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Analysis on Characteristics of Water Regime Changes of Tao'er River in Western Jilin Province in Autumn of 2018

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***Abstract*—Based on the analysis on data about water regime in the downstream of Tao'er River (Taonan Reservoir) in Autumn (September 2 ～ October 1), the author analyzes the reasons of changes of the water level and flow rate of Tao'er River from aspects of the water supply mode of the river, factors of affecting the water regime of the river, etc. through calculating the maximum value, minimum value of the water level and the flow rate during this time as well as the difference and the mean by collecting data of daily water level, flow rate, warning level, the highest safety level, etc. Particularly, the author analyzes the reason of sudden changes of the water level and the flow rate of the river within a short time.**

Keywords—Western Jilin Province; Tao'er River; water regime characteristics

I. INTRODUCTION

As a large river of Western Jilin Province, Tao'er River is of great significance for local industrial and agricultural development. The rules of changes of water levels can be summarized through recording and studying the daily water level, flow rate, warning level and the highest safety level of Tao'er River in Autumn, which is of great significance for relieving drought and water lack of Western Jilin Province in Autumn.

A. Overview of Water Regime Characteristics of Rivers in Northeast China

Northeast China spans the cold temperate zone, the medium temperate zone and the warm temperate zone, so this region is characterized by the temperate continental monsoon climate. It is the rainy season of Northeast China from June to September. The river is mainly fed by rainfall. It belongs to ice and snow melting water feeding when the ice and snow begins to melt in Spring. The flood season from June to September for rainfall accounts for 70%~80% throughout the whole year. There will be a small flood season in Spring as ice and snow melts [2]. The east region of Changbai Mountains has a high mean annual runoff rate. And the mean annual runoff rate reduces from the Southeast to the Northwest and increases in Daxing'anling Mountains. The runoff rate changes greatly in different years, featuring obvious high water levels and low water levels. Northeast China has many dry branches and fallen leaves containing less sand. From the December of each year to February of the next year, it is cold, and the river gets frozen when it is the frozen period. Normally, Northeast China will not suffer from lack of water. If there is less rainfall in Spring or Autumn, there will be a short period of lack of water, which usually happens in the western region.

B. Water Regime Characteristics of Rivers in Jilin Province

Jilin Province is located in the middle latitude zone of the northern hemisphere and the east of Eurasia, equivalent to the northernmost temperate zone of China, and closing to the sub-frigid zone. The eastern region of Jilin Province is nearby the Yellow Sea and the Sea of Japan, so the weather is moist and is of much rainfall; The western region is away from the ocean and nearby the Mongolian Plateau featuring a dry climate. The whole Province is characterized by an outstanding temperate continental monsoon climate featuring four distinctive seasons and a hot-rainy season. It extends to the inner mainland from the east to the west, so rainfall of Jilin Province from the east to the west reduces gradually. Main water systems distribute in the mid-east region: Songhua River system, Liaohe River system, Yalu River system, Tumen River system, Suifen River system. And Tao'er River in the west region belongs to the Songhua River system.

Flow rates of rivers in Jilin Province change greatly. The flow rate in Summer (June to September) (the flood season of the river) is the largest. It is the frozen period of rivers in Winter (November to March) [4]. It becomes warm in Spring (April), and the river begins to melt, so the flow rate becomes large, and the Spring flood season comes. In Autumn, there is less rainfall in the western region, so there is a lack of water in some rivers.

C. Water Regime Characteristics of Rivers in Western Jilin Province

Western Jilin Province belongs to plain featuring flat and low terrain, and the altitude of most of the Province is among 130～200m. The western plain as the south part of Songnen Plain includes the north rim of Songliao Divide and Liaohe Plain. And the western plain is adjacent to the foot of Daxing'anling Mountains. The plain mainly features alluvial terraces and plain in the east and widely flat alluvial plain in the west, covered by a large area of relatively low dunes forming the sandy landscape with alternative distribution of dunes and fields [3]. Altitude of most part of the plain is among 100～260m.. This region featuring a semiarid and semi humid weather belongs to the semiarid and semi humid weather temperate zone. Its rainfall ranges from 350 to 500mm. The rainfall during the vegetation season accounts for 88% of the annual rainfall. Spring drought is severe here, and there is much storm rain in Summer. The annualevaporation amount is among

1500～1900mm, and the evaporation-rainfall ratio ranges from 3.4 to 4.89.

