区解放公园路 71 号	2008	P(2008)011 号	湖北金凌房地产开发有限公司	9,810	2,436
53	后湖乡花桥村	2008	P(2008)007 号	武汉新苑房地产开发有限责任公司	14,250	1,612
54	汉阳区墨水湖北路以南、十升小路以东	2008	P(2008)002 号	湖北十里投资发展股份有限公司	19,400	2,605
55	中北路延长线	2008	P(2008)001 号	湖北长源房地产开发有限责任公司	21,050	2,104
56	江汉区天门墩 7 号	2008	P(2008)008 号	刘桂华	5,010	4,840
57	京汉大道 B—3	2008	P(2008)004 号	武汉银泰房地产开发有限公司	17,650	6,108
58	汉阳区新五里地区	2008	P(2007)062	武汉源洋锦绣置业有限公司	10,000	88
59	武昌区中北路 23 号	2009	P(2009) 001	武汉中北经济发展有限公司	84,200	3,237
60	硚口区操场角	2009	P(2009) 002	武汉华通置业发展有限公司	42,600	2,342
61	洪山区北港村地块	2010	P(2009)131 号	武汉维佳置业有限责任公司	47,810	1,670
62	洪山区长江村 13、16、17、18 号地块	2010	P(2009)137 号	万科	63,200	1,177
63	洪山区马湖村 K1、K2、K3 地块	2010	P(2009)132 号	保利地产	88,300	1,363
64	洪山区幸福村 1、2 号地块	2010	P(2009)138 号	武汉市源福房地产开发有限公司	80,390	1,701
65	洪山区三角路村 1、2、7、11、12、13、14、15、16、17 号地块	2010	P(2009)129 号	福星惠誉房地产有限责任公司	228,140	2,190
66	洪山区南湖村 K1、K2、K3 号地块	2010	P(2009)134 号	武汉林宇房地产开发有限公司	87,250	1,415
67	洪山区铁机村 K1 地块	2010	P(2009)135 号	武汉市铁机中润置业有限公司	224,800	1,848
68	汉阳区陶家岭村 A、B、C、D 地块	2010	P(2009)130 号	武汉市永利置业有限公司	91,600	931
69	汉阳区新新村 A、B、C 地块	2010	P(2009)133 号	武汉汉阳造地产开发有限公司	65,470	1,166
70	江岸区新荣村 K1 地块	2010	P(2009)136 号	武汉中森华置业有限公司	12,840	1,490
71	汉阳区龙阳村 A、B、C、D、E、F、H、J、K、L、Q 号地块	2010	P(2009)139 号	湖北人信房地产开发有限公司、武汉世纪龙阳置业有限公司	222,510	1,024
72	江岸区建设渠路与新湖渠路交汇处	2010	P(2009)116 号	武汉安居工程发展有限公司	110,000	1,805
73	武昌区秦园路以东	2010	P(2009)118 号	武汉九坤房地产集团有限公司	10,840	2,864

74	洪山区狮子山街珞狮南路	2010	P(2009)115 号	武汉紫菘房地产建筑集团股份有限公司	1,890	1,598
75	桥口区汉西新村	2010	P(2009)114 号	保利(武汉)房地产开发有限公司	85,400	4,150
76	汉阳区十里新村 151 号	2010	P(2009)119 号	武汉市京楚置业有限公司	11,910	2,280
77	江岸区万隆三路与正义路交叉口	2010	P(2009)117 号	武汉中鄂联房地产股份有限公司	7,360	2,357
78	江岸区新春村 A 包 P(2011)010 号地块	2011	P(2011)010 号	武汉城开房地产开发有限公司	200,000	3,063
79	珞狮南路与二环线交汇处地块	2011	P(2010)236 号	武汉招银物业有限公司	62,160	1,394
80	洪山区卓刀泉路 108 号地块	2011	P(2010)231 号	武汉凯乐宏图房地产有限公司	95,400	4,609
81	洪山区狮子山街壕沟地块	2011	P(2010)235 号	湖北广宏置业有限公司	63,890	1,600
82	汉阳区马鹦路地块	2011	P(2010)237 号	武汉枫星置业开发有限公司	49,860	3,971
83	江汉区航空路地块	2011	P(2010)098 号	武汉中弘航侧房地产开发有限公司	137,930	7,795
84	洪山区洪山乡洪山村 P(2010)209 号地块	2011	P(2010)209 号	南兴房地产(武汉)有限公司	55,500	4,820
85	江岸区塔子湖东路以西地块	2011	P(2010)233 号	武汉中鄂联房地产股份有限公司	18,000	3,170
