Feasibility of rainwater utilization of Handan City

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Abstract: Along with the rapid development of urbanization, the focus of work is the urban rainwater utilization as urban impervious area increased as well as shortage of water resources. This article unified water resources using present situation of Handan and analyzed the technology and the economical feasibility carried on the rainwate resources utilization in this area and further proposed that use the key measure in order to sped up the urban rainwater. The practice proves that it can alleviate the city water scarcity of crisis effectively, reduce the rainwater disaster, improve water environment through the urban rainwater resources utilization. It has the profound significance in guaranting the urban water resources of the sustainable utilization.

Key words:- Rainwater Utilization; Handan City; Feasibility Analysis; Major Initiatives; The Prospects of Development

1 Introduction

China's water is rich in resources and annual rainfall up to 6.2 trillion m$^3$. The total fresh water resources is 2.8 trillion m$^3$ that it ranked sixth in the world. But our country's per capita of water resources are only 2300 m$^3$, only the world average of 1 / 4. It is the poorest countries of the world's water resources per capita. In addition to water resources insufficient, there are still serious problems in uneven about country's water resources. The drought and water shortage become a major natural disaster, especially in North of China[1].

Along with our country urbanization advancement's quickening and the population gathers highly, the water resources demand increases day by day; Simultaneously the massive constructions and path causes the city water-proof area of floor swift growth. Therefore, the coefficient of run increases and rain magnanimity increased that it aggravated the urban burden of urban drainage and river flood, causing frequent flooding around under the same rainfall condition.

The aspect is the water shortage of urban, the urban ground water supplies serious insufficient, the funnel area of ultra picks be unceasingly deep and broad. On the other hand, the rain water is discharged the city by the pepole using huge rain water draindown system grown day by day, the massive rain waters drain in vain. Urban rainwater utilization is systems engineering that aims at the rain water runoff or the flood produced in the flood season, through the mechanical control measure and the non-mechanical control measure and adopt the corresponding collection measures includer gathering, infiltrating, adjusting and so on. To achieve full utilization of resources, improve ecological environment, reduce the efflux of runoff and the pressure on the purpose of the regional flood control[2]. Because it Lack guiding principle and the system knew to the comprehensive utilization of rainwater in majority of cities. Meanwhile, the don’t relate the water
resources and the urban ecology. Therefore, it becomes particularly important that how using the rainwater resources effectively and safely.

2 Water Resources of Handan

Handan city is located in the east of Taihang Mountains and south of Hebei province. The north latitude is from 36°04′ to 37°01′ and east longitude is from 113°28′ to 115°28′ that is a warm temperate semi-humid and semi-arid continental monsoon climate. It has characteristics that spring is arid multi-winds, summer burning hot and rain, autumn clear sky and fresh air, winter cold few snow. The whole city multi-annual mean precipitation is 548.9mm (1956~2007 series) and the total quantity is 6,613 billion m$^3$. This is the chief feature that the precipitation space and time distribution uneven and the year border change disparate. The annual precipitation including 70~80% concentrate in June to September. It mainly concentrates in late July and early August. The multi-annual mean water resources (fresh water resource) quantity is 1,671 billion m$^3$. The average per person water resources possessive amount is about 190.8 m$^3$ (according to 2007 population computation), approximately for the national mean value 1/12 that is lower than the international stipulation by far extreme water scarcity area average amount per capita 500 m$^3$.

Handan has the serious water scarcity problem at the same time, on the other hand has the water resources the waste phenomenon. In recent years, the urbanization advancement of Handan speeds up day by day, the urban water-proof area swift growth causes the coefficient of run to increase. Because lacks the research to urban rain water collection and the comprehensive utilization. It don’t plan design and the project facility has not formed the idea that the collection of urban rain, so the natural rainfall has been not use, not only brings the pressure for the urban flood prevention, also increased the drainage facility expense. Therefore, carries on the feasibility analysis to rainwater utilization of Handan is not only advantageous in saves the water resources but also improves the ecological environment, a effective action to construct the ecology feasibility city.

