CO-178

RESEARCH ON CARTOGRAPHIC SOLUTIONS FOR EARLY WARNING AND CRISIS MANAGEMENT USED BY EMERGENCY SERVICES IN CROATIA

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1. INTRODUCTION

The design and evaluation of cartographic symbols on maps for early warning and crisis management has received considerable attention by research cartographers over the past decade. Research articles have been published examining various aspects of emergency symbology design (Dymon 2003a; Dymon 2003b; Robinson et al., 2010) and how they affect subjective memory and comprehension (Akkela 2009). The recent attempts in North America (URL 1), Canada (URL 2), Australia and New Zealand (URL 3) to create maps for crisis management revealed the lack of guidelines and standards in emergency mapping symbology.

The purpose of this paper is to provide a review of the current situation in Croatia concerning availability and usefulness of cartographic solutions used for early warning and crisis management and to propose a national approach to crisis management symbology. First, some of the basic geographical facts about Republic of Croatia and its vulnerability by natural or man-made hazards will be presented along with basic organizational structure of emergency services in Croatia. Next, the results of the conducted research will be presented and existing cartographic materials/symbols/solutions for early warning and crisis management collected through various state and local agencies, services and organizations, private sectors, commercial software solutions, etc. will be analyzed and briefly discussed. Finally, some of the factors that need to be considered when developing and evaluating national emergency mapping symbology will be addressed.

2. VULNERABILITY EVALUATION AND ORGANISATION OF CRISIS MANAGEMENT SERVICES IN CROATIA

The Republic of Croatia (Fig. 1), with the area of 56 594 km2, is situated in the South-eastern part of Europe, surrounded by Alps in the West, Sava and Drava rivers in the North and East and the Adriatic Sea in the South. It lies between latitudes 42° and 47°N, and longitudes 13° and 20°E.

Fig. 1. Map of Croatia and neighbouring countries

According to the 2009 mid-year population estimate, Croatia was populated by 4.4 million inhabitants with the average density of 78.3 inhabitants per km2 (Ostroški, 2010) and is therefore categorized as one of the middle and less densely populated European countries. State territory is administratively divided into 21 counties and has 127 cities, 429 towns and 6752 settlements (Ostroški, 2010).

According to the relief features on the Croatian territory, three distinct geographical entities differ: plains, lakes and rolling hills in the continental north and north-east (Central Croatia and Slavonia, part of the Pannonian Basin); densely wooded mountains in Lika and Gorski Kotar, part of the Dinaric Alps; rocky coastlines on the Adriatic Sea (Istria, Northern Sea coast and Dalmatia).

2.1. Vulnerability of the Republic of Croatia to natural and technical-technological catastrophes and disasters

Regardless of economic development, all countries in the world are aware of risks to fundamental national security interests which can happen at any moment due to catastrophes or disasters.

The Republic of Croatia is not an exception, although it has not suffered a major natural or technical-technological catastrophe or disaster since it became independent. In May of 2009, the Government of the Republic of Croatia published the document Procjena ugro enosti Republike Hrvatske od prirodnih i tehničko-tehnoloških katastrofa i velikih nesreća (Vulnerability Estimation of the Republic of Croatia to Natural and Technical-Technological Catastrophes and Disasters), with major risks and dangers to Croatia being floods, earthquakes, landslides, disaster in economic objects and traffic, nuclear and radiological

disasters due to proximity of the Krško nuclear plant and fires on the Adriatic coast which endanger inhabitants, material resources and the environment each summer (DUZS, 2009).

2.2. Crisis management system in the Republic of Croatia

A unique system for crisis management has not been produced yet in Croatia. There are individual solutions responding to crises within individual organisations' authority, but a unified national system does not exist.

The Republic of Croatia has a developed concept of civil defence as a reduced model of general national defence conceived to cover parts of crisis management. Nevertheless, civil defence never covered the area, meaning it is a concept not meeting contemporary security requirements and needs and which is primarily directed to preparing the country and society to military aggression. Existing social and security occasions are very different. The probability of an armed conflict is minimal, while citizens are threatened by various crises such as natural or technological disasters, terrorism, etc. (Šegvić and Klarić, 2010).

Therefore, Croatia is redefining the concept of civil defence and its direction to a crisis management system (Zelić and Vučak, 2010). In order to advance the system of crisis management in the Republic of Croatia, let us mention some contributions. In November of 2009 and October of 2010, conferences were held in Zagreb of the Croatian Platform for Catastrophe Risk Reduction, where results are presented of reducing catastrophe risks, as well as directions of future actions and goals of mutual or priority interest to certain aspects of work and life or certain scientific fields. The international conference Crisis Management Days was held at the University of Velika Gorica in May of 2008, 2009 and 2010. The international conference accepts and publishes scientific and expert papers, as well results of interdisciplinary research, with the field of interest being contemporary security and security threats, all types of crises, special situations, crisis management models, national crisis management systems, critical infrastructure, crisis communication, business systems and crisis management, risk management, etc.

