INVESTIGATION OF USER REQUIREMENTS IN THE EMERGENCY RESPONSE SECTOR: THE DUTCH CASE

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ABSTRACT:

Emergency response is the disaster management phase with the most extreme requirements. During the crisis management, several organizations coordinate their work based not only on well-defined policies and procedures (product of careful preparation) but also on the outcomes of the decision-making process. Decision-making is a highly complicated process in crisis situations. Good support in decision-making when disaster occurs is of critical importance to react accurately, fast and effectively. Good decision-making helps to control damage, save lives and resources, and reduce unwanted consequences of a crisis.

However, the current decision-making process does not always result in optimal and adequate crisis response. Where are the problems? What are the bottlenecks? How to improve the cooperation between the different units involved in emergency response activities. To give answers to these and many more questions, a group of researchers has investigated the work of the different actors (police, fire brigade, ambulance, municipalities and other institutions) involved in emergency response organising workshops, collecting interviews and participating in various trainings.

1 INTRODUCTION

Despite all the efforts to prevent disasters by various activities such as a strict land use planning , maintenance of dykes, delineation of safety zones around industrial installations or control over transportation of hazardous materials, accidents cannot be totally be prevented. There is still a statistical probability of disasters even in safety enhanced areas (Neuvel and Zlatanova 2006). Therefore emergency preparedness deserves our full attention next to many risk prevention and mitigation activities. An appropriate and tamely response saves human lives, reduces material damages and ensures fast recovery (Kevany 2005).

From a Geo-information science perspective, crisis response is the most complex phase in the entire cycle of disaster management requiring 100% cooperation between different units involved in emergency management (Police, Fire Brigade, Para Medic teams, Municipalities, Coordination teams, Military units, etc.). The disaster extend might go beyond the provincial and even country borders and can involve hundreds of people (specialised rescue units and voluntaries). For example, in the first day after the explosion of fireworks store in Enschede (12th May, 2000, Figure 1) approximately 400-500 police, 200-300 fire brigade, 120 people from the identification team were involved in the accident. During Saturday 13th and Sunday 14th, May about 200 military people, 50 people of the Netherlands Royal Marechaussee (a special unit of the Ministry of Defence, www.mindef.nl), 100 people from the Korps National Reserve and 100 people from Germany, have joined the recovery operations. The neighbouring German Region Nordrhein-Westfalen kept in emergency fire brigade trucks and ambulances (Lulofs et al 2005).

Figure 1: Enschede after the explosion of the Fireworks store, 2000 (www.nrc.nl/W2/Lab/Enschede/ramp.html)

Decision-making in coordination of such emergency operations demands extreme support. Such a support is needed indeed at all levels: administrative organisation, subdivision of tasks, coordination and cooperation, evacuation and corresponding information technology, i.e. systems and data.

This paper presents some initial studies on the information process flow in the emergency sector in the Netherlands, carried out in period of one year. The research is part of a project for building Geospatial Data Infrastructure (GDI) for Disaster management (www.gdi4dm.nl). In the next section we will shortly present the organisation of emergency management in the Netherlands. Section 3 discusses 'types' of possible users and presents our approach. Section 4 elaborates on our current study of disaster management processes, workshops and training with end users. Section 5 concludes on our first findings regarding to the information and types of interfaces.

2 EMERGENCY MANAGEMENT IN THE NETHERLANDS

The organisation of emergency management and therefore the decision-making response in the Netherlands during a disaster can be divided into four different levels of scale (Borkulo et al 2005). Most emergency incidents, being of a minor nature are responded at a very local level, i.e. the Fire Brigade, Para medic teams, and Police (Figure 2).

