RELIABLE INFORMATION - A KEY TO DISASTER RESPONSE

Gerhard Chroust
Johannes Kepler University Linz
gerhard.chroust@jku.at
Georg Aumayr
Johanniter-Unfall-Hilfe in Österreich
georg.aumayr@johanniter.at

ABSTRACT

The growing concern over frequent wide-area disasters with massive destruction is parallelled by a qualitative jump in ICT-capabilities which can be utilized in new ways of disaster response, especially with respect to the information acquisition, processing and dissemination. In this paper we discuss the importance of information with respect to disaster response. The growing concern over frequent wide-area disasters with massive destruction is parallelled by a qualitative jump in ICT-capabilities which can be utilized in new ways of disaster response, especially with respect to the information acquisition, processing and dissemination. This paper discusses the importance of information with respect to disaster response. After a short review of the history of organized disaster response, the phases of a disaster and the types of stakeholders described. The relevant information for stakeholders is described, categorized and the associated activities discussed. The usefulness and applicability of Mass Communication and Crowd Intelligence for improving information acquisition, analysis and decision making is discussed.

Keywords: Disaster, Information, Mass Communication, Crowd Intelligence, Social Media

1 MOTIVATION

Regional disasters (often man-made or at least triggered by human activities) seemingly have grown in number, in scale and in their impact, together with an increased public awareness due to media coverage. Disasters are usually defined by the amount of damage to people, nature, and property, also by the complication that the victims *themselves* are unable to cope with (Chroust et al., 2013) (Tierney et al., 2001, p. 20) (Quarantelli, 1985) (Kreps et al., 1989) (Bolin and Standford, 1998, pp 9-10) (Mrotzek and Ossimitz, 2008; Mrotzek, 2009). Human nature usually tends to react to a disaster by choosing a 'fight/intervene' attitude (Chroust et al., 2013), i.e. trying to eliminate or at least ameliorate the immediate adverse effects of disaster and later trying to restore the situation to an acceptable state (Chroust and Ossimitz, 2011), see fig. 1.

In this paper we will discuss the focal position of reliable and useful information in today's disaster responses as well as the resulting consequences for communication equipment. Special focus will be put on social media which enables two-way communication between practically everybody involved.

We will ignore the many other needs of stakeholders (e.g. shelter and food for victims, etc.) and will concentrate on the need of information.

In chapter 2 we discuss disaster management in general, offer certain historical notes and stress the holistic challenge of modern disaster responses. Chapter 3 discusses needed information, the different types and the relevant activities. A modern trend is discussed in Chapter 4: the influence of mass media and ubiquitous communication possibilities plus the possibilities to utilize Crowd Intelligence. Communication depends essentially on the provision of information channels, the implications are discussed in chapter 5.

The paper is based on the outcomes from sessions and workshops of previous ISSS Conferences, Brisbane 2009, Waterloo 2010, Hull 2011, and San Jose 2012 (Chroust et al., 2009, 2010, 2011) and on two previously completed research projects (Roth, 2009, 2012).

2 DISASTER MANAGEMENT

2.1 Historical Notes on Disaster Management

From the dawn of civilization it has been understood that most of the possible reactions to disaster require support and help from the encompassing society. Society has to try to mitigate the effects of actual disasters and must to be prepared for emergencies ("expect the unexpected" (Tierney et al., 2001)).

Unaffected people have always helped, especially in the case of frequent and disastrous fires, and in some instances this help has even been institutionalized.

Help for victims by outside people, especially in the case of the frequent and disastrous fires, was always given and in some instances even institutionalized. An Egyptian papyrus mentions organized fire-fighting services in 200 BC. (N., 1897, Vol. 6, p. 381). In 23 AD the Roman emperor Augustus AD established the "vigiles" in Rome organization of approx. 4000 professional fire fighters (Wikipedia-english, 2013, History of firefighting) (Kenlon, 1913) (Bartels and Huber, 1990, p. 3329). They were equipped with mobile fire pumps and adequate fire fighting equipment (axes, buckets, etc.) (Wikipedia-english, 2013, Vigiles).

Like many other cultural achievements this fell to oblivion in the Middle Ages and only gradual ly re-arose starting in the 13th century (N., 1897). Up to the 17th century firefighting in Europe was performed on an unorganized voluntary basis by forming ad-hoc bucket brigades for the transport of water to the burning houses. The growth of the cities and the increase in frequency of fires (the Great Fire of London in 1666, the Meireki-fire in the then Japanese capital Edo in 1657, Constantinople being burnt down three times during the Fourth Crusade (1204), and so forth (see (Wikipedia-english, 2013, List of fires)) gradually led to the creation of professional firefighter organizations in the systemic sense of an Intervention System (fig. 1). By approx. 1870 most European cities had professional firefighters.

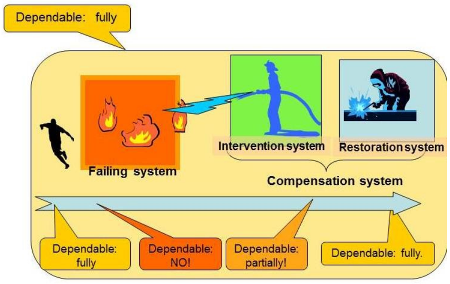

Fig. 1: Intervention and Restoration System

Parallel to this development specialized firefighting tools (ladders, fire hooks, hand pumps (Feldhaus, 1970, p.308), ...) and also mechanical and mobile firefighting equipment (pumps, etc. (Feldhaus, 1970, p.308)) were invented (cf. fig. 2 (Adam, 1973; Kenlon, 1913)).

