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Research on Regional Planning of Trans-provincial Flood Control River

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Abstract. Aiming at the problem of the integrity of the regional flood control planning with the division of administrative boundaries in the coordinated development of the region, the typical inter-provincial basin of Beijing, Tianjin and Hebei is selected as the research object, and the numerical coupling model of flood control and drainage based on MIKE11, MIKEurban and MIKE21 is constructed to identify the regional problems of river flood control, to reveal the systemicity, linkage and synergy of flood control and drainage planning under the background of regional coordinated governance, and to explore the planning ideas for linkage planning of regional flood control and drainage projects.

1. Introduction

The urban flood control and drainage system is established based on the urban water system, urban drainage system, urban regulation and storage measures, and drainage equipment. As an important part of the large drainage system, the river channel plays a vital role in flood control and drainage, and the river channel is not independent of the water system. In addition, it is regional, systemic, and linkage. This characteristic of rivers coincides with regional coordinated development. The regional linkage planning of flood control and drainage projects is based on the structural system of the water system. Therefore, scientific planning of a trans-provincial flood control and drainage system has become an inevitable demand for ensuring the safety of regional flood control and drainage.

In the context of the coordinated development of Beijing-Tianjin-Hebei, with the water system as the ecological context, nested in the urban water safety planning work, the concept of regional linkage planning for flood control and drainage projects is proposed. Taking a river basin in Beijing as a research case, exploring the calculation ideas of flood control and drainage engineering planning, and combining with the ecological requirements of regional spatial development, expand the storage space of the water system, replenish groundwater resources, and optimize the regional flood control and drainage plan. The research determines the implementation boundary of the planning scheme through flood calculation, establishes a joint plan for the Beijing-Tianjin-Hebei three places, and finally forms the conclusion of this case, which provides basis and ideas for the formulation of flood control and drainage schemes in the context of regional coordinated development.

2. Numerical simulation

2.1. Model framework

The research case is located in the southeast of Beijing, close to Langfang City and Tianjin City. Aiming at the specific characteristics of the research area and the potential flood risk in the research area, the model framework of MIKE11, MIKEurban and MIKE21 coupling is established. Taking the flood risk

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in the research area as the research direction, by comprehensively considering the characteristics and specific distribution of runoff generation and concentration of the underlying surface, construct the nested rainfall process, surface runoff generation process, drainage process of the construction area, river flooding process, river network confluence process, and the hydrological coupling model of the ground flow process. Based on the conservation and circulation principles of matter and energy, taking into account the planar and vertical spatial changes of the study area, the numerical simulation process of water movement is realized.

2.2. Parameter calibration

The specific process of hydrodynamic calculation of MIKE11, MIKE21 and MIKEurban is to construct hydrodynamic equations based on the conservation of mass, momentum, energy, and the characteristics of runoff generation in the basin, simulate the temporal and spatial changes of rainfall and runoff, and solve partial differential equations through numerical algorithms. When the number and form of the initial conditions and boundary conditions are appropriate, the changes in the flow state of the unsteady water flow over time and flow($v=v(s,t)$ and $h=h(s,t)$) can be obtained. Quantification is a key step to determine the accuracy of the model. The empirical value is determined by querying related literature and experimental research data, which is used to initially set the model parameters and correct the parameters through the calculation results of the hydrological empirical model.

2.2.1. Hydrodynamic parameters

The hydrodynamic parameters determined for the study area mainly include river roughness, calculation step length, dry and wet water depth, surface and pipeline Manning coefficient, head loss, vortex viscosity, Coriolis force, wind field, initial water level, etc. Among them, the roughness of the river channel is set to 0.02~0.03; the calculation step is set to be 0.1~1s; the dry and wet water depths are set to 0.0002m and 0.0003m; the surface Manning coefficient is set to 30~33; the pipeline Manning coefficient is set to 75~85; The local head loss is determined at the specific location according to the structural characteristics; the vortex viscosity coefficient is set to 1; the initial water depth of the river channel is set to 0.01m.

