EXPERIMENT FOR DETERMINATION OF MAP GRAPHICS SEGMENT STANDARD FOR HANDHELD CRISIS MAPS MANAGEMENT

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Original scientific paper

This paper describes a study of map symbols to display on maps that are in the service of making decisions and solving problems in crisis situations, as well as providing support to residents and experts on crisis management in times of decision making, before and during the crisis. For practical reasons maps are shown on small handheld screens. The survey was conducted by means of a questionnaire, followed by interviewing. The study involves experts in crisis situations, cartographers, students and other participants (meaning all those who accessed and filled in the online survey, and who do not belong to any of the categories mentioned). The survey covers cartographic symbols representing various crisis situations. The symbols were chosen for the questionnaire for some crisis situations, i.e. for a term that describes them. Their usability was then tested on the maps displayed on a PDA by the method of interviewing. This is the first attempt in Croatia for the standardization of cartographic symbols and their use in emergency maps adapted to new technologies and media to display and use mobile maps.

Keywords: crisis management, handheld, map graphics, symbols

Eksperiment određivanja normiranja dijela kartografike na kartama dlanovnika za upravljanje u kriznim situacijama

Izvorni znanstveni članak

U radu se opisuje istraživanje kartografskih znakova za prikaz na kartama koje su u službi donošenja odluka i rješavanja problema u kriznim situacijama, podrška stanovništvu i stručnjacima za upravljanje u kriznim situacijama u trenucima donošenja odluka prije i za vrijeme krize. Karte se zbog praktičnosti prikazuju na malim ekranima dlanovnika. Istraživanje je provedeno metodom anketiranja a potom intervjuiranja. U istraživanju su sudjelovali stručnjaci za krizne situacije, kartografi, studenti i ostali (pod ostalima svi su oni koji su pristupili online i ispunili anketu, a pri tome ne spadaju niti u jednu navedenu kategoriju). Istraživanjem su obuhvaćeni kartografski znakovi koji prikazuju različite krizne situacije. Anketom su izabrani znakovi za neke krizne situacije, odnosno pojam koji opisuju, te je potom provjerena njihova upotrebljivost na kartama prikazanim na dlanovnicima metodom intervjuiranja. To je prvi pokušaj u Hrvatskoj za normiranjem kartografskih znakova i njihovu upotrebu na kriznim kartama u skladu s novim tehnologijama i medijima za prikaz i mobilnu upotrebu karata.

Ključne riječi: dlanovnik, kartografika, signature, upravljanje u kriznim situacijama

1 Introduction

Everyday news about floods, earthquakes, storms and other natural disasters, which often take away people's lives, can often be heard, seen or read about in different media. So far in Croatia there have not been registered any greater natural disasters, and among the greatest menaces and risks threatening us worthy of mention are floods, earthquakes, torrential waters and landslides, accidents in commercial buildings and traffic, nuclear and radiological accidents because of the proximity of the Krško nuclear power plant, and fires which every summer on the Adriatic coast threaten people's lives, material goods and environment crisis. In these situations urgent treatment and good coordination of all participants in the system is necessary to implement the identified measures, activities and tasks.

The importance of geoinformatics, information about the phenomena that are directly or indirectly associated with the position relative to the Earth [1], has long been recognized as a key and critical component of any system for early warning and crisis management. The task of all organizations involved in early warning and crisis management is to reduce the possibility of occurrence of such situations, and when they occur, to ensure the safety of human life [5]. Namely, when the accident happens, spatial and other data are collected depending on the situation and they are shown on the map. Such maps are called crisis maps. The main characteristic of crisis maps is that they are often only produced during crises, and they must be interpreted quickly and under pressure. Surveys conducted after some catastrophic accidents that have recently occurred in the world displayed a lack of standardized symbols to show vital information on crisis maps [8]. Because of all this a standardization of cartographic factors (including symbols) is required as the ultimate goal. Nevertheless, if we take into account the time component, this kind of research does not end because the standards change over time [9]. In the first part of the study symbols were chosen thanks to a questionnaire, and were placed on maps to represent different objects, phenomena and conditions in crisis situations. The analysis of research data conducted in this paper has confirmed the validity of previous results. A test was conducted by using interviews with the selected map graphics applied to the map overlays.

