

CONTEXT MAP – A TOOL FOR CARTOGRAPHY SUPPORT IN CRISIS MANAGEMENT

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Abstract

Adaptive cartography aims to create the system that is adapted to the user's context. The presented paper addresses the problems of context definition in crisis management, i.e. in field when a diverse group of professionals is involved in an emergency, each of them having a specific task and knowledge background. Here, universal maps are not efficient; to minimize the time of map interpretation the final cartographic product must be adapted to a specific user. Fundamental task for the adaptive mapping system design is the selection of factors defining the user's context. On the example of flood emergency, the system of flood prevention, response and recovery in the Czech Republic is analyzed and the main activities of the involved authorities and professionals are specified. Based on the analysis, emergency context are defined based on the event, task, stage and operation range. Furthermore, relevancy of the information is discussed.

Keywords: *adaptive cartography, crisis management, flood management, context, context map*

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1 INTRODUCTION

Crisis management (CM) is a field that is characterized by the huge diversity; there is great variability of crisis situations where many different professional groups are involved in. Each group has its own task and responsibility and thus its own view on given situation.

Cartographic support plays an important role in decision making in CM. Geospatial information is ultimate basis for crisis management and emergency response – it is used during all stages of the disaster (before, during and after). Effective cooperation of different subjects involved in CM necessitates work over unique database to ensure conformity of geoinformation.

The user of geoinformation must be supplied with the right knowledge not to loose time with interpretation. Thanks to fast and rapid progress in geoinformatics, almost everybody is able to create the own map by means of web services. Users can visualize almost any data they like. But final cartography product lacks readability and to get the knowledge may be difficult.

To be effective, visualization must be not theme but task oriented. Task is related to the decision of the particular actor of the crisis management and only necessary map features inside corresponding extent are displayed [14].

Adaptive (or context) mapping offers invaluable decision making tool. It represents system that allows adaptation of the cartographic output to the needs of user – to actual context. It is important particularly in the field of CM when decisions must be made in short terms, within hours or minutes. Such situations do not leave any time to evaluate whether the data used for decision making are "accurate" or "relevant" [13]. Users must be sure that they use information that is reliable and adequate in a given situation. This requires not only a syntactical control, but especially an understanding of the semantic content of information. Adaptive mapping is a mechanisms that support the identification of the "right" data, thus guaranteeing that only such information is provided that is relevant in a specific situation [13]. According to [17] it is impossible for humans to examine the information and understand content, and then discover and combine this in a short time under time pressure in disaster management. Adaptive mapping bring an opportunity to supply user the right knowledge in the right moment.

Adaptive geovisualization is approach to user-centred geovisualization system. Adaptive cartography embodies the wide range of disciplines – informatics, cartography, psychology, etc. The presented paper deals with issues behind cartographic models creation on the example of flood events. The reminder of the paper is organized as follows: Chapter 2 gives a background of flood management in the Czech Republic that defines the domain of the presented study. Chapter 3 gives an overview of adaptive cartography and addresses issues of context definition in CM. Chapter 4 deals with emergency context definition on example of flood management. Chapter 5 describes relevancy issues and temporal dynamics of objects in CM.

2 FLOOD MANAGEMENT IN THE CZECH REPUBLIC

2.1 The institutional framework for flood management

In the Czech Republic flood protection is in focus of many legislative documents. The pivotal one is the Act of 28 June 2001 on Water and Amendments to Some Acts (The Water Act), which defines flood prevention, floodplain zones, flood activity degrees, flood plans, flood inspections, flood prediction services, rescue activities etc. Beside this Act, there is a huge number of other important legislative regulations settled in another Acts (e.g. Czech National Flood Protection Strategy - approved by Government Resolution no. 382 of 19 April 2000).

Protection itself is secured according to Flood Plans and, in the case that crisis situation is declared, according to crises and emergency plans. Protection against the natural floods is controlled by Flood Authorities that are (on territorial basis) responsible for organization of flood prevention; further they administer and coordinate the activities of other responsible actors within flood prevention. Character and activity of Flood Authorities are specified for two periods – beyond flood and during flood; their specification in hierarchical order is shown in *Table 1*.

