Analysis of the rainstorm and flood of 2003 in the Huaihe River Basin

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Abstract: In the Meiyu period from June 20 to July 21 in 2003, a wide, heavy and lasting rainstorm occurred in the Huaihe River Basin as the complex result of synoptic system, caused a flood with a high water level in the main stream of the Huaihe River and its tributaries at the same time. The main stream of Huaihe River rose its the warning level, the highest water levels for the reaches from Zhengyangguan to Huainan were higher than that in history and created the recorded ones. The maximal discharges in the reaches of downstream from wangjiaba were more than those in 1991.

This paper analyzed on the characteristics of the weather, the meteorological causation about the heavy rain, and the condition of incident precipitation and subsequent discharge. The paper expatiated upon the conditions of the flood of 2003 by using the achievement of the restoring computation of runoff of the flood, comparing with the conditions of the historic flood (for example the flood of 1954 and 1991) in Huaihe River Basin. The result indicated that the maximal water quantity in moving 30 days and 60 days at main stations of the stream of the Huaihe River was about once per 10~30 years (i.e. the return period is 10~30 years) respectively. It concluded that the flood of 2003 in Huaihe River Basin was the second largest since 1949 and it was less heavy than that in 1954.

Key Words: Huaihe River Basin　Rainstorm and Flood

1　Introduction

The Huaihe River Basin (HRB) is situated in the east part of China. It rises of the Tongbo and Funiu Mountains in west, and faces to the Yellow Sea in east. It takes the south dike of the Yellow River and the Yimeng Mountain as northern boundary, and the Dabie Mountain、the Jianghuai hill、the Tongyang canal and the Rutai canal as southern boundary. HRB totally covers 270,000km^2 in area. The Huaihe River originates from the Tongbo Mountain of Henan province and flows through four provinces, namely Henan, Hubei, Anhui and Jiangsu. Totally it is 1000km long and its main stream empties into the Yangtze River at Sanjianngying of Jiangsu province. The Hongru River, the Shaying River and the Guo River are in the north of HRB, the Shiguan River and the Pi River are in the south. They all run into the Huaihe River as the major tributaries. There are many lakes in HRB such the major lakes as the Hongze Lake and the Nansi Lake. HRB is located in the climate transition zone from north to south in China so that the climate is changed acutely there. Into flood season, the floods occurred from mountains of the upper reaches of the Huaihe River quickly run into the middle reaches. But the floods pass slowly and cannot be discharged on time in the middle reaches because the declivity changes gradual. Thus the disaster of the flood is easy to be led once there be the rainstorm.So far the flood in 1593 is the biggest one in HRB by the historic recordation. Since the 20th century, there have occurred the rainstorm and flood many times in HRB. And the bigger floods in 1954, in 1991and in 2003 are typical ones over HRB.

2　Meteorological causation and synoptic characteristics

In 2003, the greatest flood had taken place in HRB among the flood season since 1954. The flood peak discharge and flood level of the main river considerably exceeded the record set since 1949. According to the precipitation, the Meiyu period around HRB is defined as rainy period from June 20 to July 21,2003, the process of heavy rainfall can be divided into five stages, the first stage is 20 to 23 June, the 2nd stage is on 25 to 26 June, the 3rd stage is from June 29 to July 5, the fourth stage is in 8th—12th and last is 19th –21st July. The flood-causing rainstorm occurred in three periods, which were from June 29 to July 5, on July 8 –12 and from 19 to 21. The characteristic of heavy rainstorm in 2003 is widespread area, long duration, uneven in spatio-temporal, stronger intensity and large amount of total.

During flood season around Yangtze-Huaihe river basin in 2003, the main circulation pattern of two ridges and one trough was prevailing around Eurasia between in the middle and high latitude, especially from 20th June to 5th July. One blocking high was located at the Ural mountain in Russia, another blocking high was located at the Okhotsk Sea, (Fig.1), that is typical pattern of two ridges and one tough. The cold air from the Baikal Lake moved farther eastward

and southward to HRB. The subtropical high of the west Pacific Ocean moved every now and then between 18oN-24oN among June to August, but it markedly strengthened and become more stable during June 20 to July 5 and July 8 to 21,as well as its ridge was between 21oN-24oN, HRB was influenced by the northwest edge of the house high, that situation led to the Yangtze-Huaihe Meiyu front to be stationary around HRB and persistent rainfall. This circulation feature is the same as the flood season in 1991.The main factors result in heavy rainstorm in HRB included synoptic systems, such as the low-level southwest jet and Yangtze-Huaihe shear line, as well as meson-scale systems, such as

