Computer Life (CPL) ISSN: 1819-4818
DELIVERING QUALITY SCIENCE TO THE WORLD

Design and Implementation of Web-based Flood Prevention and Disaster Relief Cloud Service System

Fushun Wang[1, a], Hongquan Liu[2, b, *], Yongtao Zhu[3, c], Guoxing Zhang [3,d], Lijun Ma [4,e], Meng Yang [3,f]

[1] College of information science and technology, Hebei Agricultural University, Baoding 071001, China

[2] College of urban and rural construction, Hebei Agricultural University, Baoding 071001, China

[3] Department of Water Resources of Hebei Province, Shijiazhuang 050000, China

[4] College of resources and environmental sciences, Hebei Agricultural University, Baoding 071001, China

[a]fshw99@163.com, [b]50081999@qq.com

Abstract: This paper introduced a web service platform – flood prevention and disaster relief cloud service system (FPDRSS), which was designed and developed based on the Internet of things, GPS, GIS, object-oriented development and data processing. It realized the data management of meteorology, hydrology, key areas and "human, land, things, events and information" information, oriented to the command decision-makers, patrol, transfer and rescue executors, provided an information and emergency management platform for flood information query, analysis, work dispatch, dispatching, execution and feedback, meanwhile provided rescue services to the people in disasters. So as to achieved the effect of comprehensive information, clear instructions, standardized process, clear responsibilities and strong supervision, improved the procedural, standardized and efficient command of flood control and disaster resistance, improved the city's ability to deal with waterlogging disasters and reduced the losses caused by disasters.
Keywords: Component; flood prevention; disaster relief; cloud service; web-based.

---

1. INTRODUCTION

The process of urbanization promotes the progress of social civilization, meanwhile brings many problems and challenges to the city, among which the sudden flood disaster is one. The rapid development of urbanization has a significant impact on the original hydrological environment of the city, which makes the urban flood control work face more severe challenges[1,2]. With the development of Internet of things technology and the maturity of data perception technology, the

perceptible data sources in cities are increasing rapidly, and all kinds of big data in cities begin to emerge. How to effectively integrate, manage, analyze and mine these data and formulate corresponding countermeasures for flood control and disaster relief in time, so as to provide strong support for flood control and disaster resistance is an important topic in urban flood control research[3-5].

Although government departments at all levels and social organizations have prepared targeted plans for flood control and disaster relief, there is still great uncertainty because floods are natural disasters. When the strong wind, large rainfall and the wide range, it will still bring extremely great harm. When this kind of hazard which is difficult to predict and easy to ignore comes, the fragmentation of information, the lack of short-term rescue equipment, the unsmooth upload and release in the rescue process, and the emerging emergencies often disrupt the orderly organization of emergency rescue[6,7].

Since flood control and disaster relief involves many departments and regions, and command and coordination are very difficult, flood prevention and disaster relief cloud service system (FPDRSS) that can provide detailed data information, provide front-line work command and coordination, provide rapid response and deal with emergency events, and provide afterwards statistics, analysis and evaluation is established, it is what the staff of the city's command and Rescue Department eagerly look forward to[8,9]. The system integrates the existing network resources, communication resources and data resources, which will provide effective technical support for command and decision-making, coordination and organization, statistical analysis, minimize casualties and property losses, and ensure the comprehensive, coordinated and sustainable development of economy and society[10-12].

2. STRUCTURE DESIGN OF FPDRSS

2.1 Overall Architecture

Flood prevention and disaster relief cloud service system is a web platform for communication, information, command and decision-making, which integrates various technologies such as Internet of things, GIS, GPS, database, video monitoring and information processing. The overall architecture is designed from the aspects of system deployment and network structure, and the architecture is divided into four layers. In terms of architecture design, the system adopts the idea of framework add service, provides an open network structure, and is easy to connect with other systems for expansion and upgrading. The system adopts a four-tier architecture, they are application layer, network layer, perception layer and display layer, as shown in Figure 1.

The application layer is deployed in the core computer room of the municipal general front end, which is mainly the application platform of flood control and disaster resistance command system.