Table 1: Flood Authorities beyond and during flood on different hierarchical levels

	<i>Beyond flood</i>	<i>During flood</i>
<i>Municipality level</i>	Municipality authorities	Flood Staff of the municipality
<i>District level</i>	Authorities of the Municipalities with Extended Powers	Flood Staff of the Municipalities with Extended Powers
<i>Regional level</i>	Regional authorities	Flood Staff of the Region
<i>State level</i>	Ministry of the Environment, Ministry of the Interior	Central Flood Staff

The Flood Staff establishes Flood Authorities as an executive body to carry out extraordinary tasks during the flood in the following manner:

- To fulfil tasks dealing with flood prevention, municipality council (MC) may establish municipality Flood Commission (FC) (otherwise MC plays the role of FC)
- Mayor of the Municipalities with Extended Powers establish Flood Commission of the Municipalities with Extended Powers and chair it.
- Ministry of the Environment in cooperation with the Ministry of Interior delimitates the complex flood basins. Commissioner of the region that overlaps this complex basin becomes the chair of the Flood Staff.
- Central Flood Staff is established by the government. The chair is the head of the Ministry of Environment, the head of Ministry of Interior becomes the vice-chair.

During the flood the Flood Staff is authorized to organize securing and emergency activities.

2.2 Information sources

Flood Plans are sources of information dealing with the flood prevention and response. The Flood Plan is divided to factual, organisational, and graphic parts.

Factual part includes information necessary for securing specific object, municipality, complex basin or other territory, directive limits for declaration of degrees of flood activity, informs about the possibilities to influence discharge, etc. Organisational part includes list of names and addresses, describes communication links between involved persons, specify tasks for people and organization concerned with flood protection, assists with securing local early warning system etc. Graphic part covers maps or plans that depict floodplain extent, evacuation routs, gathering and information spots, warning system, etc.

There are four types of Flood Plans corresponding with hierarchical order of authorities and the fifth one (Other Flood Plan) that is done for the buildings and parcels that either lay in the floodplain or can influence the progress of the flood (*Table 2*).

Table 2: Flood Plan hierarchy

<i>hierarchy level</i>	<i>type of Flood Plan</i>
<i>Local level</i>	Other Flood Plan
<i>Municipality level</i>	Flood Plan of the Municipality
<i>District level</i>	Flood Plan of the Municipalities with Extended Powers
<i>Regional level</i>	Flood Plan of the Region
<i>State level</i>	Flood Plan of the Czech Republic

Another measures needs to be done in the case of the special food; the progress of the event is very rapid and urgent response is needed. Such situations must be handled according to Crisis Plan and thus it is solved by territorially assigned Emergency Plan that includes Flood Protection Plan of the area bellow the water structure.

Directive of the European Parliament and of the Council on the Assessment and Management of Flood Risks (Flood Directive) obliges the member states to assess flood risk and hazards and make maps of it. To fulfil this directive, in 2009, T.G. Masaryk Water Research Institute proposed Methodology for the Flood risks and Flood hazards map making [2].

2.3 Users of geoinformation and their activities

There are many user groups that deal with activities related to flood management, it includes:

- government and self-government authorities – municipalities, municipalities with extended powers, region, state (central) authorities
- legal entities,
- self-employed natural persons,
- basic and other units of the Integrated Rescue System (Fire Rescue Service of the Czech Rep., Police of the Czech Rep., Ambulance Service etc.)
- River Basin Districts Authorities
- Watercourse managers
- Public

All these groups can be also seen as users of geoinformation. They use geoinformation to support various activities in different stages of flood management. Following table (

Table 3) lists some activities in flood management that are in responsibility of Fire Rescue Service, Water Managers and Flood Authorities. Watercourse managers and managers of touched object (or other subjects ordered by Flood Authorities) are responsible for Flood Security Activities (detailed in Table 3). These must be coordinated with the River Basin Authorities.