2 Previous research

Early warning and crisis management are the topics of many international workshops, symposia and congresses. The fact that these events take place every year proves the relevance of the issue of early warning and crisis management and the need for finding and establishing a better system for early warning. Thanks to the great interest, there are many countries and relevant institutions, which have developed mapping solutions for crisis management. It is important to note that nobody has yet addressed the problem of symbols selection and their adaptation for use on small handheld screens, although a

similar study made for handhelds exists in the tourist cartography [4].

It is worth mentioning the works of the American Homeland Security Working Group (HSWG) [13] and the Federal Geographic Data Committee (FGDC), the Portuguese Volunteers' Teams for Urgent Interventions Association, the Emergency Management Symbology-EMS [14] which was created by the Canadian company Refractions Research and Australian institutions (Spatial Information Council-ANZLIC) [15] in cooperation with Intergovernmental Committee on Survey and Mapping-ICSM). They constructed symbols for the purpose of early warning and management in crisis situations. These symbols are primarily meant for application on paper and digital maps, and they are not adapted to handhelds. They mentioned some present WEB portals which provide information about crisis situations. It is important to mention that there is no similar study so far in Croatia on the issue of symbols selection and their adjustment to usage on handhelds.

3
The objectives

The symbols on custom emergency maps have precise meanings and being identifiable is of particular importance without further explanation [7]. This study aims to create and explore the possibilities and limitations of custom symbols using the web and handhelds for early warning and crisis management. Preliminary research was conducted in which cartographers, experts on crisis management, as well as students and other citizens chose crisis symbols. After this in this study applied was the scientific method of interviewing which shows a review of preliminary research on cartographic presentations within real situations, in which cartographers and experts on crisis management participated, as well as students and other citizens. The interview was supposed to demonstrate the level of detection of symbols, their legibility and usefulness during application. The interviewees were expected to: connect concepts with the symbol to positively assess the readability and uniformity of symbols, accept a variety of frameworks that represent the difference in the appearance of crisis situations, and positively evaluate the usefulness of symbols to prevent or reduce accidents.

4
Research Methods

The chosen research method was a questionnaire, followed by an interview. Surveying by the questionnaire method is a procedure that is based on a list of questions by which one explores and collects data, information, attitudes and opinions about the case studies [3]. The questionnaire was used for the selection of the most acceptable symbols for a specific term with a larger number of respondents, so that the results were credible. In our case we chose an Internet survey because of its advantages, and because people could be interviewed with remote access. A necessary condition for the creation of custom symbols for small handheld devices is to know their capabilities and their advantages and limitations.

Cartographic experts and crisis management experts (from Državne uprave za zaštitu i spašavanje – the National Protection and Rescue Directorate, Hrvatske gorske službe spašavanja – the Croatian Mountain Rescue Service and Ureda za upravljanje u hitnim situacijama-OEM – City Office of Emergency Management) participated as respondents to the questionnaire to provide more useful results.

4.1
Forming symbols

Dividing symbols in case of disaster as well as their mapping requires knowing the source of disaster. Accordingly, there are two types of disasters and, consequently, two types of symbols:
1) First type is natural disasters caused by natural development. We can divide them into two categories:
- Disasters caused by dynamic processes like earthquakes, volcanoes, tsunami, etc.
- Disasters caused by meteorological and hydrological effects. This category implies: flood, fires, avalanches, etc.
2) The second type of disaster is technological disasters. They are caused by technological development and different explosions, chemical effusion, contaminations, epidemics, etc. [6].

With the application of different map graphic and geovisualization tools on thematic maps, information can be offered about the area, direction of movement, properties, duration, frequency and data correlation. Symbols and their definitions must be developed to the level of providing a current and general understanding of the current crisis [2].

A selection of twenty crisis situations was presented with map symbols. For each disaster, three symbols were made, and were included in the questionnaire, and the one that best suited the crisis that it was to represent was to be chosen. The free graphics program Inkscape was used to create the symbols [12].

