DECISION SUPPORT CARTOGRAPHY FOR EMERGENCY MANAGEMENT

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ABSTRACT:

Cartographic visualisation plays important role in decision making process of a crisis management. Our research project is focused on proposal, implementation and evaluation of methods of dynamic cartographic visualisation in this area. Our aim is to improve readability of used cartographic visualisation by adaptation on context. Selected aspects of readability are discussed together with description of adaptable mapping process. In contemporary stage is our project focused on transport of hazardous materials and appropriate cartographic support. Briefly is mentioned symbology evaluation and technological background of project implementation.

1. INTRODUCTION OF THE PROBLEM

Decisions in the crisis management are implicitly spatially dependent. Maps and GIS applications are often used during such processes. During a crisis situation is necessary a quick overview of the situation. GIS tools represent improvement over map sheets in amount of necessary information and possibility to make proper combinations of data. Nevertheless amount of information can make difficulties in orientation and therefore time for decision is increasing. In our research project we are focused on cartographic methods how to design more readable front-end to crisis management decision tools. Is assumption that improvement of cartographic visualization leads to decrease of decision time and therefore overall improvement of crisis management.

2. ASPECTS OF READABILITY

Proper cartographic visualisation is often hard to define. We would like to focus easy readability of cartographic visualisations. And according to readability we can address following aspects:

- **Sufficient amount of information just in time** – analogue maps are usually overloaded due impossibility of change, in case of ad-hoc GIS visualizations is situation even worst - geodatabases are combined without generalization and without any care about graphical interaction. To make visualization more lightweight is necessary to order map features according particular purpose and make variable and linked feature content (if is increased amount of object one feature amount of objects from another features must proportionally be decreased). Unique visualisation is not theme but task oriented. There are identified task demanding decision of the responsible person and this decision are selected appropriate map features. As was mentioned involvement of user is focused on feature granularity – user can modify amount and detainees of principal features in few pre-processed steps for better understanding of interactions and spatial patterns.

- **Instant awareness of principal objects** - during solution of crisis situation importance of features (or objects) is changing according to solved task. Visualization must reflect change of purpose and increase awareness of important objects - through change of the colour scheme or by graphical alerts (blinking, patches).

Figure 1. Buildings endangered by advancing flood are changing colours thus suggesting priorities in evacuation

Another issue is multi-parametric nature of classification of some features. For better orientation of the reader is necessary to simplify a cartographic message and involve real-time reclassification into easy understandable value. Simple symbology with easy perception is evident part of feature awareness handling.

- **User-centric visualization** - for better usability of map is supposed to adapt symbology and granularity to the user. It doesn't mean that user have control over symbology, just symbology is related to the defined user groups. User groups are identified according professional background and map usage bias. This user-centric point of view cannot be restricted on different symbology for the same features but also feature definition is user dependent – every user group has individual ontology of task which needs to by

describe. In the crisis management play key role collaboration – therefore one data source is contemporary used by all attendants. Source data model is translated into user group ontology and also is necessary to ensure that individual user input will be translated into shared pool of information. User groups are also affected by the role of users in the crisis management. This division focusing mainly spatial extent of decision and therefore it is important generalisation factor.
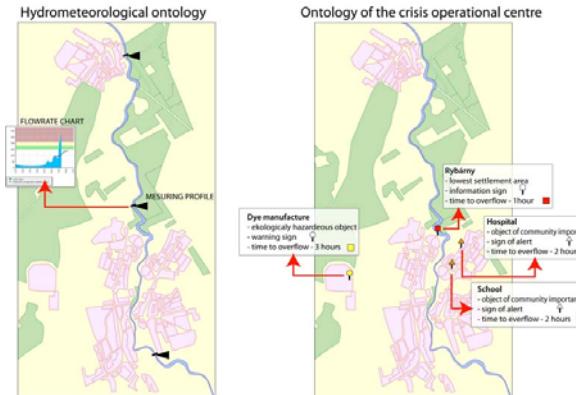

Figure 2. Ontology translation between two groups of users

3. DEFINITION OF CONTEXTS

As was mentioned before in the case of crisis management it is necessary to decompose the general emergency situation into scenarios related to particular type of danger or crisis. Such scenarios consist of individual tasks which are unique for roles of participant in crisis management. Scenarios here describe the possible interaction between a user and the system and tasks describe who (role) does what (interaction) within a given situation, for what purpose (goal). Cartographic visualization follows division into scenarios and tasks (many tasks are similar inside different scenarios). In the scenario/task oriented visualization we can distinguish following factors:

- Spatial extent – every operation has some spatial extent related to the user competence, in higher levels of user roles is necessary to combine overview extent and selected detail extents.
- Map content – features and their level of detail steps, features are derived from combination of user task demands and available information sources. A quality of sources strongly determines possibilities of manipulation with level of detail.
- Importance of features – importance of features is classified according task, nevertheless user can make individual enforcement of feature importance
- Symbology – as was already mentioned defined user groups have own symbology, but in case of intensive communication over feature position between different user groups is here necessity of standardisation and proposal of simple and commonly understandable symbol.
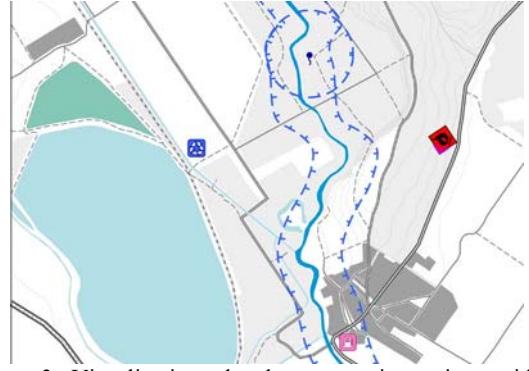