2.2.2. Topographic files

By using 5m×5m GIS raster data to construct the topographic structure file of the study area, using the divided rectangular difference grid to adapt to the spatial changes of the topography in the watershed, and at the same time, to identify the local area sensitive to water movement in the terrain, and the drainage system nodes such as rain wells and roads are treated locally. For river network control, the input section density is not less than 50m, and the section of the river channel is partially dense in the irregular river flow.

2.2.3. Confluence production parameters

Based on the principle of runoff generation in the hydrodynamic model, the underlying surface is divided into six types: high-density construction area, industrial area, traffic road, village, farmland, and green space. The specific range of the impermeability of the underlying surface is 15%~80%. Then calculates the six typical areas in this area by visual interpretation. In the urban module, the flow generation and convergence process of the watershed is generalized through the time-area curve, combined with Mike21 dynamic wave calculation, to realize the coupled simulation of hydrology and hydrodynamics. In the urban module, the runoff attenuation coefficient of the catchment area is set to 0.9; the velocity is set to 0.2m/s; the initial head loss is set to 0.0006m.

2.3. Boundary conditions

2.3.1. Rain conditions
The maximum rainfall data of 1h, 3h, 6h, 12h and 24h in the study area were calculated through the Beijing Hydrology Manual, and the rainfall data was curve-fitted through the Pearson type III curve, and the typical rainfall process in the study area was obtained as MIKE21 and The boundary conditions of the urban module.

2.3.2. Flow and water level boundary
Through the hydrological calculation of the upper reaches of the A and B rivers, the flow process of the upstream river course in different return periods is determined. Establish the topological structure of the river network within the research scope, and clarify the input and output boundaries of the Mike11 module by constructing the upstream and downstream relationships. Aiming at the local area of the B river basin at the junction of the three provinces, the water level boundary conditions of the river are calibrated by hydrological methods, and the river, pipe network and ground are coupled simulation calculations to verify the status quo under the premise of ensuring smooth drainage of the construction area and no overflow of the river. The flood carrying capacity of the B river.

3. Beijing-Tianjin-Hebei regional linkage planning

3.1. Overview of the study area
The study area is about 50km^2 , and the study area includes two main rivers: River A and River B. The end of River A merges into River B. The length of the River A is about 12km, and the total drainage area is about 84km^2. River B flows from northwest to southeast through Beijing,Langfang City, Beijing, Langfang City, and Tianjin City, the total length is about 29.43km, and the drainage area above the city boundary of Beijing is about 317km^2. The main construction areas included in the research scope are X Economic Development Zone and M University City.

Figure 1 Location map of the river in the study area

3.2. Current status and existing problems
In recent years, the underlying surface in the B River Basin have changed greatly. The original design flow and the connection arrangements between provinces and cities cannot meet the requirements of current development. The river management standards and progress of various regions have varied over the years, so this contradiction is further expanded. At the same time, because of the unclear arrangement of floods along the B River, the water level cannot be determined, the construction of flood control and drainage facilities on both sides of the bank, and the vertical arrangement of roads are lacking basis, posing safety risks. In order to solve this problem, it is necessary to carry out overall planning for this area, and realize a reasonable, clear and implementable flood control and drainage plan across provinces in the study area by taking into account linkage, system and coordination.

3.3. *Flood volume calculation*

In the numerical simulation analysis, the flood control and drainage conditions of the study area are studied when different rains and floods are encountered by the surface water, the river water level change and the pipe network overflow, and the boundary conditions are derived through the hydrological probability and empirical formula, and it is verified by model calculation results.

In order to ensure the safety of flood control and drainage in the B river basin in Beijing, Langfang City, and Tianjin City, the B river basin's current restriction requirements have been considered in an overall manner.

There are many built-up areas on both sides of the river in Langfang, to ensure safety, consider the control plan for the 20-year flood level below the current ground 1~1.5m, and the control plan that the 50-year flood level is lower than the bottom of the main bridge girder.