The equipment includes application server, management server, database server, etc., which can process the corresponding information of flood control and scientific management.

The network layer mainly realizes the transmission and exchange of flood control information through various servers provided by mobile telecom departments and the Internet.

The perception layer mainly realizes the intelligent perception in the flood control process, including the functions of information collection, capture and identification, such as cameras, hydrological

detectors, etc., as well as other perception that can transmit disaster information, such as disaster houses and disaster victims.

The presentation layer is mainly the presentation of applications. Users can operate functions on the interface. The devices in the presentation layer generally include personal computer (PC), pad, mobile phone, etc.

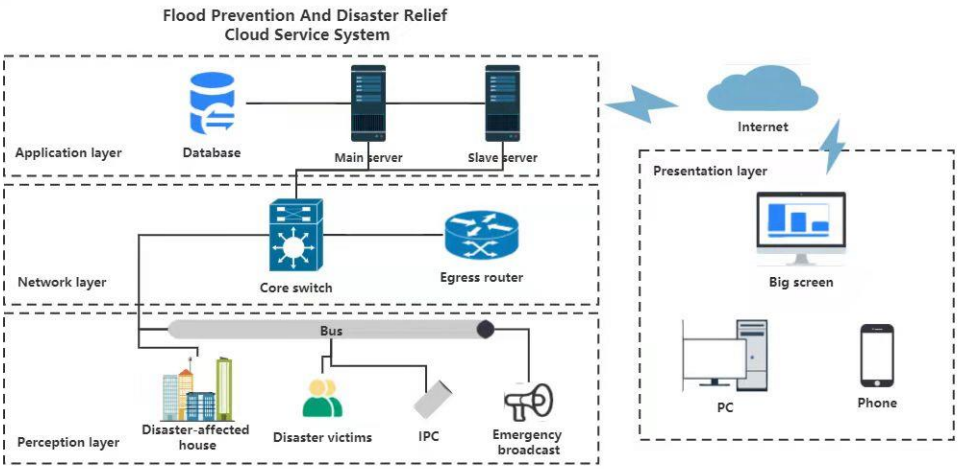

Fig.1 Overall architecture of FPDRSS

2.2 Hierarchical structure

The system adopts a three-level technical architecture, as shown in Figure 2, including basic data layer, application aggregation layer and service display layer.

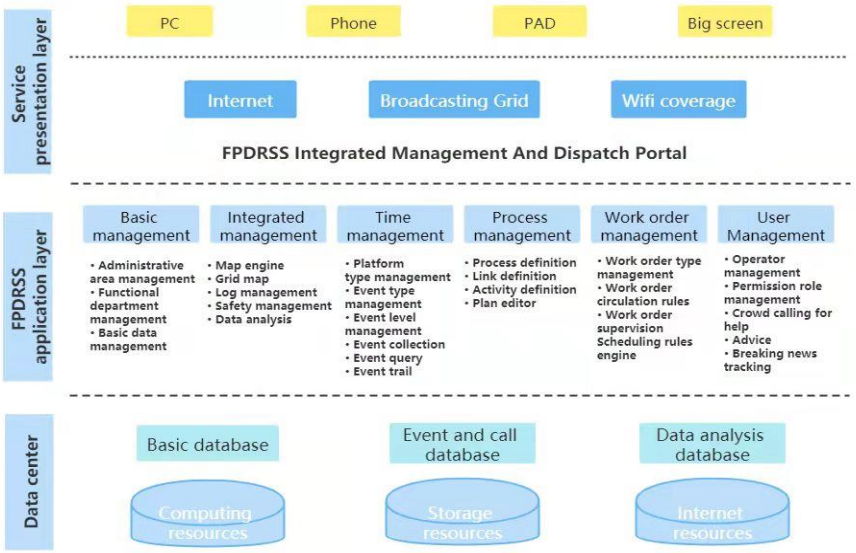

Fig.2 Hierarchical structure of FPDRSS

The basic data layer provides data storage, data access, and logical judgment and calculation support between data; The application aggregation layer provides user management and the realization of various functions of flood control and disaster resistance. The structure of the system adopts a hybrid architecture combining browser/server and client/server. The service presentation layer is mainly accessed by various terminals such as PC, pad and mobile phone.