However, the lack of a suitable system has led to using ad hoc solutions when reacting to various threats, with the tendency of civil institutions to rely on resources and capability of armed forces without involving other available civil personnel. Capabilities of those institutions haven't been systematically developed nor institutionally connected.

As a result of such a fragmented and uncoordinated approach to crisis management, an integrated national strategy of crisis management does not exist, nor does a plan supporting long-term responses to crisis situations. Such an approach is apparent in results of research on cartographic materials for early warning and crisis management conducted in various civil and public services provided in the following chapter.

3. EXISTING CRISIS MANAGEMENT CARTOGRAPHIC MATERIALS/ SYMBOLS/ SOLUTIONS AND PRACTICES IN CROATIA

The purpose of this chapter is to describe, evaluate and analyze existing relevant cartographic materials/symbols/solutions that were identified through various state and local agencies, services and organizations, private sectors, commercial software solutions, etc.

The operative part of a system has capabilities of concrete action in crises. It is developed in the Republic of Croatia and it consists of all forces and resources to be used as a response to a crisis (police, fire department, military, emergency medical treatment, Red Cross, Croatian Mountain Rescue Service, civil protection, etc.), and it is developed in various public or private institutions (ministries, administrations, institutes, non-government organisations, companies, etc.).

Hereafter, we present several examples of existing crisis management cartographic materials/symbols/solutions and practices in Croatia developed among different national emergency organizations. According to their meaning, and modelled on the framework for emergency mapping symbology proposed by Dymon (2003a) the materials were grouped into categories:

a) Planning maps for preparedness (this includes hazard maps, vulnerability maps and risk maps)

b) Crisis maps for immediate response during or immediately after an emergency

c) Emergency maps for intermediate response, leading to recovery period

d) Time series maps for long term recovery maps

3.1. Official Cartography in Croatia and some general rules and guidelines in Croatian cartography which can be applied to map graphics for early warning and crisis situations management

On many cartographic representations in Croatia, there are certain map symbols that have been used for a long time in an unchanged or very similar form. This traditionalism is very positive feature of map symbols, because it represents a part of achieved efforts in standardizing cartographic symbols on greater scale.

For example, there are rules for the use of colours on cartographic representations that were made stable and traditional through systematic application in Croatia. In this way, only blue colour is used for the water and the objects connected with water. Following selection of colours is traditional for Croatia, for objects related to terrain: green for areas covered with plants, brown for symbols of terrain features, yellow for areas of weak vegetation and without plants (Fig. 2). Black and grey are traditionally used for a topographic base (Lovrić, 1988).