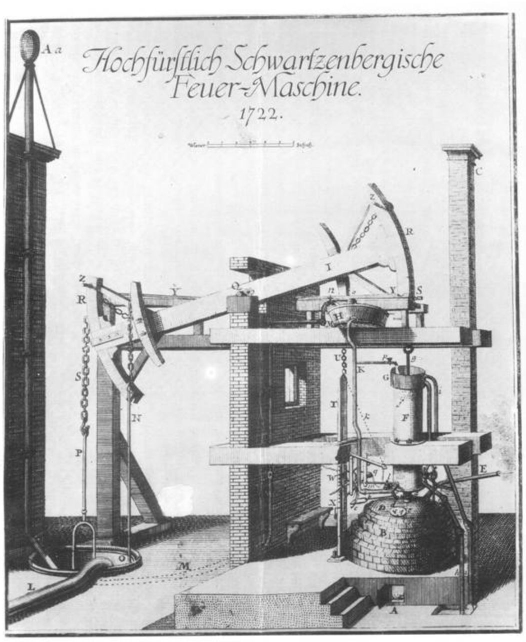

Fig. 2: Waterpump by Fischer von Erlach, ca. 1720 (Adam, 1973)

For emergency medical services, too, the establishing intentions can be traced to disasters. This can be demonstrated for the two largest humanitarian organizations and a professional emergency service in a European capital city. In Vienna, capital city of Austria, the professional emergency medical service of city council was founded after a major disaster in a Viennese theater in 1881. When a fire started during a theater performance on December 8th, 1881, nearly 400 people were injured or died during this disaster. Immediately on the next day (December 19th, 1881) the Viennese Emergency Medical Service was established.

Similarly the two major international humanitarian organizations, Red Cross and Order of St.John/Johanniter, were established after man-made disasters. The Red Cross was estabic Wars in 1863 at the battle of Solferino (1859). It was not the first organization to deal with this problem. Already during the first crusade in 1099, several crusaders decided to take up action to establish a medical infrastructure and a medical service to pilgrims, wounded soldiers and civilians of both sides, as suffering is a universal problem, undifferentiated by confession or social status. At a hospital near Jerusalem, the Knight Order of St. John was established by Fra Gerhard of Thum to serve and protect those who are in need of medical care.

Then and now the challenges of responding to disasters or crisis have to be founded on commu nication, research, and innovation. The growing dependency of our society on its infrastructure, calls for timely, adequate, and effective response to disasters as an absolute necessity. The instability of our infrastructure becomes more easily impacted by disasters and we are not well prepared for the interaction of multiple-source risks or cascaded disasters.

Adequate response to wide-spread crisis is becoming an absolute global necessity (Tierney et al., 2001; McEntire, 2007) and a social responsibility (Chroust et al., 2013). Disaster response is nowadays also understood as a systemic problem, due to the many types of disasters which endanger people, society, environment, infrastructure, and the economy in complex, multi-facetted, and interrelated ways. The response must also be interdisciplinary. A systemic view of Disaster Response is shown in fig. 1: a system which has become unreliable due to some external event is supported by a second system (the Intervention System) with the aim of getting the affected system into a state which is (at least temporally) of acceptable dependability - very likely not the original state. After the initial Intervention a third external system, the Restoration System, attempts at restoring the system back into an acceptable and sustainable state.

The ubiquity of ICT, especially with respect to mobile phones, GPS etc. has greatly improved the possibilities of First Responders with respect to information acquisition, communication, strategic and tactical decision, also for direct involvement of large numbers of helpers and vic tims (see section 4).

2.2 Phases of a Disaster

For every hazard in its own right we distinguish five phases (Fig. 3) of reaction to hazard. We have to note that the length of the phases depends on many circumstances, and also an overlap between the phases is to be expected. The only certainty is that when disaster strikes, it is too late to start preparing!

Despite the fact that disasters are essentially unpredictable, diligent preparations can help to mitigate the consequences (McEntire, 2007). Information must be provided at the right time during a phase, knowing that different types of information often need considerable time to to be generated from data and facts.

The key part of a reaction is - and always will be - in the hands (and at the risk) of First Respon ders. Modern Information and Communication Technologies provide a multitude of support tools, best practices, gadgets, and support systems which make the tasks for First Responders easier, more effective, more predictable, and less dangerous. Technology can be of support in all phases of a disaster situation (see fig. 5).

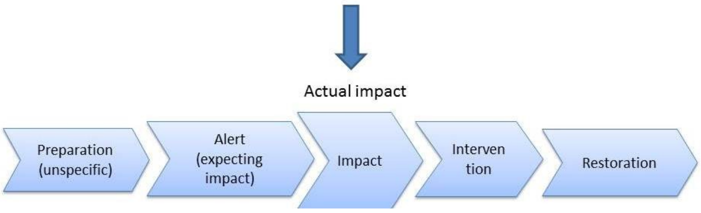

Fig. 3: Phases of a Disaster

Preparation Phase : The Preparation Phase takes place before any actual incident is incipient and considers potential hazards. The necessary data is collected, procedures and strategies are identified, recorded and trained (Sanders and Lake, 2005; Linnerooth-Bayer, 2006). Necessary materials both for the actual incident and the time thereafter are stored, etc. Organizational questions have to be sorted out (Reissberg, 2010).

Alert Phase : In the Alert Phase specific hazards are to be expected (perhaps more than one) and specific preparatory actions are started. However, it is still not certain that the disaster really will occur.

Impact Phase : The Impact Phase can vary from a very short time (e.g. an earth quake) to a lengthy period of time (e.g. a long lasting volcanic eruption). It triggers the actual Intervention phase.

Intervention Phase : The impact triggers the remedial actions via the Intervention. These are performed in order to get the system into a temporarily acceptable state (Fig. 4). This phase is responsible for quick first responses (e.g. 'First Responders') in order to contain and/or mitigate the damage and give first aid to all victims. It is successful if it manages to bring the damaged system into a temporarily acceptable state, see fig. 4. Time is a critical factor for this phase.