3. DESIGN AND IMPLEMENTATION OF SYSTEM FUNCTION

The system completes the recording and writing of database through MySQL. When an application accesses the underlying data table, it needs to make logical judgment and corresponding calculation, and finally get a result in line with the process design, so as to realize system function[13].

3.1 Design of system configuration management

System configuration is used to manage and maintain operators (users) and work roles, create users and roles, assign roles to users, and manage groups and permissions. The system does not provide the function of client user registration. Establish an account in the system as needed, and then assign the account to relevant personnel. The table structure of the operator is shown in Table 1.

Table 1 Table structure of the operator

Field name	Data type	Interpretation
User_Id	Int(8)	User number
User_Name	Varchar(30)	User's registration name
Real_Name	Varchar(30)	User's real name
Role	Varchar(50)	User’s roles
Mobile	Varchar(20)	User’s Phone number
Email	Varchar(30)	User’s email
Area	Varchar(20)	District belongs
Department	Varchar(60)	Department belongs
Status	Varchar(20)	Status recordings
Last_Login_Time	timestamp	Last login time

3.2 Design and implementation of basic data configuration

Basic data configuration management is to manage the base information elements, such as affected people, key areas, dilapidated houses, materials and equipment, and the supporting data of the system, such as regional structure, organization department, grid area, event type, etc. This supports the calling, processing and updating of data during work order execution. Here are some core basic data tables.

(1)Regional management

Regional management is a four-level management model of city, county, township and village. The system uses tree from pattern, and the tree node is currently selected as the parent node to maintain the management region. Regional management is established based on the regional division given by the water conservancy department. The regional management table is shown in Table 2.

Table 2 Table structure of regional management

Field name	Data type	Interpretation
Region_id	Int(8)	Region number
Region_name	Varchar(30)	Region name
Region_code	Varchar(30)	Region code
Ad_level	Varchar(5)	Administrative level
H_region_id	Varchar(8)	Superior region number
Region_status	Varchar(8)	Record status
Create_time	Timestamp	Creation time
Notes	Varchar(80)	Remarks

(2)Department management table

The department management is established based on the Department Division in the plan given by the water conservancy department. Department management table is shown in Table 3.

Table 3 Table structure of department management

Field name	Data type	Interpretation
Dpt_id	Int(8)	Department number
Dpt _name	Varchar(30)	Department name
Dpt _code	int(8)	Department code
H_dpt_id	Int(8)	Superior department number
Dpt_type	Varchar(8)	Department type
Region_id	Int(8)	Belong to Region number
Ad_level	Varchar(5)	Administrative level
Dpt_level	Varchar(5)	Department level
Dpt_contact	Varchar(10)	Department Contact person
Dpt_phone	Varchar(30)	Department phone number
Creat_time	Timestamp	Creation time
Notes	Varchar(80)	Remarks

The establishment of department management table is a division of work responsibilities. The elationship between the operator and the department is established through key fields, which determines the scope of work responsibilities of the operator. As can be seen from the table, departments also have established relationships with regions, so departments actually have four-level hierarchical relationships. This also establishes the basic conditions for subsequent work orders to circulate within departments.

(3)Personnel management table

In the process of flood control and disaster resistance, it is necessary to patrol and visit key areas, houses and personnel in advance, transfer personnel in dangerous areas in the process, and return visits to affected personnel afterwards[14]. Therefore, the system must establish a basic database of houses and personnel. Record the information of disaster victims and people in dangerous areas counted by the water conservancy department, and the data is basically imported from the information system counted by the water conservancy department. Take the data sheet of affected persons as an example, and the table of affected persons is shown in Table 4.