Fire Rescue Service (FRS) as one of the component of Integrated Rescue System (IRS) has many tasks within Flood Rescue Activities, Flood Security Activities and Organizational Activities. Flood Authorities are responsible for planning, organizing, securing and control.

Table 3: Selected flood activities of Fire Rescure Service, Watercourse Managers and Flood Authorities. Responsibility is marked with X.

	<i>Activities in flood management</i>	<i>Fire Rescure Service</i>	<i>Watercourse Managers</i>	<i>Flood Authorities</i>
<i>Flood Rescue Activities</i>	evacuation	X		X
	rescue of citizens by different means (by ship, car, helicopter..)	X		
	emergency medical treatment	X		
	search for people, rescue of animals, protection of prop	X		
	water pumping, works on water	X		
	technical assistance of Medical Rescue Service	X		
	liquidation of chemical disposal	X		
	provision of powers and means to support rescue activities			X
	securing of health care and emergency supply			X
<i>Flood Security Activities</i>	flood survey	X		X
	coordination with other components of IRS	X		
	citizen warning	X		
	assistance with organization and running of evacuation centre	X		
	securing emergency contact with flooded area	X		
	emergency supply of water, food and medicine	X		
	removing obstructions	X		
	indication of dangerous areas	X		
	assistance with installation of mobile flood-protection	X		
	locking supplies of water, gas, electricity	X		

	assistance with repairing priority infrastructure	X		
	measures against backwater (esp. to sewerage)		X	
	measures against water pollution		X	
	measures against landslides		X	
	temporally lockup of disrupted shorelines		X	
	protection of shoreline, measures against shoreline disruption or overflow of both watercourse and water structures		X	
	removing blockades of ice		X	
	removing obstruction form the watercourse and from the flow profile		X	
<i>Organizational Activities</i>	coordination of rescue works	X		
	organization of humanitarian aid and its distribution	X		
	dissemination of heat guns and water pumps, distribution of disinfectants	X		
	organizing of local early warning			X
	organization of flood defence			X
	compilation of Flood Plans			X
	proclamation of degrees of flood activities			X
<i>Other activities</i>	damages detection			X

3 ADAPTIVE CARTOGRAPHY AND CONTEXT

According to [16], adaptive geovisualization system should be able to play different roles in helping users to get the expected geoinformation and perform special tasks. Adaptation of geographic information (GI) can be seen as an optimization process that enables the provision of objects of high utility that satisfy a user's current situational context [3]. In CM, geographic information is produced and used by people to support decision making. For effective decision making detailed knowledge of the task is necessary.

The principles of adaptation deals with the theory of description of so called "context". According to [1] context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves. [1] define primary context types as LOCATION, IDENTITY, TIME AND ACTIVITY. [1] argue that the system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task. In another words, context-aware application responds on questions WHERE, WHO, WHEN and WHAT (i.e. what user is doing).

Fundamental for the adaptive mapping system is the knowledge of the user's context, e.g. what factors influence readability and usability of map. In cartography domain, context is set of determinants identifying particular cartographic representation. If something happens around map device, its context is changed and appropriate visual representation is selected [14].

As mentioned above, four primary context types are identified as LOCATION, IDENTITY, TIME AND ACTIVITY. All these contexts influence the way how data are transmitted to user. These context influence their selection (i.e. what is relevant or not), the way they will be visualized (i.e. method of cartography visualization), their inter-relations (what phenomena is related to what), etc.

In CM all these context type are relevant, furthermore, the context type TECHNOLOGY is being introduced [14]. The size of display limits the amount of perceptible information and thus the application must be adapted to it.

Context type LOCATION, referring to question WHERE, influence mostly the selection of object. For example: different density of phenomena (e.g. city vs. countryside – lack of POIs claims for display of object that must be omitted in city due to map content overload), specifications of the country. Familiarity of the user with the location is also important since it influences selection and enhancement of objects.

