The heavy drought of 2002 and the large flood of 2003 in NLB

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Abstract: The paper gives an introduction of the heavy drought of 2002 and the large flood of 2003 in the Nasihu Lake Basin (NLB), including its geographical location as well as hydrometeorological features. It also includes Nasihu Lake river system, natural river system and man-made channels. The precipitation, drought, flood and hydrological situation in 2002 and 2003 are analyzed. In 2002, the NLB experienced a heavy drought. The disaster in northwest area was especially serious. In 2003, the second largest of flood since 1950 happened. It caused flood disaster over large area. The lasting time of flooding was long and the water volume was great. All this led to the highest water level for some hydrological stations in the recent 30 years. The paper also gives analysis on the climatic cause of the floods and drought disasters.

1. General introduction to the basin

The Yishusi River Basin(YSSRB) is an independent watersheds. It is a part of Huaihe River Basin (HRB). The basin bounded by the old Yellow River and Huaihe water system in the south. The Nasi lake is 6th fresh water lake in China. It is composed of the Nanyang lake, Dushan lake, Zhaoyang lake and Weishan lake. NLB located in the westward of the YSSRS. There are 53 main tributaries flowing into the lake with a catchment area of 31400㎢。 In 1960 a gate (called Erjie gate) was built in the lake and the lake is divided two parts: the upper and down lakes. NLB is located in the transition belt of climate between the north and the south of China. The climate change is violent. The change of rain between years and months is uneven and the flood and drought occur frequently. The average annual rainfall is 695.2mm. The rainfall in the flood season from June to September is about 70% of annual rainfall. The average potential evaporation amount in the lake per year is 1000mm and the average evaporation amount for land is 500～650mm.The river networks in the west of the lake are richer, and their bed slopes are less so that the flow velocities are small and the flood amount are big.

Because the slope of the main stream is bigger in east of lake, the flood lasts a short period of time and the magnitude is large with rising up and falling suddenly. Although having been harnessed for many times, the criterion of the present flood control is still lower and it is to protect for 20-years occurrence flood. The typical flood events occurred in 1730, 1974, 1957 and2003. The typical drought events occurred in 1966，1988 and 2002. As an whole river basin flood happened in the YSSRS in 1957, the occurrence of flood of NSL was near to a hundred years.

2.Rainfall and water information of flood season in 2002

2.1 Rainfall

The average monthly precipitation during flood season from June to September in YSSRB are: 101 mm, 236 mm, 157 mm and 83 mm, and monthly precipitation from June to September in 2001 were 87 mm, 97 mm, 59 mm, 33 mm. It is clear that rainfalls in 2002 were less 13.9%, 58.9%, 62.4%, 60.2% than the normal year. The rainfall during flood season in 2002 was 276mm, and was less 52.2% than that of the

average annual precipitation. It was a drought year of 2002. The rainfall amount of 2002 was the minimum since the year 1953 and the heavy drought happened in the northwest of basin. In regional distributing the rainfall decreases from the southeast to northwest gradually. Fig. 1 shows Isohyets for flood season (June to September, 2002) in the YSSRB.

The average precipitation during flood season from June to September was 231 mm in NLB, and was less 52.5% than that of the average annual precipitation. The rainfalls in the northwest of upper lake of NLB were small, which was between 100 to 200mm. The rainfall in other parts of the basin was between 200 to 300mm. In regional distributing the rainfall decreased from the southeast to northwest gradually.

2.2 Water Information

The Nanyang station located in the upper lake of NLB, on the 1st of January, the water level of the station was 33.43m, just 0.43m higher than its minimum pool elevation, measured that the lake dried up at the 16th July, which was the 6th since the recordation of hydrological data. The upper lake was just sere in the end of flood season. The flood volume of the lake is 0, the flood volume has decreased 77 million m^3 during the flood season.

The Weishan station located in the lower lake of NLB, on the 1st of January, the water level of the station was 31.48m, just 0.02m less than its minimum pool elevation. On August 25, the water stage in the lower lake was 29.85 m, it was lowest which means the lake dried up. The water level of upper lake was just 30.36m in the end of flood season. The flood volume was 27 million m^3, the flood volume has decreased 143 million m^3 during the flood season.