Table 1 Samples of different symbol designs

Geophysical	◆
Meteorological	◆
Flood	●
Fire	▲
Danger	■
Pollution	⬡

For symbol visualization on handhelds, symbols must pass a simplification process and, if necessary, be changed. Symbols are divided according to appearance for different crisis situations: geophysical, meteorological, flood, fire, danger and pollution. Symbols that belong to the same category are recognized by shape and/or colour fill for better visual distinction between categories and for

better recognition of symbols and legibility on maps, which are already filled with different cartographic objects and their colours (Tab. 1).

5
Implementation and results of survey
5.1
Questionnaire

The aim of the survey with a questionnaire is the narrowing of the choice of symbols for use in the early warning and crisis management on handhelds. Respondents chose which signature is the most acceptable for a specific term. The questionnaire offered respondents (examinees) 20 symbols which depict the crisis situations displayed on handhelds. Examinees were divided into five groups:

- crisis management experts –16 examinees
- cartographers – 5 examinees
- students (university) – 58 examinees
- pupils (16 ÷ 18 years) – 21 examinees
- others – 30 examinees.

Table 2 Proposition of symbols as results of survey

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Avalanche (lavina)	
Earthquake (potres)	
Falling rock (odron)	
Landslide (klizište)	
Waterspout at sea (pijavica na moru)	
Extremely high wind (ekstremno jak vjetar)	
Fog (magla)	
Storm (oluja)	
Extremely low temperatures (ekstremno niske temperature)	
Extremely high temperatures (ekstremno visoke temperature)	
Flood (poplava)	
Tsunami (tsunami)	
Fire (požar)	
Minefield (minsko polje)	
Spread of epidemic (širenje epidemije)	
Wild animal attack (napad divlje životinje)	
Radioactivity (radioaktivnost)	
Air pollution (zagađenje zraka)	
Biochemical risk (biokemijska opasnost)	
Water pollution (zagađenje vode)	

The questionnaire contained 25 questions with no time limit to answer. The questionnaire was divided into

several parts. The first question tested the percentage of use of handhelds and viewing maps on them. Second, third and fourth questions tested the knowledge of respondents in the area of early warning and crisis management. The fifth question asked for opinion about the usefulness of crisis maps on handhelds. In questions 6 to 25, cartographic symbols were selected for the best presentation of each crisis on the map. The survey was carried out between 15.02.2011 ÷ 17.03.2011. It was conducted voluntarily and anonymously online, but with a note that the symbols would be used on handhelds. There was no time limit for filling in the survey. For better analysis and data processing, the date of the survey and IP address were stored for each survey. One can see the questionnaire online at [16], and complete results at [11]. The results of the symbols' selection are shown in Tab. 2.

5.2
Interview

For the purpose of the interview, we made a map with the symbols that respondents had selected in the highest percentage in the questionnaire. The map is located at [17]. This is a personal Google map on which places are marked with symbols. The selected symbols from the survey were used on maps in the interviewing process for evaluation of visualization on PDA of each symbol in combination with other cartographic material. Google Maps let you display different map views. These different views affect the visibility and legibility of the very symbols. In the conducted interviews we tested the symbols on all offered backgrounds. The appearance of a map made for the purpose of the interview is shown on a Nokia smartphone in Fig. 1.

The interview contains 8 questions that test the detection of symbols, i.e. recognition of their meaning to the usefulness of these symbols on maps for small handheld devices. Respondents were interviewed in the field using the map (Fig. 1) presented on the Nokia 5800 XpressMusic Smartphone and the Blackberry Torch 9800. After examining the maps, the respondents answered the following questions:

1. Do you think the symbols correspond to the meaning of the terms they are representing? (YES: 100 %; NO: 0 %)
2. Are monochrome symbols more readable? (YES: 0 %; NO: 100 %)
3. Is the size of symbols sufficient to distinguish the symbol, and are they clear, legible, understandable and unambiguous? (YES: 100 %; NO: 0 %)
4. Should the user be allowed to resize the symbols, in order to facilitate use and perception? (YES: 12,5 %; NO: 87,5 %)
5. Are you colour-blind? (YES: 0 %; NO: 100 %)
6. Is perception of the user improved if the symbol is displayed in colour? (YES: 100 %; NO: 0 %)
7. Is it better to show all the symbols inside the frame? (YES: 25 %; NO: 75 %)
8. Do you think the use of these symbols in smartphone applications or GPS navigation would be useful in preventing or reducing the number of accidents? (YES: 100 %; NO: 0 %).

