The Water Balance of the Hongru River Basin

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Abstract

This research focused on water balance in the Hongru River Basin. It would be noted that the study area was characterized by its precipitation, runoff and evapotranspiration, and their temporal and spatial distributions are discussed. Finally, a water resources development strategy was presented based on the analysis on water balance, the strategy could ensure the water environment sustainability.

Key word: *Hongru River, water balance, precipitation, and runoff*

1.Introduction

The Huaihe River Basin (HRB) was located in the transitional zone of southern to northern climate in China. The Hongru River Watershed (HRW) was one of the largest branches of HRB, and it played an important role in studing the water balance of HRB. In HRW, the hydrological observation started from 1956, and the precipitation, discharge and open water evaporation were recorded. In this paper, The physical– geographical description of HRW was presented. Temporal and spatial distribution of the precipitation, discharge and evaporation was the most important research objective in the water balance study. So far, we have been made to estimate the temporal and spatial distributions of precipitation, runoff evaporation were estimated. The objectives of this study were as follows:

- .to analyses the series of the discharge, rainfall and evaporation.
- .to estimate mean precipitation, runoff and evaporation, in HRW and to analyses water balance components of the basin.
- .to analyses temporal and spatial distribution characteristics of precipitation and runoff in HRW.

2.study area and methodology

The Hongru River was originated from the Funiu Mountains (Fig. 1),

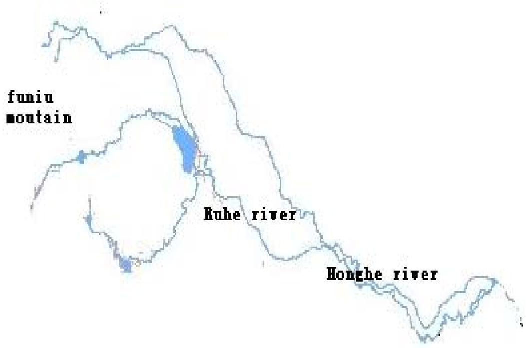

Fig.1 location of Hongru river basin

where the highest elevation is 500m roughly. It was located in northwest of the Huaihe River Basin, between 113º38´-115º30´ N and 32º30´-33º30´E, flowed to the Huaihe River main channel at the boundary between Henan and Anhui Provinces. It is one of the largest branches of the Huaihe River Basin, with a drainage area of 12,380km^2, a length of 325km. The terrain in the northwest was mountains and hilly, and in the remaining part was plain The proportion of mountains, hills, plains and low-lying areas to the total areas were 15%, 19%, 52% and 16% respectively. In this research, total 25 rain-gauges daily rainfall series and 8 stations daily discharge series were applied. All of the stations were set up at the places for the sake of spatial representative, easy for guarding, data recording and repairing..

the following general equation of water balance in HRW was as equation (1):

$$P=Q+E\pm\Delta W\pm\Delta V \quad (1)$$

where P was the total precipitation in HRW,. Q was the runoff of HRW, E was the total land evaporation, ΔW was –water withdrawal, And ΔV was stored water of reservoirs and lakes.

In large river basin, the water balance equation was used for quantitative evaluation of basin resources and for water project planning. For a long time interval, the equation (1)would be rewritten in equation (2) and (3).

$$P=Q+E\pm\Delta W \quad (2)$$

$$R= Q\pm\Delta W \quad (3)$$

where:

R was –the total runoff.

All the data series were from 1956 to 2000. The investigated monthly data series of agricultural, industrial and domestic water supplies, collected by the Hydrological Bureau of Henan Province, were also used to the water budget analysis. A conceptual basin hydrological model was built to analyze the precipitation distribution among the runoff, evapotranspiration, basin storage change and water supplies. The time series of the water budget components were analyzed also. Some parameters of the hydrological model, such as the maximum soil moisture (SM), field capacity (Fc), and so on, were estimated by the method of “trial-and error”. The efficiency coefficient of simulated runoff series to natural runoff series, which was the sum of the measured discharge, water supplies, the diverted water to outside of the sub-basin, and etc., was selected as the objective function of the modeling.

3.results

According to the analyzed result, showing the long-term average annual precipitation of Hongru River Basin was 915mm(or 11.3 $\times 10^9 m^3$) , the runoff 244 mm(or 3.02$\times 10^9 m^3$) and the evapotranspiration 650 mm(or 8.30$\times 10^9 m^3$). In the sub-basin, the temporal and spatial distributions of precipitation and runoff were uneven. Since 1956, annual precipitation and runoff data had been obtained. The largest and the smallest annual precipitation were 1379mm and 483mm respectively, and the largest and the smallest annual runoff were 657.2mm and 34.1mm respectively, so differences of precipitation and runoff between different years were large, and the largest values were more than 2.9 and 19.3 times of the smallest values respectively in Hong river basin.

The spatial distribution of the precipitation, runoff and open water evaporation was observed in HRW. Precipitation and runoff in the south were larger than that in the north, and the values in the mountains were larger than that in the plains. The precipitation in the upstream was 900-1200mm and the runoff 300-400mm. The maximum of precipitation and runoff were measured in the mountains area.

