Haiqiao TAN **G 19**
China University of Mining and Technology, 221008 Xuzhou, China

DECENTRALIZED MANAGEMENT OF URBAN STORM WATER - A CASE STUDY IN XUZHOU

Abstract
From the urban hydrological viewpoint, this paper analyses the essential cause of urban storm water and deals with the necessity, feasibility and concrete measurements aiming at the back of rain water in urban areas to the natural hydrological cycle. Based on the data collected in a studying area in Xuzhou of the project funded by National Natural Science Foundation, some concrete recommendations for the decentralized management of urban storm water in Xuzhou are proposed.
Keywords: *Urban; Storm water; Infiltration; Drainage; Management*

1. Introduction

Since June this year, even in September, there have been more and more reports about the extremely heavy rain in China. Some sayings, like "Let's go to Wuhan to see the 'beach'", "To Beijing to see the 'waterfall'" have become popular on internet. To jeer at these avoidable phenomena in the rain season, so called "new 7 famous sceneries in Beijing" were also coined and spread like wildfire. According to media reports, 5 heavy rainfalls occurred in Wuhan, a metropolis in middle China one after another, from June 9 to 24. The average rainfall amount in the city reached 417.7mm. Observations showed that in about 30 hours (from 8 o'clock on June 17 to 17 o'clock on June 18) 196 mm rainfall poured down in Hankou district of Wuhan, 134 mm in Hanyang District and 143 mm in Wuchang District. In Huangpi city near Wuhan, the precipitation was even 243 m. As a matter of fact, with rapid urbanization and industrialization, especially in the developing countries like China, extremely heavy rains have become common phenomena around the whole world, and not just staring from this summer. In August 2002 water level of Elbe reached 8.9m which broke the 100-year-record. Normally the mean precipitation in June in UK is about 140mm. In June 2007 the same amount rain poured down in just 24 hours in some area in UK. Heavy floods spread in most regions in UK in 2007. Some scholar even compared the risk of 2007 flood in UK with the terror threat[1]. On August 18, 2011 a rainfall poured in Dorset, South UK, with one-month-precipitation in just in 6 hours. Nowadays the same question is concerned by both the officials who are responsible to the water affair administration and normal dweller in a city：What happened in our city? Why do more and more rainfall turn to floods？Where could we find the way out? This paper will analyze the essential cause of urban storm water from the urban hydrological viewpoint, and propose some recommendations for the urban storm water management by looking into its root cause and surface phenomena.

Urban storm water: drainage or management

It is easy to find that there is an almost fixed mode of thinking in the reports about urban storm water in China: the linkage between urban flood and capacity of a city's drainage system. It seems that there would be no flood problem in a city if its drainage capacity could be strong enough. According to the recent reports about urban flood problem in China, it is the drainage system in London, Paris or others that keep the cities almost no rain water accumulation. Unfortunately it is not true. As pointed in a paper published in

[1] http://www.guardian.co.uk/uk/2007/dec/17/weather.world

2006 (Tan, 2006), rainfall is a natural process of hydrological cycle in urban area. No rain water should simply be drained. What we should think over is the reason why there is no more place in a city used for the rain water retention and infiltration, why we could endless extract much more ground water but remain no way for ground water recharge.

