

A Visualization Model of Geological Disaster Emergency Scheme Based on Ontology

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Abstract: With the development of information science and technology, how to achieve the digitalization and visualization of geological disaster emergency scheme is an important research subject in the geological disaster emergency command system. This paper designs a visualization model of geological disaster emergency scheme, which was divided into three main steps, including emergency scheme structuring, visualization modeling based on ontology and visualization technology. Based on this, computer technology, GIS(Geographic Information System) technology and network information technology are used to develop the visualization software result of geological disaster emergency scheme. This paper aims to provide a set of scheme for the visualization work of emergency scheme. It contributes to improve the operability of the emergency scheme and provide an intuitionistic intelligent auxiliary means with geological disaster emergency response.

Keywords: GIS, emergency scheme, sudden geological disaster, visualization.

1. INTRODUCTION

As the basis of geological disaster response, geological disaster emergency scheme is regarded as the standards and guidelines for emergency response [1]. As the emergency command system of geological disasters in China is gradually perfected, a preliminary emergency system of sudden geological disasters has been achieved. However, the informatization scheme only stays at the stage of information management, such as the retrieval, view, addition, deletion, modification of the electronic file, so it is not a good solution for the operability of the scheme [2-5]. Therefore, how to achieve the digitalization and visualization of geological disaster emergency scheme is an important research subject in the geological disaster emergency command system [6].

Guided by the national emergency scheme of geological disaster, this paper analyzes the implementation methods and process of emergency scheme to design a kind of visualization model; in addition, based on this, it develops the visualization software for the emergency response scheme of geological disasters. The traditional scheme has some defects such as boring form, difficulty in query, non-intuitive expression, poor maneuverability, etc [7], and all these defects have been improved. Therefore, it standardizes and visualizes the scheme. It has technically enriched the geological disaster emergency system [1], which could provide an intuitive intelligent assistant decision-making means for abrupt geological disaster emergency response.

2. VISUAL DECISION PROCESS OF EMERGENCY SCHEME

The process flows of the emergency scheme includes reporting the disaster, launching the emergency scheme, emergency response, emergency guarantee and other major implementation processes. When sudden geological disasters occur, how to quickly extract the elements of schemes and form specific and feasible emergency scheme is the key to ensuring efficient emergency response [1]. The flow chart of emergency scheme decision-making is shown in Fig. (1).

Among them, the rating scale of the geological disasters and hazards is shown in Table 1.

3. VISUALIZATION MODEL OF THE SCHEME

The visualization model of the emergency scheme of geological disasters is based on the national emergency scheme of geological disasters, which is realized by turn from the aspects of the structuralization of the emergency scheme, ontology-based digital modeling of the emergency scheme, and the visualization of the emergency scheme. The visualization structure model of its emergency scheme is shown in Fig. (2).

3.1. Structuralization of the Emergency Scheme

The structuralization of the emergency scheme is the digital processing of the text scheme of the national emergency scheme for geological disasters, which will form an emergency scheme library. All the information in the library should be expressed in a structured way [2], which is an important prerequisite to achieve the visualization of the emergency scheme [8].

