Research on the emergency management pattern and adjustment system for urban waterlogging

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Abstract. Urban waterlogging events have become more frequent in big cities, causing a considerable economic loss and casualties. Waterlogging disasters exert increasingly severe influences on cities, which has become a research hotspot under changing environment. In view of that problem of insufficient information in the waterlogging emergency management, it is necessary to build emergency management pattern to adapt to the changing environment of urban waterlogging and design support emergency management pattern implementation of adjustment system. Through the process of "pre-event, in-event and after-event", a set of emergency pattern is designed to face the urban waterlogging event, which ensures that the management personnel could grasp the state of the occurrence of the event at each stage of the event and take countermeasures for the occurrence of the event quickly. The digitalization and visualization of urban waterlogging emergency management can be realized by using customized components, drawing knowledge map and designing adjustment system. According to the urban waterlogging emergency management pattern, the Beijing emergency plan component and the component based on similar historical case analysis are customized, and the functions of the components are realized through the integrated adjustment system. The application shows that emergency management adjustment system of urban waterlogging can realize the quick use of information, offer users customized waterlogging emergency management services, and provide the management with the support of effective emergency management decision. The results can provide conceptual and technical support for urban emergency management. It can also improve the timeliness of urban response and the level of urban flood control.

1. Introduction

With the rapid changes in the natural environment and social environment, urban waterlogging disasters have become increasingly serious over the whole world. China's waterlogging events have caused a large number of economic losses and casualties, endangering the healthy and sustainable development of social and economy [1]. Therefore, it is necessary to pay attention to reduce the impact of disaster and improve the ability of emergency management. The main objective of emergency management is to "prevent and minimize the loss caused by the occurrence of incidents". Emergency plan, as one of the core of emergency management, is of great significance in distinguishing, managing and responding to emergencies. The rapid development of the information age, in the traditional way, faced the emergency, unable to achieve the desired efficiency. At the present stage when modern information technology is relatively mature, it is the general trend to complete emergency management by means of information.

In recent years, urban flood disaster has posed a serious threat to urban development. Also, the problems of urban flood have been highly valued by leaders of various departments, experts and scholars [2,3]. For example, Hirabayashi *et al* used a variety of climate models to calculate the global flood risk, and concluded that the flood risk would increase with the increase of global warming [4]. Hammond *et al* argues that scholars, experts and management personnel in urban flooding need to understand the impact of floods, and address the impact of extreme flooding events with a flexible mindset, by establishing flood-resistant cities [5]. In terms of monitoring and early warning, Jiang *et al*. designed and developed three dimensions early warning and monitoring platform for flood prevention through the three dimensions geographic information system. Based on the platform, they conducted research on urban waterlogging emergency response and scenario simulation, and proposed a multi-source flood control basic information integration scheme [6]. Murthy used remote sensing and geographic information technology to enhance the effectiveness of field observation targets. At the present stage, using remote sensing technology to obtain effective information has become a research hotspot in various countries [7]. In the aspect of emergency plan, Deng *et al* proposed a modular method for emergency response program. By standardizing the response process of emergency plan, they provided a way for rapid adjustment of emergency plan and emergency response [8]. Previous studies have investigated the causes of the flood, the effects of the flood, the solutions and the assessment, and the contribution to the city's flood management.

In order to ensure the integrity of the emergency execution process, this paper constructs the urban waterlogging emergency management pattern and analyzes the emergency plan. A component-based flood emergency management system with a better visual effect, which is used to realize quick response information, ensuring that managers can communicate effectively and complete tasks efficiently. Finally, taking Beijing as an example, the digital display of Beijing's emergency plan and the preplan generation method based on similar historical case analysis are carried out to provide reliable support for the emergency management of urban waterlogging.

2. Material and methodology

2.1. Data collection

The data of the emergency plan were downloaded from the official websites of the governments of cities and counties directly under the central government. We collected them, according to different emergency response contents. The data used in this paper is the urban flood control plan. We divided the plan into chapters and sections. The plan information is stored orderly in the database, which is convenient for information acquisition and use.