3 Feasibility of rainwater utilization of Handan

3.1 Resources feasible

(1) Estimate the amount of rainwater resources

The whole city average precipitation is 462.8 mm in 2007. The rainfall catchment area mainly is the building roofing, the path and the green space area. According to the rainfall amount formula$^{[4]}$:

$$Re = \psi \times A \times Hn$$

In the formula:

$\psi$ — runoff coefficient

$A$ — catchment area (m$^2$)

$Hn$ — annual precipitation (mm).

The Handan urban district construction, the path, the green space occupying land area situation and the runoff coefficient including Table 1

<table>
<thead>
<tr>
<th>Name</th>
<th>Area /km$^2$</th>
<th>Occupying land area percentage %</th>
<th>Runoff coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>49.72</td>
<td>46</td>
<td>0.75</td>
</tr>
<tr>
<td>Road surface</td>
<td>19.45</td>
<td>18</td>
<td>0.75</td>
</tr>
<tr>
<td>Green space</td>
<td>38.91</td>
<td>36</td>
<td>0.15</td>
</tr>
</tbody>
</table>
City rain water resources total quantity (Re):

①annual mean runoff amount of construction object: Re₁ = 17.25781 million m³;

②annual mean runoff amount of path: Re₂ = 6.751095 million m³;

③annual mean runoff amount of green space: Re₃ = 2.701132 million m³;

sum total Re = 26.71004 million m³.

(2) Estimates the amount of available water resources

In the formula:

\[ \alpha — \text{season baffling coefficient (Handan takes =0.65)}; \]

\[ \beta — \text{abandon coefficient for the initial period}. \]

the computation obtains the roofing rain water availability: \( Q₁ = 9.759292 \) million m³; path rain water availability: \( Q₂ = 3.817735 \) million m³; green space rain water availability: \( Q₃ = 1.527490 \) million m³; the total rainwater quantity availability: \( Q = Q₁ + Q₂ + Q₃ = 15.110170 \) million m³. It is obvious that Handan's annual mean rainwater availability is quite considerable: 15.110170 million m³. After near 3 year development and house development, Handan's area nearly increased 1/2, particularly path's area increased much.

3.2 Technically feasible

Our country's urban rainwater utilization research and application began in the 1980s, developed in the 90s. At present, many cities have been carrying out the research about collection and rainwater utilization. Modern urban rainwater utilization is a new multi-objective integrated technology. It be mainly divided in rainwater harvesting and use of rainwater infiltration and rainwater comprehensive utilization. These domestic and foreign has the rich experience and the mature technology.

(1) Rainwater harvesting and utilization

The rainwater harvesting mainly collect the rainwater of the roof, the garden, the road surface, the square and so on. After the collection, through facility storage and rain water storage pit so on, enters the reservoir after handle properly. Used in the family, public and industrial areas of non-potable water, such as green space irrigation, toilet flushing, cooling cycle, car washing, landscape water, spraying the streets and other sectors. This approach don't enable the effective rainwater utilization and reduce water emissions, but also increase the available water resources to alleviate the current water shortage situation in the city, is an effective way to cut expenditure.

(2) The utilization of rainwater infiltration

The rainwater infiltration is also called the indirect use. It mainly use the permeable surface layer material paving ground and increase the facility of infiltrates to carry on the infiltration. The permeable paving ground is that make the rainwater quickly infiltrate and not water or the few water on the surface under the flood situation. It usually made up by the paving surface layer, the breaker strip and the basic. Permeable ground usually paving in garden, square, ike path and small mobile traffic lane of plot traffic flow magnitude. The facility of increases
(1) Urban rainwater utilization project can reduce the burden of municipal administration draining wastewater pipe and the fund that construct large-scale sewage treatment plant and the collection sewer line and the extension facility.

Ground rainwater nearby be collectea and rechargee the underground, not only may reduce the sewage overflow at rainy season, improve the water body environment, but also reduce the burden of sewage factory, enhance the urban processing effection of ewage factory. 