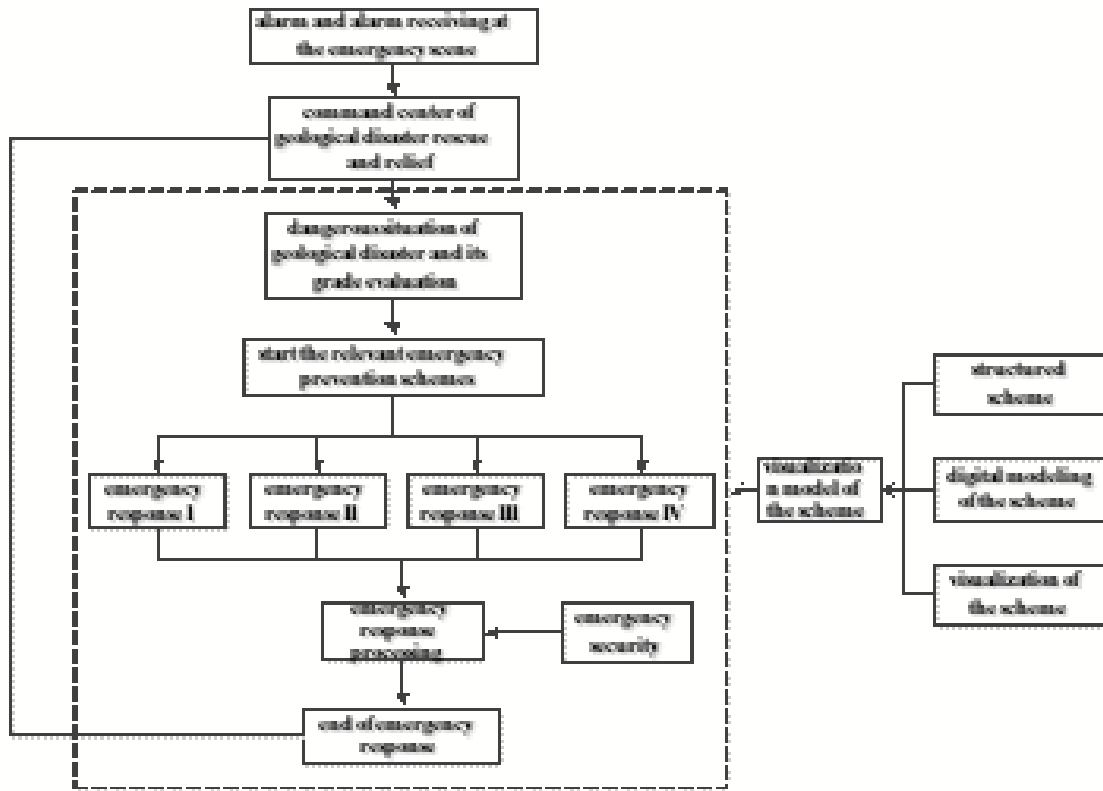


Fig. (1). The flow chart of the decision-making of the emergency scheme.

Table 1. Rating scale of the geological disaster degree (disasters and hazards).

Indicator Level Type and Unit of Measurement			Super Large-Scale (Disaster at Level I)	Large-Scale (Disaster at Level II)	Comparatively Large-scale (Disaster at Level III)	Common (Disaster at Level IV)
Situation of a disaster	dead or missing	number of people	≥30	30~10(including 10)	10~3(including 3)	<3
	direct economic losses	ten thousand	≥1000	1000~500(including 500)	500~100(including 100)	<100
Dangerous situation	people should relocate due to the threat of geological disasters	number of people	≥1000	500~1000(including 1000)	500~100(including 100)	<100
	potential economic losses	ten thousand	≥10000	10000~5000(including 5000)	5000~500(including 500)	<500
Emergency response			It is led by the Provincial People’s Government, combined with the coordination and command from the headquarters of Provincial Emergency Prevention and Control of Geological Disasters.	It is led by the Provincial People’s Government, combined with the coordination and command from the headquarters of Provincial Emergency Prevention and Control of Geological Disasters.	It is led by the Municipal People’s Government, combined with the coordination and command from the headquarters of Municipal Emergency Prevention and Control of Geological Disasters.	It is led by the County People’s Government, combined with the coordination and command from the headquarters of County Emergency Prevention and Control of Geological Disasters.

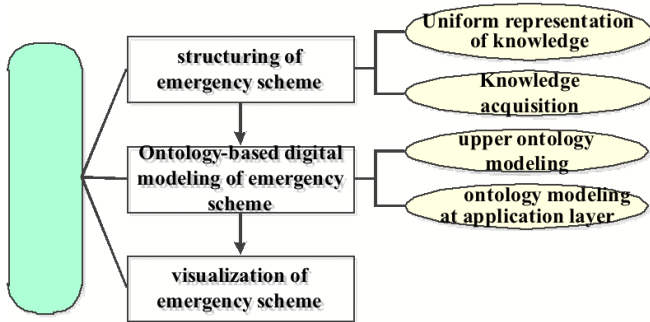


Fig. (2). The visualization structure model of the emergency scheme.

