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Towards an Integrated Approach to Emergency Management: Interdisciplinary Challenges for Research and Practice

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Abstract

This article presents an interdisciplinary vision for large-scale integrated emergency management that has been inspired by the transition from platform centric to integrated operations in the oil and gas fields, which uses remote emergency control centres collaborating virtually with local responders. The article discusses some of the most salient research challenges for integrated emergency management, including the role of mobile technology, human-centred sensing, citizen participation and social media, and the socio-cultural determinants of disaster management. The purpose of this article is to frame an integrated emergency management approach that adopts a multi-disciplinary approach, including human computer interaction, information systems, computer science, development studies and organization science employing different methodologies. Most importantly, we need to better understand the socio-cultural determinants of how people prepare to, respond and perceive disasters, in order to evaluate whether and what kind of information and communication technology (ICT) support is appropriate. There is need for more research as to why in some regions local people ignore official orders to evacuate, and rather follow the advice of local leaders, elders or religious leaders. In other instances, disasters are seen as 'acts of God' thus shaping disaster preparedness and response.

Keywords: Disaster, disaster perception, disaster vulnerability, social media, emergency management, integrated operations, information and communication technology, human-centred sensing, ad hoc networks, smart phones, virtual collaboration, Integrated Operations

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Introduction

Large scale emergencies require response and management under circumstances disrupted by the disaster itself (Simpson and Hancock 2009). When indigenous systems have been disrupted, emergent groups that often do not share common practice and experiences must be coordinated. On site conditions may have been adversely affected and the lack of integration across phases and organizations, together with exhaustive stress impairs the response quality (Turoff et al. 2010). Experiences with Integrated Operations, pioneered in the Norwegian offshore oil and gas fields, suggest a different model – an Integrated Emergency Management approach. This is a promising approach for emergency management and is a realistic goal in the next ten years.

Most important, mobile phones are spreading rapidly, with soon reaching one mobile phone subscription per person creating new opportunities to realise Integrated Emergency Management (International Federation of Red Cross and Red Crescent Societies 2013). Even if technological solutions, such as smart phones, are available underpinning an Integrated Emergency Management approach, for instance to warn populations at risk, it is not clear how local communities can effectively use them and be involved in managing the disaster (Drabek 1999). Moreover, do solutions developed for environments with sophisticated and well-functioning infrastructure, also work in emergencies and regions with poor technological infrastructure and lack of technological awareness? Furthermore, cultural differences may make it difficult to apply solutions that are developed for and in industrialised countries that may not work in a different cultural setting in countries, where religious and spiritual beliefs dominate.

Notwithstanding, ongoing activities in early alerts, collaborative decision making systems, situation room technology, integration of physical data, remote sensing, geographical data and social media information for emergency management can be viewed as emergent components for Integrated Emergency Management (IEM). This article proposes four major research challenges for creating a future IEM approach, discusses its strength and weaknesses, by focusing on the socio-cultural aspects of Integrated Emergency Management.

Making Integrated Operations Relevant for Emergency Management

In an Integrated Operations approach, teams in onshore control rooms, working in three to four time zones around the globe, virtually collaborate with a local offshore workforce to handle oil and gas operations. Since different oil and gas companies implement Integrated Operations in different ways there is no common description of the Integrated Operations concept. However, all Integrated Operations solutions share the following generic properties: 1) Use of ICT and a digital infrastructure to enable new work practices; 2) increased capture of offshore performance data; 3) use of real-time data to monitor and manage operations across geographical and organizational borders; 4) use of collaborative technology to link different actors in a closer, more efficient way; 5) access to expert knowledge (Albrechtsen and Besnard 2010). Integrated Operations implementations include processes for all stages of emergency management in oil and gas platforms. A serious test of emergency management using Integrated Operations has not yet occurred since there have been no recent major accidents in the Norwegian offshore operations. However, Albrechtsen (2010) argues that Integrated Operations is an enabler for new practical approaches to risk assessment and management; that risk assessment may be improved through use of real time data; and that it provides better risk visualization and facilitates effective safety support. While Integrated Operations is relevant for Integrated Emergency Management as it employs ICT infrastructure to react quickly and appropriately to unforeseen events, emergencies involve a large array of actors and victims, who are not part of the same organisation, using different modes of communication, and having divergent societal and cultural backgrounds and identities.

