Research and Practice of Emergency Response Map Multi-pattern Symbol Design

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Abstract: Firstly, the classification, definition and characteristic of emergency response map are discussed. The problems of emergency response map symbolization are analyzed and the concept of emergency response map multi-pattern symbol is put forward. Then, this paper discusses the design principles of emergency response map multi-pattern symbol, and designs lots of emergency response map symbols which are of multi-equipment, multi-state and multi-style.

Keywords: emergency response map, multi-pattern symbol design, equipment, state, style

1 Introduction

Our society is a risky society. Various incidents happen frequently. Not only are there some natural disasters, such as snowstorm, earthquake, tsunami, fire, flood and so on, but also some abrupt incidents, for example, contagion, terror incidents, accident and war [1]. Along with the development of information science, computer technology, satellite navigation and positioning technology and GIS, the role of map in emergency environment becomes more and more prominent. It has become an indispensable tool to deal with emergency. Map can not only predict before the emergency, but also can provide current information of disasters, such as space and location information, state information, which will help command organization and rescue workers establish rescue plan and decision-making plan. And it can reflect the development, trends and loss situation of disaster. After the disaster, we use map to evaluate our damage and to alert publics. But, at present the study for emergency response map is less, especially in the field of symbol design, which directly plays an important role of information transmission. Systematic research is lack. It directly affects efficiency of disaster prevention and rescue work. Therefore, aiming at this issue, this paper analyses and discusses deeply.

2 Overview of Emergency Response Map

2.1 Classification and definition of emergency response map

There are three main stages of incidents, the forecast stage before they happen, the response stage and after-disaster stages. The environments of stages are different and the demands of map are different. Accordingly, from broad sense, emergency response can be classified into three categories as follows:

(1) Forecasting emergency response map. Before the potential disaster, people focus their attentions on disaster prediction. This is a long-term process. The map is mainly used for establishing long-term strategies. The map we used in this stage is a kind of forecasting map.

(2) Instant emergency response map. Instant emergency response map refers to the map we used in disaster. It is able to provide immediate geographic information to individual users or command aid agencies for their decision making.

(3) Resuming emergency response map. It is a kind of map used to support loss assessment, reconstruction and public education after a disaster, such as the disaster loss map, disaster frequency map, post-disaster reconstruction map, disaster distribution map, etc. At this time, map can be considered as an integrated information source. It is a kind of tool for people analysising hazard information and sharing hazard information.
2.2 Features of emergency response map

As a special thematic map, emergency response map has its special characters and we can explore from
the following several aspects:

(1) Characteristics of representation contents of emergency response map

The content of emergency response map covers a wide range. Compared to ordinary thematic maps, its
attention is different. Not only should it indicate the specific geographic entities, such as location of
disasters, safety export, place of explosion source, important transport hub, commodity distribution sites,
etc., but it also pays attention to the states information of ordinary facilities, for example, the diffusion
scope, the current state of the bridge or road (unobstructed or collapse), the number of circulation, etc.
In addition, we should mark some elements which are not belonged to the geographical entities, such as
tent, water and food supplies.

(2) Using features of emergency response map

According to classification of the emergency response map, its users can be divided into the following
categories: evaders, command aid agencies, the general public and government departments. And the
different characteristics of them are shown in table 1. Actually, the users are more than what this paper
lists. There are some other users, such as insurance institutions, economists, meteorological scholars and
map-making scholars. This paper studies universal characteristics of emergency response map, so we
focus on the users listed in the table.