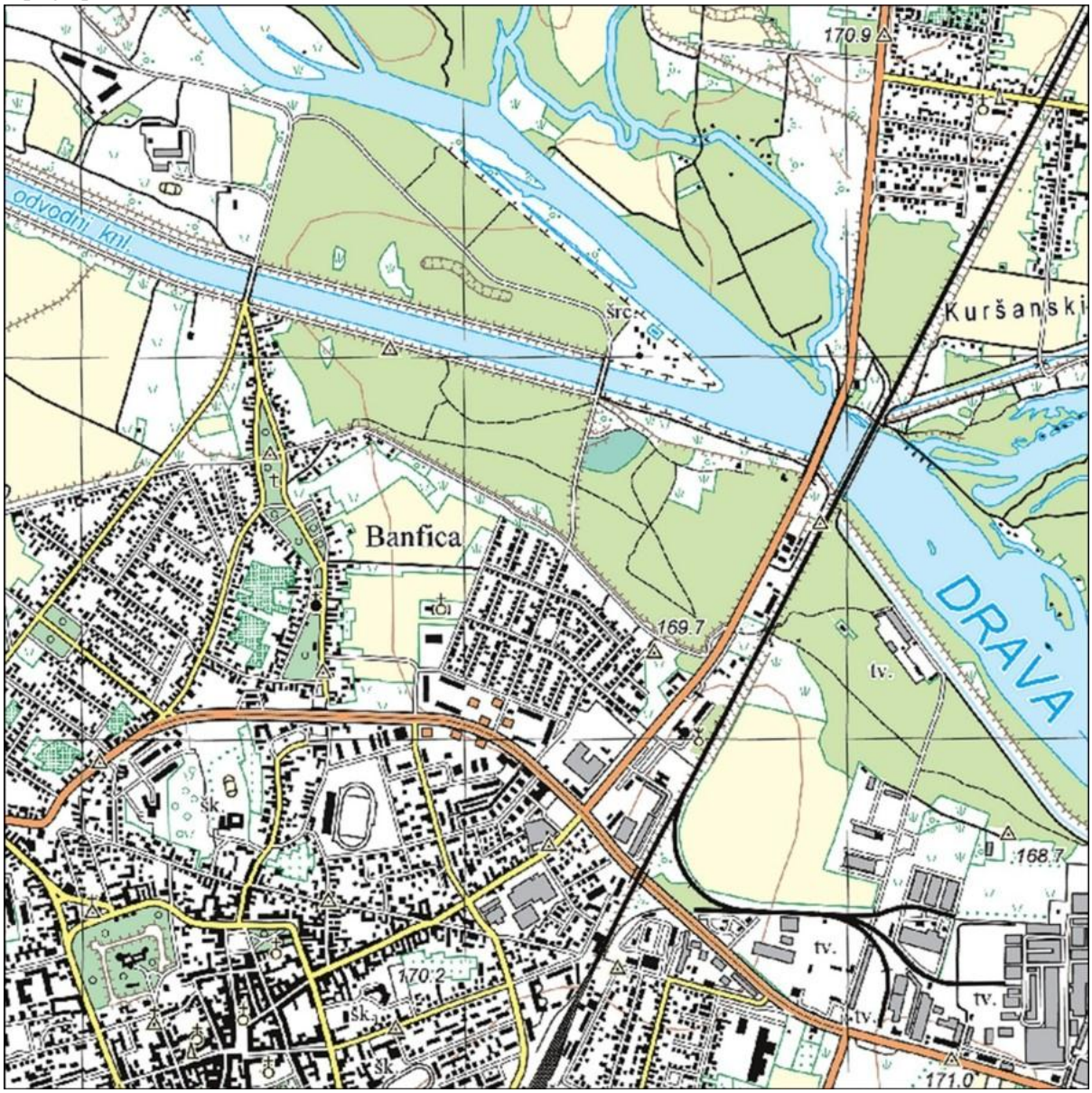

Fig. 2. Section of the official topographic map at the scale of 1:25 000 showing selection of colours that is traditional for Croatia

State Geodetic Administration

The State Geodetic Administration (URL 6) is a state administrative organization which carries out administrative and professional works from the field of geodesy, cartography, cadastre and photogrammetry, and also deals with cadastre and official state cartography (1:5000, 1:25 000, 1:50 000, 1:100 000, 1:250 000).

These maps provide basic information about topography, political boundaries, highways, location of settlements can be used as base maps. Good base maps are essential in any disaster situation and can be used for any type of hazard, risk and disaster management mapping.

The State Geodetic Administration produced a proposal of the new Regulations on Map Symbols with the accompanying Collection of Map Symbols (DGU, 2010). According to a public inspection (after January 1, 2011), the Regulations and the Collection are going to be officially published.

Although map symbols from the Collection mostly refer to the representation of map symbols on topographic maps, cadastral plans, sketches, base maps and other georeferenced representations, there are other symbols in the Collection (e.g. church, public building), and e.g. table of colour for map symbols which can be used for crisis management maps (Fig. 3). It is to be expected that some organizations will adopt these cartographic symbols (from the collection) and accept cartographic conventions (like using blue lines for rivers and green colours for vegetation) for their maps.

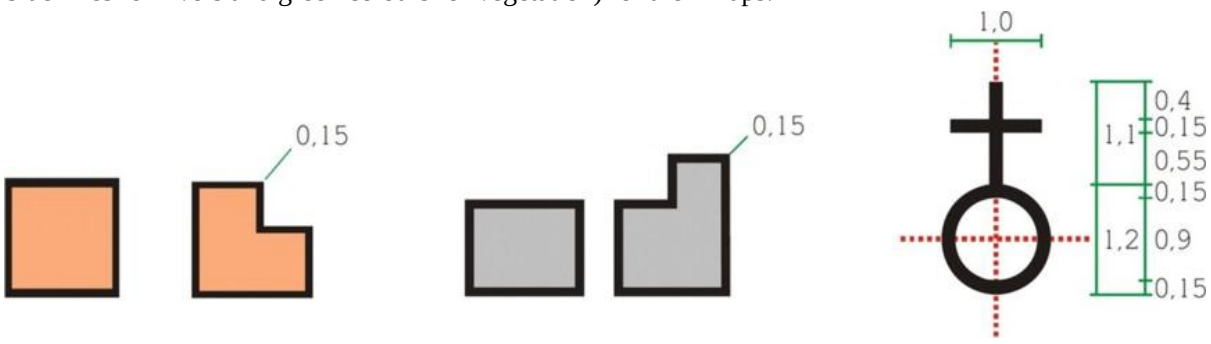

Fig. 3. Map symbols (with measures in millimetres for representation at scale 1:25 000) for: a) housing building b) industrial building and c) church – examples from the Collection of Map Symbols (DGU, 2010)