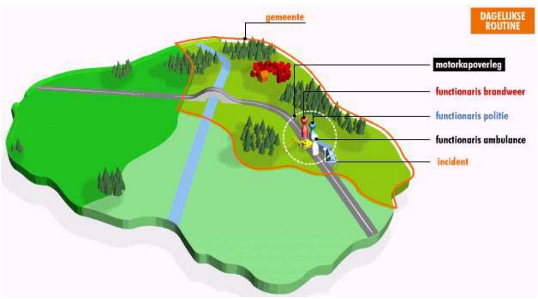

Figure 2: Daily routine: traffic accident in which only police, fire brigade and ambulance are involved

However, depending on the nature and magnitude of the emergency, other parties at other administrative levels (even from EU member states) can become involved in the emergency management organisation. Figure 3 shows a snapshot of the last level (GRIP 4). This is the case when the magnitude of an accident leads to a serious threat to a large part of the community and severe damage to property or the effects extend beyond regional borders. Then the Ministry of Internal Affairs takes the administrative lead. They will work together with coordinating, supporting and operational teams at National, provincial, regional and local level to manage and mitigate the disaster.

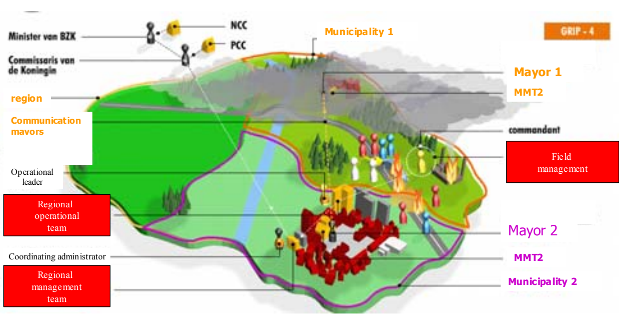

Figure 3: The organisation of Emergency Management at level 4 (GRIP4) (www.handboekrampenbestrijding.nl.)

A particular disaster may require the involvement of extra-specialised organisations. During a (imminent) flood, experts from the Water Board, the Ministry of Transport, Public Works, and Water Management (www.verkeerenwaterstaat.nl) will be involved in coordinating teams. When we have to deal with a nuclear disaster, experts from the National Institute for Public Health and the Environment will be asked to join the crisis management team.

These procedures are extensively explained in all kinds of documents, illustrated with animations and schemas, some of which are even available for access via internet. The procedures are accompanied with several important plans, which are compulsory for the authority they refer to. For example, a municipality has to have a disaster management plan (Hoogendoorn et al 2005), the province should have at its disposal a coordination and calamity plan, each emergency response sector (Police, Para medics, Fire Departments) should have their own organisational plans. As shown in Diehl and Heide, 2005, the responsibilities of the units (police, fire brigade, ambulance and municipality) directly involved within fighting the consequence of an accident on the field, are strictly defined (25 activities) and distributed accordingly. For example, while the identification of victims is a responsibility of the police, the registering of victims is already a task of the municipality. The reporting hierarchy is clearly defined at each level and between the administrative levels.

3 THE USERS

This study on the organisation of disaster management has revealed a large diversity of users with respect to their involvement in the decision-making process, responsibilities, specific background, skills and qualifications, location with the respect of the area of accident, information demands and devices. An end-user classification has always been a challenging tasks but emergency response experience the largest variations. Winter et al, 2005 distinguish between:

- decision-makers, responding to the event and coordinating the work between different teams;
- consultants, giving advise on specific aspects and issues, for example type of explosives;
- emergency response workers in the field, like police, fire brigade, ambulance, red cross;
- victims: serious injuries that will be transported by specialized transport or have to stay in locally organized first aid centers;
- journalists;
- the general public.

Zlatanova and Holweg, 2004, classify end-users with respect to the environments they are working with into users working within tangible environments (augmented, virtual and mixed reality), mobile users (working wireless on light computers and hand-held devices) and desktop users. A variety of further classifications can be made with respect to the underlying technology for providing services. Very often classification is made with respect to the type of disaster (Fabbri and Weets, 2005).

In the GDI4DM project, we follow a different approach: the users and their requirements will be identified with respect to the 25 disaster management activities (as specified in the Netherlands). The user requirements will be defined by: 1) a careful study of these activities, 2) organising of workshops to discuss how these activities have to be completed in reality and 3) observe training on the field. The following section reports first results of initial investigations.