2.2. Methods

Framework is a structure used to deal with complex problems in software products. The framework can improve the reusability of the code and the extensibility of the system, shorten the development cycle of the application software system. It is convenient for maintenance and quality improvement of the system. The advanced application framework is an application framework that conforms to the Java 2 Platform Enterprise Edition (J2EE). Following the Browser/Server (B/S) and Client/Server (C/S) combined way, we carried out the system. The system was divided into several relatively independent modules according to different functions. Subsequently, the Model-View-Controller mode (MVC) in Java Server Pages is combined to better display the system page and separate the underlying logical relationships. In the MVC pattern, JSP technology and Servlet technology is respectively used to display pages and do a lot of transaction processing. In addition, JavaBeans can encapsulate data in the underlying database [9,10]. Ultimately, the user's business needs are implemented.

2.3. Pattern construction

2.3.1. Urban waterlogging emergency management process. According to the process of "pre-event,

in-event and after-event" of emergency event, a set of emergency pattern facing urban waterlogging event is designed. The pressure-state-response mode of the emergency subject at each stage of the event is analyzed, and various processes of the event process are improved to pave the way for further research on urban waterlogging emergency management. As shown in figure 1, by establishing a procedural mode of urban waterlogging emergency management, it is ensured that the emergency subjects have clear guidelines to deal with the incidents in each procedural stage of "pre-event - in-event - after-event". In the "pre-event" stage, we are under the pressure of potentially serious damage from urban waterlogging. Emergency supplies need to be prepared in advance according to the forecast analysis. If the monitoring and warning system alerts the disaster, the managers should be informed of the event information, and then make an emergency response. In the "in-event" stage, managers need to have emergency consultation on the current event status under the pressure of coping with events. Thus, the emergency response plan of emergency rescue, emergency support, on-site monitoring and other aspects is obtained. The implementers shall take emergency actions according to the response plan. In the "after-event" stage, when the direct loss of urban waterlogging disaster to social life is reduced to a negligible state, the emergency response of urban waterlogging event is over. In order to guarantee people's normal life, the post-disaster construction is carried out on the disaster site. At the same time, the experience is summarized to form cases, so as to provide a basis for the emergency management of urban waterlogging in the future.