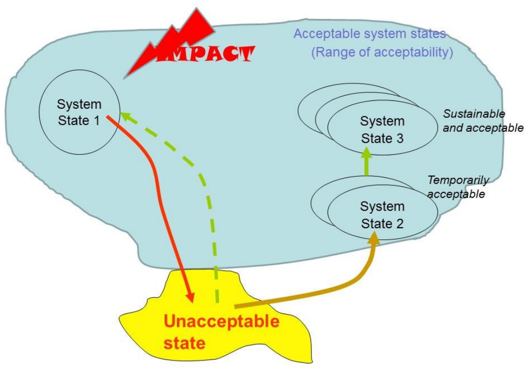

Fig. 4: Acceptable / unacceptable system states and transitions

Restoration Phase : After a 'settle-down' time the Restoration Phase can start. The Restoration System needs long-term planning view and aims at restoring the damaged system to a state which can be accepted as an adequate replacement of the original system, usually not the same one as before the impact (Fig. 4).

The Restoration System will also try to implement on all necessary levels improvements which will avoid or at least mitigate future damages by the hazard ("Hazard analysis and emergency preparedness", see fig. 5). Typical examples are legislation on new building codes (safety standards), rules concerning behavior, improved steps for information provision, prescription of different materials for objects, improved training of First Responders, etc.

The interplay between Impact, Intervention, and Restoration is shown in fig. 1 where a dependable system becomes unreliable due to an impact. Via Intervention and Restoration finally a dependable state is reached. From a systems point of view we split the recovery into an *In tervention System* and a *Restoration System* as a result of the widely different expectations on these two systems (Chroust et al., 2010, 2011). The personell required for these tasks need different qualifications: the First Responders during the Intervention must be generalists while the Restoration Phase needs specialists.

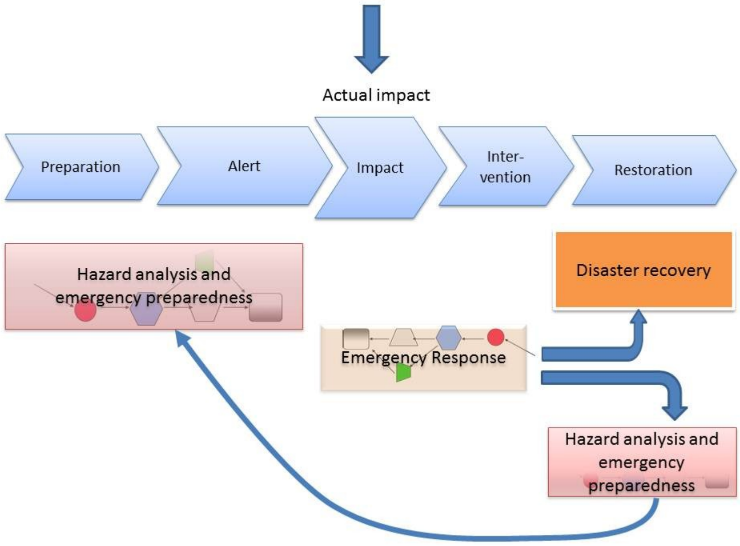

Fig. 5: Disaster Phases and corresponding response processes

2.3 Stakeholder

A disaster involves numerous differing stakeholders, most of them having different information needs in relation to their status, their situation, and their tasks.

A rough classification of stakeholders with respect to their involvement could be as below (McEntire, 2007, chapter 2), but we have to notice that a person can have several roles at the same time!

immediate victims these are persons immediately affected by the disaster, being physically or mentally injured, having lost relatives, and/or property

persons associated with victims These have themselves not suffered damage, but worry about victims they are associated with

First Responders These are organized groups of persons (fire brigade, rescue services, medial people, technical support, etc. on the scene of the disaster. They may even come from distant and even far away places.

voluntary helpers In the case of an emergency many people rush to the scene to help (Neal et al., 2012). Their interference ranges from usefulness to helplessness and being an outright nuisance. Their willingness to help depends strongly on their social milieu (Wikipedia-english, 2013, sinus milieu).

government officials Persons who are in charge of the area and are responsible for policy and organization of the disaster area.

media (McEntire, 2007, chapter 72). Media includes reporters, camera teams, and radio and television speakers. They provide information to the public. They are keen on news and are at the same time a disturbing factor in disaster response.

general public The general public, local and distant want to be informed. Their information depends on the media and on bits of information by other stakeholders. In times of the new media it is practically impossible to limit, restrict, and control the information reaching the outside world.

A second way of classifying stakeholders is to distinguish them by their personality and also gender, age, degree of handicaps, local vs. foreigner, different cultures (Hofstede and Hofstede, 2005), trained versus untrained helpers etc., social milieu (Wikipedia-english, 2013, sinus milieu).

3 INFORMATION MANAGEMENT: KEY TO SUCCESSFUL DISASTER RESPONSE

3.1 Needed Information

First Responders rushing to a disaster site due to a local call for help might lack some of the global information (which might not even be clear at that moment), especially if the incident is part of a large-area disasters. Additionally humans do not have any inborn sensors for many of today's dangers like chemical or radioactive emanations (Rainer et al., 2009). First Respon ders arriving from larger distances might lack local knowledge with respect to geography and available resources (water!).

They have to rely on 'derived information'. Similarly victims often cannot recognize many of the dangers and in most cases do not have do not have the knowledge as to how to react/behave in an optimal way. The key to a successful, effective, and reliable intervention and reaction to disasters is *information* (Haddow and Haddow, 2008).

Analyzing past disasters from early urbanization up to the present (Kenlon, 1913) it emphasizes the lack of preparation and foresight, together with the lack of communication means often resulted in wrong decisions and as a consequence losses of life and property.

Effective disaster response calls for appropriate information (Haddow and Haddow, 2008) with the right content, at the right time, at the right place, and in adequate form. On a very high level of abstraction the information needs are related to two dimensions : when is the information needed and who needs it.