It has two key points:

(1) Unified representation of knowledge

It means to carry out structural decomposition on the various elements of text emergency schemes. Through the extraction of entries and text parsing, the elements of the scheme are extracted to form a targeted and feasible emergency scheme.

The information and knowledge described in the national emergency scheme for sudden geological disasters are expressed in a structured and unified way, including rating of disasters and haphazard, emergency response, emergency guarantee and many other aspects. The structural elements of emergency schemes need to adopt a unified way to describe and must follow certain rules to form a standardized structure [2], so as to ensure that the data of emergency schemes can be stored in a unified, and efficient way.

(2) Knowledge acquisition

Conduct an in-depth analysis and study of the text scheme in the national emergency scheme for sudden geological disasters to ascertain the knowledge that needs to be represented in the emergency schemes as well as the acquisition ways of them and to carry out knowledge representation and knowledge acquisition. The database technology is also

applied to achieve a unified management of the structuralization of emergency schemes in the computer and their structured storage.

3.2. Digital Modeling of Ontology-Based Emergency Scheme

ABC (Antecedent-Behavior-Consequences) ontology model is to describe the creation, change and transfer of the object as time goes on, and then use some concept such as Event, Situation, Action, Agent concepts and the conceptual relations to express the content of the event and the changing process over time [9]. Ontology model has the two-tier structure, the upper ontology and ontology at the application layer.

3.2.1. Upper Ontology Modeling

Adopt the extended ABC ontology to conduct modeling and establish the conceptual models for the organizational structure, emergency response, action process related to this study area, and call the constrained relationship. The structure of its extended ABC ontology model is as shown in Fig. (3).

(1) Emergency refers to the sudden incident in a region which requires activating emergency schemes. This concept, as an extended subclass of the Event, has an attribute Level: level I– super large-scale, level II – large-scale, level III– medium-scale, level IV– small-scale geological disasters.

(2) Emergency Response refers to the emergency measures of geological disasters at different levels. As an extended subclass of Temporality, it is triggered by the Emergence of sudden geological disasters.

(3) Expert and Personnel are the organization and staff responsible for the emergency command, and it is an extended subclass of action subject Agent.

(4) Resource is used for emergency security including response team, funds, materials, equipment, etc.

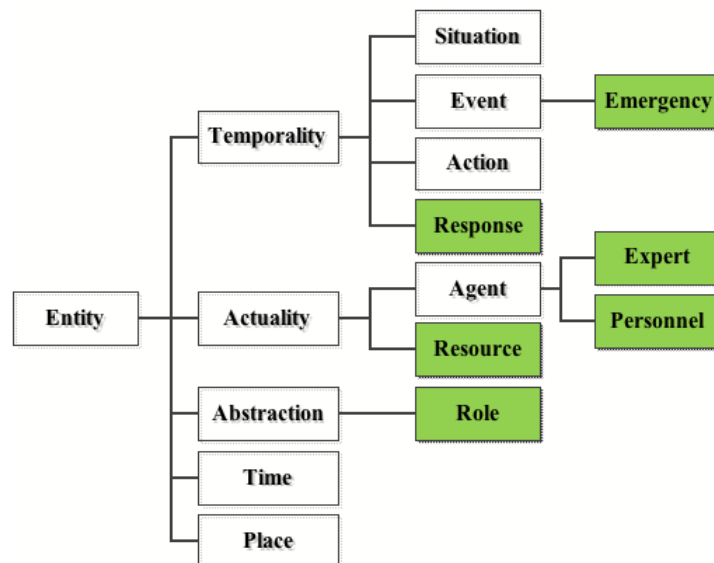


Fig. (3). Structure of extended ABC ontology model class.