Both of temporal distributions of the precipitation and runoff were uneven. In a year, more than 50% of them concentrated in summer from June to August. Fig.2 and Fig.3 were the monthly variation of precipitation and runoff. The maximum and minimum of precipitation were in July and December respectively, and the maximum and minimum of runoff were in August and January respectively.

Fig.4 showed that precipitation and runoff were scarce in winter and spring, and abundant in summer and autumn in HRW.

Corresponding to the year with an exceedance probability of 90% (P), annual

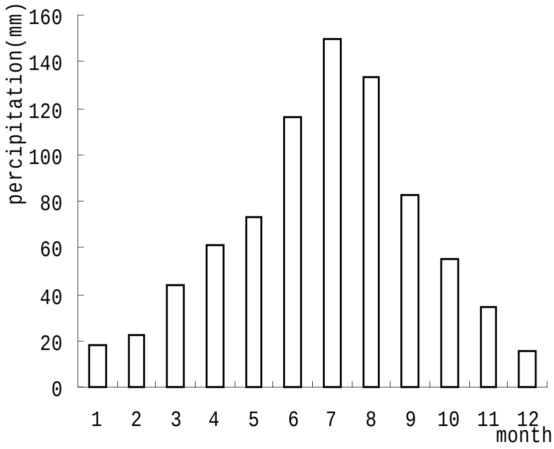

Fig.2 the monthly variation of precipitation

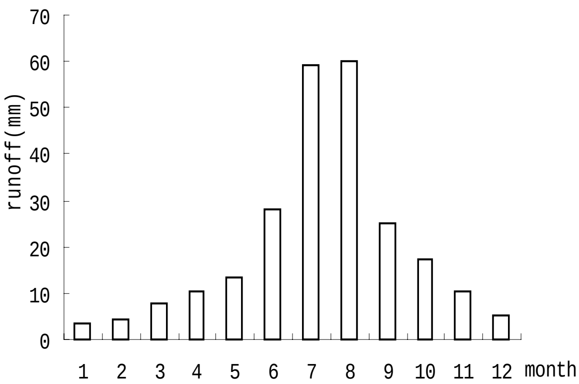

Fig.3 the monthly variation of runoff

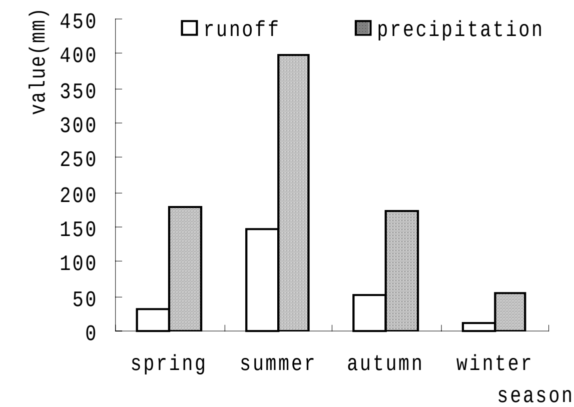

Fig.4 the seasonal variation of runoff

precipitation of HRW was 89.1mm(or 1.10$\times 10^9 m^3$), the runoff 47.5mm(or 0.59 $\times 10^9 m^3$),which was 9.7% and 19.5% of the average annual precipitation and runoff respectively. Analyses were made with these data to understand the trends of precipitation and runoff in this watershed. The preliminary analysis showed that there was a tendency of decrease about precipitation and runoff during 1956-2000.The long-term annual precipitation and runoff over 21 years (1980-2000) was smaller than that of over 24 years (1956-1979).

The long-term average agricultural, industrial and domestic water supplies were 116 $\times 10^6 m^3$, $3\times 10^6 m^3$, and $2\times 10^6 m^3$ respectively. The agricultural water supplies accounted for 85% of total water supplies roughly. Fig.5 showed that the trend of water supplies was increase, especially after 1980 due to the quickly local economy development and the increase of population. Therefore, the conflict between water demand and water supply was gradually serious.

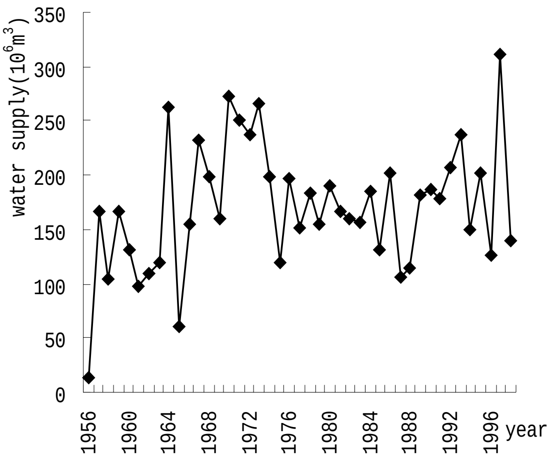

Fig.5 annual series of total water supply

Finally, a general water resources development strategy for HRW was presented based on the water balance analysis. Huaihe River Basin faced water shortage problems in many places due to rapid development in terms of population growth and industrialization. The water consumption would continuously increase. The objective of development strategy was to ensure the water environment sustainability.