Figure 1 Map displayed on the screen of a Nokia smartphone with different visualizations – above is the terrain map, and on the bottom is a map a general background [10].

6
Discussion

Comments received by the survey respondents, but also obtained in interviews confirm the need to establish a system for early warning and crisis management in the city but also in the entire country, a system that will provide key information in real time and be easily accessible. Respondents evaluated the work as a quality initiative to establish such a necessary system. Most respondents (76 %) knew what early warning means, but only a small part of them (38 %) saw the crisis maps. There should be more citizens with knowledge about early warning and instructed about the basic meaning of an early warning and crisis management system. The process of selecting symbols (those that best suit the offered term) does not differ much from the respondents profile (70 % of the selected symbols have been selected by all of the respondent categories). This is probably due to the fact that a small proportion of respondents (mostly experts in the field) are familiar with already standardized symbols. We received positive results from the interview with regard to the readability and recognisability of the symbols displayed on PDAs (100 % of the respondents assessed the symbols as corresponding to the concepts they represent. The authors also think that the symbols are highly readable, understandable and intelligible). Furthermore, they are also convinced of the potential usefulness of early warning systems on PDA devices and smartphones, an opinion shared by respondents (100 %), which could serve to reduce or even prevent an accident as a result of a crisis situation. Here are some of the comments received from the questionnaires and interviews:

1) An interesting survey that prompted me to think about buying a smartphone that could support this more than useful feature, especially when travelling.
2) A useful initiative, I hope that it will be realized.
3) Early warning maps are only partly available in terms of weather, water level and extent of fire. They are not readily available and are poorly developed.
4) I'm glad that someone is working on creating conditions for early warning in the event of danger. Early or timely warning provides enough time to organise the necessary search and rescue forces.
5) A very valuable contribution to disaster risk reduction.
6) Symbols for the storm and landslide are less visible.

7
Conclusions

Due to the frequent occurrence of crisis situations there is a greater need for a system of early warning and crisis management in the country, which will provide key information in real time and be easily accessible to everyone. This is confirmed by comments received from survey respondents, who evaluated the work as a quality initiative for the establishment of such a necessary system. One of the key parts of the early warning system crisis map is to show the locations of all key services, enabling the urgent and coordinated action of all participants in the system established for the

implementation of emergency measures, activities and tasks. Some countries like the U.S. and Canada have standard symbols for displaying crisis situations, while here in Croatia it is not the case. Experts in the field of geodesy and geoinformation from around the world participate in annual international conferences and symposia held to discuss the usefulness of geoinformation in emergency situations and problems of visualization of crises which confirms the relevance of the issues this paper deals with. One of the key parts of the early warning system is the crisis map showing the position of the crisis, which enables urgent action and proper coordination of all participants in order to implement the set of measures, activities and tasks. Most of the respondents knew what early warning means, and only a small part of them saw the crisis maps. The authors propose further activities for the education of citizens on early warning and crisis management with more instructions. Knowledge of the procedures during crisis situations is the key to save lives and property. More than half of respondents (63 %) use a PDA device or smartphone, and view maps on them, which confirms that handhelds are a good platform for early warning. The expanding smartphone market and the potential usefulness of early warning systems will continue to grow. The symbols are divided according to occurrences in crisis situations, and 75 % of respondents considered their depiction and the terms used as good, while 25 % thought it would be better to have all the symbols in the same frame. During the interview, we received positive results with regard to readability and recognition of symbols displayed on the PDA (100 % of the respondents confirmed that the symbols correspond to the terms and there is no doubt that the symbols are readable and understandable). Finally, respondents find that the potential usefulness of early warning systems on PDA devices and smartphones could reduce and prevent accidents resulting in crisis situations. Judging by the respondents comments, the goal was achieved.

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