Storm Water Logging Analysis and Pre-warning System Construction in Beijing City

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ABSTRACT: In this paper the analysis of natural cause of Beijing Storm inundation and the effect of the human activities has been taken. Flood risk can hardly be eliminated solely by projects. Pre-warning system established is an efficient measure to minimize the influence of flood. Several main functions of this system and their examples are described in the paper, such as: monitoring, forecast, scheme, warning, dynamic decision-making and information publication.

1. INTRODUCTION

Recently, storm in local scope usually arise in Beijing and caused severe inundation, which disturbed the city functionality, environment and resources. On 10th July 2004, sudden storm reached 50~110mm in five hours. 4698 urban houses were damaged, 6 buildings collapsed, 2 persons injured, over 70 roads submerged and the traffic was jammed for six hours. In 2007, the storm in Shunyi District interrupted the traffic of airport highway.

Improving the key points in flood control process by analyzing storm inundation causes is very important to enhance the emergency responding ability, reduce flood loss, protect the life and property, ensure the continuous economics development and city modernization process.

2. THE NATURAL CAUSE OF BEIJING INUNDATION

There are three main sources of Beijing inundation:

- Continuous rainfall in Yongdinghe Basin caused flood and broke the left dyke, so the urban area inundation resulted. This was recorded in books of Ming and Qing Dynasty. After 1949, such case had not happened for over fifty years due to the government's focus on flood control projects reinforcement.

- Storm in large scope in urban area (100~300mm rainfall in 24 hours). Low drainage capacity of city rivers causes inundation. This is not usual, but the influence on living and production is significant.

- Extremely intense rainfall in short time causes inundation in low areas, which commonly leads to power failure or houses collapsing. This case is quite often, such as the traffic jam due to local intense rainfall on 10th July 2004.

3. THE HUMAN ACTIVITIES

- The high temperature and much dust in air lead to "City rainfall effect". The frequency

and intensity of rainfall in urban area are higher than other place.

- For the flat ground of Beijing, the flood from upstream western mountains discharges into Tonghui River and Liangshui River through urban area, increase the burden of city rivers.
- Expansion of city causes the runoff changed and water fast converged. The runoff coefficient is 4 times bigger the old value.
- The drainage capacity is not enough. Storm usually causes inundation for the intense rainfall.
- Urbanization process cut off many original rivers and channels, which greatly reduces the flood discharging capacity.
- The low area in the city is often inundated and such location usually causes traffic jam in surrounding area.
- The management, coordination and dispatching of government, such as pump station breaking down.

4. FLOOD CONTROL MEASURES

According to previous analysis and the flood control experience of developed cities, there are several measures we can adopt:

- Take flood control into consideration during city plan process. Make reasonable balance between safety and investment.
- Increase the rainwater storage capacity of city.
- Decrease the runoff coefficient of ground, which can also increase the underground water supply.
- Establish city rainwater management system. This is a fairly complex system relevant to many fields and should be improved by multi means.
- Flood risk can hardly be eliminated solely by projects. We should increase self-adaptability to minimize the influence of flood and establish monitoring, forecast, scheme, warning and emergency responding system by advanced technologies.

5. URBAN PRE-WARNING SYSTEM CONSTRUCTION

The overall objective of this system is: monitoring, forecasting inundation by simulation and analysis, giving reference of inundation warning class, publishing data to relevant departments and staffs, assisting emergency responding by scheme query, database and dispatching simulation.

The logical structure of system is illustrated as Fig.1.

- Flood risk evaluation. Develop city flood risk map by available resources and establish management systems, which can be used to query and publish data and serve as technical reference during dispatching.
- Emergency responding schemes. The part is designed to manage the annual conventional flood control schemes. By metrology, hydrological, hydraulic and dispatching models, the schemes can be improved from abstract rule description to operational measures.