As there is no governance plan for the Langfang and Tianjin sections of River B, the simulation is based on the current situation. The two banks of this section of the river are currently farmland and woodland. There are existing embankments along the two sides of the river. The pavement is about 1 to 2m higher than the ground. After calculation, the flood carrying capacity of the Langfang and Tianjin sections cannot meet the calculation. According to the value requirement, if the flood is discharged based on the calculated flow, the flood level in 20 years will inundate the current construction area. Through hydrological calculations and model verification, the study considers that the 20-year flood level of the control plan is basically flush with the surrounding ground, and the 50-year flood level of the control plan is not less than 1m below the embankment on both sides.

Taking the water level as the control condition, through model verification, the flow rate of River B is deduced and determined as follows:

Table 1 Table of B river discharge results

Section location	Watershed are（km^2）	Q_{20}（m^3/s）	Q_{50}（m^3/s）
Starting point	0	35(diversion)	51(diversion)
Entering the boundary of Beijing	205	229(planning leaked 130)	328(planning leaked 160)
Out of Beijing Boundary	316	215	270

After analyzing the relationship between the flood process line of the B river and the three tributaries, and considering other current limiting solutions, it is determined that the discharge of the A river into the B river once in 20 years is not more than 57 m3/s, and the discharge into the B river once in 50 years is not more than 77 m3/s.

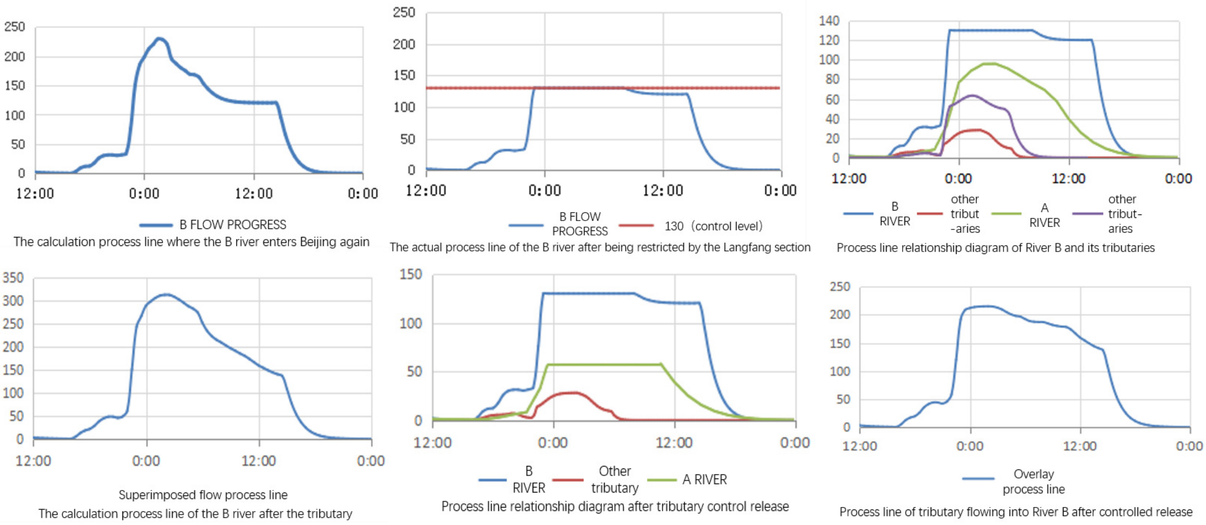

Figure 2 River flow process line

3.4. Flood and Volume Interaction Planning
Due to the limitation of the flow of River B, part of the flow of River A needs to be resolved within the basin. This study considers various solutions such as regulation and storage in the river course, regulation and storage of flood storage and detention area, river overflow, upstream tributary segment regulation or overflow, and combination schemes. At the same time, the research is carried out on whether to set up pumping stations.

First of all, the regulation and storage in the A river can not meet the flood volume requirements, posing a flood threat to some low-lying areas; through simulation calculations, the flooding risk and loss caused by the flooding plan of the river course to the farmland area can be controlled, but three villages have suffered flooding Disaster; At the same time, it is difficult for the upstream tributary segmented regulation and storage plan to meet the requirements of the regulation and storage volume; the investment in setting up pumping stations on the basis of the above plan is too large. After comparative analysis, it is finally determined that an ecological flood storage and detention area will be built on the basis of the available ponds in the submerged basin.