4 USER REQUIREMENTS IN GDI4DM

4.1 Formalising Processes

These activities are named ‘processes’ in the Dutch documentation to emphasise on the fact that those are already quite complex and cannot be considered in isolation. Just in opposite, these activities have to be seen as complexes of many sub-activities, yet forming a continuous process, which requires an extremely well-organised communication between different actors. For example, process 13 ‘traffic control and management’ is related to processes 4 (disinfection of vehicles and infrastructure), 10 (medical psychosocial help), 11 (clearing up and evacuation), 12 (removing and guarding), 16 (guiding), 18 (informing) and 19 (taking care of) (Figure 4). The high complexity of these processes has motivated us to investigate first the specific activities, realise what the tasks are, what the relations are with respect to other activities and only after that define what kind of data and technology would be necessary for successful completion of a particular activity.

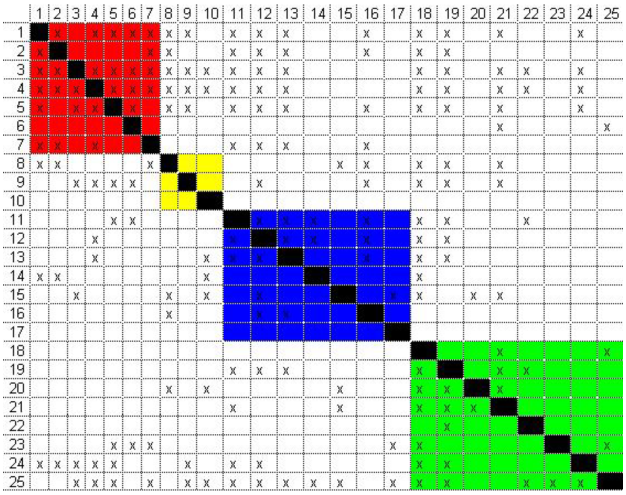

Figure 4: The 25 disaster management activities and their correlations (shown with 'x')

In the first phase of the project (November 2006), we are going to complete process 5 (observations and measurements) and process 13 (traffic control and management). These two processes have been selected, because they are currently seen as the most challenging ones.

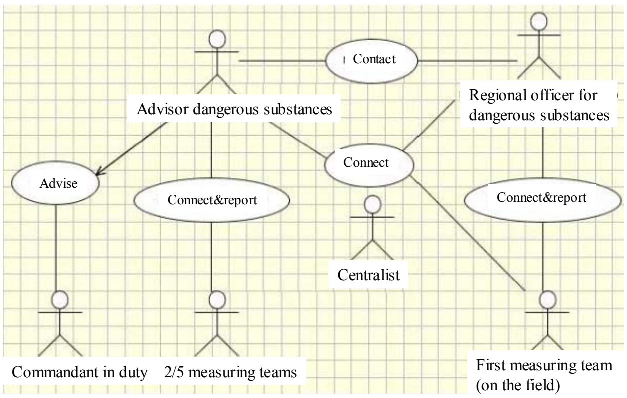

Figure 5: Actors and their relations in process 5 (observations and measurements)

To give and example of the complexity, we will briefly discuss the process 5. It is related to performing all kind of measurements that might be needed if dangerous substances have been released in the air, on the surface, in the soil or in the water. In this process of obtaining the first call about the accident, setting up the appropriate teams and performing the measurements, there are six actors involved as follows: advisor dangerous substances, regional officer for dangerous substances, first measuring team (which perform all the measurements at the field), second until fifth measuring teams that can be send to the field after the first results are ready, centralist (the person who receive the first call and inform the advisor and the regional office responsible for the dangerous substances) and finally the commandant in duty (usually from the Fire Brigade). The actors and the relations between them are modelled using UML (Figure 5).

Following this approach all the processes will be studied and the communication within a process and between processes will be clarified and formalized. Knowing the actors (and respectively their roles) and the way they communicate, the specification for the systems will be identified.