It is worth to point out that like air and soil, precipitation, including rainfall, is an indispensible part of life supporting system on the Earth, on which all living beings depend. In the urban area with concentrated human activities the demand on water resource is increasing rapidly. Indeed, human's activities have obstructed almost all the natural ways for rain water retention, infiltration and discharge. To some extent, occurrence of extremely heavy rainfalls should be seen as a natural response of Earth system to human's disturbance, when not yet destruction. According to William K. M. Lau of NASA, more than 300 wildfires in Russia and heavy flood in Pakistan were caused by one abnormal weather system happened in 2010 (Lau, W. K. M. et .al., 2011). So it is not a wise decision to try every possible method for draining away all the rain water from the urban area. It is not because of human's demand on water resource, but because of the necessity to recover the natural way in the urban area for rainwater retention, infiltration and discharge, so that the natural hydrological cycle could be compensated and recovered as much as possible. As well known, what we are lacking in treatment of the urban storm water is not the technology, but a smart management. To realize such targets, many efforts haven made and many publications related to this issue have been delivered by scholars at different levels. Among them are "Urban Stormwater Management in Developing Countries" (Parkinson, J. et. al, 2005), "Guidelines for Urban Stormwater Management" (Government of South Australia, 2002). Principle and methods for construction of ASR (Aquifer Storage and Recovery) are described in the "Guideline" mentioned above. Undoubtedly a drainage system is absolutely necessary for any city. But it should not be used for draining rain water, unless in emergency. As an emergency measurement, rain water rain drainage should, and could not serve as the essential solution for the urban storm water problem. A lot of examples in China illustrate that the drainage-centred management of urban rain water has entered an endless vicious circle: the more the built areas, the more the sealed surface, and the more urban storm water problem. As a result the construction of urban drainage system always falls behind the expansion of built areas. Nevertheless man would rather believe the capacity of the drainage system than the compensation and discovery of the infiltration conditions in urban areas. Media reports about the linkage between urban expansion and rainwater drainage system mirror such a dilemma situation in China.

Solution: Decentralized management

London drainage system built in 1859 has often been mentioned in China recently. No man doubles that this system is a miracle in architectural engineering. But as designed by J. Bazalgette its basic function was a sewer system that should solve the "Big Stink" in Thames River. Different from this famous system, what we are facing nowadays is the disappearance of surface water bodies, together with the increasing demand on water resource in urban areas. In most urban areas there is no more original way for rain water retention, infiltration and ground water recharge. In this case, increase of drainage capacity of a city drainage system serves as the same as drinking poison to quench thirst.

Despite of the urban storm water problem the process of urbanization did not stop in China. Data show that the urbanization level in 1978 was 18%, 30% in 1995, 39% in 2002, and 46.59% in 2009. That means not only the increase of urban population, the increase of the demand on water resource, but also the increase of the sealed surface. With the further deterioration of infiltration conditions in urban areas, urban storm water

problem will certainly become worsen. Drainage-centred urban storm water management mode could only strength the tendency of "compensation deficit" of ground water。
Based on the research results of the project supported by NSF (China National Foundation of Natural Science), decentralized management of urban storm water could be used as an effective solution.
As elaborated in the second UN World Water Development Report published in 2006. "It is essential to understand the pathways of water as it arrives in the form of Precipitation and migrates through the cycle components", "The water crisis is thus increasingly about how we, as individuals, and as part of a collective society, govern the access to and control over water resources and their benefits." This paper focuses on the decentralized mode for urban storm water management. "Decentralized" means herewith not the decentralized administrative or decentralized plan, but the decentralized water governance according to the natural pathway.
Firstly, "back to nature" of the urban storm water should be targeted for the decentralized management. Urban storm water should neither be seen as "calamity" nor as a usable resource. Rain water should return to its hydrological cycle along its natural pathways for retention, infiltration and recharge.
Secondly, "appropriate infrastructure" should be planned and constructed for urban storm water to ensure its pathways mentioned above. Such infrastructure, like ditch, pond, well, and so on should be designed in the overall plan stage, and constructed parallel to the urban expansion. So that the ground water deficit could be gradually compensated. Emergency flood wall should also be covered in the plan.
Thirdly, infiltration index could be used as the basic technical indicator for infrastructure design in urban areas. Decrease of infiltration index could effectively reduce the runoff in urban areas. Available data show that even 10% of the built area is large enough for decrease of the surface infiltration index in the built area with about 90% sealed surface, when well designed and constructed.
Fourthly, "patch by patch" is the concrete method for decentralized management. A patch could be a campus, a green land, a community, or a villa. In each patch we can find a small piece of land for rain water retention and filtration, including roof greening. In most situations, no complicated technique is needed. As shown in Table 1, we can effectively reduce the runoff and then delay the water accumulation by using different covering material.