During the flood season of 2002 there are no obvious floods. The peak discharge of the Si river, the biggest tributary of the lake was only 2.5 m^3/s. The flow from other tributaries was also much less. The amount during the flood season of 2002 was only 8.2% compared with the averaged amount of same season. The gates in the upper and down lake were closed in this year.

The groundwater was over used because of the shortage of the water resources this year The groundwater table was 4.15m deeper than that of the normal year. The area of cone of depression 12289.9 km^2 and the depth was from 13 to 49m。

2.3 Draught Information

The rainfall in NLB in 2002 was badly small, which is much less than that of normal year. It led the heavy drought. The occurrence of the drought is 50 year according to calculation, the drought was serious especially in the west of the basin.

After the 16th July 2002, the upper and lower lakes dried up one after the other, till 16th June 2003. Only a few water in the lake such as deep-routes and river channels in the lake. The large big continuous water surface was not visible. The whole bottom of the lake looked like regions of drainage system. The inter-crossed channels were visible. There were farmlands and pounds on each side and grass flourished in the wasteland. Cars could travel freely. Every tributary dried up so that the lake dried up. There were no any water in the lake and river. There were some cracks in the bottom of lake and river with 10 cm wide.

The economic development, people living and social stabilization in NLB had been impacted seriously by draught. The economic loss reached 1.33 billion RMB. The loss of farming, fishing, aquiculture, ship and tourist was great. The natural environment had been destroyed greatly.

2.4 Formation of weather

The average temperature in YSSRB persisted high from Jan. to April in 2002 and as a result, evaporation augmented. Subtropical high was a little stronger than normal year in April and May. However,

the main rain belt was located in the north region of HRB. The precipitation was small in the NLB.

In June, the subtropical high was a little weak and the rainfall was small. In normal years, Meiyu period is between the 22nd June and the 10th July. The stabilization time of subtropical high was short in this year and Meiyu period of the basin was just nine days from 19 to 27 June. During the Meiyu period, there was only one day, when the area rainfall exceeded 5mm in NLB.

In July and Aug. of the normal year, the rainfall is rich in main flood season of NLB. From last days of June to 20th July 2002, the subtropical high was a little weak There was a course of heavy rain, but the time was short and the rainfall was small in NLB. In September this year, the subtropical high was a little weak continuously and the precipitation was small.

3. Rainfall and water information of flood season in 2003

3.1 Rainfall

The rainfall was 835mm from June to September of 2003, which exceeded the average annual precipitation by 50.5%. Monthly rainfall from Jun. to Sep. was 140mm, 315mm, 272 mm, 108mm respectively, and exceeded the average annual precipitation by 40.0%, 42.5%, 68.9% and 45.9%, respectively. There was much precipitation in the continuous four months and it was the abundant water year. Total rainfall in the flood season of 2003 was 839mm, and ranked in the 2nd since 1953. Fig. 2 shows isohyets for flood season (Jun. to Sep., 2003) in the YSSRB.

The rainfall was 800mm~1000mm in the east of YSSRB, and exceeded the average annual precipitation for this area by 30%~50%. The rainfall was 600mm~800mm in the west of YSSRB. It exceeded the average annual precipitation by 20%~40%. It was smaller than 600mm in the northwest of the basin. In distribution, the rainfall decreased from the southeast to northwest.

3.2 Water Information

From last ten days of June in 2003, the hydrological condition in NLB was changed so much that drought quickly turned into flood. The water stage of the upper lake on 22 July reached the 33.00m (minimum pool elevation), and then reached the 34.20m, the flood prevention level on August 31, it reached the 35.28m on 22 July, the highest stage since 1973. The water stage in the Weishan station of lower lake reached the 31.00 m (minimum pool surface)) on 12 July, it reached 32.50m, the flood prevention level on August 27, and it reached 33.33m, the highest since 1974 on October 14,. The water gate in Erjie dam（it is way out of the upper lake）, Hanzhuang water sluice（it is way out of the lower lake） were opening fully in September. The flood amount flowing from the two gates are 1.404 and 1.636 billion m^3, respectively. They were the largest ones since 1985 and 1974, respectively.

After the flood season of 2003, the groundwater table rose 4.32m and the groundwater amount increased 3.57 billon m^3.

The occurrence of moving maximum flood amount of 15 days is 10-years. The flood caused the inundation of the farmland around the lake for long time.

