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ARTICLE

ANALYSIS OF DESIGN FLOOD AND WATERLOGGING FLOW DESIGN IN NO DATA AREAS

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ABSTRACT

This paper takes Dawa District as an example. Because there is no measured hydrological data in the territory, it is impossible to directly calculate the design flood. The design of rainstorm and flood was calculated in this area, and the drainage flow of this area was calculated at the same time, which provided a scientific basis for flood control and drought relief in this area in the future.

KEYWORDS

Design flood, drainage flow, dawa district

1. OVERVIEW

Dawa District is located in the southwestern part of Liaoning Province, the most downstream of the Liao River, the north bank of Liaodong Bay, and its geographic coordinates are 121°47'-122°20' east longitude and 40°39'-41°09' north latitude. It is interdependent with Panshan County in the north, facing Yingkou City across the Daliao River in the southeast, adjacent to the sea in the south, and adjacent to the Liao River in the west [1].

Dawa District has a total land area of 1,526.61 km^2, 776,000 mu of arable land, 754,000 mu of rice planting area, and 266,000 mu of reed field. There is still a large area of tidal flats for development and utilization [2]. It has jurisdiction over 15 towns, two streets, a total of 169 villages and 1,001 village name groups. By the end of 2014, the total number of households in the district was 11. There are 730,000 households, the total registered population is 315,493, and the non-agricultural population is 290,114, accounting for 92% of the population of the whole district [2-5]. Birth rate 6. 64%, the mortality rate was 4.16%, and the natural growth rate was 2.48%.

2. RIVER SYSTEMS

Facing rivers on both sides and the sea on the other side, Dawa District has a unique geographical location and many rivers, with a total of 22 rivers. There are two large rivers, the Liao River and the Daliao River.

In Dawa District, the Liao River starts from Gangzi Drainage Station and ends at the mouth of Liao River in the south, with a total length of 49.8 km, a maximum safe flood discharge capacity of 3000 m^3/s, and a population of 4. 7.48 million people, arable land area 6. 680,000 mu, and 150,000 mu of reed fields. The flood control standard of the Liao River Embankment in the area is 20 years, and the total length of the concrete road at the top of the embankment is about 40 km. The flood discharge width of the river channel is 1000-1800 m, the widest part of the river beach is about 1200 m, and the narrowest part is about 200 m. The 7.18 km upstream river channels and embankments are managed by the Liaohe River Reserve Management Bureau; most of the downstream Liao River Diding Road (from Yuxin Wulian to Jieguanting tide gate) passes through Weitang, which is the basic project of local tourism projects, and the Liao River is on the right side of the road. On the left side are the reed ponds and cultivated land of Zhaohai Reed Industry. The main vegetation on the river bank and the beach is reeds, papyrus, scallions and other aquatic plants.

The Daliao River is the Huntai River Basin. The Hun River and the Taizi River flow into the sea after the confluence of the Sancha River, with a total drainage area of 1 962 km^2. The river in Dawa Strict starts from Dongfeng Drainage and Irrigation Station in the north and ends at the mouth of the Daliao River in the south, with a total length of 85. 2 km. The maximum safe flood discharge volume is 8,795 m^3/s, the population of the basin is 120,000, the area of arable land in the basin is 230,000 mu, and the area of reed fields is 15,000 mu. The flood control standard of the Daliao River embankment in the area is 50 a once, and the total length of the concrete road at the top of the embankment is about 61. 3 km, (Dongfeng Drainage and Irrigation Station - Liaobin Street). The flood width of the river is 1 000-1 800 m, and some sections are about 700 m. The wider river beach is mostly in the upstream section, that is, the section from Dongfeng Drainage and Irrigation Station to Rongxing Weijiagou Dangchao Gate. The total area of the floodplain is about 3. 80,000 mu, most of which have been developed and utilized by the local government and farmers, mainly for rice fields, freshwater aquaculture, and some dry fields for growing corn and soybeans. The main vegetation on the river bank is local aquatic plants such as reeds, papyrus, scallions, etc. In recent years, the pollution has been controlled and the water quality has improved.

3. DESIGN RAINSTORMS

Dawa District is located in the southwest of Liaoning Province. It belongs to the warm temperate continental sub-humid monsoon climate, with rain and heat in the same period, and the average annual precipitation

Table 1: Pearson type III curve modulus coefficient table.

Parameter	C_v	C_s/C_v	K_p			
			P=2%	P=5%	P=10%	P=20%
Numerical value	0.60	3.5	2.76	2.20	1.77	1.35

Table 2: Calculation results of different frequency design rainstorms in Dawa District.