<table>
<thead>
<tr>
<th>User</th>
<th>Time</th>
<th>Map type</th>
<th>Equipment</th>
<th>Reaction time</th>
<th>Concerns</th>
<th>Purpose</th>
<th>Map knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaders</td>
<td>When the event occurs</td>
<td>Instant emergency response map</td>
<td>Embedded equipment</td>
<td>shortest</td>
<td>Export, the current state of the channel, etc.</td>
<td>Finding escape quickly</td>
<td>No</td>
</tr>
<tr>
<td>Command aid agencies</td>
<td>In a short period after the event</td>
<td>Instant emergency response map</td>
<td>Big screen</td>
<td>shorter</td>
<td>Current state and original state of incidents; distribution of various supplies, etc.</td>
<td>Finding relief way quickly</td>
<td>No</td>
</tr>
<tr>
<td>General public</td>
<td>Prior to the incident; After the incident</td>
<td>Forecasting emergency response map; Resuming emergency response map</td>
<td>Big screen; Televisi on; computer</td>
<td>long</td>
<td>Incidents and their affected scope, the trend of disaster</td>
<td>Learning the event situation</td>
<td>No</td>
</tr>
<tr>
<td>Government departments</td>
<td>Prior to the incident; in a short period after the event; After the incident</td>
<td>Three kinds of emergency response map</td>
<td>Big screen; Televisi on; computer</td>
<td>long</td>
<td>Casualties, incidents and their affected scope and trend (in details)</td>
<td>Learning the trend, establishing prevention system, disaster evaluation</td>
<td>No</td>
</tr>
</tbody>
</table>

2.3 Problems of emergency response map symbol
Emergency response map plays a very important role in all phases of the incident. At present, the study for emergency response map symbol is less and most emergency response maps are made hastily. The main problems are as follows:

(1) The types and styles of symbols are single and much of them continue to use traditional paper map symbols. On emergency map, the simple line symbol is given priority to, which cannot satisfy the multi-pattern display of emergency response map, such as multi-user, multi-equipment, multi-state, multi-purpose and so on.

(2) The symbol design does not utilize the graphic and image advantages of computer well. The representation ability of symbol need to be enhanced and the display effects of some key symbols are not prominent. Visual level of map feels poor.

(3) When symbols are designed, the use features of emergency response map are considered less. So the symbol design can't meet the actual demands and it is not so scientific and practical.

These problems affect the speed and quality of information, which may cause decision-making errors or rescue delays and the consequence is unimaginable.

3 Principles of Emergency Response Map Multi-pattern Symbol Design

Through the above analyses, considering the real demands of emergency response map, concept of emergency response map multi-pattern symbol is put forward. In view of the influence of different equipments, different states and different styles, it refers to the different display forms of the same spatial data. We can draw the emergency response map multi-pattern symbol design principles:

(1) Considering the demands of multi-equipment, multi-state and multi-style

For emergency response map, the main factors which affect its symbol display effect are equipment, state and style. Therefore, when we design symbols, firstly we should take advantages of different cognitive environments of all sorts of equipment and avoid defects of them. Only in this way can we meet different device display needs. In addition, considering the particularity of emergency response map, there should be different states series symbols for one symbol, which will satisfy the fast drawing needs. Then, in order to make the map display be more layered and the users grasp the important information quickly, symbol design should also be style-distinct, eye-catching and outstanding.

(2) Considering the characteristics of electronic map cognitive environment

Emergency response map often displays in an electronic environment, such as mobile phone, PDA, big screen, television, and so on. So characteristics of electronic map cognitive environment should be considered fully. Compared with papery map, electronic map cognitive environment is different, such as bearing media, map color display principle, visual range, minimal size, using form and so on. In symbolic design, we should give full play to the computer advantages, for example, high-speed calculation, bright color, convenient operation and flexible function. At the same time, we also should pay attention to overcoming its faults, such as low resolution and small display range. In electronic map scale concept

In conventional mapping, the scale is one of the main mathematical basises of map. When the purposes of map are determined, map scale is the determining element of map accuracy and content. While in electronic map, map can be zoomed in and zoomed up. Map scale mainly refers to the screen scale, and the screen load is not only related to the detailed degree of data source, but also related to the screen display scale. Which make it be different from papery map, large & medium scale symbols and medium & small scale symbols can satisfy the basic needs.

(4) Considering cognitive inertia, innovation should be based on inheritance.