(3) Good prospects for the industry. Urban rainwater utilization is an emerging industry that can form the new economic growth point. This industry can play the positive role in reducing government finance disbursement, promoting economic growth, buying in employment aspects and so on.

4 Major initiatives to strengthen the city rainwater utilization

Urban rainwater utilization launches the deep research at the same time, also has a series of problems. In order to guarantee the urban rainwater utilization project smooth implementation, we should take positively the following measure.

4.1 Strengthens the legislation work of rainwater utilization, perfect laws and regulations system construction

It is late that the research of urban Rainwater Utilization engineering in our country, lacks the necessary policy and the laws, so its research and the promotion lacks the safeguard. Therefore we must evelop facilities construction and management of rainwater and the corresponding laws and regulations under local conditions. We must require of the new district that it have to be involved in rainwater utilization facilities, make gradually rainwater utilization into the orbit of legalization.
and standardization.

4.2 Strengthens the policy guidance and increases the support dynamics of fund

Rainwater utilization is the environmental protection industry. But, the major part fund self-provides for the Development organization since financial assistance is limited given by the Government. So it brings certain difficulty for the rain Hong use's impetus and the development. Therefore, we should make full use of economic leverage, through measures such as stormwater permit system, to ensure the implementation of rainwater utilization in cities. Meanwhile, the Government should set up special funds to support the development of rainwater utilization industry. Through each kind of preferential policy and benefit mechanism reassignment enthusiasm of developer and institutions.

4.3 Strengthens the global administration

Urban rainwater utilization belongs to the water supplies development and the management category. It involves to questions including meteorology, geology, water conservation, urban construction and so on. The departments including water conservation, urban construction, geology and so on should coordinate cooperate, strengthen management, formulate the corresponding technical standard and the standard according to local conditions when concrete implementation, thus popular urban rainwater. In order to ensure the sustainable development of rainwater utilization, we must establish the enabling organization, be responsible for the coordination and management and the project's construction management and supervision.

4.4 Strengthens scientific research on rainwater utilization

The rainwater utilization technology has been developed into the standardization, industrialization phase, and gradually integrated, comprehensive direction, while China is still in research stage[9]. We should train a group of professional technicians, learn mature foreign technology and management experience and technical innovation. Finally we explore a sustainable development of urban rainwater utilization of the road adapting to our country.

4.5 Increases propaganda intensity rainwater

Because the price of water low in China, the people save water consciousness to be weak and lacks the related propaganda intensity, so the public lacks to the understanding to rainwater utilization environment, the ecology and the economic efficiency. Therefore, we should popularize the related knowledge, transfer public idea, enhance enthusiasm which the populace participation and promot water-preservation society's construction through each kind of channel.

5 The prospects of development

Increasingly scarce water resources in China, develop rainwater utilization is undoubtedly an important and the broad channel. Has not caused the precious resources which people excessively take seriously to rainwater long term, not only causes the urban rainwater disaster's source, also solves our country city water scarcity question's capital stock. Although rainwater utilization just started in China, rainwater utilization is ultimately along with environmental consciousness's enhancement. Urban rainwater utilization will everywhere, not only make it with urban construction, water resources optimization, effective integrated consideration of ecological construction, but also put the water catchment, storage, treatment, reuse, infiltration
underground drainage and so on into the city construction and urban planning\textsuperscript{[10]}. Not only may effectively alleviate the water resources crisis through a series of measures, increase the ground water, the improve cological environment, reduce and slow down the rain water displacement as well as decrease questions of urban rainwater disaster, but also positively promote the urban rainwater utilization and the management advancement, cause it to become a whole harmonious project that collect economic efficiency, the social efficiency and the ecological benefit.

Reference:
[4] Weiqing Li, Yanli Li, Analysis and Exploration to Rainwater Utilization in Henan Province [A], Modern Agricultural Science and Technology, 009, 05