Figure 3. Visualization related to a water impacting accident

The standard operational techniques verbal descriptions have been analysed in order to identify particular roles and actions to be taken. Fire rescue brigades' materials and national Security Council disasters classification have been used as templates for the pilot project development. Since the ongoing research is realized in a close collaboration with the regional government the pilot is focused on the transportation of hazardous chemical material and mitigation of potential hazards. Five different scenarios have been identified describing one operational and four emergency situations. The operational scenario is focused on tracking vehicles with hazardous material. This tracking is enriched by evaluation of level of danger – amount and importance of nearby sensitive objects. According to the nature of accident was prepared initial overview visualisations for four different cases – fire, water, air and blast. For identified cases were selected appropriate features and objects – artificial and natural. Also reference base was modified in relation to case thematic content and relevancy for the decision. Map content for particular tasks of crisis mitigation process are derived from intervention methods of the national Security Council. In this stage is ontologic description focused on fire brigades and local government crisis management. This practical point of views is confronted with ontology of existing data sources.

4. SYMBOLOGY DESIGN

Cartographic symbology is developed according to contemporary studies and conventions in crisis management realm. Existing cartographic resources have been analysed and ontology of presented features described. For non-specialist user groups are proposed new symbol sets. Although we suppose individual symbology, we also admit cases of verbal description of map field. For such cases it is necessary to use standardized sets of symbols. In case of standardisation we try to harmonize our effort with already existing initiatives for symbol set definitions in EU or US. If international symbols will fit readability demand we would like to propagate their usage in local conditions. Even if symbols set will not complete our demands we suppose to keep ontology and appropriate thesaurus of tested sets for potential international usage of data sources.
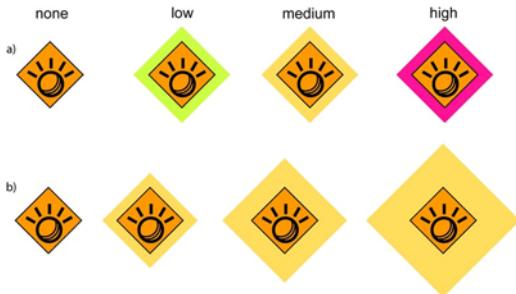
Figure 4. Variants of visual alerts on level of danger

In cartographic orientation of our research is important a verification of the visualization. We address perceptional and cognitive issues. In perceptional aspects we are focused on comprehension and distinctiveness of symbols. User and device related issues as well as stress factor play an important role in perception process. Cognitive aspects are tested according to solution time, memorizing and change awareness. Testing is provided by samples of visualisations with students. This test together with evaluation of existing practice is instrumental for pre-processing of test on real users. This is because of difficulty to reserve time of crisis management actors for extensive testing – we suppose to test on them just promising symbologies.
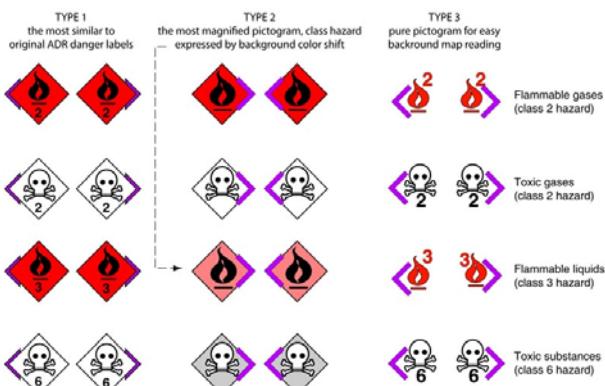

Figure 5. Three possible types of ADR signs cartographic transformation

5. TECHNOLOGICAL BACKGROUND

From technological point of view we try to use standardised methods as much as possible. For data transfer we use OGC WFS, for visualisation we use WMS with SLD. All thematic and geometric manipulation is made within database engine supporting OGC Simple Features specification (contemporary we use PostgreSQL). Only proprietary part is description of context for adaptive cartographic visualisation - context is send by client and translated by server into WMS query. Of course standardized graphic handling through SLD brings some limits to the visualisation capabilities. Such limits we consider like reasonable constraint for easy implementation into heterogeneous environment of data sources for the crisis management.

6. CONCLUSION

Cartographic support of decision process in the crisis management is quite underdeveloped and research in this area is very demanded by responsible actors. On other hand integration of data source is in this stage more challenging then just improvement of visualisation process. According visualisation is very sensitive if cartography play in particular task principal or marginal role and if such marginality is result of customs or nature of task. Nowadays we are focused on detailed elaboration of hazardous material problematic. Created solution will used like pattern for another cases of the crisis management (unique cases are ordered according demands of local centre of crisis management, next one is case of forest fire). We would like to extend user base by police and ambulance. Contemporary visualisation contexts are created for fire brigades and local centre for crisis management. Another planed extension is to incorporate higher levels of the crisis management and enable possibility of cross border collaboration. Already were initialized compilations of Czech - German thesauri in area of the crisis management support.

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