Several key activities (which are usually accomplished by a Assessment Team) are:

- acquisition of timely, relevant, and accurate data from whatever available source,
- collecting, aggregating, processing, and interpreting available data,
- projecting and predicting future developments based on the available data,
- making sufficiently correct decisions of tactical and strategic nature and deriving the necessary instructions,
- disseminating of information appropriate for all stake holders,
- providing fast and reliable inter-communication and feedback between different stakehol ders ,
- activating/acquiring/securing non-public channels for tactical communication,
- recording and archiving of relevant data for later analysis, learning, and training,
- communicating with higher level authorities and even international agencies.

Above activities have to be accomplished despite the disadvantage that in the wake of a crisis needed facilities themselves might be severely incapacitated or damaged, especially communication and dissemination facilities.

The success of most of these activities strongly depends on the availability and useability of robust and adequate communication channels which can be used for the type and importance of information to be communicated.

3.2 Types of Information

Needed information comes in different, sometimes overlapping forms:

direct information: Information needed by a stakeholder in order to fulfil his /her task. This type of information becomes necessary in all phases but is most critical during Impact and Intervention. It may include the direction to run, to where needed supplies can be found, and information concerning the overall situation, etc. In the Restoration Phase information about the status of buildings before the impact is necessary. Some of this information can partially or fully be prepared in the Preparation Phase and sometimes refined in the Alert Phase. With respect to the recipients we can distinguish:

mass information The same information is provided to everybody within a certain do main (e.g. general alarm).

mass customized information General information which is somewhat tailored to a specific set of people but can be derived from general information (e.g. hand gesturing for deaf people, language translations) (Piller, 2006).

individualized information Information which is only meant for a single persons or a very small group (e.g. for a person in a wheelchair stuck in a house, or for a squad of Fire Fighters)

indirect information Information needed to derive/create/define more specific information which finally (perhaps over several steps) becomes direct information (e.g. the evacuation maps in a hotel, photos/sketches of buildings, forecast of weather and storm direction).

global information Information which is valid (and useful) for a group or all stakeholder (e.g. Weather forecast) and enables general orientation

ancillary information Information which in itself cannot be used during intervention but gives a general overall view and perhaps consolidation and assurance (information about Rescuers on their way, speech from a high-ranking official)

An essential difference is also whether the information is returned on-request or offered of own accord.

3.3 Data Management Tasks

The activities listed in section 3.1 are discussed in more detail below. These tasks will differ both in importance, urgency and effort determined by the different phases. In many cases they will be significantly different for either ’authority use’ or crowd-based applications.

3.3.1 Data Acquisition and Surveillance

Information needed by the various stakeholder in case of disaster (government agencies, First Responders, emergency control centers, volunteer helpers, victims, general public, and the me dia (Haddow and Haddow, 2008)) plays a crucial role. It must be solicited and acquired in relation to the availability of various information sources: human (active response, feedback, passive observation of social media, passive observation of position data) and technical (sen sors, pictures analysis, automatic measuring equipment, distance reconnaissance). Judgement of the veracity and importance/scale of issues is often problematic. (Loewer, 2011) notes that old legends often contain a grain of truth which points to a ’dormant’ danger which lasts over a very long period of time before creating any trouble.

Certain information can be prepared aforehand, other data has to be acquired in real-time. Data will come from archives, from individuals (requested or un-solicited), collected from crowd actions, and - not to forget - from sensors networks (Welsh, 2010) and robots (Laursen, 2013).

3.3.2 Processing and Interpretation of Available Data

The utilizations of available data requires a basic understanding of its meaning, quality, significance, and impact. Appropriate models and/or simulation tools are needed in order to explain the Past, the Presence, and the probable Future(s?). Pattern recognition for pictures, data mining, comparison with other similar disasters, and similar activities are needed. Potential suggestions and responses of victims and helpers with respect to planned measures in the current situation need to be considered (Crowd Intelligence (Miller, 2010). During the impact and Intervention Phase the trade-off between speed and reliability/quality must be carefully evaluated. All data must be interpreted in a holistic way, encompassing as many variables and inputs as possible. The type of disaster and its probable evolution play a decisive role (Chroust and Ossimitz, 2011; Mrotzek and Ossimitz, 2008).

3.3.3 Decision Making

Reliable, up-to-date, and understandable information is the key to high-quality decisions. Under the stress caused by the disaster situations stress due to urgency and uncertainty an adequate representation of information is very helpful. Based on the available date and their interpretation tactical (and sometimes also strategic) decisions have to be made. ICT offers a plethora of tools (simulation, diagrams, Virtual Reality, Scenarios, game-type what-if simulations, etc.) which help decision makers to consider the consequences of the disaster including different potential futures based on assumptions and decision and the anticipated evolution of the disaster (Roth, 2009; Mrotzek, 2009).

3.3.4 Creating Information and Instructions

Based on the available and processed data it is necessary to give information and instructions to all stakeholders. This information must be formulated and formatted in relation to the needs and the available media (Haddow and Haddow, 2008). Contents and form must be carefully formulated (forms and skeletons prepared during the Preparation Phase are helpful!) in order to be unambiguous, effective and convey trust. The wider the audience the more critical are formulations etc., especially in view of cultural difference (Chroust, 2008b), disabilities and language problems.

3.3.5 Dissemination of Information and Instructions

Ideally dissemination is dependent on appropriate, uninterrupted, and reliable communication channels. Both the ability to acquire information and the dissemination of information might be strongly affected by the disaster itself, be overloaded due to massive speech traffic or enquiries (e.g. in the case of epidemics), damaged by terroristic attack, or disabled by a general blackout. Problems at even a few central key points can bring down a whole network, similar as defects can propagate to very distant systems.

Providing alternative routes for information in case of gaps in communication channels (Chroust, 2008a) provide considerable technical challenges and require flexibility and creativity.