Table 1 ：Influences of different roof material on runoff

Roof	Runoff (mm)	Runoff (%)
Standard	866	81
5cm pebble	633	77
5cm green layer	409	50
10cm green layer	369	45
15cm green layer	329	40

2. A case study: recommendations for urban storm water management in Xuzhou

Xuzhou has a monsoon-influenced humid subtropical climate. The annual total precipitation is about 830 mm. 56% of the precipitation falls down in the rain season, from May to September. With the expanding of urbanization, more and more impermeable materials are used for roads, buildings, and other constructs. In the rain season, 90% of the rainfalls in the built areas, together with waste water, flow into the overloaded drainage system. According to the data collected in the study area of the NSF project, zero runoff could be realized even when the daily rainfall exceeded 100mm, and monthly rainfall reached 391.7mm. Calculation shows that rain water of about 0.75 million cubic meters could be collected in an area of one km2 by using such infrastructure, in the case of an annual precipitation of 830 mm and infiltration index of 0.9. Calculation based on a conception model of Tianjin Meijiang Community also shows that the controllable rain water infrastructure could be used to effectively regulate the infiltration index and then the surface runoff. From figure 1 we can see the delay effect of decentralized rain water infrastructure on the surface runoff in urban areas.

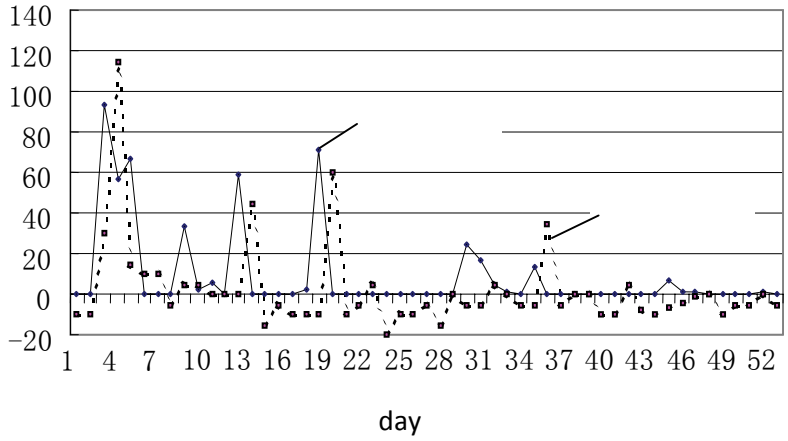

Figure 1 - Delay effect of an infrastructure on rain water accumulation.

solid line: precipitation record (mm); dotted line: water level in retention pond (mm)

Based on the research results from the study area, some concrete recommendations could be proposed for the urban storm water management in Xuzhou city:

An overall plan for urban storm water management is needed for the city Xuzhou. It should cover the main policy, regulation, limits of patch imposed for rain water infrastructure, and sections for emergency flood wall;

Investigating the distribution of potential areas for storm water retention and infiltration;

Reducing the area of the impermeable surface maximally;

Performing more demo-project for urban storm water management before realize the overall plan.

Conclusions

Based on the discussion above, some conclusions can be drawn as follows:
The key factor of urban storm water is the worsening of the infiltration condition in urban areas due to urbanization. So the first task of urban storm water management is to reduce the ground water compensation deficit;
Decentralized management of urban storm water is the effective method for regulating the infiltration condition, deceasing the reliance on urban drainage system, and effectively controlling the surface runoff;
Capacity of an urban rain water management system has also its limits. To face the extreme climate, rain water well and emergency wall should also be integrated in the overall plan.

References:

Lau, W. K. M. and Kim, Kyu-Myong: *The 2010 Pakistan Flood and Russian Heat Wave: Teleconnection of Hydrometeorologic Extremes.* Journal of Hydrometeorology, e-View doi: 10.1175/JHM-D-11-016.1, *2011*

Government of South Australi：*Guidelines for Urban Stormwater Management*. 2002

Parkinson, J. and Mark, O. Urban *Stormwater Management In Developing Countries*. IWA Publishing, 2005

Tan H. Q.：*Nature-oriented Mode for Rainwater Management in Urban Area, Journal of China University of Mining and Technology*, Vol.9, No.2, 144-148, 1999

Tan Haiqiao：*The way back to nature for urban rain water*.《Science News》, B3, Sept. 25. (in Chinese)