86	武昌区武珞路 421 号 P(2011)001 号地块	2011	P(2011)001 号	丰泰置业有限公司	50,100	3,251
87	江汉区常青路与后襄河北路交汇处 C 地块	2011	P(2010)205 号	海马万利(武汉)房地产有限公司	71,200	6,034
88	青山区武东路 8 号 P(2010)208 号地块	2011	P(2010)208 号	武汉怡佳房地产开发有限公司	4,170	1,002
89	洪山区长江村 P(2010)210 号地块	2011	P(2010)210 号	武汉万科新里程房地产有限公司	58,000	1,360
90	江汉区青年路 59 号 P(2010)211 号地块	2011	P(2010)211 号	武汉怡景地产有限公司	122,680	8,591
91	江汉区常青路与后襄河北路交汇处 A 地块	2011	P(2010)204 号	武汉西北湖地产开发有限公司	46,000	8,778
92	洪山区和平村 A 包	2012	P(2011)255 号	武汉福星惠誉欢乐谷有限公司	131,500	1,960
93	洪山区和平村 B 包	2012	P(2011)256 号	武汉福星惠誉欢乐谷有限公司	103,700	1,960
94	洪山区青菱乡园艺场	2012	P(2011)259 号	湖北昕阳房地产开发有限公司	13,600	1,220
95	江岸区三金潭村	2012	P(2011)242 号	武汉世纪泓博房地产开发有限公司	64,100	1,843
96	硚口区汉西村	2012	P(2011)241 号	武汉市兴华房地产开发有限公司	120,300	2,098
97	洪山区和平村	2012	S(2011)006 号	武汉市洪荣物业发展有限公司	28,060	1,207
98	汉阳区汉江村 B 包	2012	P(2011)238 号	湖北汉江新世纪投资有限公司	136,300	1,824
99	洪山区珞瑜路 6 号	2012	P(2011)248 号	群光实业(武汉)有限公司	30,480	4,066
100	汉阳区汉江村 A 包	2012	P(2011)237 号	湖北汉江新世纪投资有限公司	35,000	1,968
101	洪山区珞狮南路与雄楚大街交汇处东北角	2012	P(2011)266 号	武汉南国置业股份有限公司	88,750	3,702
102	汉阳区鹦琴路与琴断口路交叉口西南角	2012	P(2011)218 号	武汉市大江房地产开发公司	17,600	2,605
103	武昌区沙湖大道与罗家港交汇处	2012	P(2011)211 号	武汉双马置业投资有限公司	11,300	3,077
104	汉阳区十里新村 154 号	2012	P(2011)217 号	武汉东港地产有限公司	9,200	2,014
105	汉阳区夹河路 107 号	2012	P(2011)214 号	武汉市雅苑房地产开发有限责任公司	30,200	2,432
106	硚口区常码头村	2012	P(2011)216 号	武汉硕实房地产开发有限公司	4,640	1,995
107	洪山区烽火村 B 包	2013	P(2012)276 号	武汉市烽火房地产开发有限公司	50,000	1,857
108	江岸区红桥村 A 包	2013	P(2012)259 号	福星惠誉	175,500	1,831
109	武昌区向阳村	2013	P(2012)274 号	武汉阳光嘉业有限公司	126,100	1,003
110	江岸区红桥村 B 包	2013	P(2012)260 号	福星惠誉	166,300	2,487
111	洪山区烽火村 D 包	2013	P(2012)278 号	武汉市烽火房地产开发有限公司	55,200	1,798

112	洪山区烽火村 F 包	2013	P(2012)280 号	武汉中博润发投资有限公司	24,900	1,895
113	江岸区红桥村 C 包	2013	P(2012)261 号	湖北福星惠誉金桥置业有限公司	58,500	1,618
114	洪山区烽火村 E 包	2013	P(2012)279 号	武汉市烽火房地产开发有限公司	34,300	1,860
115	洪山区烽火村 C 包	2013	P(2012)277 号	武汉中远鹏润投资咨询有限公司	46,100	1,813
116	洪山区烽火村 A 包	2013	P(2012)275 号	武汉常阳润力房地产开发有限公司	125,150	1,918
117	洪山区关山街小张村	2013	P(2012)234 号	武汉康恒房地产开发有限公司	35,400	2,960
118	硚口区长丰村 A 包	2014	P(2014)014 号	武汉园博园置业有限公司	159,270	1,682
119	硚口区长丰村 D 包	2014	P(2014)018 号	武汉名流时代置业有限公司	75,000	2,295