These several examples of traditionalism, which lead to standardization, show that a cartographer does not have complete freedom in every moment of selection and application of map graphics and that one must be particularly careful when designing new set of map symbols on maps for early warning and crisis management for that not to result in a conflict between standardized symbols and symbols that need to be designed following demands specific for Croatia.

3.2. National Protection and Rescue Directorate

National Protection and Rescue Directorate is the leading organization for the protection and rescue of people, assets and environment in the Republic of Croatia. In Procjena ugro enosti… (DUZS, 2009) 12 maps were published – maps that identify and display the location of hazard zones, e.g. floods, earthquakes, nuclear hazards, technical-technological hazards, areas where there are dangers to humans and their property for the whole territory of the Republic of Croatia at the scale of 1:3 000 000. All published maps can be categorized as planning maps for preparedness.

Fig. 4 represents a hazard map of the Republic of Croatia published in Procjena ugro enosti... (DUZS, 2009). Since the map identifies and displays the location of hazard zones and areas where there are dangers to humans and their property it can be categorized as a hazard map. The map at the scale of 1:3 000 000 represents the entire area of Croatia with hazards – technical-technological disasters, nuclear plant Krško hazard zones, railway and road hazard areas, 9° earthquake hazard areas, mine hazard areas, flood hazard areas, and the map also shows district centres and borders. These hazards are listed in the map legend in addition to pertaining map symbols. In addition to the legend, there are numerical and graphical scales and the map title.