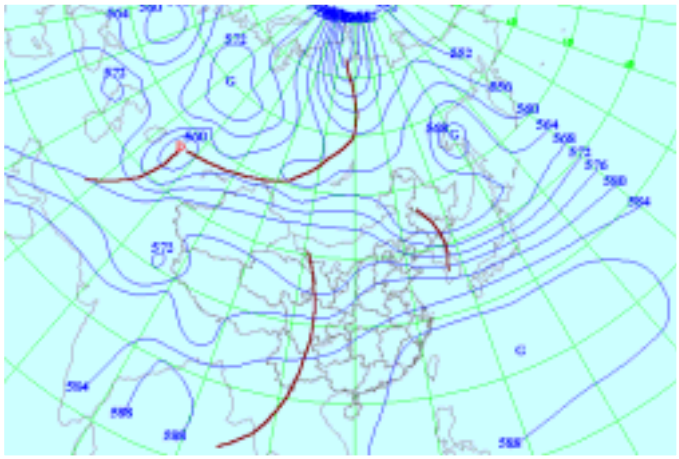

Fig.1 Contour chart at 500hPa on June 30

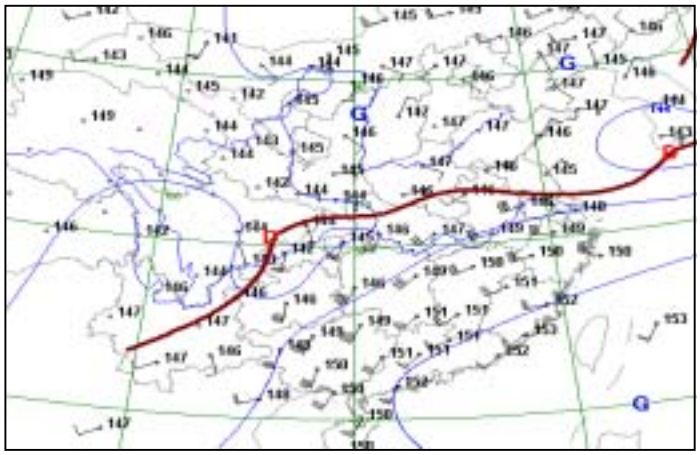

Fig.2 Synoptic chart at 850hPa on July 1

low vortex. As generally speaking, the low level southwest jet at 850hPa set up before heavy rain (Fig.2), it transported a lot of moisture from Bay of Bengal to Yangtze-Huaihe river basin. During the period of flood-causing torrential rain (June 29 to July 5, July 8 to 12), the shear line appeared at both 850hPa and 700hPa, and quasi-stationary. The heavy rain would stop when the shear line weakened or disappeared. The low vortex is the meson-scale system that lead to strong heavy rainstorm directly in the Huaihe river, there were nine low vortexes among June to July and influenced Huaihe river, they often formed over southwest part of China, then moved eastward along the shear line, when they reached the Huaihe river region and become stronger, which resulted in persistent heavy rainstorm.

3 The conditions of rainfall, flood and disaster

3.1 The conditions and characteristics of rainfall

It was the Meiyu period over the Yangtze-Huaihe River Basin from June 20 to July 21 in 2003. (Fig.3) Due to the Meiyu front over there was quasi-stationary; five wide rainstorms were occurred in HRB. The major rainfall lied on the area along the Huaihe River, the Dabie Mountain, the middle and lower reaches of the tributaries on the north of the Huaihe River and the partial Lixiahe area. The rainfall of the stage from 28 June to 5 July was the heaviest, the most lasting and the most concentrative one in 2003. Maximum precipitation was 546.0mm occurred at the Taihe station of the Ying River and 534.6mm occurred at the Huji station of the Quan River. So that the first flood of HRB in the flood

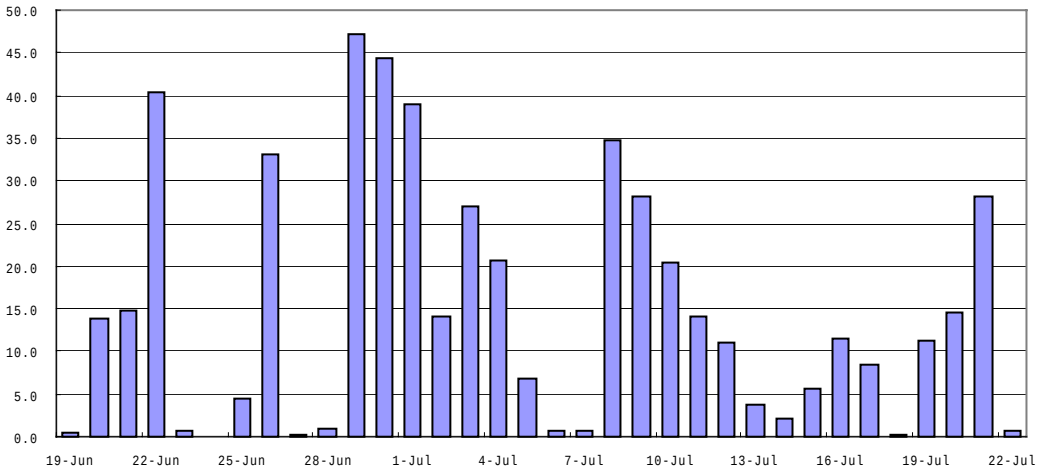

Fig.3 Daily precipitation in Meiyu period of 2003 on Huaihe Water System

season of 2003 resulted from this rainfall.