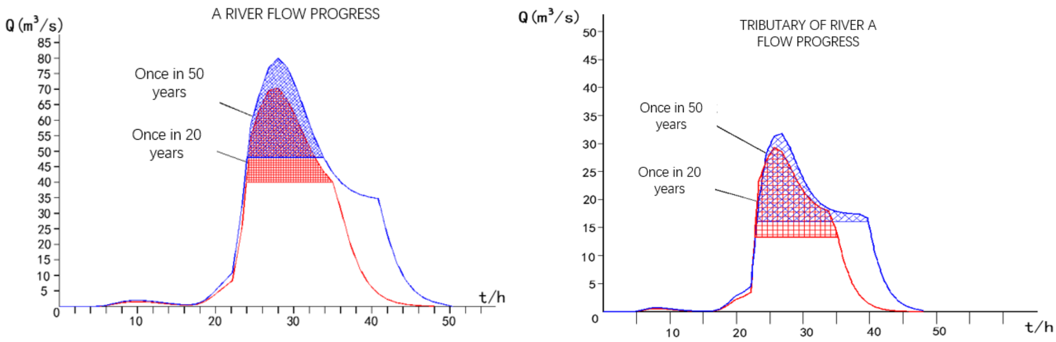

Figure 3 Schematic diagram of planned flood storage and detention area

According to the current topographical features in the basin, use local low-lying areas to set up two flood storage and detention areas to absorb the peak flow, set up planned flood storage and detention areas by setting controllable buildings for the river in MIKE11. Determine the storage scale according to the regional flood control and drainage standards. The flood storage and detention area is calculated and analyzed by the model, and the specific flood control and storage capacity is obtained on the premise of meeting the safety requirements of the local flood control and drainage. After regulation and storage in the flood storage and detention area, the flow of the flood once in 20 and 50 years from the river A to the river B is shown in the figure below.

4. Flood prevention and drainage plan
According to the characteristics of the three provinces in the study area, the plan is made with the idea of overall planning, system and linkage, and the current characteristics of the river channel and the implementation plan are studied section by section. The boundary conditions of the study area are reasonably determined, and the upstream and downstream restrictive factors are considered to realize the regional linkage of flood control and drainage projects. Planning, formulate an overall plan for regional planning.

By coupling the three modules of MIKE11, MIKE21 and MIKEurban, considering the pipeline network of the construction area in the study area, surface topography changes, river planning, and current conditions, the model boundary conditions are calibrated through hydrological calculations, and after different re-calculations, the model is used to add verification, in the process of repeated verification and calculation, the iteration of the planning scheme is realized. The specific technical route is shown in the following figure:

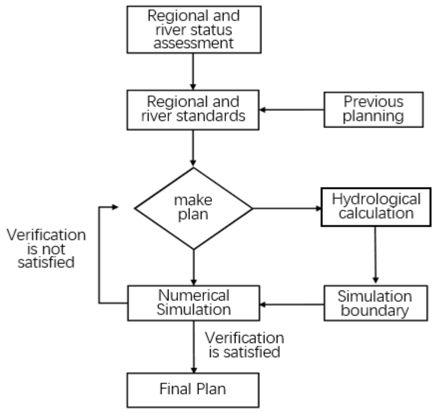

Figure 4 Technical roadmap of planning scheme

5. Conclusion

From the perspective of river flood prevention and waterlogging prevention planning research, regional development is systematic, linked, and synergistic, and the division of administrative boundaries splits the complete water system from the perspective of governance and implementation. Considering the trend of regional integration development, break through the traditional planning ideas, and build the foundation of the spatial governance capacity of metropolitan areas and super-large cities with a regional strategic vision—the linkage planning of flood control and drainage area. In addition to planning ideas, it also provides a new entry point for the coordinated development of urban water safety areas from a planning perspective.

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