Rainstorm mean		C_v	C_s/C_v P=2%	Design rainstorms			
				P=5%	P=10%	P=20%	
3d	120.0	0.60	3.5	331.2	264.0	212.4	162.0
24h	100.0	0.60	3.5	276.0	220.0	177.0	135.0
6h	70.0	0.60	3.5	193.2	154.0	123.9	94.5
1h	40.0	0.60	3.5	110.4	88.0	70.8	54.0

is 651. 0 mm, mostly concentrated in summer. Due to the lack of measured rainfall data in the project area, the "map-checking method" was adopted for the design of rainstorm calculation. , check the contour map of rainstorm, consider the P-III type distribution, and calculate the design rainstorm with different frequencies.

According to the "Calculation Method of Design Storm Flood in Small and Medium Watersheds in Liaoning Province (No Data Areas)", the hydrological division of Dawa District belongs to the district, and the design storm and parameters are shown in Table 1 and Table 2.

4. DESIGN FLOODS

By applying the method of combining causal reasoning and empirical correlation, the empirical formula of river basin confluence duration, river length and gradient is determined, and the correlation of runoff coefficient is considered to calculate the design peak flow. The empirical formula is as follows.

$$Q_p = 0.278\varphi_P \mathrm{i}_P S$$

$$i_P = \frac{P_{i_P}}{\tau}$$

$$\tau = x\left(\frac{L}{\sqrt{J}}\right)^y$$

$$P_{i_P} = P_{24} \bullet 24^{n2P-1} \bullet 6^{n1P-n2P} \bullet \tau^{1-n1P}$$

In the formula: Q_p is the design peak flow; φ_p is the runoff coefficient of the design peak flow; i_p is the design rainstorm intensity during the confluence duration; P_{ip} is the design area rainfall over time at the design frequency; τ is the confluence duration; x, y are the regional confluence parameters; n_{1p} and n_{2p} are rainstorm indices.

The hydrological division of Dawa District is divided into districts. According to the "Calculation Method for Designing Heavy Rain and Flood in Small and Medium Watersheds in Liaoning Province (Regions without Data)", this area 2. 5, 0. 85. The design rainstorm is based on the calculation results of the design rainstorm. The basin parameters are measured by the measured topographic map, and the point-surface reduction coefficient is determined according to the attached table of "Calculation Method of Design Stormwater Flood in Small and Medium-sized Watersheds (No Data Areas) in Liaoning Province", as shown in Table 3.

The Xinkaixi River is divided into two flooded areas, the Nanheyan flooded area to the south of the Hejia Drainage and Irrigation Station, and the Yangjia flooded area to the north. Xinkaixi River Yangjialuo is bounded by Shuangqiaozi, which is divided into two parts: north and south. To the north of Shuangqiaozi, it flows from north to south, and to the south of Shuangqiaozi, it flows from south to north and flows eastward to Shuangqiaozi. Convergence, westward flow into Crab Ditch.

Table 3: Reduction coefficient of rainstorm point surface in Dawa district.

Drainage area		0	10	20	50	70	100
	24h	1	0.998	0.994	0.985	0.962	0.948
K_f	6h	1	0.995	0.988	0.96	0.95	0.93
	1h	1	0.985	0.975	0.945	0.932	0.91

5. DRAINAGE HYDROLOGICAL ANALYSIS

5.1 Drainage Standard

According to the "Design Specification for Irrigation and Drainage Engineering" (GB50288-99), combined with the actual development of the Dawa District, the design drainage standard adopts 10 a once in 3 d rainstorm to the shallow irrigation layer of the crops in the corresponding growth period, 5 d drain to return to normal water level (ie., 5 d drain).

5.2 Drainage Modulus

Dawa District belongs to the coastal polders and plain areas of Liaoning Province. According to the "Design Specifications for Irrigation and Drainage Engineering" (GB50288-99), the design drainage modulus of paddy fields in the plain area adopts the average exclusion method. The specific calculation formula is as follows.

$$q_w = \frac{P - h_1 - E - F}{86.4T}$$

In the formula: q_w is the designed drainage modulus of the paddy field ($m_3/s \cdot km_2$); P is the designed rainstorm amount (mm); h_1 is the stagnant water depth of the paddy field (mm); E is the evaporation of the paddy field (mm). mm); F is the amount of leakage from the paddy field (mm); T is the drainage duration (d).

