

## Cause Analysis and Countermeasures of Urban Waterlogging

Zhaoyun Ding <sup>a</sup>, Huihui Li <sup>b</sup>

School of Tourism, Resources and Environment, Zaozhuang University, Zaozhuang,  
Shandong, 277160, China

<sup>a</sup>zhaoyund@uzz.edu.cn, <sup>b</sup>2695098525@qq.com

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*Abstract: At present, China is in the peak period of urbanization, population and wealth are constantly concentrated in the city, the urban area is becoming larger and larger, and urbanization along with the emergence of urban waterlogging. "Every rain will flood, and water will be paralyzed". Frequent urban waterlogging disasters not only affect the normal development of the economy and society, but also affect the work and living order of urban residents. How to address the problem of urban waterlogging has become an urgent research topic. This paper takes urban waterlogging problem as the research object and makes a profound study of the causes of urban waterlogging, the influence of urban waterlogging and the measures to solve urban waterlogging.*

*Keywords: urban waterlogging, Urbanization, City planning, Reason, Countermeasures and suggestions.*

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### 1. RESEARCH BACKGROUND

According to at 0:00 on November 1, 2010 as the standard point for the sixth national census, 34 provinces, autonomous regions and municipalities directly under the central government in mainland China and the population of a soldier in active military service, compared with the 2000 Fifth National Census in the urban population, the urban population increased by 207.14 million people, the rural population decreased by 133.24 million, the proportion of urban population has increased by 13.46%. Rapid urbanization has greatly promoted China's social progress and led to the continuous growth of China's economy.

However, the rapid expansion of urbanization and the rapid economic growth has also brought severe urban problems. Every summer there are many cities waterlogging in varying degrees. "Urban waterlogging" is the high frequency words in the rainy season in 2011. On June 23, a heavy rain let the city of the ancient flustered, a lot of swelling appeared in the city, part of the road has been paralyzed, so as this netizen called it as the new eight sights in Beijing, like "water airport", "subway waterfall", etc. These are also special attention of foreign media. Urban waterlogging refers to the phenomenon of waterlogging caused by heavy precipitation or continuous precipitation beyond the capacity of urban drainage. Urban waterlogging affects

not only the normal development of the economy and society, but also the damage to our personal and property safety. Therefore, it is imperative to solve the problem of waterlogging in cities.

## **2. RESEARCH MEANING**

One is through the case study and practice research, analyses the causes of the waterlogging in the city of China, summarize the experience and lessons, according to the different geographical position, for the different reasons, finally adopted measures are different, and put forward the corresponding improvement suggestions and solutions, so as to provide effective and reliable measures to solve the problem of city waterlogging;

The two is through the analysis of foreign successful management of city waterlogging case, based on the basic situation of our country to learn from experience, and formed a set of suitable for China's city waterlogging prevention measures, so as to reduce the emergence of city waterlogging;

The third is through the construction of some measures in flood engineering and non engineering, alleviate the city waterlogging, thereby reducing the loss.

## **3. ANALYSIS OF THE CAUSES OF URBAN WATERLOGGING**

Urban waterlogging is a systematic and comprehensive problem. From the point of view of system theory, every factor and factor associated with urban waterlogging is at the root of urban waterlogging. Taken into consideration, these factors and factors can be divided into 2 categories, one is natural, and the other is human.

### **3.1 Natural factors.**

The objective cause of waterlogging is heavy rainfall, and the range is focussed. Looking at the occurrence of urban waterlogging in China, it can be found that the occurrence of urban waterlogging in China has a solid season. Most of the city in our country by the monsoon climate impact of rain heat over the same period of the phenomenon, the strong rainfall season mostly concentrated between May and September, after heavy rainstorm or after long after the rainfall, the city waterlogging appeared; there are some differences between the north and the south, but roughly the same(Qiao, 2015). And today's global warming led to seasonal abnormal atmospheric flow, extreme rainfall occurred frequently, so many places have heavy rain(Qiao, 2015).