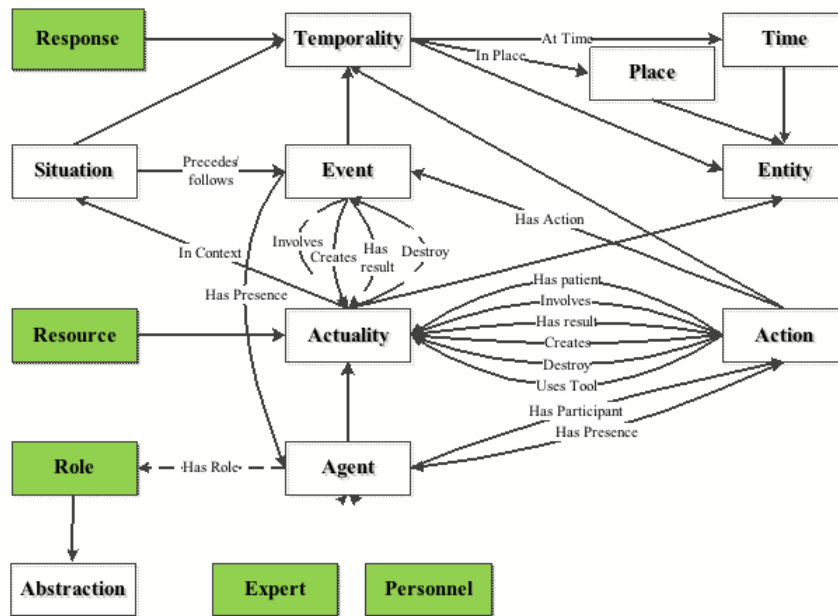


Fig. (4). Structure of extended ABC ontology model class.

(5) Role refers to the function of action subject Agent, and it is an extended subclass of Abstraction.

The extended ABC ontology model utilizes the ontology languages to describe the basic knowledge involved by geological disaster emergency schemes as much as possible. The description for the semantic relations between emergency process-related concepts is as shown in Fig. (4).

3.2.2. Ontology Modeling at Application Layer

The extended ABC is regarded as the upper ontology to build the ontology modeling at application layer of the emergency scheme. EC_Domain Ontology can be defined as a quintuple:

EC_DomainOntology=<EC_Concepts, EC_Relations, EC_Functions, EC_Axioms, EC_Instances>

EC_Concepts, EC_Relations, EC_Functions, EC_Axioms, EC_Instances

respectively denotes a collection of concepts, a collection of binary relations between concepts, a collection of conditional rules, a collection of valid axiom, examples of concepts [9].

(1) EC_Concepts

EC_Concepts={C} represents the collection of concepts in the emergency schemes of sudden geological disasters, mainly including Emergency Information, Emergency geological disasters, Behaviour Subject, Behaviour Object, Emergency Event Developmental Process, Emergency Response, Organizational Framework, Emergency Resource, etc.

(2) EC_Relations

EC_Relations={R(c1,c2)|c1,c2∈EC_Concepts } refers to the collection of binary relations between concepts of the

emergency scheme, mainly including compose, use, implements, has Role, follows, etc.

(3) EC_Functions

EC_Functions={F : S1×S2×...×Sn×T→S|S1,S2,...,Sn, S∈

EC_Concepts∪EC_Relations, T∈EC_Concepts} means the collection of transfer rules between situations, where Si represents the place of the event, T is the current transfer condition.

(4) EC_Axioms

EC_Axioms={A:S1×S2×...×Sn→S|S1,S2,...,Sn∈EC_Concepts∪EC_Relations∪EC_Functions, S∈EC_Concepts∪EC_Relations}, condition T does not exist in EC_Axioms transfer rules, meaning it is true in any context.

(5) EC_Instances

EC_Instances={ Instance| instance∈EC_Concepts∪EC_Relations}, representing the instantiation of concept and relation in the emergency scheme.

3.3. Visualization of Emergency Schemes

Based on the above structure and digitization, the visualization of emergency scheme is to adopt the current advanced data visualization technology, geographic information system (GIS) technology to build a visualization system, namely, conducting visualization for knowledge, so that emergency schemes can be visually expressed through a graphic.

Associate the situation of the areas greatly suffering from geological hazards, emergency schemes and specific information in GIS layers to display the geological hazard information and measures in emergency schemes to users in a complete way. Combined with GIS maps, integrate the spatial and temporal information through the browser to display

the disposal process of the emergency schemes in the form of a flowchart [10].