It was the Maximum of the accumulated rainfall for moving 30days from 20 June to 21 July in 2003 (Fig.4). The total rainfall in Dabie Mountain, the partial middle reaches of the Shaying River and the north area of the Hongze Lake was more than 800mm. The precipitation was 940mm at the Liulaojian gate of the Lixiahe area, 937.3mm at the Qianfan station of the Dabie Mountain and 879.4mmat the Guanji station of the Ci River.

The characteristics of rainfall of 2003 in HRB were: (1) lasting, and more concentrated on the time, (2) wide, but uneven in spatio-temporal, (3) heavy, and the gross of precipitation being greater.

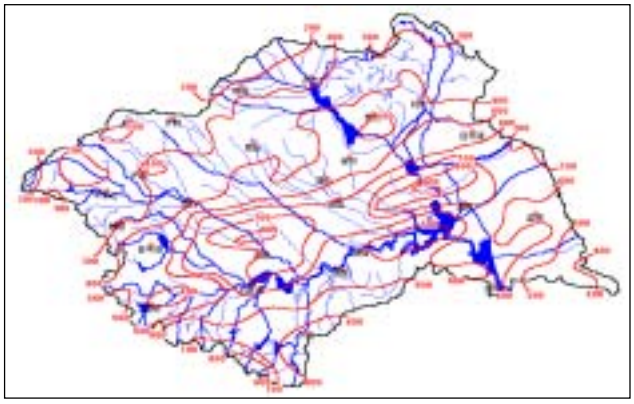

Fig.4 Isohyets during 22 June to 21 July 2003 in HRB

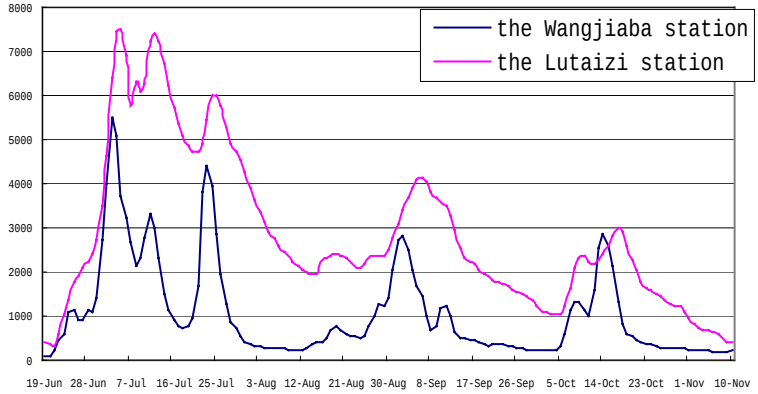

Fig.5 Daily discharge at the Wagjiaba and Lutaizi station in flood

3.2 The conditions and characteristics of flood

The rainfall resulted of eight floods in the middle reaches of the Huaihe River since onset of Meiyu. (Fig.5) Through Henan, Anhui and Jiangsu provinces (about 750km long) at the major stations in mainstream as Xixian, Wangjiaba, Zhengyangguan, Bengbu, Hongze Lake and the stations in tributaries as the Huang River, the Hongru River, the Shiguan River, the Pi River, the Shaying River, the Guo River and so on, the water lever were about 0.16-3.35m higher than the warning lever. The lever at the Wangjiaba, Zhengyangguan, Lutaizi station in the mainstream and the partial stations of tributaries as the Pi River, the Hongru River, the Shaying River was 0.02-1.47m higher than the assuring lever. The peak water lever at the stations of Wangjiaba, Zhengyangguan, Bengbu and Zhongdu were 29.42m, 26.80m, 22.05m and 14.37m. And at these four stations the peak water lever were 6^{th}, 1^{st}, 2^{nd} and 2^{nd} and the peak discharge were 7^{th}, 5^{th}, 3^{rd} and 2^{nd} respectively since the found of the P.R.China. The peak discharges of the partial tributaries were greater than that in history. According to the frequency analysis on the maximum flood magnitude of moving 30 days, the return periods decrease from upper to lower: 11years for the flood event at Wangjiaba, 23 years at Bengbu and 29 years at Zhongdu station.