At the end of flood season, the storage volume compared with those of the last ten days of June in upper lake and lower lake increased 1.251 and 1.223 billion m^3, respectively. During the flood season, the inflow volume was 4.11 billion m^3 in the NSL.

During the flood season, the reservoirs stored the flood volume as much as possible according to the flood management and regulation rules to guarantee the safety of rivers and lakes.

3.3 Main water information in other parts of YSSRB

The runoff amount from upper Luoma lake basin was 7.09 billion m^3. The biggest flood discharge was 3290 m^3/s and the accumulative discharged water amount was 5.90 billion m^3 and the sixth biggest one since 1974.

During the flood reason of this year, HRB suffered the heavy flood, is the second largest (The flood in 1954 is the largest.) since 1950. The Huaiyin water gate was opened for discharging flood from Huaihe basin to Yishusi Watershed on July 6.The maximum discharge was 1720 m^3/s. The accumulative water amount at Huaiyin water gate is 264,000,000 m^3.

Shuyang Station of the New Yi River witnessed the highest water level since 1974. The water level reached the highest level of 10.71 m. It surpassed the Alert Water Level by 1.71m and ranked second in the history. The flood peak at Shuyang Station was 4860 m^3/s and ranked third in the history.

3.4 The Storm mechanism

In the summer of 2003, the precipitation amount was more than usual in the YSSRB. The precipitation concentrated on the period from June 20 to September 8.The precipitation in this period could be divided into two stages.

The first stage was Meiyu precipitation from June 20 to July 28. The second stage was from August 14 to September 8. The Subtropical high during this stage was evidently stronger and extending to west than that's in the first stage. The cold air moved towards deflection north and also the typhoon was very activity during the period. The precipitation of YSSRB was stronger.

4.Conclusion

2002's drought and 2003's flood situations expressed the circumstance of two kinds of typical models of drought and flood in YSSRB. It reflected the basic characteristic of YSSRB:

(1) The drought is very easy to happen due to average annual precipitation is small and have no stable water source to supply in YSSRB with a short sources of river and complicated river systems;

(2) The criterion of flood control is low to hydraulic engineering in YSSRB, so flood is probably to take place.

Now, constructing **South-to-North Water Transfers** project and **the second period of towards east-to-towards south flood control** project which can advance the flood control standard of YSSRB to be 50-year, we will completely change this fact that flood and drought is very easy to happen.

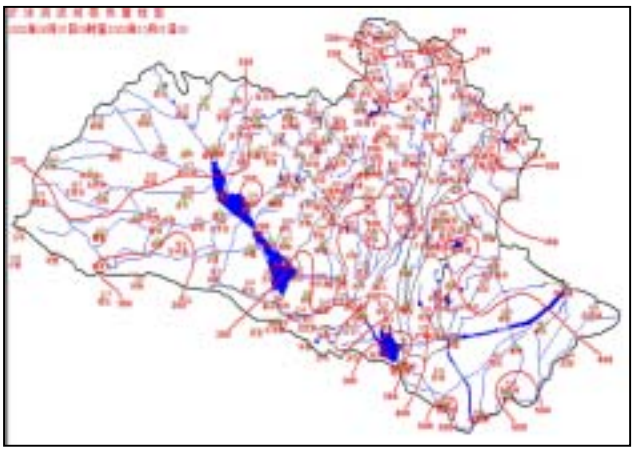

Fig.1 Isohyets from Jun. to Sep., 2002

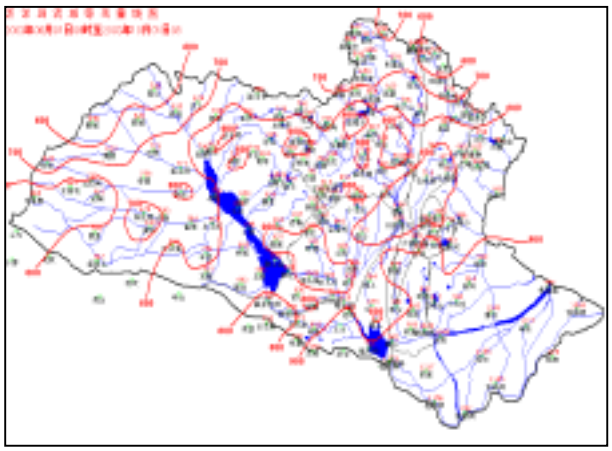

Fig.2 Isohyets in Jun. to Sep., 2003