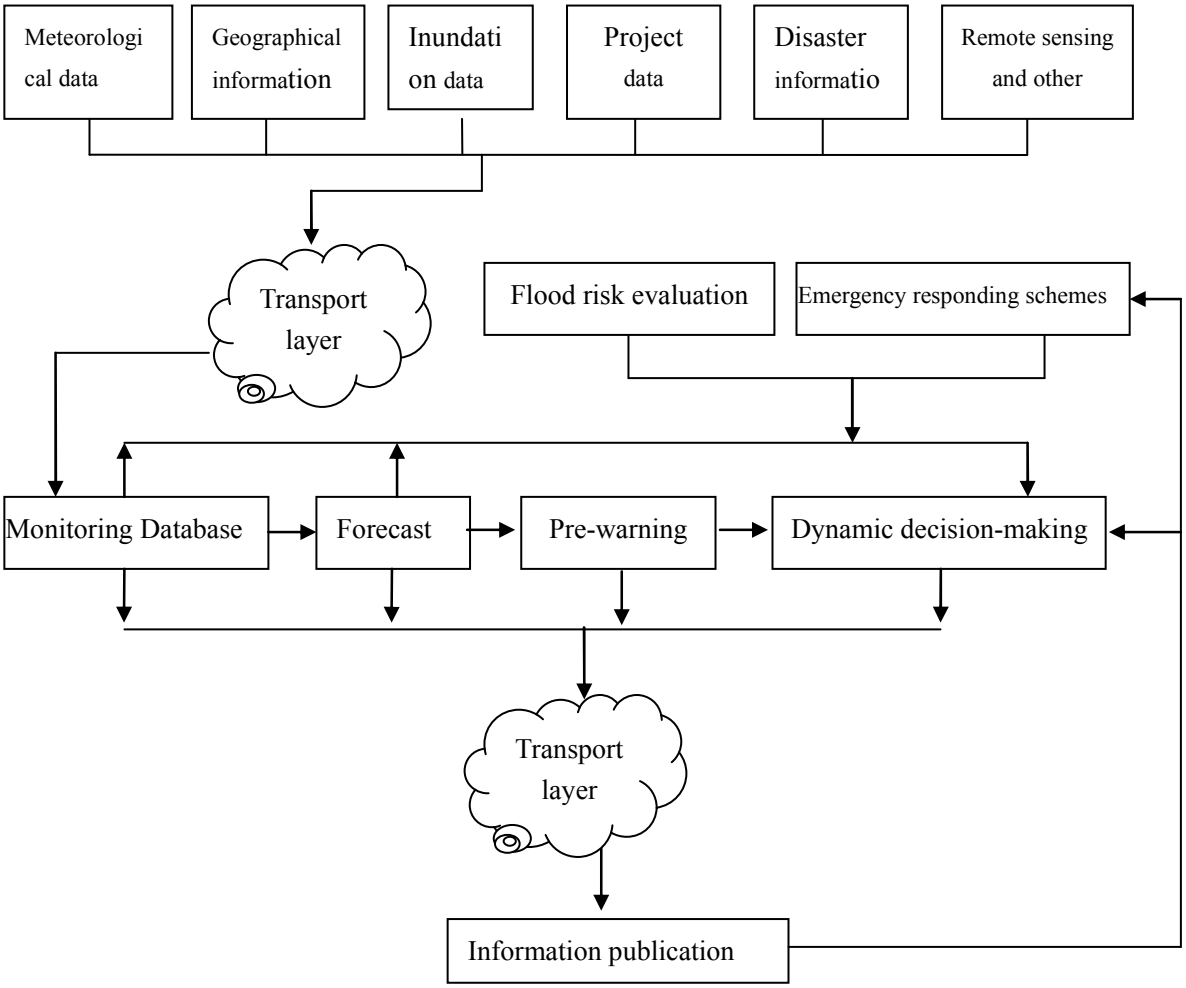


Fig.1 Logical structure of system

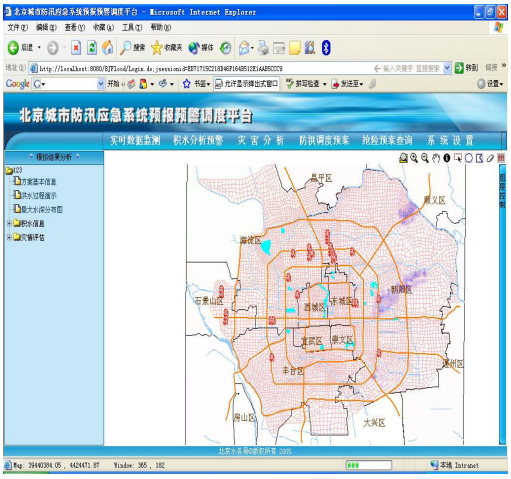
- Monitoring. Acquire metrological, water level, discharge, inundation, important facilities video, remote sensing and other data from relevant departments respectively. Constitute distributed database by inter-component to serve as data collection and transition platform, as will enable the data share of public service departments.
- Forecast. Publish rainfall forecast by metrological data. Establish distributed hydrological model, hydraulic model and flood loss evaluation model. Thus we can get the information such as: future rainfall, possible inundation, flood flow and the result. As will earlier pre-warning and provide comprehensive analysis tools for decision-making.
- Pre-warning. Make research on natural and social guideline to reflect current situation and the corresponding result. Under multi-guideline framework, output comprehensive and classified information by real-time monitoring data and forecast data. Such system will be highly expandable.
- Dynamic decision-making. Based on scientific schemes, find the most similar implementation directly in scheme management platform to perform rapid decision-making. However real-time analysis is still necessary for the difference of floods. Simulation model should be provided to enable real-time access of monitoring data, forecast data, pre-warning data.
- Information publication. Perform rapid decision informing and result feedback by