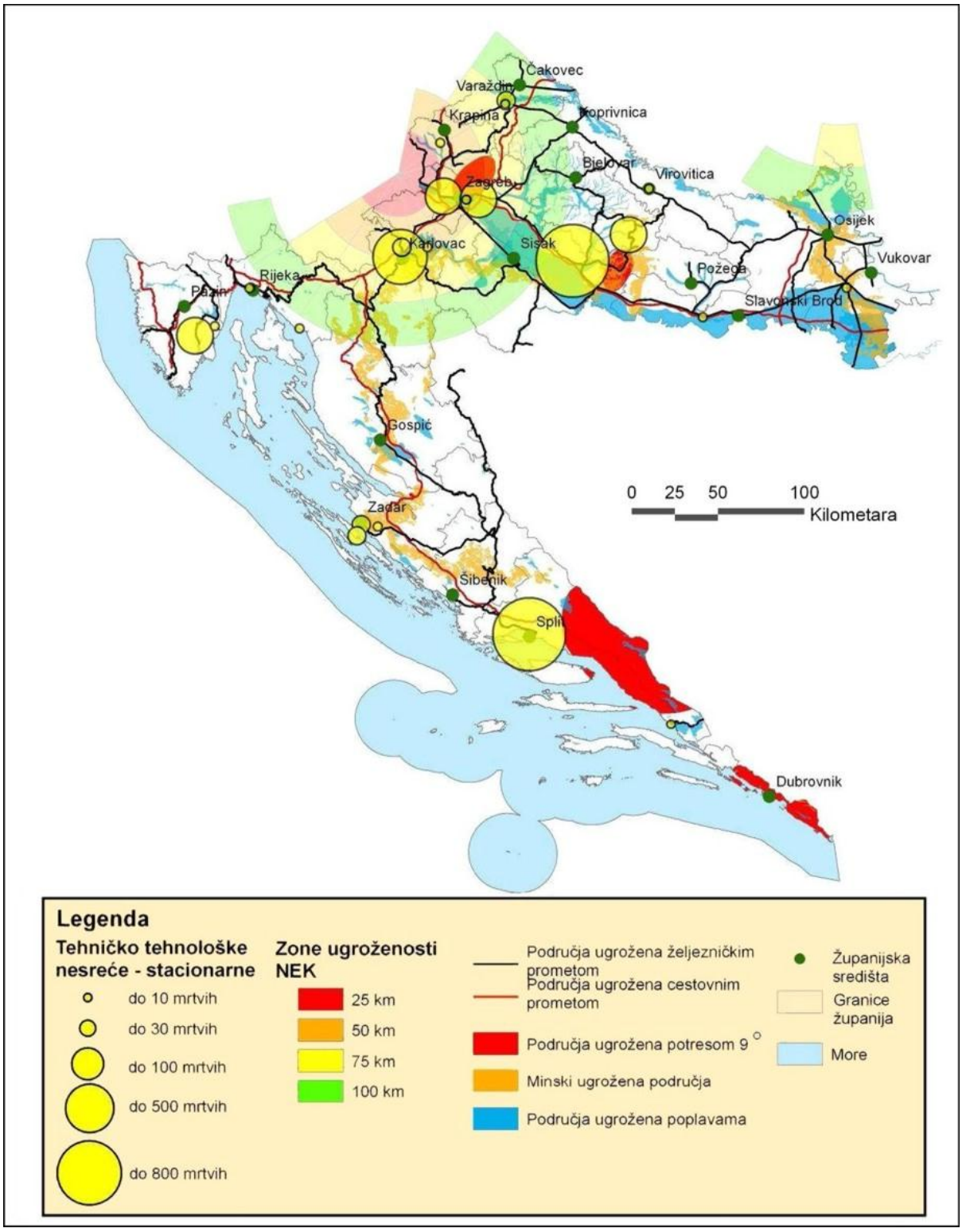

Fig. 4. Hazard map of the Republic of Croatia (DUZS, 2009)

Fig. 5 represents a seismological map of the Republic of Croatia for the return period of 500 years (DUZS, 2009). This map can be categorized as risk map since it portrays the spatial distribution of risk computations – conditional probability that a given area will experience an earthquake. The map at the scale of 1:3 000 000 represents the area of entire Croatia and indicates areas of maximum expected earthquake intensities. Different colours indicate different intensity areas (green for the least intensity, yellow and orange for moderate intensity and red for the greatest intensity), which can be seen in the legend.

