DISCUSSION ON THE FLOOD VOLUME INVESTIGATION FOR THE UNGAUGED CATCHMENTS

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ABSTRACT

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The hydrological research of ungauged basins became the new topic of international hydrological plan, the flood investigation can effectively make up for the information insufficient of the contemporary remote sensing technology and traditional statistical interpolation techniques. Take Dasha River rainstorm for example, water surface slope was monitored of 8‰ by slope-area method, the peak flow was calculated of 1830 m³/s. According to the measured multi-peak flood hydrograph simulates single peak hydrograph and five points probable, the flood volume was calculated of 109 million m³, the runoff coefficient is 0.84 and runoff depth is 505 mm. The river basin has 250 mm previous rainfall, and the underlying surface was saturated, so the result indicated that it accord with runoff yield and concentration theory. The method can be extended for medium and small size river.

1. INTRODUCTION

The hydrological research of ungauged basins became the new topic of international hydrological plan, not only for water resources management, but also for flood control and drought relief [1]. Medium and small size river (basin area between 200 -3000 km²) harness has been listed into the new five-year plan for 2011 to 2015 in China, but most of the projects are in the ungauged basins and the flood investigation is the necessary basic work for project design.

In the last ten years, the new theory and method were used to solve the difficulties of traditional hydrology [2-4]. It includes the gray system theory, artificial neural network, fractal geometry and wavelet analysis, etc. But it is still hard to get the data such as the traditional flow, water level, flood peak discharge and flood volume in ungauged basins [5-7].

Historical flood is the flood that has occurred in the local area. Using historical flood investigation can get traditional hydrological data and improve the calculation accuracy of design flood. However, the historical flood data with both occurring years and volumes are extremely less, the available historical flood data with occurring years but without volumes are relatively more, and it is a new issue to rationally and fully apply these data in estimating the designed floods [6,8].

The flood investigation can effectively make up for the information insufficient of the contemporary remote sensing technology and traditional statistical interpolation techniques. Slope-area method is the main method to flood investigation, but it is only get the flood discharge. Five points probable was used to calculate the flood volume by investigation, it still either need measured time parameter, or need has single peak flood progress [9-10].

In order to make up for the deficiency of the studies existing, the author mainly uses the basin measured multi-peaks flood progress to analysis flood volume.

2. Materials and methods

The Dasha River is a medium and small river in the southeast of Liaoning province, with the basin area of 214 km², the main stem is 31 km. In August of 2010, there was 601.6mm rainstorm in the area of Dasha River

that Wulongbei city has seen an infrequent serious rainstorm flood second only to the flood of extra 50 return years occurring in 1934 since there was hydrological record.

Slope-area method accords to measure water level and sectional data, uses the hydraulic formula to calculate the instantaneous flow of the river. It is a kind of the velocity-area method, and is the main method to flood investigation [7-8].

Five points probable was used to calculate the flood volume of medium and small size river without measured data. Here are the three Form Feature coefficients as given below:

$$K_a = \frac{Q_a}{Q_m}, \quad K_w = \frac{W_z}{W}, \quad K_t = \frac{t_z}{t}, \quad (1)$$

where, K_a , K_w and K_t are form feature coefficients, Q_a : inflection point flow of rising flood(m³/s), Q_m are flood peak discharge(m³/s), W_z are part of the flood discharge(m³), W are The total flood peak discharge(m³), t_z : The rise lasting time(h), t : The total lasting time(h). K_a , K_w and K_t can be obtained by choosing analogy basins, single peak flood progress.

After getting the data of Q_m , and the time parameter, we can use follow formula:

$$Q_b = K_b Q_m \quad (2)$$

$$K_b = \frac{1-2K_w}{\frac{1}{K_t} - 2} \quad (3)$$

Where, Q_b are recession inflexion flow (m³/s).

3. Result

Investigation into Dasha River flood occurred in August 2010, the survey reach is straight long 500m, in the village of downstream. Three slope sections were set up and each distances is 100m. According to the fourth-grade leveling measurement, the starting point distance of each flood mark and elevation as shown in Fig.1, surface slope is 8‰, and three sectional parameters and flow as shown in Tab.1.

Figure 1. Surface slope of the flood in the measured section

Table 1. Sectional parameters and flow of Dasha River flood investigation

Section	I	II	III
Flood level (m)	20.64	20.55	20.38
Surface slope (‰)	8		
Sectional area (m ²)	806	741	831
Width (m)	157	139	185
Hydraulic radius (m)	5.14	5.32	4.48
Roughness	0.035		
Average velocity (m/s)	2.47		
Flow(m ³ /s)	1830		

Multi-peaks flood is not suitable to application five points probable, but hydrological station only has one time measured multi-peaks flood data, as shown in Fig.2, the broken line is the measured flood peak progress, all the rising stage of the peaks is approximately parallel each other, and the recession flow stage is also approximately parallel. In this paper, we parallel mobile hydrograph, virtualized single peak flood progress, as shown in Fig.2 of thin line, according to thin line, and then, proceeding five-point probable, as shown in Fig.2 of heavy line [8]

Figure 2. Measured, Virtualized and five point probable flood progress

In this section, analysis of five point probable three form feature coefficients, firstly, according to the runoff yield and concentration theory, base-flow is need to separation. The rising stage base-flow is 0, and the recession flow stage, the flow from 50 m³/s to 5 m³/s lasting 20d, but 1d

the discharge can be 30 m³/s, so the base-flow is 30 m³/s. Secondly, virtualized single peak flood progress lasting 58h, and the rise lasting time is 20h. Finally, result: $K_a = 0.03$, $K_w = 0.469$, $K_t = 0.345$, $K_b = 0.069$.

As shown in Tab.1, we can know the peak flow is 1830 m³/s, according to formula 1, so $Q_a = 54$ m³/s, $Q_b = 126$ m³/s. In this paper, we modified the time parameters by the precipitation data, the result is: $t_r = 10$ h, $t = 66$ h, based on the principle of multiple proportion to calculate the flood volume is 109 million m³[7-8].

4. Discussion

Five point probable got 109 million m³ flood volume, between two inflection points the flood volume is 102 million m³, accounting for 93% of the total flood peak. Unit line depends on the basin landscape structure and hydraulic conditions [8], Dasha River basin is long and thin, this is the whole basin precipitation, from upper to estuary, the shapes of flood peak process line fits the characteristics of river basin.

Analysis the relationship between precipitation and runoff, the basin total rainfall is 601.6 mm, the whole basin is 129 million m³, runoff coefficient is 0.84, runoff depth is 505 mm. Before this time precipitation, the river basin had four strong precipitation process, and cumulative rainfall is 250 mm, the underlying surface of basin was saturated, so it is reasonable that runoff coefficient as high as 0.84, the nearby watershed measured data also shown the same characteristics.

5. Conclusion

Research has shown that virtualized single peak flood progress from multi-peaks flood, and proceeding five-point probable is a reasonable method. According to the method, Dasha River flood volume is 109 million m³, runoff coefficient is 0.84, The result indicated that it is accord with runoff yield and concentration theory. The method can be extended for medium and small size river.

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