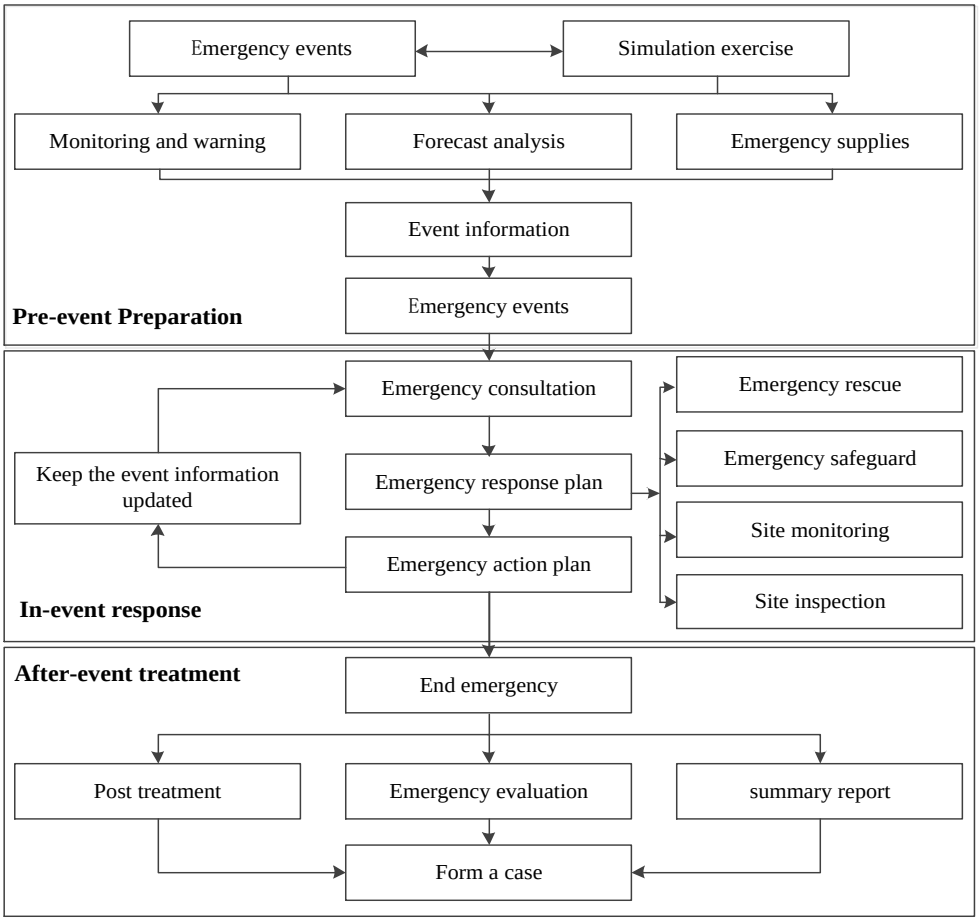

Figure 1. Flowchart of "pre-event, in-event and after-event" application process pattern.

2.3.2. Research on emergency plan management. Emergency plan should run through the whole process of dealing with emergencies. According to the preplan requirements, the event monitoring and

prevention, prediction and early warning, as well as strengthening the simulation exercise are concerned about. In the event, each department must determine their responsibility and respond to emergencies with high efficiency. After the event, it is necessary to summarize the event and gain experience to form a case text.

In China, the content of the emergency plan varies from place to place. It takes a lot of time and labor to find the corresponding paper version, and it is even more difficult to find the emergency plan applicable to the current event. There are many ways to ensure the effective implementation of the plans. First of all, a large number of national and provincial plans as well as historical events have been sorted out. Secondly, according to the different characteristics of the plan, the plan library is established. Then, the process knowledge map of the plan management is drawn for the written features of the emergency plan. Finally, traditional text plans are digitally presented and managed based on an adjustment system. In the face of events with different characteristics, the fuzzy query mechanism of emergency plan is studied, which provides a new idea for the construction and application of urban waterlogging emergency plan.

2.4. Research on adjustment system

Intelligent emergency management plays an important role in the process of dealing with emergencies. It provides scientific and rational basis and data support for decision makers to choose appropriate emergency plans. The use of modern means of information in constructing urban waterlogging emergency management adjustment system, it can realize real-time updates, event routing information description and emergency decision. The system displays the knowledge graph to present the event flow, constructs the information in the form of components, uses the database to store the information, and finally realizes the construction and development of the system environment through the Java. Knowledge graph can transform text into intuitive entity nodes, and managers can realize task output simply and conveniently through the customization of nodes. Due to the flexibility of components, personalized customization of different services can be realized, and cases of events can be guaranteed to be found through the effective support of database information. Through the knowledge graph library, business component library and database, process business combines the information of the whole process to form personalized service. In response management, users can directly access the corresponding response plan by clicking the node of the knowledge graph, and quickly realize the emergency management service.

3. Results and discussion

Beijing, the capital of China, is taken for an example for the application of urban waterlogging emergency management adjustment system. For the past years, Beijing city had experienced several urban waterlogging events. For example, on 15th July, 2018, Beijing experienced a rainstorm, which lasted for about 58h. The rainstorm directly led to the closure of schools, flooded roads and trapped some people, causing serious social and economic losses.

In view of the characteristics of waterlogging events in Beijing, the paper adopts the knowledge map management method, based on the urban waterlogging adjustment system, in order to provide decision-making support for emergency management of waterlogging events. According to the "pre-event, in-event and after-event" pattern of urban waterlogging emergency response management, the flow chart of Beijing waterlogging emergency response is drawn, as shown in figure 2. The relevant government departments can prepare for flood control before the event. First of all, they carry out rainfall forecast analysis, and timely understand the long-term trend of rainfall in Beijing. Secondly, the emergency management should be guaranteed in terms of fund, system and technology. In addition, the flood control monitoring system and information sharing mechanism should be improved. Finally, relevant flood control headquarters shall organize at least one training before flood every year, focusing on the training of flood control personnel. In the event, the relevant departments determine the response level according to the development of the event, and organize on-site consultation and study the disposal measures. They should arrange the work of each branch according

to preplan, arrange rescue team and material, and do a good job personnel avoid danger the job. At the same time, they timely collect information on the scene and actively voice to the media. In the post-treatment, the government emergency supplies supplement and disaster compensation. After that, relevant departments make a comprehensive and objective summary and assessment of the whole event, put forward improvement measures and form an assessment report.