Table 4 Table structure of affected persons

Field name	Data type	Interpretation
Per_id	Int(8)	Personnel number
Per_name	Varchar(10)	Personnel name
House_name	Varchar(20)	House name
Addr	Varchar(60)	Home address
Id_type	Varchar(15)	Type of certificate
Id_num	Varchar(15)	Certificate number
Opt_name	Varchar(20)	Operator’s name
Per_status	Varchar(10)	Status

In the table, the responsible person field is associated with the operator. Through the subordinate relationship of address and region in geographic location information (GIS), it can be judged that the

affected people (Supposing A) belong to a region (Supposing B), and the person in charge of this region is an operator (Supposing C). Therefore, the operator C must be responsible for the affected people A, such as transfer, rescue, etc. Any event initiated from affected people A or area B will be distributed by the system to operator C.

3.3 Design and implementation of workflow configuration

According to the designed flood control and disaster resistance process, the flow of work departments and execution steps need to be customized in the system, so the process customization management function is required. Process customization adopts step-by-step design[15,16]. It is related to event types. First, define a process, and then decompose it into multiple work segments. Those segments are divided into three types: start segment, intermediate segment and end segment. Finally, add activities in each segment, that is, what operations to perform. In this way, the system defines the complete implementation process of an event disposal in the plan. The process design, management and maintenance of reserve plan release, work sign in, work order assignment, execution and tracking, event reporting and emergency call for help in the system can be carried out in the process management, details as shown in Figure 3.

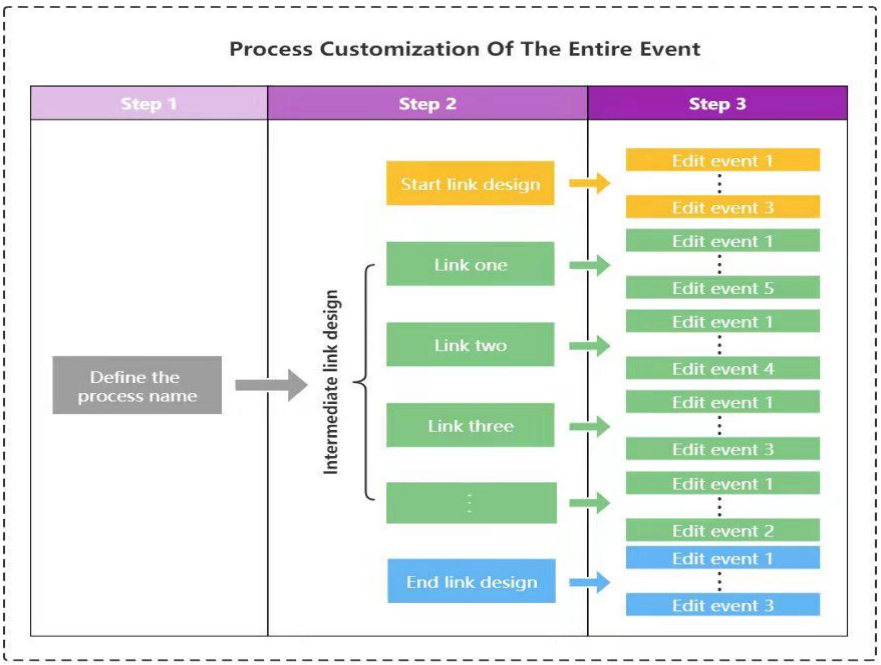

Fig.3 Workflow Configuration of FPDRSS

4. SYSTEM TEST AND ANALYSIS

(1) Test purpose: verify whether all functions of PC end system meet the design requirements.

(2) Test environment: ThinkPad, Win10 system, Google Chrome, MacBook, iPads and Smartphones (Android).

(3) Test method: black box test method was used in test, logs in to the system page through the PC browser, and configures the basic data of "people, affairs, things, regions, organizations and processes". The system linkage response was used to verify each function.

(4) Result analysis: the system tests the functions of login, sign in, start plan, call for help record, work order management and action track record, optimized and adjusted according to the test results, and finally the system is normal and runs well.