On the human side there are barriers with respect to information dissemination. (Haddow and Haddow, 2008) remarks: *"Emergency management operations must work with community-based organizations to establish neighborhood-based communications networks that recruit and train trusted community leaders to deliver alerts, warnings, and evacuation/shelter-in-place information to neighborhood residents. It is important that trusted community leaders are involved as they can validate the information and the information source."*

3.3.6 Interaction and Feedback

Feedback is a key in order to provide better, faster, and more targeted responses and decisions. Feedback should not only be limited to answering of questions from the authorities but should also involve all stake holders (including victims!) and should also take into account unsolicited input (e.g. from social media, see section 4). Social media like Twitter and Facebook are able to inform a huge number of persons in relatively short time (it creates an avalanche of 'viral messages' (Wikipedia-english, 2013, Viral phenomenon) thus providing fast dissemination, ranging from good (everybody is warned) to disastrous (creating panic).

When interacting with robots (e.g. mobile sensors (Soboll et al., 2009)) special considerations apply (Laursen, 2013; Sonntag, 2002) : how much independence/control is granted for the robot? What are the legal implications of autonomous robots?

3.3.7 Recording, Archiving, and Analyzing

Historical data dealing with diasters are a valuable help in all Phases. Today's search engines can locate and identify similarities very fast and thus help decision making. Historical data are also very helpful in the Restoration Phase and also for the settling of claims. Tools and methods for analysis, for simulation, and interpretation are needed (Kelton et al., 2007; Mayrhofer, 2007; Neubauer, 2008; Krishnan, 2012; Roth, 2012). The analyzed data can later be used as decision- support during the following disaster (section 3.3.2). (Leigh, 2013), for example, describes the Community Risk Registers and the Local Resilience Forums in the UK which provide valuable data from previous disasters and also repository information, plans, and projections for future events.

4 MASS COMMUNICATION and CROWD INTELLIGENCE

Traditional information management using standard information technologies is able to cope with most of the problems and activities described in section 3. Modern technology has added considerable speed, storage amount and computing power. It has also provided an ubiquitous communication potential which was unknown some 20 years ago. This means that electronic equipment, as a result of today's Information and Communication Technologies (ICT), can support and improve above activities, sometimes in ways not previously anticipated (e.g. pattern recognition, data mining, simulation, virtual reality, etc. (Chroust, 2012)), dramatically increasing their applicability and usability.

4.1 Social Media in Disaster Response

In the last decade a completely new paradigmatic support medium has emerged: Social Media (Surowiecki, 2005) (Grifantini, 2009) (Leimeister, 2010) (Miller, 2010) (Hossfeld et al., 2012).

(Haddow and Haddow, 2008) states: *"The emergence of new media-online news sites, e-mail, blogs, text messaging, cell phone photos, and the increasing role played by "first informers"- witnesses who now have the ability to transmit information immediately from the event. [They] are redefining the roles of government and media. ... government's historical role as* *gatekeeper is now an anachronism. Traditional media's role as the sole conduit of reliable and officially sanctioned information has been eclipsed by the increasing use and influence of new media."* The typical disaster management cycle is well known but information gathering processes are not visible, especially not if information gathering from crowds is involved. For this, we propose a disaster communication cycle for crowds (fig. 6).

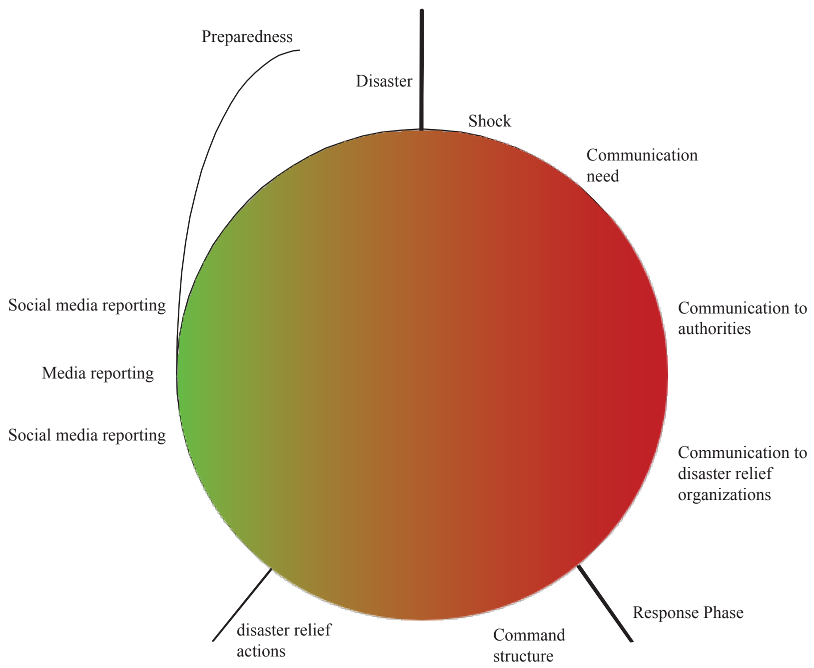

Fig. 6: Disaster Communication Cycle (read clockwise)

Taking into account the known telecommunication behavior during a crisis or large scale events it has been experiences that right at the beginning of a disaster a huge amounts of communi cation occurs causing a breakdown of the infrastructure. As a result of this disaster response profits in at least two ways. Firstly, the crowd profits as individual members of the crowd can send warning messages to everyone, thus enhancing their safety. Secondly by sending messa ges of warning to the authorities the quality of disaster response and situational awareness of authorities and disaster relief units can be improved and hastened.

In most of the European countries there is a large network of volunteers in disaster relief units (Emergency Medical Service, Firefighters etc.). These volunteers have at their disposal indivi- dual channels of communication to get in touch with their organizations and to give qualified information about the situation and estimated damage to man and infrastructure. In this case the communication network has to carry large amount of data, especially if there are pictures and videos involved. High capacity networks are necessary to conquer this data flood but would be worthwhile. After a certain period of unavailability the communication infrastructure would be available again. During this gap it is essential to bridge the loss of communication infrastruc ture and give tools to reestablish communication channels for the crowd. After a first flood of incoming data, there is will be a drop to essential streams of communication. In this way the Interventions Phase leads into the Restoration Phase. Disaster relief is organized and takes up coordinated work. The communication flow will return to normal.