First challenge: Enabling Infrastructure-less Communications

Today, worldwide cellular networks are the fundamental infrastructure for communications among citizens. However, such an infrastructure is vulnerable in large-scale emergencies. Even in small-scale emergencies, e.g. the storm in west Norway in December 2011, thousands of people can lose network connectivity for weeks (Nyfløt 2011). Although a satellite-based infrastructure will still be operational after natural disasters, handset prices of around USD 500-1,700 and high subscription fees restrict citizens' use of satellite phones. Therefore, improving the resilience of infrastructure-based mobile systems by enabling infrastructure-less ad hoc communications is a paramount theme for emergency management. Thus, availability, reliability, robustness, coverage, and energy efficiency are essential topics for building and deploying ad hoc networks in emergency areas. Future research work concerns enhancing network connectivity by introducing redundancy to infrastructure-based mobile systems using ad hoc networks. Network connectivity can be improved by using easily deployable ad hoc networks to provide redundant links (Egeland and Engelstad 2009). However, current works fail to propose concrete strategies on how to combine partial static topology with dynamic links. Furthermore, the performance of such strategies needs to be evaluated through mathematical analyses, simulations and test-beds. Moreover, in an emergency, mobile base stations must be rapidly deployed to emergency areas. A promising approach is to integrate ad hoc networks with infrastructure-based communication systems using mobile base stations and mobile devices. This could form a standalone network, e.g., as a citizen-to-citizen, or rescue team-to-rescue team network, or a combination of both. This network could also form an easily deployable temporary wireless network, connecting to other infrastructure networks such as satellite or cellular systems. In such context, a light-weight mobile base station or gateway will be an optimal alternative. In order to ensure effective first response to emergencies, reliable and robust communications over large areas for rescue teams and affected citizens must be established. Considering link instability and topology of ad hoc networks, a bi-connected topology has been proposed for reliable communications (Ogier and Spagnolo 2009). However, this imposes strict requirements on high node density, which is unrealistic in emergency scenarios. Another approach is to develop new Media Access Control (MAC) mechanisms and routing schemes for low density ad hoc networks in order to provide peer-to-peer reliable communications in emergency scenarios. Lastly, lifetime of communication networks need to be extended in an emergency situation. Recent research (Jung and Ingram 2011) demonstrates that per-hop transmission range can be extended by cooperative transmissions of neighbouring nodes towards a common destination. In this way, an energy-constrained node can survive over longer periods, resulting in improved network lifetime. Here work could focus on designing energy-efficient mechanisms to extend network lifetime.

Second Challenge: Human-Centred Sensing

Recently, “human-centred sensing” has been introduced for emergency management, using humans as information collectors (Jiang and McGill 2010). By taking advantage of smartphone based sensor technology, human-centred sensing offers the potential for remote sensing and information fusion in an emergency (Schade et al. 2012). Mobile wireless devices such as mobile phones and smartphones are widespread, including developing countries, and are often equipped with advanced sensor technology, including accelerometer, digital compass, gyroscope, global positioning system, microphone, and camera. Consequently new types of smart phone applications that connect low-level sensor input with high-level events are emerging (Lane et al. 2010). These applications can involve individuals, groups of users, and even entire communities. An example is the automatic classification of a smart phone’s environment by using its microphone (Lu et al. 2009). By combining the smart phone's accelerometer with GPS, the owner’s movement patterns, e.g. walking, running, or cycling, can be determined (Zhang et al. 2010). Interaction between multiple smart phones provides further possibilities. For example GPS data collected from large user groups can identify the places frequented by different subpopulations. Consequently users can receive targeted recommendations on evacuation paths, emergency equipment, and nearest hospitals, fire brigades and police stations, etc., based on the behaviour of the subpopulation that best fits the user's own movement patterns. Another example is using smart phone sensor technology to determine how the actions of large groups of users cause different types of environmental pollution (Mun et al. 2009).