Due to the impact of topographic factors, the city which is situated on the mountain is low-lying and prone to waterlogging. And lie in the center of the basin and its surrounding water system, the size of the river flowing from around the basin center, the riverbed rise, can't drainage normally and causing waterlogging problems when the rainy season approaching(Hui et al., 2011). Taking Wuhan as an example, mainly plain terrain, with few low hills and hillock, and flat plain located around the Yangtze River and Hanjiang River and its tributaries and lakes on both sides. In When meet a heavy continuous rain, higher elevation of the upstream and downstream of the rain, the accumulation of water, due to the flat terrain, slow drainage, and

easy to generate urban flood disaster. In addition, the low point of the city, such as city overpass, underground tunnels, underground garage, underground market, because the location is very low, in case of heavy rain, and did not do the corresponding defense measures, not only will cause waterlogging, and the personal and property safety threat. In July 18, 2007, Ji'nan and its surrounding areas were subject to intense rainstorms, with precipitation exceeding the historical maximum since the meteorological record, and the maximum precipitation of 3 hours reached 180mm. The Ginza shopping mall, located beneath the Quancheng Square, has caused significant loss of life and property due to its low-lying terrain and poor drainage. At least 34 people have gone out of their life.

Taking Wuhan as an example, during the storm, the territory of Wuhan in the upper reaches of Hanjiang River to undertake precipitation and precipitation in the region, the river water level soared, in addition, Hanshui River Bend, since ancient times "is the Han song", and with the people, reclaiming land from lakes, Lake storage function can be decreased, which results in the not timely discharge of the river, thus increasing the possibility of city waterlogging.

With the acceleration of the urbanization process, the green land is gradually replaced by impervious cement ground and various construction facilities, and the rate of urban green space drops sharply. This is some other important factor that leads to urban waterlogging.

### **3.2 Humanistic factors.**

Urban heat island effect produces three conditions: (1) adequate water vapor supply;(2) the air flow up to over saturation; (3) enough water vapor condensation module (Liu, 2007). Among them, the first factor is mainly affected by the climate zone, while the second and third factors are more affected by human activities in the city. Large-scale urbanization will affect the movement of air flow, and air pollution will increase precipitation in the atmosphere, condensation of tuberculosis(Ye et al., 2010). Urban heat island effect helps to increase air convection in the city and increases the amount of water vapor in the air. With the increase in water vapor content, enough condensation and the air convection intensity, these three factors lead to the increase of storm intensity in urban interior(Chen et al., 2010).

With the rapid development of urban construction, urban green space is being replaced by hardened road and asphalt road, which seriously reduce the infiltration rate of rainwater. Generally, the runoff coefficient of green space is about 0.2, while that of cement pavement or asphalt road is about 0.9. If the rain runs into the hardened Road, only 10% of the water can penetrate underground. The remaining 90% will be required to drain drainage pipeline. Nonetheless, if it falls on the green, 80% of the rainwater can seep into the ground, and only 20% of the rainwater will be discharged from the drainage pipe(Hui et al., 2011). Rainwater is concentrated and discharged rapidly, which leads the increase of rainfall runoff, and accelerates the accumulation of rainwater, thus forming urban waterlogging.

In the fast city construction, City builders often pay more attention to the formation of the city skyline, creating an visual sense which is visual, surface, so as to improve the overall image of the city, but often ignored the synchronous update of underground drainage system. City Construction and city function adjustment, resulting in the catchment area of the existing

drainage increases; in addition, part of the city drainage system which is not included in the early city planning, along with the regional development and construction, needs to bring into the drainage system of the nearest city, this will increase the catchment area of the drainage system and the drainage system load, appear in accordance with the original drainage function is inadequate, resulting in city regional waterlogging(Ju et al., 2011).

City rainwater consumption mainly through two channels: One is the city's internal storage water, such as pond water consumptive flood directly. The two are the City Unicom River and lake system to regulate floor. Rivers, lakes, depressions, ditches and so on are natural "water storage containers" which have the function of regulating rainwater, conserving seepage and regulating runoff. During the construction of the city, due to lack of realization, anxious, did not make scientific planning and demonstration, blindly leveling depressions and diverting lake, Human destruction has resulted in a sharp reduction in the capacity of lakes and other natural water storage containers, and the ability to regulate rainwater has been reduced(Huang, 2012) . For the convenience, the citizen dumped garbage into the nearest drainage network, causing the man-made blockage of the drainage network. Numerous old cities in China are rainwater and sewage drainage system, waste water containing a large number of leaves, fruit leather, animal fur, oil mixture of these substances and emissions, after long-term accumulation, will form a very thick, fermentation expansion material.

#### **4. INSPIRATION OF SUCCESSFUL PREVENTION OF WATERLOGGING IN SOME CITIES AT HOME AND ABROAD**

##### **4.1 The Situation of some domestic cities.**

In Jiangxi Ganzhou City, a drainage system was established in Song Dynasty called the longevity ditch, made the thousand-year-old city which also suffered crippling rains little waterlogging. The reporter visited a drainage which is located in the longevity ditch Gong river mouth, there is a water outlet valve, its working principle is that when the city waterlogging occurs, the water will automatically open the valve water to Gong Jiang, when Gong Jiang water exceed the valve, the valve will be automatic shutdown to prevent water of the Gong River from flowing backward to the city(Ju et al., 2011). As shown in figure 1.