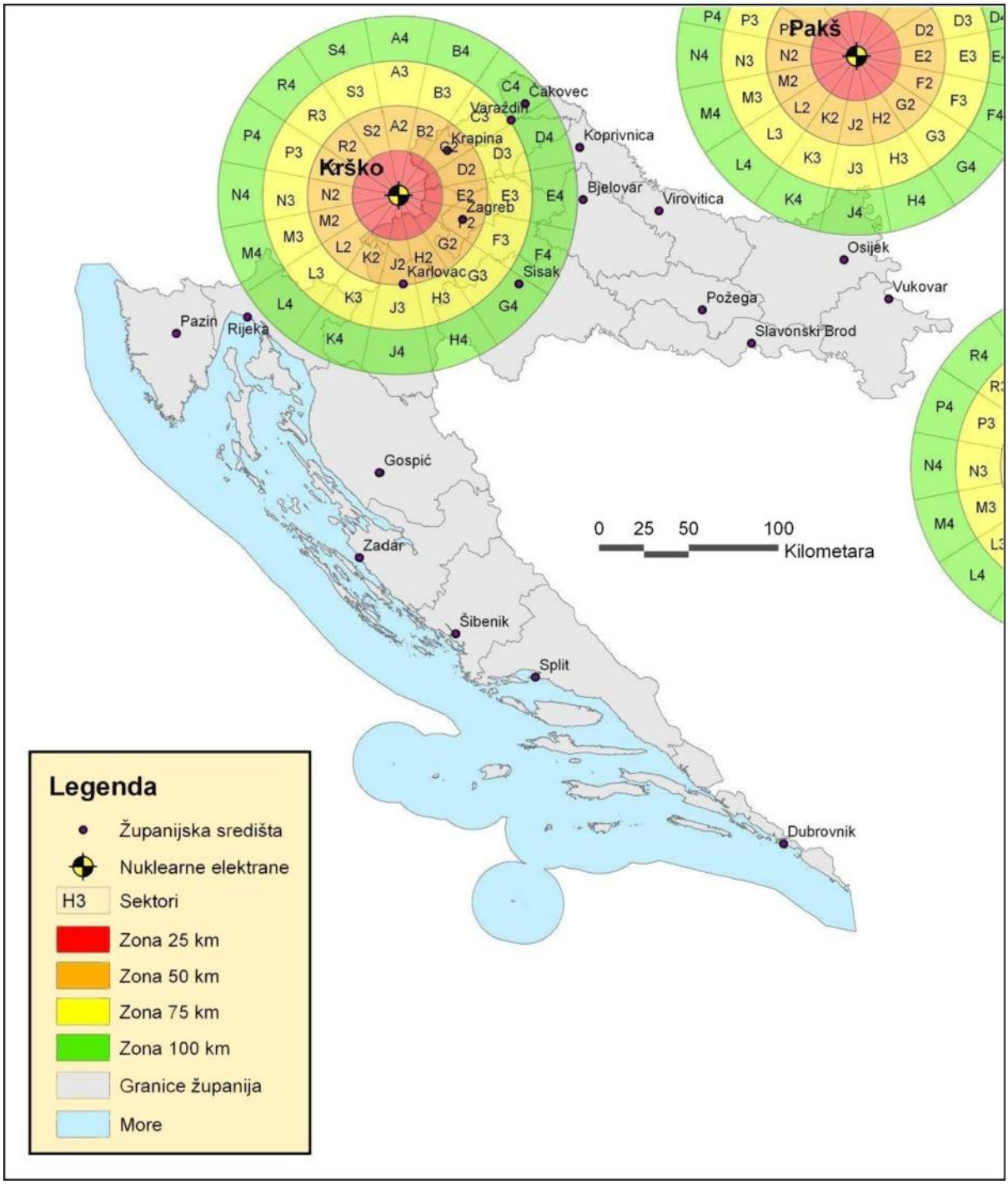

Fig. 5. Seismological map of the Republic of Croatia for the return period of 500 years (risk map), (DUZS, 2009)

The Croatian National Protection and Rescue Directorate started developing its GIS (ZeOS) in 2007. It is a computer system capable of integrating, saving, editing, analysing and representing spatial and other information, and it consists of a documentation base, an alphanumeric base and a spatial database, and it was conceived as a "smart map" which enables users to create interactive queries and analyse spatial data.

The system consists of several application intended to various services of the Croatian National Protection and Rescue Directorate and can be used in all phases of crisis management.

Fig. 6 represents a section from an application of the Directorate for system 112. The service collects and analyses information and data about all discovered dangers and their consequences, informs and alarms citizens, legal persons, national administration bodies, rescue services, authorised civil protection workers and other authorised managers of the Directorate.

The application used by the Directorate for System 122 is based on ESRI technology and uses implemented ESRI map symbols (emergency map symbols) to represent objects on the map.