Tao'er River is the main river of this region as well as the largest tributary on the right bank of Nenjiang River. It is located in Hinggan League of Inner Mongolia of China and the Northwestern Jilin Province. It comes from Gaoyue Mountain in the southeast foot of Arshaan, Daxing'anling of Inner Mongolia, and consists of ten different sizes of small rivers running into it. It flows through Horqin Right Front Banner, Taonan City, Zhenlai County in the southeast region, runs into Yueliangpao Lake, and then runs into Nenjiang River. It is 553km in length and covers a basin area of 30.8 thousand km2, runs into Guiliu River in Ulanhot from the northwest to the southeast, and then turns the running direction into northeast in Taonan City of Jilin Province and runs into Nenjiang River. [5]. Tao'er River is characterized by a wide and flat river valley and a large gradient of about 16.6%, but the gradient reduces to 0.2% in Taonan Plain. The mean flow rate of Cha'ersen reservoir over years is 26.9m3/s (over 1700 m3 /s to the maximum), the mean flow rate in the estuary is 50m3/s, and the total runoff flow rate is about 1.6 billion m3. The River is characterized by water feeding of snow in Winter and Spring and rainstorm in Summer and Autumn. The frozen period can be up to 4～5 months.

Its upper and middle streams flows through the mountain region of Inner Mongolia Autonomous Region. From Cha'ersen, Gegen Temple to Longhuatu sluice in Baicheng City, there is much rainfall from July to September, flash floods occur, a large quantity of sediments will be brought to the riverway and farmlands on the bank of the downstream often suffer from flood threats [6]. It's the plain in south of Zhenxi where the river channel becomes wide, the flow rate becomes slow, meander develops and there are many bottomlands. It is the downstream of the River in south of Taonan where dunes, sand hills, bottomlands and marshlands distribute widely. There are many willows and bushes on two banks. When floods come, water in the River will come out and integrates with Yueliangpao Lake. Upstream provides good sources of hydropower. There is the Project Tao'er River Water Diversion to Huolinhe River in the downstream.

Western Jilin Province suffers from severe drought. And drought happens often in Spring, Summer and Autumn. Since rainfall varies greatly in different seasons and years and there is a few of rainy days, Tao'er River suffers from severe lack of water.

II. DATA COLLECTION

A. Data Source

All the data of the paper come from the following website: http://www.weather.com.cn。 This website is the core portal of China Meteorological Administration to provide the public with meteorological information services. It contains the latest meteorological service products and rich timely meteorological information of all the subordinate business departments of China Meteorological Administration. This website is organized by CMA Public Meteorological Service Center which is responsible for specific development, operation and maintenance. The network service room of the CMA Public Meteorological Service Center is responsible for construction, operation and maintenance as well as business cooperation and marketing of the website. [7]

B. Data Processing

The author summarizes the water regime data of the downstream of Tao'er River (Taonan Reservoir) from September 2, to October 1, 2018 with excel software [1], and the following table is made:

TABLE I. WATER REGIME DATA OF TAO'ER RIVER (TAONAN RESERVOIR) FROM SEPTEMBER 2 , 2018 TO OCTOBER 1, 2018

Time (2018)	Water level (m)	Flow rate (m3/s)	Warning level; danger level	Highest safety level (m)
8:00 on Sep. 2	144.67	10.80	149	150.5
8:00 on Sep. 3	144.73	12.20	149	150.5
8:00 on Sep. 4	144.79	14.70	149	150.5
8:00 on Sep. 5	144.73	12.20	149	150.5
8:00 on Sep. 6	144.64	10.40	149	150.5
8:00 on Sep. 7	144.64	10.40	149	150.5
8:00 on Sep. 8	144.09	0.80	149	150.5
8:00 on Sep. 9	144.31	3.50	149	150.5
8:00 on Sep. 10	144.36	4.40	149	150.5
8:00 on Sep. 11	144.42	5.60	149	150.5
8:00 on Sep. 12	144.36	4.40	149	150.5
8:00 on Sep. 13	144.32	3.60	149	150.5
8:00 on Sep. 14	144.30	3.30	149	150.5
8:00 on Sep. 15	144.22	2.00	149	150.5
8:00 on Sep. 16	144.20	1.90	149	150.5
8:00 on Sep. 17	144.19	1.70	149	150.5
8:00 on Sep. 18	144.30	3.30	149	150.5
8:00 on Sep. 19	144.38	4.20	149	150.5
8:00 on Sep. 20	144.40	5.20	149	150.5
8:00 on Sep. 21	144.32	3.80	149	150.5
8:00 on Sep. 22	144.29	3.10	149	150.5
8:00 on Sep. 23	144.32	3.80	149	150.5
8:00 on Sep. 24	144.29	3.10	149	150.5
8:00 on Sep. 25	144.12	0.93	149	150.5
8:00 on Sep. 26	144.27	2.80	149	150.5
8:00 on Sep. 27	144.24	2.40	149	150.5
8:00 on Sep. 28	144.19	1.90	149	150.5
8:00 on Sep. 29	144.03	0.60	149	150.5
8:00 on Sep. 30	143.98	0.30	149	150.5
8:00 on Dec. 1	144.02	0.50	149	150.5

III. COMPREHENSIVE ANALYSIS

A. Analysis of Water Regime Data of Tao'er River

According to recorded water regime data of Tao'er River from September 2 to October 1, we can find out that the water

level of Tao'er River in Autumn is among 143.98~144.79m, the flow rate is among 14.700m3/s~0.300m3/s, and the warning level is 149m, so all the water levels of the River from September 2 to October 1 are below the warning level, and the highest safety level is 150.5m.

1) Monitoring of water levels of Tao'er River in Autumn

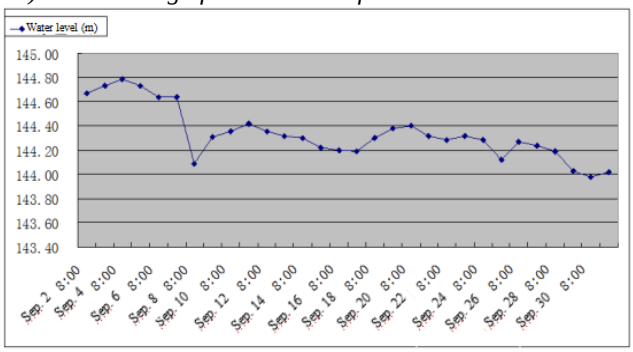

FIGURE I. WATER LEVEL CHANGES OF TAO'ER RIVER (TAONAN RESERVOIR) FROM SEPTEMBER 2 ～ OCTOBER 1

We can find out from the water level changes figure of Tao'er River from September 2 ～ October 1 that: The water level of Tao'er River on September 4 is the highest (144.79m); and that on September 30 is the lowest (143.98m). So the difference between the highest water level and the lowest water level is 0.81m. And the mean water level of these days is 144.34m.

Since Tao'er River is located in Western Jilin Province, and the temperature in Autumn is relatively high, and rainfall is relatively little but evaporation amount is large, so atmospheric precipitation feeds little water to the River and drop of the underground water level results in a little amount of the feeding of underground water to the River, as a result, the water level of Tao'er River is relatively low. Increase of use of agricultural water aggravates sudden drop of the water level. This phenomenon is particularly obvious from September 7 to September 8, and the water level of the River drops from 144.64m to 144.09m, decreasing by 0.55m which is the maximum value of daily water level drop during this time. After the end of September, it is the low-flow period, and the water level of the River drops to the lowest level.