According to the calculation results of the design rainstorm, the average maximum 3 d rainfall in the Dawa District for many years is 120.0 mm, the maximum 3 d rainfall P = 212.4 mm; the stagnant water storage depth of the paddy field is 60 mm, and the other parameters refer to the analysis results of "Analysis of Drainage Modulus in the Central Plain and Southeast Coastal Polders of Liaoning Province". After calculation, Dawa District drainage modulus = 0. 33 $m^3/s \cdot km^2$.

5.3 Drainage Flow

Table 4: Calculation results of drainage flow in the project area.

Drainage zone	Segment	Drainage area	Drainage modulus	Drainage flow
Xinkaixi River South River along waterlogging sheet	Xinkaixi River Yangjia waterlogging sheet	36.3	0.33	12.0
Zhenjia Gate - Hejia Drainage and Irrigation Station	North of Shuangqiaozi	3.87	0.33	1.28
	Crab ditch	6.52	0.33	2.15
Hejia Drainage and Irrigation Station - Shuangqiaozi	Hekou - Yangjia Drainage and Irrigation Station	32.8	0.33	10.8

The drainage flow is determined according to the drainage modulus and drainage area, and the formula is as follows.

$$Q_d = q_w \bullet F$$

In the formula: Q_d is the drainage flow (m^3/s); q_w is the drainage modulus ($m^3/s{\cdot}km^2$)); F is the drainage area (km^2).

The Xinkaixi River is bounded by the Hejia Drainage and Irrigation Station, the Yangjia floodplain to the north and the Nanheyan floodplain to the south. After calculation, the drainage flow of each plot is shown in Table 4.

6. DESIGN FLOOD LEVEL

This project involves the main function of Xinkaixi River drainage, the determination of the scale of the river channel, considering that the waterlogged water enters the river channel in the form of self-draining, that is, the design flood calculation result is used as the river channel overflow, and the water level of the river channel is based on the principle of energy conservation. Curve-by-segment trial algorithm.

6.1 Flow

Use design flood calculation results.

6.2 Roughness

The selection of the channel roughness is based on the “Design Specifications for Irrigation and Drainage Engineering” (GB50288-99). The river channel in the project area is relatively smooth and straight, with a little siltation, and some sections are poorly maintained. The comprehensively selected channel roughness is 0.025.

6.3 Starting Water Level

Starting from the end of the Xinkaixi River channel, the starting water level is calculated according to the gradient at the end of the channel, and the normal depth is calculated. After calculation, 1.91 m is used as the starting water level, and the water level on the Zhenjia 1 sluice gate is pushed to 2.81 m as the starting water level of the Xinkaixi River in this project.

The starting water level of the crab ditch is calculated according to the gradient at the end of the channel, and the normal depth is calculated, and 2.20 m is used as the starting water level.

Table 5: Design water level table of some nodes in the current river course.

River course	Station	Design water level
Xinkaixi	K0+000-K4+500	3.30-3.05
	K4+500-K8+000	3.05-2.98
	K8+000-K17+650	2.98-2.60
Crab ditch	P0+000-P3+850	2.98-2.20

6.4 Calculation Method

The calculation of the water surface line is based on the principle of energy conservation, and adopts the section-by-section trial algorithm of the water surface curve of the channel section. The calculation formula is as follows.

$$z_1 + \frac{(\alpha_1 + \zeta)}{2g}\frac{Q^2}{A_1^2} - \frac{Q^2}{K_1^2}\Delta s = z_2 + \frac{(\alpha_1 + \zeta)}{2g}\frac{Q^2}{A_2^2}$$

In the formula: Q is the cross-section flow rate; A1 and A2 are the cross-sectional areas of the upper and lower sections; z1 and z2 are the water levels of the control section; ξ is the local loss coefficient; Δs is the distance between the two sections; K is the flow modulus, $K = \frac{AR^{2/3}}{n}$; R is hydraulic radius; n is channel roughness; α1, α2 are kinetic energy correction coefficients.

The bridge drop is calculated as follows.

$$Z = \eta(V_M^2 - V_O^2)$$

In the formula: η is the coefficient: V_M is the average flow velocity under the bridge: V_O is the average flow velocity of the section.

The calculation results of the design water level of the river channel are shown in Table 5.

7. CONCLUSION

There is no measured hydrological data in Dawa District. In the design process, the empirical formula in “Calculation Method of Design Storm Flood in Small and Medium Watersheds in Liaoning Province (No Data Areas)” is used to calculate the peak discharge. The calculation is carried out, which can be used as a reference for the flood control design and drainage design in this area.

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