Context type TIME, referring to question WHEN, is important from two points of view – day time or seasonal weather condition influence the visibility of the map and thus enhancement of symbols. On the other hand, relevance of seasonal object is evident (e.g. icy phenomena).

Context type IDENTITY referring to question WHO, influence appearance of the symbols used in the map. For example age of the user influence perception ability and thus size and use of colours, education and professional background influence how explicit the knowledge expression must be and influence design of symbol (familiar representation is more effective).

Context type ACTIVITY is the most crucial one in our study and will be in detail described in the following chapter.

4 EMERGENCY CONTEXT IN CRISIS MANAGEMENT

The most important question in design of context-aware application, and design of map in general, is the purpose of the map, e.g. WHAT the user will use it for. It influences primary design of geodatabase, content of the context map and the resulting cartography model. This context type is influenced by many factors and its definition is very complex. We refer to this kind of context in crisis management as *EMERGENCY CONTEXT*.

4.1 Parameters of Emergency Context

We define emergency context as follows: *Emergency context characterizes the situation of the CM user from the viewpoint of the task that the user is responsible for in case of specific emergency event that is in specific stage of progress.*

Following this definition we refer to emergency context to be based on three **primary parameters**:

- EVENT
- TASK
- STAGE

EVENT is general type of crisis situation that is being solved. Here, we refer to EVENT "flood". Another events may include forest fire, car accident etc. Examples of others can be found in [12].

TASK is the activity that the user is responsible for. It is the most crucial factor that determinates the specific view of the reality; by familiarity with the knowledge that user must get to be able to perform decision making it is possible to guess about relevance of spatial object and thus define map content. Question of relevance will be detailed further in the text. Following the analysis of flood management in chapter 2 we specify five main tasks (including number of subtasks) within flood management that application will support. These are:

- PREDICTION – development and expected progress of the flood
- TECHNICAL SUPPORT – technical support in inundation area – support of Flood Security Activities
- RESCUE – evacuation of the citizens
- ORGANIZATION – organization of power and means
- PUBLIC INFORMATION – information for public about flood development, evacuation etc.

Some tasks may appear even within other emergency events (e.g. ORGANIZATION, RESCUE), while the others are event-specific (e.g. PREDICTION).

The role of crisis management is not limited to the response phase of the event but come across all emergency management circle.

We can specify four phases of emergency management circle [11] that correspond to four *STAGES*:

- PREVENTION
- PREPARATION
- RESPONSE
- RECOVERY

Question of scale is crucial for design of cartography model and thus there must be introduced another parameter of emergency context - *OPERATION RANGE*. It refers to typical level of detail in which the task is done. Some tasks (e.g. organization of emergency staff) require overview map (e.g. including access roads from fire stations to place of event), the other (e.g. dike reconstruction) requires detail view. We classify operational range to be the **secondary parameter** of the emergency context because it is more or less specified by the combination of task and event. Operation range defines in which level of detail information will be (most probably) used, i.e. influence level of generalization and selection of data with proper spatial quality. We define basic four operation ranges:

- REGION (i.e. area of administrative region or COMPLEX FLOOD BASIN)
- DISTRICT (i.e. area of Municipality with Extended Powers)
- MUNICIPALITY (i.e. area of municipality or lower administrative unit)
- LOCAL (i.e. particular area in detail – e.g. a part of floodplain)

Scale for operation range span from large (i.e. 1:5 000 – 1:2 000) for LOCAL to small (i.e. 1:500 000 – 1: 1 mil.) for REGION to capture appropriate (administrative or natural) unit. The scale of operation range is very vague because size of the unit may vary rapidly and it serves only as light information for definition of map content.

4.2 Emergency Context Definition

Emergency context is defined as a unique combination of *event*, *task* and *stage*. If necessary it may be defined also by *operation range*. Within this study we refer to event "flood" and thus only *task* and *stage* will serve as primary context parameters. Following figure (Fig. 1) illustrates emergency context definition – it shows how each *task* is decomposed by *stage* of emergency to define emergency context. E.g. technical support in preparation stage of flood management forms emergency context *technical support alarm*.