Parallel to formalising processes for clarifying users and their requirements, as mentioned above, we have organised few workshops and we have participated in trainings on the field.

4.2 Workshops

The first workshop we would like to mention is the Veiligheidsnet workshop that was held in the province of Gelderland in June 2005. One of the objectives of the Veiligheidsnet project is the realization and implementation of a system that allows for the exchange of geographic and administrative data between the different partners involved in emergency response (Diehl and Van der Heide, 2005). The workshop was attended by representatives of Fire Brigade departments, Police departments, Para Medic teams, Municipalites, Provinces, Water boards and Universities. During the workshop, actual bottlenecks for the exchange of geographic and administrative data were investigated. To rank the bottlenecks mentioned at the workshop, we’ve asked our respondents to prioritize the bottlenecks. The following bottlenecks were judged as bottlenecks that need a high priority.

- During emergency response, there is a great need for a dynamic exchange of date, since much relevant data (such as data about toxic clouds or traffic) continuously changes over time. This exchange is not always possible.
- Much geographical and administrative data needed for emergency response is spread out over many involved parties. This data is not always easily accessible for other parties Because of this, data is isolated and the data supply is not optimal.
- Sometimes, information is private. Rules, legislation and security devices hamper the data exchange in crisis situations.
- There are many initiatives to improve the information exchange; however coordination between the numerous initiatives is needed.
- The use of geo-information is scarcely embedded in daily practices.
- The responsibilities, roles and task of authorities related to data management are still unclear.

Next to an investigation of current bottlenecks, end users' desires for further development of geo-information services were investigated. The following objectives came to the fore:

- The realisation of a multi-disciplinary information system that enables information exchange between fire brigade departments, police departments, para medics, municipalities and other parties involved in emergency response at both the local, regional and national level.
- The information services should be available in both the emergency preparation phase as the emergency response phase. The availability of the system for 'daily practices' in the preparation phase is important to get familiar with the system, which enhances the usability of the system in emergency response.
- New technical developments (such as mobile services or 3D applications) should become available.
- Next to 'digital maps' paper maps should be also available. Such a recommendation is also made by Kevany, 2005 as follow-up of 9/11 analysis.

The second workshop to be discussed is the Borssele workshop, which consisted of three phases: preparation, real training and discussion and analysis. There was a large national training organised on 25 of May 2005, which was a part of a project related to improving national contingency plans for nuclear power plant accidents (Grothe, 2005). The training has particularly focussed on utilisation of geo-information and geo-services.

Nuclear power plant calamites usually have a large impact on the society and are much more complex to fight with compare to any other type of disaster. Therefore they require a complex network of different specialist and decision-makers. The level of emergency can very fast reach GRIP 4, i.e. national (or even international) level of emergency. In contracts to other emergencies, which are reported at local call centres, threat of nuclear accidents are reported directly to a call centre at the Netherlands Ministry of Housing, Spatial Planning and the Environment (www.vrom.nl).

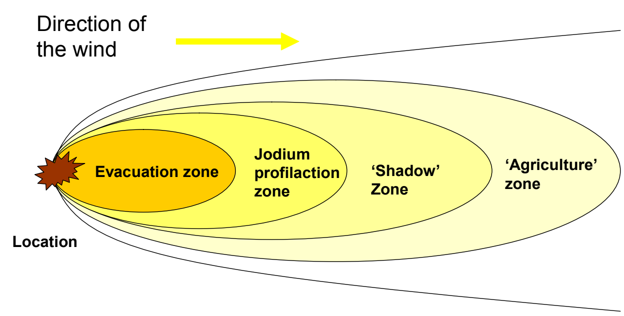

Figure 6: Response zones in a nuclear accident

Depending on the nature and the scale of the accident, a special management team is to be formed, which consists of one Front office and three Back offices responsible respectively for medical, radioactive and operational information. In addition to these teams, various supporting centres are activated, which has to provide information about meteorological and nuclear reactor situation, localisation of citizens, agriculture and water protection, etc. The information flow is also quite complex. The Front office receives and analyses all the data and reports from the three Back offices, and prepares an advice for the Management Board. The Management Board makes decisions, which are further communicated to all the offices and supporting centres.