2) Monitoring of flow rate of Tao'er River in Autumn

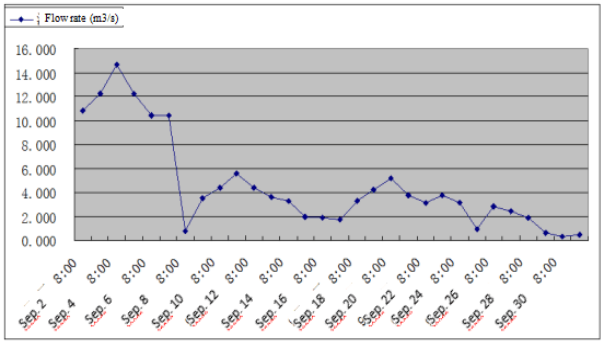

FIGURE II. FLOW RATE CHANGES OF TAO'ER RIVER (TAONAN RESERVOIR) FROM SEPTEMBER 2 ～ OCTOBER 1

From Figure 3.2 we can find out that the daily flow rates of Tao'er River from September 2 to October 1 is unstable. The maximum flow rate (14.70m3/s) happens on September 4, and the minimum flow rate (0.30m3/s) happens on September 30, and the difference between the maximum flow rate and the minimum flow rate is 14.40m3/s. The daily flow rates from September to September 8 change significantly from 10.400m3/s to 0.800m3/s. The daily dropping range is up to 9.60m3/s which is the maximum daily descending value during this time; From the daily flow rate data we can find out that the mean flow rate during this time is 4.59m3/s; It is relatively lower than that of rivers in middle and east regions. After September 29, the flow rate of the River is below 0.600m3/s.

As one of the large rivers of Western Jilin Province, Tao'er River is mainly fed by atmospheric precipitation, while the temperature of Western Jilin Province in Autumn is high and much of the rain evaporates, as a result, little water is added in the River. Especially with the increase of agricultural water, the flow rate of Tao'er River drops sharply and the flow rate is rather low. The sudden drop of flow rates from September 7 to September 8 should be resulted from sudden increase of use of agricultural water.

B. Summary of the Water Regime change Characteristics of Tao'er River in Autumn

Based on the water level, flow rate, highest safety level and warning level of Tao'er River from September 2 to October 1 and monitoring of these data, the water level and flow rate of Tao'er River during this time is relatively low which is caused by natural and artificial factors.

Tao'er River is one of the most important rivers of Western Jilin Province. As a river which is mainly fed by precipitation, changes of its water regime are mainly affected by atmospheric precipitation. The annual rainfall of this river basin ranges from 350mm to 500mm, the annual evaporation is among 1500mm～1900mm, the rainfall-evaporation ratio is among 3.4～4.89, and the moisture coefficient is about 0.5. We can find out from these data that the evaporation amount is rather more than the rainfall. The evaporation-rainfall ratio in Autumn is the maximum, and a large quantity of agricultural water will be used in Autumn. So the direct use of water in Tao'er River and exploit of underground water makes the amount of underground water fed to the River decreases sharply, which is the reason of resulting in a low flow rate and water level of Tao'er River during this time.

When the water level of the River drops and the flow rate decreases, needs of normal industrial and agricultural water cannot be met, which to some extent will affect industrial and agricultural development, so the study on water regime of Tao'er River is of significance for development of Western Jilin Province.

Sudden drop of the water level and flow rate of the River on September 7 and September 8 embodies an outstanding characteristic of the water regime during this time that is the effects of increase of use of agricultural water on the flow rate.

IV. CONCLUSIONS

The author analyzes the water regime change characteristics of Tao'er River during a short period from aspects of the daily water level, flow rate, warning level and highest safety level, by monitoring of the water regime of Tao'er River in Autumn, and the following conclusions are drawn from changes of water levels and flow rates of the River:

- Tao'er River located in Western Jilin Province is a major tributary of Nenjiang River. It is mainly fed by atmospheric precipitation. So its water level and flow rate are affected by atmospheric precipitation significantly;
- There is less rainfall and great evaporation in Western Jilin Province in Autumn, and the ratio between the evaporation and the rainfall is above 3.0, so the water level of Tao'er River in Autumn is relatively low, and no water level above the warning level has occurred. Its flow rate is rather small, and even ultra-low flow rate has occurred;
- The rainfall of Jilin Province decreases gradually from the east to the west. As a river in Western Jilin Province, the water level and flow rate of Tao'er River are relatively lower than those in the east;
- The water level and flow rate of Tao'er River drop sharply from September 7 to September 8 when a lot of agricultural water is used. Sudden increase of use of agricultural water is one of the reasons of these changes; In addition, the drop of underground water level results in decrease of feeding amount for the River, which is also an important reason of the sharp drop of its flow rate.

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