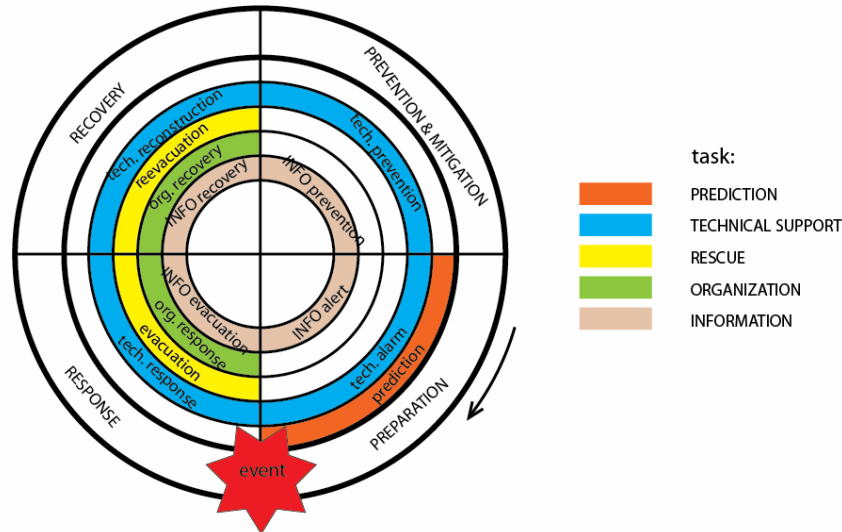


Fig. 1 Emergency context definition within disaster management circle

Following matrix (Fig. 2) demonstrates the definition of emergency context on the basis of *task*, *stage* and *operation range*. Only task *prediction* is further detailed according to operation range. Apparently, *prediction* differs substantially with operation range – user expects information of different character in the scale of region (development of the flood in the basin) and the scale of municipality (particular area in thread). Because Flood Authorities are set in hierarchical order (see chapter 2.1) emergency contexts are defined across all administrative hierarchy (region-district-municipality).

The fact that each emergency context is assigned to one particular operation range does not mean that user is not able to work in another scale. Assigned operation range defines the basic level of detail for which map content is defined. Users should be able to zoom in/out but they will be informed that are working out of operation range and that maximum information to support their activity will get in it; in lower scale data will be generalized and in higher scale users will probably not get more detail information.

task	stage				operation range
	PERVENTION	PREPARATION	RESPONSE	RECOVERY	
PREDICTION		PREDIC. REGION			REGION
		PREDIC. DISTRICT			DISTRICT
		PREDIC. MUNICIPAL.			MUNICIPALITY
					LOCAL
TECHNICAL SUPPORT					REGION
					DISTRICT
	TECH. PREVENTION	TECH. ALARM	TECH. RESPONSE	TECH. RECOVERY	MUNICIPALITY
					LOCAL
RESCUE					REGION
			EVACUATION	REEVACUATION	DISTRICT
					MUNICIPALITY
					LOCAL
ORGANIZATION					REGION
			ORG. RESPONSE	ORG. RECOVERY	DISTRICT
					MUNICIPALITY
					LOCAL
INFORMATION					REGION
					DISTRICT
	INFO PREVENTION	INFO ALARM	INFO EVACUATION	INFO RECOVERY	MUNICIPALITY
					LOCAL

Fig. 2 Definition of emergency event based on task, stage and operation range

5 BEHIND CARTOGRAPHY MODEL

As far as the emergency contexts are defined, cartography model for each context map can be designed. The first question is the definition of data content and the issue of information relevance. Further more, temporal dynamic will be addressed in this chapter.

5.1 Relevancy in CM

In CM many different professional groups are involved in crises situation. Each group is responsible for different activity and thus requires getting different decision support knowledge. Even though the same spatial phenomenon may be important for each of them, different property of it will transfer the knowledge.