For the purpose of the exercise specific tools were provided at the client side, which allowed for some spatial analysis. For example, the zones indicating required measures to be taken with respect to the distance and direction from a nuclear accident (Figure 6), were modelled in a template, which could further be adjusted to a direction of the wind.

To be able to investigate the role of geo-information in this process a geo-portal was established within the Front Office. The geo-services have been built on a distributed principle, i.e. it was assumed all the data remain by the institutions responsible for their maintenance, and only the needed data were extracted and replicated on a central server (at Geodan, www.geodan.nl). This server has played the role of geo-portal, providing geo-services based on the Open Geospatial Standard WMS (www.opengeospatial.org). Additionally, connection was established to the server of RWS (www.rijkswaterstaat.nl), containing road and water data.

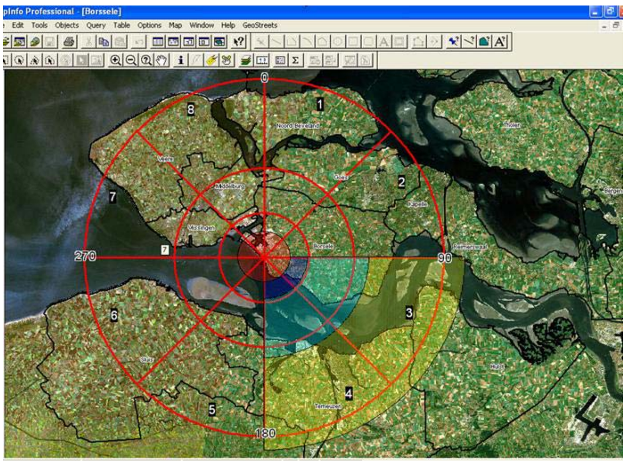

Figure 7: Template with nuclear zones, overlaid with an orthophoto image

This template can be overlaid with the layers of geo-data retrieved from the two servers, for analysis and decision-making (Figure 7).

This exercise has clearly revealed the need of information exchange. Moreover geo-information sharing at very early stage was identified as a critical for the exercise. Much more transparency has been requested on both the information flow process and the way decisions are made. During the exercise none validated information caused misunderstanding of the situation.

Attention was drawn on the quality, reliability, accuracy and resolution (scale) of geo-data. Low resolution or outdated data can easily lead to wrong decisions, which may be fatal for later crisis management activities. In this respect it was the decision to retrieve data from the 'source' was considered most appropriate. Additionally, geo-information (maps) can not be isolated from interpretation and other related information. In this respect, availability of geo-expects would be essential improvement for the crisis management.

Another important issue discussed after the exercise was the diversity of needs for geo-information. While operation teams require large-scale maps, decision-making teams feel overloaded and distracted by too many details. Apparent is the demand for carefully selected data, filtered with respect to the teams and their tasks.

Borssele training has confirmed the dynamic nature of crisis management. However, the demand for dynamic updates was surprisingly less compared to the demand for static (existing) data. The reason behind might be twofold. On the one hand, the complexity of organising, collecting, processing and analysing dynamic data is still very high. On the other hand, the availability of exiting information is still far way from the wanted level. For example, Ministry of Agriculture, Nature and Food Quality (www.minlnv.nl) possesses various data sets and aerial photographs but they could not be accessed during the exercise.

This exercise has yet again emerged the authorisation aspect. Information sharing requires strict rules: whom what kind of data has been delivered. Security and authentification was referred as critical aspect.

The most important conclusions of this training were summarised as follows (Grothe, 2005):

- The need of geo-information is apparent.
- Sharing of geo-information is highly needed
- Geo-information for crisis management should be retrieved directly from the source
- The knowledge about and awareness of geo-information is still at very low level with decision-making teams.
- A good information system cannot be built without cooperation between diversity of teams involved in different projects

Interestingly, these conclusions largely coincide with the investigations of Carter and French, 2005 performed for Belgium, Germany, Slovakia and UK (within the FP5 project EVATECH).