television, broadcast, network, fax, mobile phone message and other communication means. Based on current flood control organization, design scientific information publication rules facing different roles in the system.

6. SCHEMES

The following interfaces are typical UI in the established "Beijing urban flood control and emergency responding platform".

- Storm inundation analysis. Two dimensional hydraulic unsteady model outputs the inundation information under certain rainfall and projects dispatching scheme. In fig2, the possible inundations of all urban areas are revealed. In fig3, the inundation process at important locations are shown in the form of charts, animation and graphs.



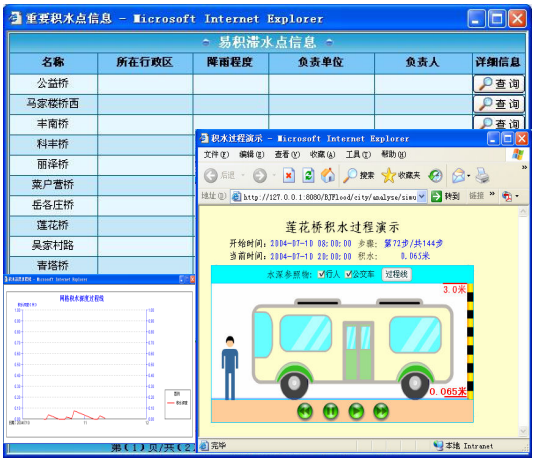


Fig.2 The possible inundation of all urban areas. Fig.3 The inundation process at important location

Pre-warning. Automatically judge the warning class by inundation simulation result according to preset standard. Users can manually adjust the class based on monitoring data and other situation. Users can also publish warning to other organizations by system, as illustrated in Fig4.

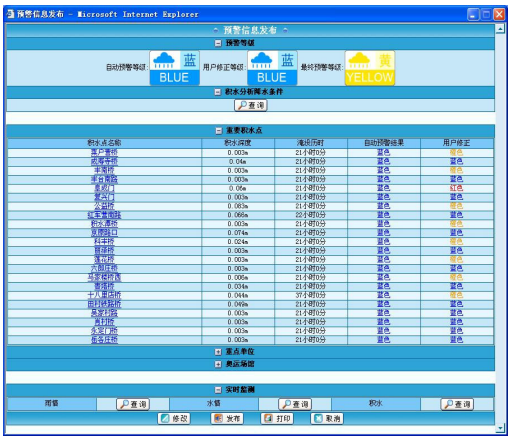


Fig.4 Automatically judgment the warning class by inundation simulation results

Fig.5 Three dimensional visualization

- Three dimensional visualization. Three dimensional scenario of Beijing has been established by integrateing GIS, flood control theme data, monitoring data and certain analysis visualization, which is shown in Fig5.

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