For example, let's have an object *school* and three activities for which object of school may be relevant. The first activity is flood risk assessment, the second evacuation, the third navigation. For risk assessment object school play a role of endangered object and the relevant property is the number of pupils that will be affected. For evacuation, object school can be seen as emergency accommodation and thus lodging capacity is an important property. For the purpose of navigation to place of emergency, school is just a point of interest that eases the navigation. In case of such objects we have to deal with its multirepresentation. Such problem can be solved only by using ontology.

Relevancy of geoinformation for emergency context is similar to relevancy for geospatial communities. As the same objects are modelled differently in different geospatial information communities [13] it may be modelled differently in different emergency contexts (Fig. 3). The usability of information that is suitable in one context is often of limited use in other contexts. For the usage of GI this means that the same object, represented in different ways, is possibly relevant for one emergency context but not for the other. This depends on a specific view of the reality that depends on the task.

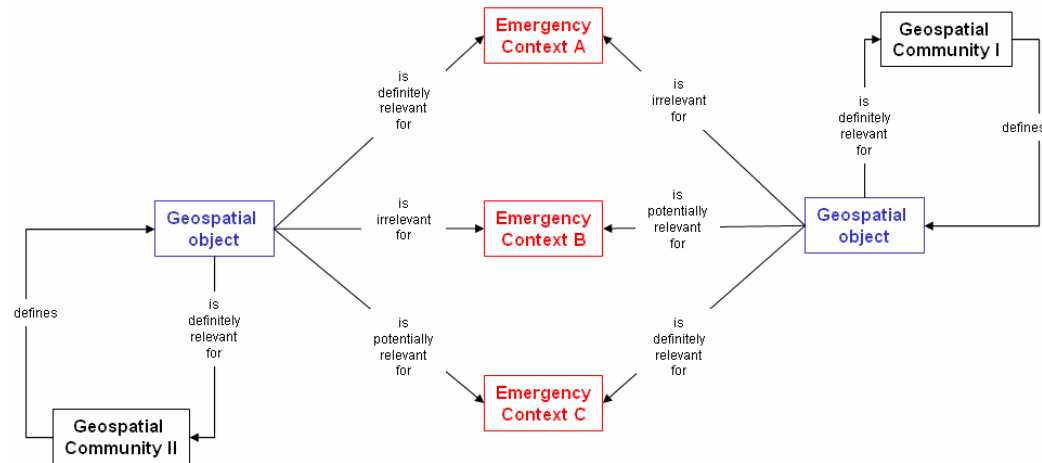


Fig. 3 A model of relevance for geospatial information (adapted from [13])

Relevancy can be seen from two main aspects: semantics and quality.

Two aspects of quality need to be considered: time and geometry. Up-to-dateness of data is obvious and already addressed thanks to the intention to use all data directly from their managers and to share data from the field by all groups involved in the emergency. Geometric quality is important due to fact that emergency contexts are defined through all scales. In the case data are too detailed, generalization will occur; both quantitative (aggregation) and qualitative (reclassification hierarchy). More difficult is to handle the lower quality of data that are needed in emergency context. It is still a research issue how to visualize the uncertainty of data.

Semantic relevance and issue of multirepresentation has already been mentioned. Besides thematic also spatial properties of object are important. Relative location of object or phenomenon towards the other object or phenomenon influences both the *impact* and the *relevance*. E.g. school that lies out of floodplain are not relevant for flood risk assessment, on the other hand, school standing on the bank of flooding river is not relevant as an emergency lodging. *Impact* may be given by the distance from related observed phenomenon. It is necessary to understand the relationship of concerned object towards the others and thus to express this relationship by using cartographic methods (e.g. school lying in 20-year flood zone is much more important than those lying in 500-year flood zone in the case that 10-year flood is expected). Selection of only spatially *relevant* object and their enhancement according to its *impact* reduces time needed for interpretation and thus speed up decision making process.