5. CONCLUSION

The emergency treatment function of flood prevention and disaster relief in a city is related to the sustainable development of the city and the safety of public life and property. After analysing the advantages and disadvantages of emergency rescue at home and abroad, according to the characteristics of openness, safety, economy, easy maintenance and innovation, this paper designed a set of unified and efficient information channels, decision-making assistance, command and dispatching and effect evaluation tools for the department of flood prevention and disaster relief. Through the introduction of system network architecture and technical architecture, this paper expounded the database table structure of each module in the system in detail, analysed the relationship between each table, and the specific implementation process of system main event linkage, tests the linkage function of the system, analysed the test results, and the results show that the requirements were met totally. The successful implementation of the system can help the competent authorities solve the problems of lax supervision, poor connection and ineffective accountability in the command process to a certain extent, and improve the city's ability in dealing with waterlogging disasters.

ACKNOWLEDGEMENTS

This work was financially supported by the Applied Research Project of Water Safety Assessment of Hebei Province.

REFERENCES

[1] Duan J G. “Research on construction of flood control dispatching decision System under informatization process”. Water resources planning and design,Vol.06: p15-17.
[2] Wang H，Zhou H C and Peng Y. “Research on Automatic Construction of Dispatching System for Flood Control Decision Support System”. Water Resources and Power, VOL35(01): p57-60+64.
[3] Cheng C T and Chau K W.“Fuzzy iteration methodology for reservoir flood control operation”. Journal of the American Water Resources Association,Vol.37(5): p1381-1388.
[4] Yu Y B, Wang B D, Wang G L, et al.“Multi-person multiobjective fuzzy decision-making model for reservoir flood control operation”. Water Resources Management, Vol.18(2): p111-124.
[5] Tung Y K.“Flood defense systems design by risk-based approaches”. Water International, Vol.30(1): p50-57.
[6] Jin A T, Baekchunwoo.“Development of Decision Making Model for Optimal Location of Washland based on Flood Control Effect estimated by Hydrologic Approach”. Journal of Korea Water Resources Assocition, Vol.41(7): p725-735.
[7] Vladimirova T, Yuhaniz S.“An intelligent decision-making system for flood monitoring from space”. Soft Computing, Vol.15(1): p13-24.
[8] Radmehr A, Araghinejad S.“Developing Strategies for Urban Flood Management of Tehran City Using SMCDM and ANN”. Journal of Computing in Civil Engineering, Vol.28(6).
[9] Klyuev V V, Rezchikov A F, Kushnikov V A, et al. “Informational-Control System for Decision-Making Supply During Elimination of Floods’ Consequences”. Vestnik komp'yuternykh i informatsionnykh tekhnologii, Vol.11: p39-45.
[10] Wang M, Sweetapple C, Fu G, et al.“A framework to support decision making in the selection of sustainable drainage system design alternatives”. Journal of Environmental Management, Vol.201:

p145-152.
[11] Zhu F, Zhong P-A, Sun Y, et al."Selection of criteria for multi-criteria decision making of reservoir flood control operation". Journal of Hydroinformatics, Vol.19(4):p558-571.
[12] Zhu F, Zhong P-A, Sun Y, et al."Real-Time Optimal Flood Control Decision Making and Risk Propagation Under Multiple Uncertainties". Water Resources Research, Vol.53(12): p10635-10654.
[13] Emami K."ADAPTIVE FLOOD RISK MANAGEMENT(dagger)". Irrigation and Drainage, Vol.69(2): p230-242.
[14] Wang Q, Zhou J, Huang K, et al."Risk Assessment and Decision-Making Based on Mean-CVaR-Entropy for Flood Control Operation of Large Scale Reservoirs". Water, Vol.11(4).
[15] Zhu F, Zhong P-A, Wu Y-N, et al."SMAA-based stochastic multi-criteria decision making for reservoir flood control operation". Stochastic Environmental Research and Risk Assessment, Vol.31(6): p1485-1497.
[16] Chen J, Zhong P-A, An R, et al."Risk analysis for real-time flood control operation of a multi-reservoir system using a dynamic Bayesian network". Environmental Modelling & Software, Vol.111: p409-420.