Other channels, e.g. media and social media, will transport information to a broad public and report on situational updates. During this phase data mining by authorities can be initialized.

In the case of the crowd being involved in response and recover at the scene of disaster, there are certain needs on both sides: both from the disaster response organizations and from the crowd side.

During the initial phase of disaster, especially for manmade disaster, the reaction of crowds tend to record the situation on mobile devices. This reaction could be observed during the Boston Marathon bombing in 2013. Police service were able find the culprits by using the data gathered by the crowd within very short time. As to accurate this research was is not subject of discussion here, but the mechanism is obvious. In coping with the extreme situation, documenting the horror is a way of memorizing the scene for a later roll-up and also helps in getting over the initial shock.

4.2 Psychological Effects of Mass Communication

There is also a change in people's attitude. (Haddow and Haddow, 2008) states: *"We have to recognize that people today have a different expectation with respect to information and its availability. Spoilt by the 'normal' operation of the internet people expect immediate availability of information and also instant communication facilities. Waiting hours for an official communique ist often not accepted. Additionally social media provide a web of interconnections providing information and disinformation to a wide area of listeners."*

Keeping people active is a way to reduce the direct psychological stun effect, as experience in emergency situation has proven. A person who is shocked and paralyzed by disaster can be reactivated by getting an active task of support for recovery. This is helpful in two ways. First of all people are involved in recovery actions. This increases resilience or activates the potential of resilience. The impact of disaster concerning psychological effects is probably reduced.

Secondly, these activities provide valuable sources of information. Surveillance is a major aspect in situational reconnaissance. The additional advantage is that First Responders need not immediately access the disaster area: as an initial step they can rely on the "First Informers".

5 COMMUNICATION MEDIA – NEEDS and THREATS

Information is only useful if available correctly at the right place in the right time and in the adequate form. Thus the provision of adequate reliable and robust communication channels has to be analyzed too, with the communication medium matching the type and importance of the information.

The information identified in the previous sections needs a channel (medium) in which to be *transported*, At a scene of disaster situation the communication media might also be stressed, even overloaded or destroyed.

Key requirements are:

Quality of channels: high-capacity, stable, and reliable channels

Filtering of Information quality: qualified vs. non-qualified, reliable or unreliable

Filtering of priorities: disaster related content vs. standard communication content

Information compression: in order to reduce band width requirements, e.g speech-to-text conversion can be used. This is a purely technical issue.

Coordinated actions for gathering useful information aggregation of individual data, comparison and elimination of not trusted ones.

Trust in authorities Providing authentication of messages, preventing hoax and disinformation (McEntire, 2007).

Some of the measures are purely technical (e.g. technical compacting ..), others are, however, closely related to the information type and/or need and the technical possibilities e.g. converting speech to text and later text to speech in order to reduce transmission bandwidth, or also a code for certain standard situations (e.g. we have a "205"-incident). Other measures need human intervention or sophisticated artificial intelligence software.

Key approaches will be:

- Design of a complementary communication structure for the direct and selective input to and feedback from concerned parties, and profiling these individual responders (Chroust, 2008a).
- Empirical analysis of the communication needs, requirements, and behavior, including the willingness of voluntary helpers to be available by taking into account gender issues and social milieus.
- Seamless and uninhibited communication with individuals with special needs or disabilities.
- Handling of bulk inquiries (e.g. during epidemics and major events) through digitization and automation with consideration of adaptation to geography, culture and lifestyle of different populations, and their legitimate information needs.
- Wide-area situation evaluations from a distance by observation via social media (Twitter, Facebook, ... (Hughes and Palen, 2009)), by querying sensors and robots (Laursen, 2013), by communication with the so-called First Informers and the use of crowd sourcing.
- Reducing bandwidth requirements and increasing quality of communication by use of voice-to-text input / output systems together with transformation between language and text.
- Offering specialized apps for mobile phones in order to enable improved support in disaster communication (Marella et al., 2011) .
- The provision of alternatives and fall-back solutions, especially since the disaster may damage and disable the needed communication resources.

6 SUMMARY

Disaster have and will always be with us, but nowadays it seems that on one hand:

- disasters are more destructive and frequent

- the infrastructure is more fragile and less robust
- new dangers and vulnerabilities arise (chemical, radioactive, ...) (Bolin and Standford, 1998; Altomonte, 2012)
- society depends more on the reliability of their environment
- tolerances and safety margins in housing and technical equipment have been reduced
- expectations with respect to reliability and safety are higher ("a safe world") especially triggered by overdrawn promises of technology

On the other hand we also can rely on

- new technologies with respect to speed and effectiveness of computing support to analyze and present data
- new technologies for predicting future developments
- better, faster and more reliable/alternative communication means
- ICT providing new ways of coordination and response
- new cooperation models including all stakeholders (utilizing Crowd Intelligence (Miller, 2010; Surowiecki, 2005)).

The progress in Information and Communication Technologies (ICT) has revolutionized Disaster Management as it has in many other fields. The speed and the ubiquity of wide-area two-way communication is a completely new phenomenon which can be used in a manifold ways to improve, and accelerate the efficiency and effectiveness of Disaster Response.

We are now at the brink of an informational revolution in disaster response. In former times possibilities were lacking which enabled the broad mass to become involved in disaster response. Most of the people are not trained in disaster response activities and disaster relief organizations are not very well trained in acting with the public. Mobile technologies bring a new aspect to the game. The broad mass, the Crowd, is able to help in gathering information on site. Further more, there are already ideas of a pre-strategic stadium for giving commands and requests to the crowd in order to activate the resilience potential.