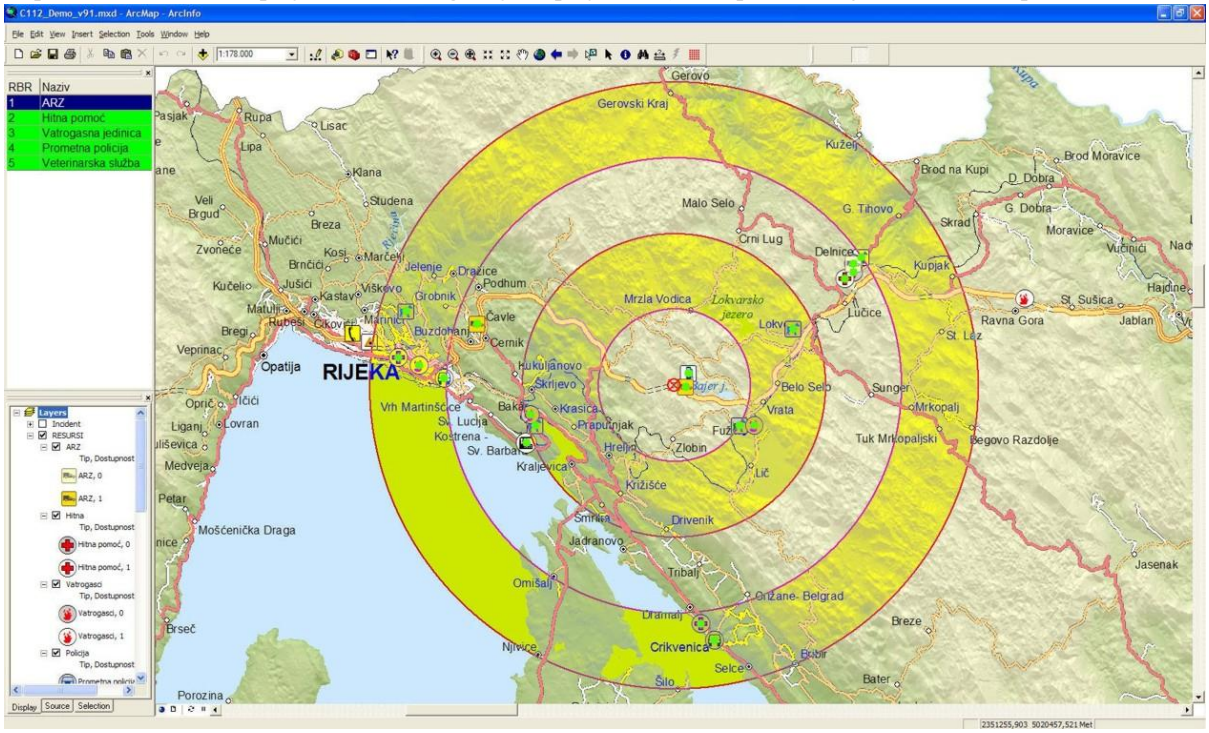

Fig. 6. Section from the GIS (ZeOS) application

3.3. The City of Zagreb Emergency Management Office

The Emergency Management Office was established in Zagreb in 2008, and it deals with defence, civil protection, natural disaster protection and rescue, fire fighting and fire protection. In April of 2010, the Emergency Management Office started collaborating with the Faculty of Geodesy of the University of Zagreb on creation of an emergency situation geoinformation system of the city of Zagreb. They worked on tasks related to production of the Operative Protection and Rescue Plan of the City of Zagreb in Case of Earthquake. Although the plan has not been completed, a significant amount of data were vectorized, georeferenced and included into maps, offering a base for producing a Protection and Rescue GIS of the City of Zagreb.

It is important to mention that emergency map symbols were produced for that purpose, using existing standardised symbols of UN. Some of them are represented in Fig. 7.

Fig. 7. Emergency map symbols for a) airport b) public hospital and c) church in Emergency GIS of the City of Zagreb

3.4. Meteorological and Hydrological Service in Croatia

Meteorological and Hydrological Service's services include METEOALARM (http://www.meteoalarm.eu). METEOALARM is a warning system of dangerous weather in Europe using map symbols and colour coded maps to provide updated warning of expected dangerous weather for the next 48 hours in most of Europe. The system can be classified as planning map for preparedness in case of dangerous weather conditions.

