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Beijing storm of July 21, 2012: Observations and reflections

Ke Wang[1], Lu Wang, Yi-Ming Wei, Mao-Sheng Ye

1. Introduction to the extreme rainstorms

During a twenty-hour period from July 21 to 22, 2012, the heaviest rain in six decades lashed Beijing, the capital of China. The rain started at noon on July 21 and ended on the morning of July 22. The city received around 170 millimeter (mm) (6.7 inches) of rain while the township received 215 mm (8.5 inches) of rain on average. Areas with precipitation above 100 mm (3.9 inches) of rain accounted for 86% of the whole are of the city. Precipitation in the suburban districts of Fangshan, Pinggu and Shunyi reached over 200 mm (7.8 inches), in particular, Fangshan District received 460 mm (18.1 inches) of rain, which was the heaviest recorded during this event in Beijing; and Shijingshan District was second highest with 328 mm (12.9 inches) of rain. Apart from the extreme rainstorms, some suburban areas suffered also from floods and even tornadoes. The Juma River flooded its banks and reached a maximum flow rate of 2,500 cubic meters per second (m^3/s) (88,250 cubic feet per second) and the Beiyunhe River reached a maximum flow rate of 1,700 m^3/s (60,010 cubic feet per second).

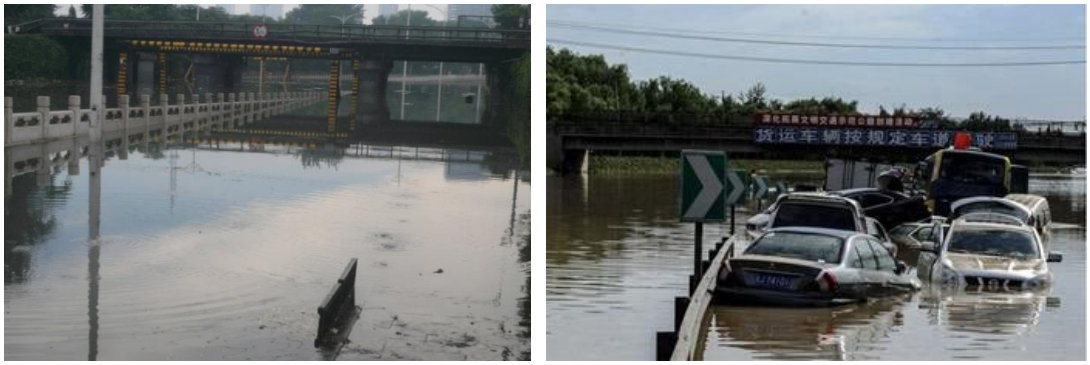

Figure 1 Automobiles were immersed in the low-lying areas due to water nearly overflowing the bridges (Sources: Sina, Hexun)

Beijing has suffered great damages and losses from the biggest downpour in 61 years, of which losses were estimated to exceed CNY ￥11.6 billion (US $1.86 billion). An area of about 16,000 square kilometers and more than 1.6 million people were affected by the flood. Infrastructure, like roads, bridges broke down, in total, about 63 main roads were flooded, and nearly twenty thousand automobiles were immersed in the city flood and were damaged (Fig.1). Moreover, thousands of acres of crops were submerged, to be exact, 8,000 acres of maize and vegetable plots and over 13,000 acres of fruit trees were seriously flooded. In

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addition to this, 56,933 people were evacuated in Beijing during the rainstorm and flood, while the floodwaters killed 79 people (71 of them were identified), destroying at least 8,200 houses. Deaths toll and causes of deaths in different districts of Beijing are listed in Table 1.

Table 1 Deaths toll and causes of deaths in different districts

District	Deaths toll	Causes
Fangshan Dist.	46	Drowning/ Physical trauma/Electrocution/ Mudslide/ On duty
Chaoyang Dist.	6	Drowning/ Electrocution
Fengtai Dist.	5	Drowning/ Building collapse
Shijingshan Dist.	5	Drowning/ Building collapse
Tongzhou Dist.	3	Falling objects/ Electrocution
Miyun Dist.	2	Drowning/ On duty
Dongcheng Dist.	1	Drowning
Daxing Dist.	1	Drowning
Haidian Dist.	1	Drowning
Huairou Dist.	1	Drowning

Fangshan District, located in the southwest part of Beijing, was the most heavily-affected area, which received a record-setting 460 mm (18.1 inches) of rain. It was estimated that this extreme flood, induced by the torrential rain, caused CNY ￥6.1 billion (US $0.98) of losses and 46 deaths in Fangshan District. In total, 800,000 people were affected and over 20,000 have been evacuated; 66,000 houses were damaged and over 8,000 of them were destroyed; 300 roads were damaged and 50 bridges collapsed; 5,000 acres of crops and 2000 acres of agricultural facilities were affected.