In this paper we have described - from the viewpoint of information exchange - needs and trends. It has to be understood that the technical communication media must keep pace with the abilities and the requirements of information interchange. The optimal utilization of the information processing capabilities and the communication facilities still prove considerable challenges both for technical and human factors experts.

Acknowledgement

The content of this paper is based on work during 2009-2011 in the project "KIRAS PL3:SimRad.COMP: Simulations- und Informationssystem zum Administrieren von Hilfseinheiten bei Katastrophen...", KIRAS-Project no. 818784 of the Austrian Federal Ministry for Transport, Innovation and Technology (BMVIT).

REFERENCES

Adam, A. (1973). Vom himmlischen Uhrwerk zur statistischen Fabrik. *Verlag Munk 1973*.

Altomonte, H. (2012). Japan's nuclear disaster: Its impact on electric power generation worldwide [in my view]. *Power and Energy Magazine, IEEE*, 10(3):96 –94.

Bartels, K. and Huber, L., editors (1990). *Lexikon der Alten Welt*. Artemis Verlag Zürich, 1990.

Bolin, R. and Standford, L. (1998). *The Northridge Earthquake: Vulnerability and Disaster*. Routledge, London 1998.

Chroust, G. (2008a). Bridging gaps by cooperation engineering. In Kotsis, G., Taniar, D., Pardede, E., and Khalil, I., editors, *Proc. of the 10th Int. Conference on Information Integration and Web-based Applications and Services (iiWAS2008)*, pages 382–389. OCG (Austrian Computer Sociey) and ACM 2008.

Chroust, G. (2008b). Localization, culture and global communication. In Putnik, G. D. and Cunha, M. M., editors, *Encyclopedia of Networked and Virtual Organizations, vol II*, pages 829–837. Information Science reference, IGI Global, Hershey USA 2008.

Chroust, G. (2012). ICT support for disaster management. In Doucek, P., Chroust, G., and Oskrdal, V., editors, *IDIMT 2012 ICT-Support for Complex Systems, vol.38 Sept 2012*, pages 13–23. Trauner Verlag Linz, 2012.

Chroust, G. and Ossimitz, G. (2011). A systemic view of interventions in regional disasters. In Doucek, P., Chroust, G., and Oskrdal, V., editors, *IDIMT 2011 Interdisciplinarity in Complex Systems, vol.36 Sept 2011*, pages 81 – 94. Trauner Verlag Linz, 2011.

Chroust, G., Ossimitz, G., Roth, M., Sturm, N., and Ziehesberger, P. (2013). Chapter 8: First responders in regional disasters - a social responsibility. In Mulej, M., editor, *Social Responsibility*, page 23. Bentham Science Publishers, 2013.

Chroust, G., Rainer, K., Sturm, N., Roth, M., and Ziehesberger, P. (2010). Improving resilience of critical human systems in CBRN-emergencies: Challenges for first responders. In Leonard, A., editor, *ISSS 2010: Governance for a Resilient Planet*, page 18 (paper no. 1367). ISSS, 2010, also : http://journals.isss.org/inde.php/proceedings54th/issue/archive.

Chroust, G., Schönhacker, S., Rainer, K., Roth, M., and Ziehesberger, P. (2009). Training and supporting first responders by mixed reality environments. In *53rd Annual Conference - The International Society for the Systems Sciences " Making Liveable, Sustainable Systems Unremarkable"*, page 18. The International Society for the Systems Sciences 2009 (CDROM), July 2009, paper no. 2009-1248-Chroust.

Chroust, G., Sturm, N., Roth, M., and Ziehesberger, P. (2011). Regional disasters and systemic reactions.
In Wilby, J., editor, *ISSS 2011 and ISKSS 2011: All Together Now: Working across Disciplines*, page 15 (paper no 1631). (CDROM)Int. Systems Science Society, UK, 2011.

Feldhaus, F. (1970). *Die Technik - der Vorzeit, der geschichtlichen Zeit und der Naturvölker - Ein Lexikon*. Löwit, Wiesbaden 1970.

Grifantini, K. (2009). Can you trust crowd wisdom? *Technology review (MIT), Sept 16, 2009*. Researchers say online recommendation systems can be distorted by a minority of users.

Haddow, K. and Haddow, G. (2008). *Disaster Communications in a Changing Media World*. Butterworth-Heinemann Homeland Security, kindle-book, 2009.

Hofstede, G. and Hofstede, G. J. (2005). *Cultures and Organizations - Software of the Mind*. McGraw-Hill, NY 2005. dimensions, more scientific than Hampden-Trompenaars, similar results.

Hossfeld, T., Hirth, M., and Tran-Gia, P. (2012). Crowdsourcing. *Informatik Spektrum, vol. 35 (2012) no. 3*, pages 203–208.

Hughes, A. and Palen, L. (2009). Twitter adoption and use in mass convergence and emergency events. In J. Landgren, J. and Jul, S., editors, *In Proceedings of the 6th International ISCRAM Conference, Gothenburg, Sweden, May 2009*.

Kelton, D., Sadowski, R. P., and Sturrock, D. (2007). *Simulation with ARENA*. mcGrawHill, Boston 2007.

Kenlon, J. (1913). *Fires and Fire-Fighters - A History of Modern Fire-Fighting with a Review of its Developments from Earliest Times*. George H. Doran Company 1913, reprint. reprint.

Kreps, G. et al. (1989). *Social Structure and Disaster*. University of Delaware Press, Newark, 1989.

Krishnan, K. (2012). Weathering the unexpected. *Comm. ACM vol. 55 (2012), no. 11*, pages 48–52.

Laursen, L. (2013). Robot to human: "trust me". *IEEE Spectrum vol. 50 (March 2013)*, page 13. Human vs robot, trust and control.

Leigh, M. (2013). Assessing the risk of civil protection - hazards in the uk getting the methodology ight. Technical report, Emergency Planning College - Occasional Papers - New Series, Number 5.