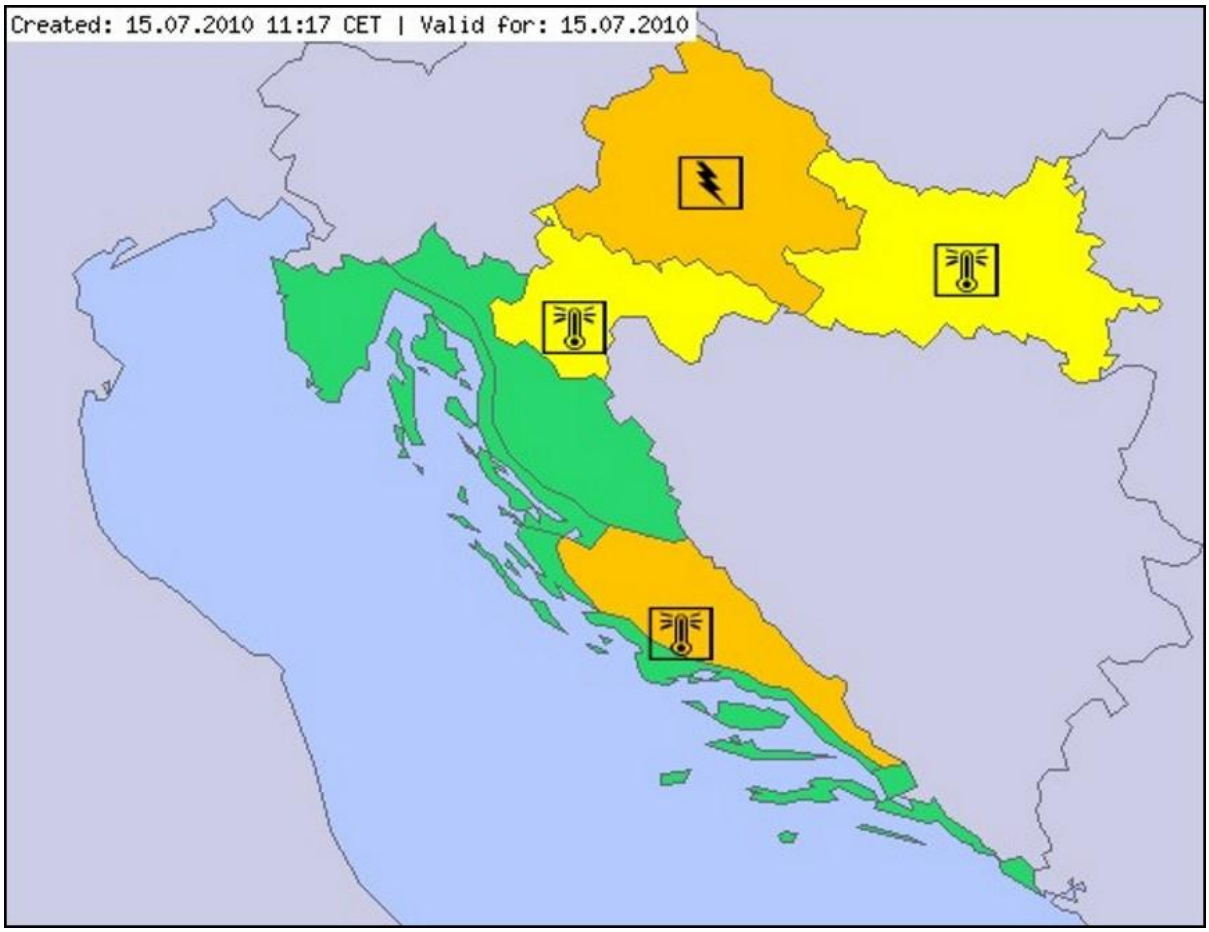

Fig. 8. METEOALARM – warnings of dangerous weather are produced for 8 different climate regions in Croatia (URL 7)

3.5. Crisis Management in Higher Education in Croatia

We would like to point out three high education institutions in Croatia which offer courses related to crisis management. The Faculty of Geodesy of the University of Zagreb has a graduate study of geodesy and geoinformatics, which offers the course Risk Management. The undergraduate study of geography at the Department of Geography of the University of Zadar offers the course Geography of Natural Threats. University of Applied Sciences Velika Gorica offers the study programme Crisis Management.

4. CONCLUSION AND FUTURE WORK

This study clearly shows there is a lack of national guidelines, standards, and symbology to create maps for crisis management and to communicate during emergency situation. The commonly accepted cartographic conventions and design methods such as symbolization, meanings of colour ranges and other design characteristics on reviewed cartographic materials do not provide a common ground for understanding these materials in planning and in emergencies. Maps reviewed in this paper have very little (or nothing) in common, and one preparing them are often not familiar with wider aspect of crisis mapping.

Different approaches (or lack thereof) among different national emergency organizations show that there is still a long way to a unique national emergency management cartographic approach. Given the current trends in the areas of cartography, geoinformation systems and geoinformation science, this is the time to create national guidelines and standards for crisis management maps. Standardized and widely accepted cartographic solutions could improve coordination and communication among all participants in an emergency situation and could contribute to a better understanding of crucial information during emergency situations.

Therefore, it is necessary to plan activities which are going to assist achieving this goal. These activities will comprise methods to build a comprehensive cartographic symbol set for crisis management following the directions on symbol design and standardization addressed in previous research studies (Robinson et al., 2010; Akella, 2009; Ahonen-Rainio et al., 2007; Dymon and Mbobi, 2005; Winter and Dymon, 2003). While doing this, one must be particularly careful for that not to result in a conflict between standardized

symbols and symbols that need to be designed following demands specific for Croatia (mentioned in chapter 3). Additionally, validation and extension of existing North American (URL 1), Canadian (URL 2) and Australian (URL 3) symbols should be completed. Novel design would be created for symbols that are previously tested (Akella, 2009) and did not achieve necessary comprehension level and for symbols that are still missing in these symbol sets – symbols that support wide range of mission needs beyond basic emergency response.

The design of each symbol should be evaluated and tested based on approved comprehension criteria for symbols (Wogalter et al., 2002). Both the ISO 3864-1 Standard from International Standardization Organization (ISO, 2004) and the ANSI Z535 Standard of the American National Standards Institute (ANSI, 2007) have established minimum acceptable levels of comprehension by the general population (67% and 85%, respectively). If the post test results would not be satisfactory, map symbols would be revised and tested again. Alternatively, behavioural responses to map symbols can be trained using strategies such as education, laws and regulations (Wogalter et al., 2002). So, in case that post post-test results fail again, workshops would be organized for emergency personnel in order to train them to respond to various map symbols when they read them on map, without having a look for instructions in a map legend.

Finally, in this paper, by providing the review of the existing cartographic solutions for early warning and crisis management in Croatia, possible problems in communication during an emergency event or preparing for one (caused by using inadequate maps, or lack thereof) are revealed. This highlighted the role of cartographic experts, who are trained to abstract the complexity of the real world, and to model spatial objects and relationships between them. These skills are indispensable for future effective visualization and usage of digital spatial data, and process of cartographic communication for early warning and crisis management.

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