4. RESULTS ACHIEVEMENT

According to the decision-making process of its visualization process and utilizes its visualization model, combined with the database technology, geographic information technologies (GIS) and network information technology to achieve the visualization system.

4.1. Functions Achievement

According to the requirements of *Emergency Scheme of National Sudden Geological Disaster*, the system is designed as several functional modules, including disaster reporting, disaster grade determination, disaster emergency security, disaster emergency response, disaster assessment, system management, etc., and there is a logic relation between these modules. Fig. (5). is the core function block diagram of the emergency scheme's visualization system.

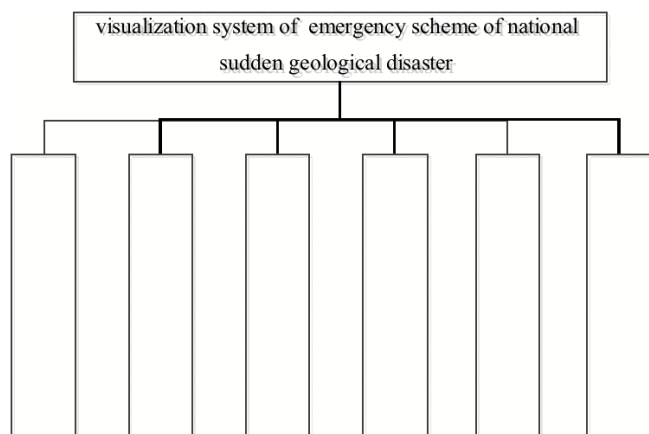


Fig. (5). The function block diagram of visualization software of emergency scheme of national sudden geological disaster.

(1) Disaster reporting

Monitor working staff's reporting of the form of emergency scheme for geological disasters. Make sure they fill the disaster and haphazard information of geological disasters based on the content of the form.

(2) Disaster level evaluation

System can automatically determine the level of disasters and haphazard of geological disasters according to casualties, economic losses and thereat level in the form, and mark the location of the specific disaster and haphazard point in the map. Tap the point and we can see the disaster and haphazard information of the point.

(3) Disaster emergency security

Configure and equip emergency response teams, funds, materials, and equipment to set up an emergency expert and working groups according to the disaster level of geological disasters.

(4) Disaster emergency response

Emergency expert and working groups commence sudden geological disaster emergency work, and delimit geo-

logical hazard zone, establish warning signs, and select evacuation routes combined with the specific circumstances of disasters and haphazard.

(5) Disaster assessment

Assess the disaster after the end of the entire emergency response to geological disasters and improve the various information of describing the disaster, such as causes, impact, work progress, analysis of the development law of geological disasters and introspection of emergency work.

(6) System Management

Manage the basic information of users, including changing passwords and log information, and other basic operations, as well as reminder function of a number of important issues and events.

4.2. System Operation and Results

The visualization system of emergency scheme makes full use of its structuralization and digitization based on ontology and visualization representation techniques and applies SQL Server database and GIS to build an all-in-one information system. The operating results of the visualization system of national emergency schemes for sudden geological disasters are shown in.

CONCLUSION

The visualization of the emergency scheme for geological disasters is a hot topic of the application of the emergency command and decision-making in the current geological disasters, but this area is still in its infancy. This paper has designed a set of visualized decision-making processes of emergency schemes for geological disasters and visual models of schemes and has accomplished the expected results of the visualization system of emergency schemes for geological disasters, which has carried out analysis and reflection at all levels from the theory, methods and applications. However, with the strengthening of practical applications, there are some issues to be resolved, such as how to use intelligent analysis means to achieve intelligent emergency schemes and achieve rapid analysis and optimization assessment of emergency programs [11]. In the future course of the study, it still requires further in-depth analysis and improvement.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

ACKNOWLEDGEMENTS

The paper is funded by Special Project of Ministry of Land and Resources for Public Industry Research (201211055) and the Central Universities (CUGL130259), the views expressed are the authors' alone.

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Received: September 22, 2014

Revised: November 30, 2014

Accepted: December 02, 2014

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