To sum up we can distinguish following factors dealing with relevance:

- semantic relevance
- spatial relevance
- semantic impact
- spatial impact

Relevance inform about existence of object in the application. We say that object is relevant for the activity when information about it is necessary for decision making and must be emphasized. Object is irrelevant when information about it is useless; its knowledge could be confusing and thus is omitted. We also introduce the term *supportive information* when talking about the object that is not directly relevant to the activity but its knowledge may support decision. Judgment about relevance is important from cartographic point of view because very large number of object that are visualized on the map limits its readability and thus their effectiveness as cartography decision making tool. We can specify semantic relevance and spatial relevance (Table 4).

Impact assesses importance of objects stated as *relevant*. It depends on the nature of the property in concern and its relationship to the task (semantic impact) or on the distance from object or phenomena in concern (spatial impact) whether all object of one type will be visualized and how (symbol's scale). Following table (Table 4) describes factors of relevance in detail.

Table 4: Factor of relevance

	<i>meaning</i>	<i>example</i>	<i>cartographic aspect</i>
Semantic relevance	inclusion/exclusion of object due to <ul style="list-style-type: none"> its nature in relation to the performed task property in concern 	<ul style="list-style-type: none"> visualization of fire stations when organizing the response visualization of the water structures when interested in capacity of the reservoirs 	presence/absence of object, symbol highlighting
Spatial relevance	inclusion/exclusion of object based on the spatial relation to another object	<ul style="list-style-type: none"> highlight of buildings lying in the area of the highest recorded natural flood 	presence/absence of object, symbol highlighting
Semantic impact	importance of object based on its property	<ul style="list-style-type: none"> Flood Staff according to administrative hierarchy 	presence/absence of object, scale of symbol
Spatial impact	importance of object based on different distance ranges from related object	<ul style="list-style-type: none"> high flooding risk for houses within predicted flood line, lower risk out of it 	presence/absence of object, scale of symbol

5.2 Temporal dynamics of object

In case of emergency, object underlies temporal short-termed changes [13]. Landscape affected by disaster shows specific spatial characteristics before the event, during the disaster it change and after the emergency its face is modified.

Temporal dynamics is another important aspect of object. During the emergency the object is changing. Its dynamics has many aspects: 1. Dynamics of object is given by the character of object (e.g. school – all pupils are present only during time of classes, less at the afternoon, non on weekends), 2. Object is influenced by the disaster (e.g. school may be directly affected by flood, may be in danger of flooding etc.), 3. Dynamics is changing due to activity (e.g. school during evacuation – lodging capacity is filled up, capacity is full yet).

Following table (Table 5) describes the factors of temporal dynamics.

Table 5: Factors of temporal object dynamics

	<i>meaning</i>	<i>example</i>	<i>cartographic aspect</i>
Object dynamics	existence of object or its property due to character of object	<ul style="list-style-type: none"> ice cumulations only in winter and spring time 	presence/absence/enhancement of object according to time period
Disaster dynamics	change of the status of object due to disaster impact	<ul style="list-style-type: none"> bridge is stabile/destroyed by water 	colour enhancement
Task dynamics	change of the status of object due to progress in task	<ul style="list-style-type: none"> emergency lodging is fully occupied/has free capacity 	colour enhancement

Here, dynamics is introduced as *status of object*. While object dynamics influence mostly presence or absence of the object on the map, disaster impact and task progress has to be handled continuously. We define the three *status of object* (Table 6). Colour enhancement is assigned to each status and its concrete meaning is based on the emergency context (see Table 7). Beside these three statuses we also define *status 0* which means that object does not undertake temporal changes or if so, it is not information that is necessary for decision.