However, human-centred sensing also implies a number of research challenges. Firstly, human-centred sensing in emergency situations with ad hoc networks implies a plenitude of fragmented information, collected and propagated in an opportunistic manner through locally formed “communication hubs” (Hall and Jordan 2010). Also, different emergency response agencies will have their own interpretation of what is important data, and their own storage formats. Furthermore, crucial data may be provided even by citizens and victims of the emergency, in an ad hoc manner (Jiang and McGill 2010). The resulting data heterogeneity and huge amounts of data, introduces several research challenges (Tomaszewski et al. 2007). Integrating different formats using a common information model, and the intelligent routing of the data constrained by limited communication resources, are great challenges in human-centred sensing.

Distilling pertinent cues from collected information in order to obtain situational awareness at the individual, local, and global level of an emergency, forms a formidable data fusion problem (Hall and Jordan 2010). Such fusion includes context dependent hazard forecasting, damage and risk estimations, and statistical analysis. The problem must be solved in a decentralized manner, as dictated by the resource constrained computing and communication devices involved. Moreover, spatio-temporal aggregation of information fragments is required since information from geographically related sensing devices may also be used to recognize and track evolving local and global emergency patterns. Additionally, conflicting or even contradictory information, typical in the early emergency phase, requires harmonization, and methods are needed to discriminate between erroneous, misleading, and awareness-bringing information.

Opportunistic mobile phone sensing requires privacy preservation (Kapadia et al. 2008). In some emergency situations, e.g. terrorist attack, shared information could be abused posing significant risks. Information sharing may also lead to the spread of false information. To prevent hostile attacks, human-centred sensing should ensure information integrity and guard against information misuse. An ability to interpret sensor readings so that a threat picture may be formed is central to IOs. Furthermore, a comprehensive picture can only be formed when the sensor measurements from several devices are taken in context (Hall and Jordan 2010), possibly in combination with information from involved authorities.

Third Challenge: Citizen Participation and Social Media

In recent years our society has seen huge advances in information technologies resulting in marked changes in the way that individuals interact and communicate. The emergence of the smart phone and other ICT has given us mobile access to web services, such as social networking sites, which encourage sharing and exchanging information. Through these ICT developments, citizens are now playing a much more active role in providing information to emergency managers. Recent large-scale emergencies, such as the Haiti Earthquake in 2010 gave rise to an unprecedented surge of citizen involvement where humanitarian workers tried to cope with massive amounts of information provided by citizens through web portals, platforms, and new social networking media, such as SMS feeds, Twitter, etc. (Dugdale et al. 2012). Such is the increase of citizen participation that current information systems for emergency management, e.g. the SAHANA Open Source Disaster Management System and the crowd-sourcing platform Ushahidi, now purposely provide ways to incorporate information sent by citizens through social media and SMS.

Emergency response may be viewed as an integrated socio-technical system where citizens play a key role in shaping the response through information provision and action (Palen et al. 2010; Palen and Liu 2007). However, this vision has not been realized in practice. IEM should incorporate as an essential element a citizen participation component. Despite the well-documented advantages of citizen participation, e.g. in organizing public action and improvising rescue efforts (Qu et al. 2009), providing practical help with temporary housing and food (Palen et al. 2007), providing eye witness accounts and images to help rescue recovery (Cowan 2005), etc., challenges remain in integrating citizen participation into IO, as well as into IEM. The first concerns the sheer volume of information that emergency managers receive. Additionally, there are difficulties in processing information in a non-standard format from different sources and in various languages. One solution was to use a globally dispersed, virtual community of humanitarian volunteers to filter and process the information. This solved some problems but it proved difficult at a macro level to manage these communities (Koeppinghoff 2011). There are also problems with the validity and value of the information, e.g. 80% of reports of people trapped in rubble received via SMS by rescuers from citizens in the Haiti earthquake were incorrect (Koeppinghoff 2011). The same applies for disaster warnings: if disaster warnings are unclear or not precise, people affected may interpret the information received to minimize their perception of risk making them more vulnerable, as Drabek argues (Drabek 1999). However when the information was aggregated it became useful at an area level, highlighting general search locations. In addition archiving and summarizing of information is required if we are to benefit and learn from past mistakes (Starbird and Stamberger 2010).