Figure 2. Beijing waterlogging emergency response process.

According to the standard requirements for the preparation of national emergency plans, the traditional text plan of Beijing flood control plan is digitized based on the system. Thus, a reusable componentized plan is formed. As shown in figure 3, the contents of each chapter and section of the emergency plan are correspondingly divided into seven modules, including the general principles, command system and responsibilities, general requirements, monitoring, early warning and emergency response, recovery and reconstruction, and appendix. Then, it is expressed and displayed digitally in the system.

Figure 3. Beijing waterlogging emergency plan.

When an event of urban waterlogging with complex characteristics occurs, an effective emergency plan must be adopted to minimize the loss caused by the event. In order to deal with emergencies, decision makers usually need to learn from previous emergency rescue experience to deal with events quickly and effectively. As shown in figure 4, we determine the characteristic parameters of the target case. Secondly, we collect historical cases, including information about previously relevant decision problems, solutions, and implementation effects of solutions. Then, the similarity between the historical case and the target case is calculated based on the logical components of the system. Finally, the alternative plan of the target case is generated.

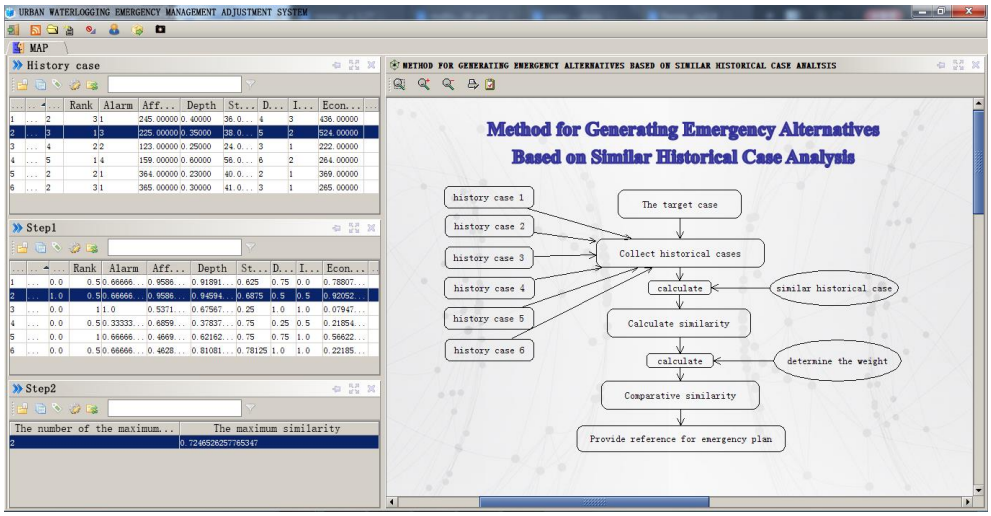

Figure 4. Visual display diagram based on similar plan generation method.

When the event occurs, the componentization plan is analyzed and discussed based on the adjustment system. In the face of similar cases, users can make visual query and dynamic adjustment of the emergency plan on the adjustment system according to the actual situation, so as to develop a response plan for urban waterlogging. Finally, the flood control and disaster reduction ability of Beijing is improved, and the loss of waterlogging disaster is reduced.

4. Conclusion

- Through the establishment of the urban waterlogging emergency management pattern of "pre-event, in-event and after-event", the emergency process and emergency plan of each link are effectively analyzed. Then, it can ensure the effective communication between the emergency bodies. This scientific decision-making mode provides a new mode for the emergency management of urban waterlogging under the changing environment.
- Based on the urban waterlogging adjustment system, non-engineering measures are implemented in the emergency management of urban waterlogging. It has the effect of reducing casualties and property losses in the face of emergencies. It is convenient for managers to operate and use, which is conducive to improving the level of urban flood control and providing reliable support for the emergency management of urban waterlogging.

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