Tongzhou district, which is the lowest area of Beijing, suffered from the torrential rain. During a ten-hour period beginning from 2 pm on July 21, Tongzhou received 152 mm (5.9 inches) of rain on average, in particular, Lu Town received a maximum amount of 190 mm (7.5 inches) of rain. During the same period, a devastating rainstorm-triggered tornado came across some areas, which has caused great damage to infrastructure, in particular, roads and bridges in some places were wrecked, and some were even destroyed. Moreover, plenty of mud brought by upstream floods resulted in sediment being deposited in many channels across Tongzhou District and over 20 small culvert wing walls were wrecked. Pictures shown in Fig.2 reflect the scenes when flood receded, many roads in Daxinzhuang Village were crowded with fallen trees and buildings, resulting in a serious traffic jam and in Fatou Village, houses collapsed and furniture flew out, and even broke into pieces. Overall, the rain-induced flood contributed most to the damages in Tongzhou District.

Figure 2 Houses in Tongzhou District were destroyed due to the rain-induced flood (Sources: photos taken by author in Daxinzhuang Village and Fatou Village on the afternoon of July 21, 2012)

2. Canals in Tongzhou District

Canals played a very important role in discharging floods in this devastating downpour. As one of the five main drainage channels in Beijing (Fig.3), Beiyunhe River which originates from Changping and Haidian areas, stretches south to Tongzhou District, runs through Hebei Province, Wuqing District in Tianjin and finally flows into Haihe River, after a journey of 120 km (74.56 miles). With functions of discharging and water delivering, Beiyunhe River serves as the main branch of Haihe River. The map in the upper-left corner illustrates that Beijing is located in the northeast part of China; the map on the left side marks the location of Tongzhou District and Fangshan District, as well as the rivers mentioned in this article; the map on the right side is enlarged to show the route of Beiyunhe River through Tongzhou District.

Figure 3 Geographical map of the area under discussion: the upper-left corner is the map of China; the left side is the map of Beijing and the right side is the map of Tongzhou (Source: Beijing Municipal Commission of Urban Planning)

Liangshui River is the main branch of Beiyunhe River and has an estimated length of 58 kilometers (36 miles). It originates from Fengtai District and flows through Fengtai, Daxing and Tongzhou Districts before flowing into Beiyunhe River. Currently, Liangshui River also functions as pollutant discharge stream in the southern city. The standards of flood prevention for water control planning are ascertained as: peak discharge reaches 167-956 m^3/s (20 year return period); and peak discharge reaches 246-1271 m^3/s (50 year return period). During the flood period, the maximum discharge volume of Beiyunhe River was 1700 m^3/s and those of Liangshui River and Tonghui River were 690 and 507 m^3/s respectively.

From the relics of some flooded areas, what had happened in July 21 can be deduced. Fig.4 shows that a great amount of mud brought by the city flood has not yet been removed.

From Fig.5, one can see that the flood almost overtopped the bridge that was newly constructed for tourists. No one died in the flood-triggered events, owing to the prompt evacuation to the Hui Town. Affected people were transferred to an elementary school in the Hui Town for safety until the flood receded. Nonetheless, they were threatened by the water pouring into the school wall, as can be seen by the watermark on the left side of Fig.6. People used sandbags to resist the water to flow up further, as can be seen on the right side of Fig.6.

Figure 4 Aftermath of flooded area around Canals in Tongzhou Dist. (Source: photos from left to right were taken of Beiyunhe River bank, Liangshui River on the afternoon of Dec.11 by author)

Figure 5 Aftermath of Grand Canal Forest Park in Tongzhou Dist.; the red line denotes the height of the maximum flow during the flooding period (Source: photos were taken of the Grand Canal Forest Park on the afternoon of Dec.11 by author)

Figure 6 Aftermath flooding in Hui Town in Tongzhou Dist., the red line marked on the left photo denotes the height of the water flow when the river ran along the school; and the red circle on the right highlights the sandbags which were used to resist the flood (Source: photos were taken of the Hui Town on the afternoon of Dec.11 by author)

3. Rescue and reflections

During the whole process of city-wide rescue work, Beijing showed its human spirit and virtues to the nation and the world. Directed by the local government, about 160,000 people participated in the rescue, and in particular, several local officials died in the line of duty. Besides, thousands of citizens voluntarily drove to the airport for pickup and provided needed supplies to houses and for those people who lived in the basements. With the joint efforts, the panic and disorder were basically controlled. Refugees were mostly evacuated, repairs of infrastructure as well as facilities were largely completed (Fig.7).

Figure 7 Emergency rescue teams in Tongzhou Dist. were working day and night to provide security (Sources: the upper two photos were taken in Bage town on July 21, 2012; and the lower two photos from left to right were taken Yulin Town and Lu Town July 22, 2012 by author)

However, some reflection and evaluation is needed as to what has happened. Although the administration has issued a widespread warning in advance, the city still suffered serious damages and losses from this devastating disaster, which aroused attention as well as criticism from the nation and the world. First, public anger was triggered by the poor construction of underground drainage systems and river's governance, which was mainly

neglected during the process of urbanization, due to lack of sufficient governmental grants and low standard of design and assessment. No one can deny the fact that this is the direct cause of waterlogging induced by heavy rain. After this event, questions on how to cope with this problem and the possibilities of minimizing risks and losses became one of the most urgent matters for authorities to consider. Second, there is large room for improvement of governmental administration, for example, official emergency rescue teams could function as they are supposed to be and emergency plans should be more flexibly designed and rationally implemented.