Existing symbolic system has been used for many years, and it has obtained users’ wide acceptances. In order to make people in emergency situations identify various symbols quickly, the symbols we design should be based on the existing schema of symbols. In addition, in view of the characters and the flexibility of electronic map screen display, some symbols should be adjusted in the aspects of size, color, shape and so on, to adapt to the emergency response map display characteristics.
4 Methods of Emergency Response Map Symbol Design

Symbolic design is the core tache of mapping and its design effect will directly affect the expression of map. Methods of emergency response map multi-pattern symbol design can be discussed from three aspects.

4.1 Symbol design based on different equipments

There are two kinds of emergency map equipments which we used often: embedded equipment and large screen equipment. The symbol should be designed according to the features of equipments. The main characteristics of embedded system are that the memory and computing capabilities are limited, the screen is small and resolution is lower. The following aspects should be considered:

(1) The quantity of the symbol ought to be small, such as simple line symbols. The danger zone, vigilance region, safety export, shelter, etc can be designed with some special effects symbols. Some voice prompt information can also be added. But special effects symbols and multi-media information should not be excessive, otherwise, the slow reflection of equipments will cause the information delay, whose consequence is unimaginable.

(2) With an eye to that most of the users of embedded equipments are individuals, and in emergency environment, personal orientation changed frequently, the direction of mobile map should be adaptive. It is to say that the users’ facing direction and its real direction should always keep consistent, so that users can find direction rapidly and reach the destination quickly.

(3) Label ways can be used to show some urgency information to arouse users’ attentions. For example, when sudden emergencies happen, in order to get users to note, we can use pop-up text box symbols. In addition, symbols with underlay can also cause the users’ attention. Parts of emergency mobile map symbols designed by this article are shown in figure 1.

Big screen equipment is a kind of projection equipment which is used by command organization to understand emergency information, conduct various demonstration and analysis. Emergency big screen map's main purpose is to make command organization understand the distribution of forces of every region, the resource scheduling status, diffusion of emergency and so on. Its load is larger and the elements of foundation map are more and relatively disorder. Therefore, the strong contrast color, saturation high color and bright pure color shall be adopted so as to division conveniently. Pure red, blue, white and black are used usually, and the special effects can be added at the same time, such as drawing border and shadow effects, which will make bright contrast to the foundation map to achieve better effect. Parts of emergency big screen map symbols designed by this article are shown in figure 2.

4.2 Symbol design based on different states
One of the main features of emergency response map is that one symbol shall also have different states: for example, how is the bridge? Is it in normal? Destroyed? Repaired? How is the traffic condition? Are the persons scarce? Normal? Excessive? Are the tents and other relief supplies scarce, right or excessive? All of these state information for emergency map is very important, so there should also be different state styles to meet demands. When we design different states symbols, attention shall be paid to the connections between symbols. Color or size can be used to distinguish them, figure 3 shows the three states of tents.

![Figure 3 Three States of Tents (Scarce \ Appropriate \ Surplus)](image_url)

### 4.3 Symbol design based on different styles

In order to make the target symbols more outstanding and make the visual administrative levels of map clearer, computer graphic image technology and multimedia technology should be used to expand map symbol types. Different symbol styles should be designed for the same data, which will make the map more vivid. We can also use some static special effects, such as embossment and projection, or some dynamic effects, such as flicker and shine, and some multimedia information, such as video and audio. All of these can give us strong multi-sense impulsion. Figure 4 shows symbols of different display styles.

![Figure 4 Symbols of Different Display Styles](image_url)

### 5 Conclusion

In this paper, theories and methods of emergency response map multi-pattern symbol design are explored, attempting to advance the consistency between symbols and users’ understanding through the symbol design of different equipments, various states and different styles. Map-makers should make maps which can be understood easily by users. An a kind of special thematic map, its main function is to help users know geographical phenomena and the spatial relationships between all kinds of things, and explore the potential rules. Although this paper has made some attempts (such as the use of bright color, simplifying the symbols, expanding symbol expression types, etc.), considering the utilization of multi-source data, data processing and the relationship between data and symbol, there is larger space for emergency response map symbol design. The development of technologies will bring new ideas to emergency map symbol design continuously, such as the increase of symbols types and the expansion of visual and auditory perception variables, etc. “Dynamic interaction wisdom multimedia emergency map” will become a trend of emergency maps.

### References