Leimeister, M. (2010). Kollektive intelligenz. *Wirtschaftsinformatik, no 4 (2010)*, pages 239–242. Erstellen vs. Entscheideen, Hierarchie vs. Crowd.

Linnerooth-Bayer, J. (2006). Planning for disasters. *Options (IIASA), summer 2006*, pages 18–19.

Loewer, C. (2011). Katastropen - können uns uralte legenden vonr katastrophen warnen? *PM Magazin NO. 2011/09*.

Marella, A., Mecella, M., and Russo, A. (2011). Collaboration on the field: Suggestions and beyond. In *Proceedings of the 8th Int. ISCRAM Conf., Lisbon, Portugal, May 20, 2011*.

Mayrhofer, R. (2007). *Concept, Simulation and Practical Application of a Decision Support System for First Responders. Dissertation, , 2007*. PhD thesis, Technical University Vienna 2007.

McEntire, D. (2007). *Disaster Response and Recovery: Strategies and Tactics for Resilience*. Wiley, USA 2007.

Miller, P. (2010). *Smart Swarm - Using Animal Behaviour to Change our World*. FSC + HarperCollins, 2010.

Mrotzek, M. (2009). *Catastrophe Dynamics - A Systemistic Exploration of Catastrophes towards a Set of Catastrophe Archetypes Using the System Dynamics Simulation Method*. PhD thesis, Alpe-Adria University Klagenfurt, Faculty for Technical Sciences, Feb. 2009.

Mrotzek, M. and Ossimitz, G. (2008). Catastrophe archetypes - using system dynamics to build an integrated systemic theory of catastrophes. In Chroust, G., Doucek, P., and Klas, J., editors, *IDIMT-2008 - Managing the Unmanageable - 16th Interdisciplinary Information Management Talks*, pages 3671–384. Verlag Trauner Linz, 2008.

N., N. (1897). Meyers konversationslexikon, 5. auflage, 17 bände. *Bibliographisches Institut, Leipzig - Wien 1893-18977.*

Neal, R., Bell, S., and Wilby, J. (2012). Emergence in the disaster response to the june 2007 hull floods. In Bichler, R., Blachfellner, S., and Hofkirchner, W., editors, *European Meeting on Cybernetics and Systems Research 2012 - Book of Abstracts*, pages 85–87. Bertalanffy Center for the Study of Systems Sciences 2012.

Neubauer, B. (2008). Introduction of process modeling using rockwell arena. *J. Comput. Small Coll.*, 24(2):164–169. number - ACM DL 1409858.

Piller, F. (2006). *Mass Customization: Ein wettbewerbsstrategisches Konzept im Konzept im Informationszeitalter*. Deutscher Universitätverlag Wiesbaden, 2006.

Quarantelli, E. (1985). The need for clarification in definition and conceptualization in research. In Sowder, B., editor, *Disasters and Mental Health - Selected Contemporary Perspectives*, pages 41–73.

Rainer, K., Sturm, N., Schönhacker, S., and Chroust, G. (2009). SimRad.NBC - simulation and information system for rescue units at CBRN-disasters. In G.A., P. and Badica, C., editors, *Intelligent Distributed Computing III*, pages 297–303. Springer Lecture Notes vol. 237, Berlin, Heidelberg 2009.

Reissberg, A. C. (2010). A cybernetic approach to hurricane hazard management on O'Ahu, Hawaii. In Leonard, A., editor, *ISSS 2010: Governance for a Resilient Planet*, page (paper no. 1350). ISSS, 2010.

Roth, M. (2009). SimRad.NBC: Simulations- und Informationssystem zum Administrieren von Hilfseinheiten bei Katastrophen - im Fokus auf NBC-Bedrohungen, endbericht projekt kiras 813798. Technical report, Öesterr. Forschungsförderungsgesellschaft mbH (FFG) 2009.

Roth, M. (2012). Simrad.COMP: Simulations- und informationssystem zum administrieren von Hilfseinheiten bei Katastrophen - Erforschung von Systemkomponenten zur Überprüfung der Einsatztauglichkedit der SIMRAD Technologie, Endbericht projekt KIRASs 818784. Technical Report, Österr. Forschungsförderungsgesellschaft mbH (FFG) 2012.

Sanders, R. L. and Lake, J. E. (2005). Training first responders to nuclear facilities using 3-d visualization technology. In *WSC '05: Proceedings of the 37th conference on Winter simulation*, pages 914–918. Winter Simulation Conference.

Soboll, M., Binder, B., Quix, C., and Geisler, S. (2009). Prozessmodellierung der mobilen datenerfassung für den rettungsdienst bei einer großschadenslage. In Höhn, R. and Linssen, O., editors, *Vorgehensmodelle und Implementierungsfragen - Akcquisition - Lokalisierung - soziale Maßnahmen - Werkzeuge, 16. Workshop d. FG WI-VM der Ges. für Informatik, April 2009*, pages 109–125. Shaker Verlag Aachen 2009.

Sonntag, M. V. (2002). Legal aspects of mobile agents. with special consideration of the proposed austrian e-commerce law. In *Cybernetics and Systems 2002. Proc. of the 16th European Meeting on Cybernetics and Systems Research*, pages 153–158. Austrian Society for Cybernetic Studies, Vienna 2002.

Surowiecki, J. (2005). *The Wisdom of Crowds*. Anchor Books, Random House, New Aork 2005. schwach Kap 1/2 zum Thema, rest eher über Gruppen (nicht crowds) Entscheidungsfindung etc., unterschei- dung: cognition/coordination/cooperation.

Tierney, K., Lindell, M., and Perry, R. (2001). *Facing the Unexpected - Disaster Preparedness and Response in the United States*. Josef Henry Press, Washington DC, SA 2001.

Welsh, M. (2010). Sensor networks for the sciences. *CACM vol. 53 (2010) , no 11.*, pages 36–39.

Wikipedia-english (2013). Wikipedia, the free encyclopedia. http://en.wikipedia.org/wiki/.