120	硚口区长丰村 B 包	2014	P(2014)015 号	名流置业武汉江北有限公司	65,170	1,888
121	硚口区罗家墩村下千校村湾	2014	P(2014)019 号	武汉古田联合置业有限公司	21,000	2,339
122	硚口区长丰村 C2 包	2014	P(2014)017 号	武汉美好锦程置业有限公司	77,550	2,254
123	硚口区长丰村 C1 包	2014	P(2014)016 号	名流置业武汉江北有限公司	160,090	2,224
124	汉阳区四新南路与梅林东路交叉口东北角	2014	P(2014)003 号	武汉华发置业有限公司	49,700	3,935
125	江岸区兴业路与百步亭路交叉口	2014	P(2014)004 号	武汉汉朴投资有限公司	24,010	2,565
126	汉阳区四新大道与连通港交叉口西北角	2014	P(2014)002 号	中铁大桥局集团有限公司	109,100	1,957
127	硚口区工农路与联工路交汇处	2014	P(2014)001 号	向　　继　　红	18,480	2,471
128	青山区工人村 2、3、4 村	2014	P(2013)233 号	武汉申智成置业有限公司	48,950	2,052
129	硚口区南泥湾大道以北	2014	P(2013)236 号	武汉九立置业有限公司	31,450	3,678
130	青山区工人村 2、3、4 村	2014	P(2013)235 号	武汉申智成置业有限公司	147,130	2,526
131	洪山区铁机村	2015	P(2015)016 号	湖北保利普提金置业有限公司	87,240	4,362
132	武昌区中北路	2015	P(2015)018 号	中铁十八局集团武汉房地产开发有限公司	19,100	2,178
133	硚口区古田二路与南泥湾大道交汇处	2015	P(2015)012 号	武汉海智房地产开发有限公司	124,800	4,288
134	汉阳区汉阳大道以北,五琴路以东	2015	P(2015)006 号	武汉市轨道交通建设有限公司	34,100	3,210
135	洪山区珞狮北路 61 号	2015	P(2015)001 号	湖北中信鑫鑫置业开发有限公司	28,000	8,144
136	汉阳区琴台大道以南,知音东路以东	2015	P(2015)005 号	武汉工控资源有限公司	4,700	2,592
137	江汉区姑嫂树村长港路	2015	P(2015)007 号	黄　　雪　　竹	17,900	3,418
138	青山区工业二路与冶金大道交汇处	2015	P(2015)002 号	恒大地产集团武汉有限公司	105,800	4,258
139	洪山区白沙洲四坦路特 1 号	2015	P(2014)169 号	武汉建工富强置业有限公司	13,930	2,363
140	洪山区板桥村 B 包	2016	P(2015)183 号	武汉东原睿丰投资有限公司	69,860	2,587
141	江岸区岱山村 A 包	2016	P(2015)184 号	武汉祥悦房地产开发有限公司	128,210	3,112
142	洪山区板桥村 A 包	2016	P(2015)182 号	武汉东原睿丰投资有限公司	45,110	2,588
143	江岸区岱山村 C 包	2016	P(2015)186 号	武汉祥悦房地产开发有限公司	105,760	3,185
144	汉阳区玫瑰园东路 2 号	2016	P(2015)166 号	武汉亘星资源有限公司	12,200	3,536
145	江岸区岱山村 B 包	2016	P(2015)185 号	武汉祥悦房地产开发有限公司	101,140	3,112
146	武汉经济技术开发区三环线与龙阳大道交汇处	2017	P(2016)11 号	远　　洋　　地　　产	753,500	9,327
147	归元寺北路以南,国博大道以北,鹦鹉大道以西,归元寺路以东的归元片 B 包	2017	Missing	中信泰富有限公司	992,000	8,457
148	江岸区二七沿江商务核心区北片,东至沿江大道,南至规划 206 号路,西至解放大道,北至规划 201 号路	2017	Missing	武汉市中联晟鸣置业有限公司	42,500	2,461
149	汉阳区三环线与汉阳大道交汇处附近	2017	Missing	武汉平华置业有限公司	326,000	8,101

150	江岸区二七沿江商务核心区南二片	2017	Missing	北京鑫景通达置业有限公司	286,428	19,095
151	江汉区青年路与雪松路交汇处	2017	Missing	上海复臻投资有限公司	801,000	15,184
152	东至上洞街,南至沿河大道,西至乡镇家电市场,北至汉正街	2017	Missing	上海复臻投资有限公司	500,000	10,555

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