The characteristics of flood of 2003 in HRB were as follows: (1) the flood ran fast and high water lever was lasting, (2) the flood was higher water lever and greater discharge, (3) the flood met the rainfall so that the flood was occurred in the main reaches of the Huaihe River and its tributaries at the same time.

3.3 The conditions and characteristics of disaster

The rainstorm and flood of 2003 came into being the severe disaster in Henen, Anhui and Jiangsu provinces. There were 37.3×10^6 people in the disaster, 770×10^3 houses collapsed and 3.847×10^6 cropper being waterlocked. Those direct caused the RMB:28.6 $\times10^9$ economical losses.

The characteristics of disaster in 2003 were : (1) no man died because of the flood storage areas and flood detention areas operation, (2) the waterlocked areas were not wide, (3) the economical loss was not great correspondingly.

4 Comparison with the historic floods (in 1954 and in 1991)

4.1 Comparison the rainfall of 2003 with that of 1954 and 1991

The Maximum of accumulated rainfall for moving 30 days in 2003 compared with that in 1954 and in 1991 was little, and less than 1000mm. But maximum in 1954 and in 1991 was more than 1200mm. It indicated that the rainfall in partial areas in 2003 was no heavier than in 1954 and in 1991. The area of the precipitation being more than 400mm in 2003 was all narrower than in 1954 but wider than in 1991. But the area of the precipitation being more than 900mm in

2003 was narrower than in 1954 and in 1991. The precipitation gross of the maximum of the accumulated rainfall for moving 30days in 1954, in 1991 and in 2003 were 981.7 $\times 10^8 m^3$, 788.7$\times 10^8$ m^3 and 959.2$\times 10^8 m^3$ respectively. Thus the gross in 2003 was about 2.3 percent less than in 1954 and about 30 percent more than in 1991.

The mean precipitation for moving 30 days in 2003 was 475mm, 516mm in 1954 and 389mm in 1991. So it indicated that the mean precipitation in 2003 was 8 percent less than in 1954 and 22 percent above in 1991.The mean precipitation in 2003 in major areas except for the Lixiahe area was less than in 1954 and more than in 1991. (Table.1)

Table.1 Precipitation at the major areas of the Huaihe Water System in 1954, in 1991 and in 2003（unit：mm）

Area	Days	In 1954	In 1991	In 2003	No.1	Remark
Huaihe Water System	30	516	389	475	In 1954	1991< That in 2003 < 1954
Wangjiaba	30	623	395	471	In 1954	1991< That in 2003 < 1954
Zhengyangguan	30	566	380	440	In 1954	1991< That in 2003 < 1954
Bengbu	30	533	374	438	In 1954	1991< That in 2003 < 1954
Zhongdu	30	514	378	454	In 1954	1991< That in 2003 < 1954
Lixiahe area	30	550	637	592	In 1991	1954< That in 2003 < 1991

4.2 Comparison the flood of 2003 with that of 1954 and 1991

In 2003, the maximum discharge at the major stations of the Huaihe River was 1,230-5,120m^3/s less than that in 1954. and as well less than in 1954 at the main tributaries such as the Shaying River and so on. According to the frequency analysis on the flood magnitude, the maximum of moving 30 days, 60 days and 120 days in 2003 were less than in 1954, and their frequency of 2003 were less than that of 1954 at the same. (Table.2)

The peak water lever and discharge of 2003 at the control stations of the lower reaches from the Huaibin station were higher and greater than that of 1991. The water lever of the watercourse to Yangtze and the Lixiahe area around the Hongze Lake in 2003 was higher than in 1991. Compared the flood magnitude at the major stations of the main stream in the flood season of 2003 with which of 1991, the discrepancy of them was not large. The maximum of moving 30 days in 2003 was above in 1991, but the maximum of moving 60 days was udder in 1991 by the frequency analysis on the flood magnitude. Otherwise there were 17 flood storage areas or flood detention areas operation in 1991,but only 9 areas operation in 2003.

Table.2 Return period of the Huaihe Water System in 1954,in 1991 and in 2003

Return period \ Stations		Wangjiaba	Runheji	Zhangyangguan	Bengbu	Zhongdu
30 days	In 1954	40	48	51	56	68
	In 1991	9	13	12	13	18
	In 2003	**11**	**13**	**15**	**23**	**29**
60 days	In 1954		32	42	37	40
	In 1991		11	11	12	14
	In 2003		**9**	**9**	**10**	**13**
120 days	In 1954			24	21	22
	In 1991					
	In 2003			**15**	**18**	**24**

Analyzing on the comparison the rainfall and flood in 2003 with that in 1954 and in 1991, it concluded that the rainstorm and flood of 2003 in HRB was heavier than that of 1991, but less heavy than that of 1954. So it was the second largest flood in HRB since 1949.