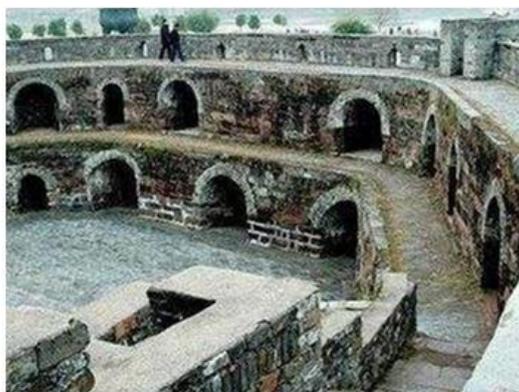


Figure 1. Jiangxi Ganzhou Fushou Ditch

The adequate drainage system in Qingdao is due in part to German writing more than 100 years ago. In order to improve the city's drainage system, at the same time when the Germans in the laying of drainage pipes, they also make full use of the undulating topography of the Qingdao which is sea on three sides, the East West High low, according to the natural slope in the vicinity of Qianhai ditch ditch and culvert construction, both sides used to ditch stone reinforcement, in order to better guide the flow of rainwater. Through the combination of ground and underground ditch culvert construction, city drainage system gradually perfected. In the next place, the German design covers a sewer connection iron basket, which can cut many solid debris, such as leaves, plastic bags, sludge, stone etc. As a result these solids could not be rushed into the sewer to jamt(Hui et al., 2011).

#### **4.2 Successful practices of the abroad.**

After the 1993 floods, the United States starts building the water conservancy facilities, including building underground tunnel water system, roof water and recharge system, which not only can irrigate the farmland utilization by using the rainwater, but also can prevent flooding. Not merely in engineering support, but also formulated a series of relevant laws to support(Cui, 2017).

Multifunctional reservoir in Japan in addition to cope with the flood disaster, more emphasize on the dry season or no heavy rain, the reservoir of all or part of the city landscape, play green space, parks, parking lot, playground and public leisure gatherings and entertainment field functions such as normal(Deng, 2014) . The constructed wetland beside the reservoir that is in the Japanese city of Doliunto is a good practice case. The water in the reservoir leads through to the wetland, and the substance such as the vegetation in wetlands adsorbed, precipitated and purified the pollutants in the water. The wetland is adequately integrated with the surrounding environment, and while creating a beautiful landscape, the water quality in the cistern is improved with the help of natural forces, reflecting its ecological price(Xing et al., 2014). As shown in figure 2.



Figure 2. Constructed Wetlands near the Reservoir in Japan

Sewer Museum in Paris, France, is not uncommon in appearance, but it is an ordinary manhole cover, but it opened as if it had entered an underground palace. There are about 26 thousand

sewer covers, more than 6000 underground cisterns, and more than 1300 skilled maintenance workers. It is a spacious underground reservoir project and a developed, complex, flexible and flexible operation mechanism. As shown in figure 3.



Figure 3. ancient Paris drainage

Summing up the above, whether it is the Song Dynasty longevity ditch construction, or the sewer in some western countries can be regarded as, the cause of the city does not appear waterlogging in thousands of years, mainly with scientific nature and advanced consciousness. We should get the understanding from the lesson, so as to resume the concept of urban planning and construction and strengthen public management and emergency mechanism of the city.

## **5. SOLUTIONS TO WATERLOGGING IN CITIES**

### **5.1 Restore the functions of rivers and lakes in the city.**

The biggest function of rivers, lakes, depressions, and canals is tantamount to contain water, regulate the climate, and decrease the heat of the city, thereby easing urban heat island effect.

### **5.2 Increase green space.**

When the rain falls on the green land, the 80% of the rain water penetrates into the ground and only 20% of the rainwater are discharged by the drainage pipe. So it not only stores water, but also narrows the load of the drainage pipe. The same rainfall, if it can be kept in natural grassland, shrubs and wetlands, can prolong the time of its confluence and increase the amount of infiltration, thus reducing the amount of water accumulated in a short time(Hui et al., 2011).

### **5.3 Build sunken green spaces.**

The sunken green space is equivalent to a green rain infiltration system, and the other surrounding rainwater flows naturally through gravity, slowing the flow speed under the influence of vegetation. It holds the function of guiding rainwater runoff, retaining and promoting rainwater infiltration (Deng et al., 2014).