Table 6: Status of object

	<i>colour enhancement</i>	<i>meaning</i>
status 1	green	e.g. stabile, OK, finished, used, 1st degree of flood activity (DFA) - state of alert
status 2	orange	e.g. in thread, in process, partly usable, under the survey, 2nd DFA - state of danger
status 3	red	e.g. destroyed, unusable, the highest priority, 3rd DFA - state of emergency
status 0	no enhancement	supportive information

5.3 Map content

According to origin, data for the use in CM can be divided into four groups:

- Existing data that are administered and produced by Spatial Data Providers (e.g. utility data, hydrological data, transportation data), by National Mapping Agencies (topographic data) or ad-hoc emergency management data (e.g. flood maps, critical infrastructure), national registers (e.g. register of the citizens).
- Sensor data – visualization of real-time data.
- Model outputs – visualization of outputs from external models – e.g. hydrological prediction. Inputs for the models are existing data and real-time data.
- Operational data – data that originate from the operational procedures – e.g. organization of powers and means.

Our application presumes using of existing data directly from its providers so that currentness is ensured. All data would be shared amongst all involved groups; only visual face of data will differ.

According to thematic, data can be divided into three groups:

- Topobase – data serving as reference background. These are general topographic data, ortophoto images, land parcel maps.
- General emergency management data – data essential in any emergency situation – e.g. critical infrastructure.
- Disaster specific data – here data specific for floods.

For each emergency context basic cartography model will be defined. According to the analysis of relevance it will be specified what object to visualize, what property become a label or information on demand, what cartography method to use etc.

Beside the task itself, temporal dynamics of object is one of the major factors that influences presence and symbolization of the object in the context map. Within emergency contexts that are defined based on the same task (and within the same operation range), data content differs only according to it; as task develops objects become relevant/irrelevant, some status is relevant/irrelevant etc. (Table 7).

Table 7: An example of object types and its presence/absence in selected emergency contexts
(number refers to status of object and their interpretation is given)

<i>emergency context</i> object type	<i>tech. prevention</i>	<i>tech. alarm</i>	<i>tech. response</i>	<i>tech. recovery</i>	<i>org. response</i>	<i>org. recovery</i>
Highway	0-evidence	2-in threat/ 0-evidence	3-unpassable/ 0-evidence	3-disrupted/ 2-in repair/ 1-repaired/ 0-evidence	3-unpassable/ 0-evidence	2-partially passable/ 3-unpassable/ 0-evidence
Location of Fire Rescue Units	---	---	---	---	size of symbol according to semantic impact + 1-alerted/ 0-evidence	size of symbol according to semantic impact + 1-alerted/ 0-evidence

6 CONCLUSION AND FURTHER RESEARCH

Flood management and its cartographic aspect are in focus of different European projects. They deal with flood risk and hazard mapping (e.g. [5]), risks modelling and simulation (e.g. [6]), forecasting in emergency management (e.g. [7]) or hydrometeorological visualization (e.g. [11]). EXCIIMAP handbook [4] serve as a technical instrument for practitioners, detailing general aspects and features of flood maps and providing examples from all over Europe.

Proposed approach address all aspects of cartographic support in crisis management. It represents the tool for decision making in all stages of flood management. The first step in building complete application for decision making support in crisis management is illustrated. It has been shown how emergency context is defined based on parameters of *event*, *task* and *stage* and how *operation range* influences model definition. The paper also described issue of relevance in crisis management and how temporal dynamics can be addressed. Future research in this area will focused on optimization of the map use of proposed context based representation with respect to map collaboration processes. Another research direction is development of procedures for incorporation of external temperer geo-information resources like ad-hoc model results.

The proposed solution is based on current system of flood management but still face many problems. We can specify both technical and legal constraints. While technical problems such as dealing with heterogeneity of data, on-line access, visualization techniques etc. depends mostly on the technology being used, the legal constraints are much more difficult to deal with. The first is the question of communication and data sharing amongst all groups of user. It is still on improper level. The other open question is availability of data and on-line access to it. Some groups has access to databases defined by law (free for public service) while the others has no right to access it (e.g. security data) or can access it on commercial basis.

Research has been done within the research plan “Dynamic geovizualization in crisis management”. In near future we will focus in implementation of proposed solution. Prototype will be build based on technology of the context web service SISSI [9] on which it has been already implemented and tested an another scenario “Transport of dangerous goods” [15].

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