Figure 8: Firemen investigate whether there are people in a collapsed building.

4.3 Training

Many of the bottlenecks and desires mentioned in the workshops could be recognized during life training in the field. For example, we have observed a training exercise in the Province of Gelderland, which simulated a traffic accident between a school bus and a train. The train as well as the bus was heavily damaged with many casualties. During the training, a lot of (geographical) information was requested by both the emergency services as well as the coordinating teams like: Where is the accident? How many people are involved? What kind of materials (dangerous substances) are stored in the adjacent industrial area? Are there gas tubes in the underground? Where is the field hospital? How can the accident area best be reached etc.

Figure 9: Field Hospital at the emergency training site.

Figure 8 and Figure 9 give an impression of the training in Arnhem. Especially at the coordination centre at the accident site, the VNet application (Diehl and Heide, 2005, Borkulo et al 2006) was used to exchange information with the regional coordinating team.

Similar training is planned for November 2006, but focussed on the two processes 5 and 13 as explained in section 4.1.

5 GENERALISED USER REQUIREMENTS

Based on our current activities and investigations, we have identified general user requirements for a system providing services in emergency response. However, these have not been specified with respect to the 25 disaster management processes in the Netherlands, yet.

The first very important principle we need to consider is time. Respondents from emergency services stated that their service requirements are time critical and in emergency response they demand almost instant and reliable responses from mobilising systems. On the other hand most procedures in risk prevention are not time critical and data response can be acquired over many hours or even days.

Related to this time aspect, respondents involved in crisis response argue that much of the information they request during a crisis can be seen as dynamic information. Mentioned examples are: what's the current magnitude of a toxic cloud and how will this cloud develop over time? What is the current capacity of the nearest hospitals? Which roads are accessible and which not?

Because the circumstances during an emergency may change every moment, continuous monitoring of the developments and a continuous distribution monitored changes is necessary.

As emergency management is a multi-disciplinary activity, it should be possible to exchange information between different partners at different administrative levels. To realise this, a decent spatial data infrastructure is required. Because time forms a critical factor in emergency management, the spatial data infrastructure should be suitable for quick data input and transfer.

Another often heard bottleneck was the issue of data management. It was often unclear who should be responsible for the data management and who should pay for it. In addition arrangements should be made about the use of ‘private’ data.

Our discussions also raised some interface issues. In a crisis response system heavy emphasis is placed by operators on simple intuitive interfaces with simple methodologies for communication and data access. Much attention is drawn on appropriate icons and symbols (see also Tatomir and Rothkrantz, 2005).

The requirements for extended functionality or even artificial intelligence in support of decision-making are minimal. In situations of stress, system operators place more reliance on their own judgment and the judgment of other human beings than they do on any form of artificial intelligence. However, there are projects working in this direction e.g. ESCAPE (Windhouwer et al 2005).

Interrelated to this is the desire to have a system that can be used in daily routine work that they are ‘comfortable’ with. The motivation behind this is directly related to the specifics of crisis response. Working with a non-familiar system will contribute to critical delays, will contribute directly to operator stress which will inevitably lead to ‘expensive’ errors when mobilising emergency resources to life threatening situations.

Requirements for advanced spatial visualisations are the subject of topical discussions but still unable to cope to an agreement. The demand for intuitive, ‘simple interfaces is prevalent. The use of more ‘natural’ representations (realistic 3D visualisation, videos, images, etc.) is increasingly recognised, especially amongst younger generations.

Tangible interfaces such as Augmented and Virtual Reality have increasingly been under consideration. The three most obvious areas within Virtual Reality and Virtual Environment applications in emergency response are training, collaboration, and remote navigation. Training addresses the rescue team in action, while collaboration and remote navigation is about cooperation and decision support systems. Several systems are already available or under development concerning trading (e.g. Berlo et al 2005). Much more developments and acceptance are needed during ‘real’ crisis management.

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