### **5.4 Reduce hardening ground and build a new sponge City.**

With the rapid development of city construction, the muddy path already replaced by asphalt, as a result of the hardening road made the water retention time shortening, rainwater is

unwavering focus on emissions, cause rainwater runoff increased. Therefore, in urban planning, permeable pavement, green roof, rain garden, sunken green space, pocket park and so on should be used to build a sponge city(Lu, 2015, Wen,2017). There are three aspects of the connotation of sponge city construction: First, from the perspective of resource utilization, sponge city construction should follow the city water resources characteristics and the buildings of laws of nature, in accordance with the building roof - green - hardening roads -rain district -rain city river five one-piece drainage system to protect the rain in the city of circulation, make urban rainfall can be system of collection, storage, purification and utilization; Second, from the analysis of city flood control of city building requirements can coexist with the harmonious system of the city can better prevention, response of city flood, to reduce disaster losses; Third, from the point of view of ecological environment protection, it calls for the harmonious development of urban construction and nature, and reduces the ecological risk of urban construction(Yi, 2017). Thus, sponge city construction is the eternal theme of the indispensable domestic and foreign urbanization and the history of the city group progress, it is the only way which must be passed our city construction development strategy and the sustainable development of resources. Construct a new sponge City, both to decrease urban waterlogging, and conservation of water, landscaping, protection of the environment.

#### **5.5 Construction of urban drainage pipe network information system.**

First, we should carry out a comprehensive investigation to the urban drainage network, to find out the urban drainage pipe network structure, quantity, distribution, construction age, construction standards, drainage capacity and other conditions, and established a detailed database of drainage network. The two is to learn from foreign experience that is the construction of drainage pipe network system based on GIS system, using modern GIS technology, computer technology, network technology, sensor technology and other construction of drainage pipe network information system for real-time monitoring and comprehensive analysis, forecast, information release, pipe repair and macro decision support service(Huang, 2012).

#### **5.6 Strengthen the civilized drainage propaganda education and raise citizens' awareness of environmental protection.**

To solve the drainage problem, we must solve the problem from the perspective of the whole people. Although the urban environment is very crowded, but if we could be specific to each district, everyone, it will be simple and easy. Start with me, start with a little bit, grow some trees, plant some grass, make some flowers, see the green suture, you can also make the highest floor greening, vertical greening. Strengthen the source of rainwater and promote green building and ecological community (Gong, 2015).

#### **5.7 Urban planning should be ahead of consciousness.**

With the rapid progress of the city, surface buildings emerge in endlessly, while the underground drainage facilities are chaotic, complete surface cities lack sound drainage facilities. In addition, due to the lack of vision of city planners, the river and the lake, which are originally used to drain away the water, are surrounded by the expansion of the city, turning into a ditch sewer,

weakening its drainage function. Therefore, before urban construction, long-term planning should be made so that underground drainage facilities can be fully adapted to the development of urban construction on the surface.

### **5.8 Perfect urban flood emergency mechanisms.**

Improve the municipal flood emergency mechanism, should perform the following work: First, draw up urban rainstorm flood risk map. Using a variety of ways to disclose the flood risk map to the whole society, so that each citizen can understand the flood risk, and raise the awareness of the individual to actively cope with flood risk and flood control and disaster reduction; Second, draw up emergency plans for urban drainage. According to the applicable regulations of the state on urban flood control and urban drainage, the emergency plans for municipal drainage shall be compiled scientifically, and the demonstration and exercises of the plans, and the daily emergency preparation and prevention of drainage shall be prepared. Ensure that urban drainage emergency plan can be effectively implemented, thereby decreasing the loss of urban waterlogging caused by(Huang, 2012).

## **6. SUMMARY**

At present, China's urbanization rate has reached 53.75%, in the next few decades, China's urbanization process will continue to maintain a high speed development trend, the size of larger and medium-sized cities and small towns will need to be further expanded. This study shows that the main reason of city waterlogging is not entirely because of natural disasters, largely caused by unreasonable behavior of city development, city development can not be too much emphasis on economic benefits while ignoring the social and environmental benefits, not too much emphasis on immediate interests while ignoring long-term interests, at the expense of the environment, blind development and construction for short-term economic benefits is not sustainable in the long run, is bound by the law of nature of punishment.

In the new period and a new situation, urban development should be more scientific and comprehensive. Only through systematic and comprehensive treatment of problems encountered in urban development can we assure that cities can develop better in the future (Su, 2015).

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