Fourth Challenge: Putting Emergency Management into the Socio-cultural Context

Emergency management is context specific, and this is key to all previous research challenges. Even if human-centred sensing is promising to provide useful data, it only can work in societies where public and private sectors work together in a synergetic way. Citizen participation is important but as mentioned, linguistic and cultural common codes need to be established to improve the sense-making of relevant information. Moreover, to what extent emergencies affect people depends on socio-political circumstances (O'Riordan 1999). Historically, disasters have always shaped human society and its interactions with nature for centuries. For example, the poor response of the Pakistani leadership to the Bhola tropical cyclone in 1970 played into the hands of those seeking independence of East Pakistan, leading to today's country of Bangladesh (Reilly 2009). More recently, and in terms of disaster impacts, the year 2011 was one of the most damaging years in human history: 302 disasters claimed 29,782 lives; affected 206 million people and caused damages of an estimated USD 366 billion, according to the United Nations (EM-DAT 2012). This, of course, is partly due to the devastating tsunami in Japan, and most of the economic and human loss occurred in Asia. Figures show that some countries are capable and well trained to respond to hazards such as Norway and Cuba, while others, such as Myanmar and Bangladesh are poorly prepared and ill-equipped to withstand hazards. Today, every country, rich or poor, risks experiencing a hazard or emergency. Yet, the physical, economic and human impact of hazards and emergencies vary greatly.

Poor communities are affected by hazards and emergencies to a far greater extent. While the majority of economic damages (82 percent in 1977-97) occurred in the developed world, the gross of the fatalities (87,4 percent in 1977-97) occurred in the developing world (Alexander 1997). For instance a single event, a tropical cyclone hitting Bangladesh in April 1991 caused 145,000 deaths alone (Alexander 1997). Another, more contemporary example is the Chilean earthquake of 2010 that was far stronger than the Haitian one in 2010, though it affected far less people. The death toll in Haiti, a country with a 20 times smaller Gross Domestic Product compared to Chile, was 500 times larger compared to Chile (Mutter 2010). The increased disaster risk in poor countries is a function of the natural hazard and vulnerability (Alexander 1997). Vulnerability refers to the capacity to be wounded, argues Hans-Martin Füssel, and this is a good starting point (Füssel 2007). This definition implies that vulnerable societies are already weakened and therefore more sensitive to external stress, such as tropical cyclones or seismic events (Webersik 2010). The vulnerability concept is important as it includes issues of marginalisation, past losses, susceptibility to future damage, race, gender, culture and other socio-economic factors.

Moreover, there is also the need to better understand the long-term impact of hazards on development, measured in mortality and fertility rates, and other human development indicators. For instance, re-population and recovery of essential social amenities, such as schools and hospitals, were much slower in poorer neighbourhoods of New Orleans compared with the wealthy parts of the city following the 2005 hurricane Katrina (Mutter 2010). Previous research confirmed this notion that disasters can push poor communities into long-term poverty. Drawing on data from the three-year drought in Ethiopia in the 1990s and Hurricane Mitch in Honduras in 1998, research shows that the lowest wealth groups needed more time to rebuild their lost assets compared to wealthier groups. Further, the lowest wealth groups tended to settle on a low equilibrium and then do not grow in terms of capital assets (Carter et al. 2007).

However, in a rather provocative article, entitled "Do natural disasters promote long-run growth?", Skidmore and Toya (2002) argue that higher frequencies of natural disasters correlate with higher rates of human capital accumulation, more specifically economic growth. Their article examines the long-term impact of natural hazards on economic growth. The long-run aspect makes their research interesting. Most disaster studies examine the immediate economic and physical loss natural hazards cause. For instance, the risk to lose economic income due to drought is particularly high in sub-Saharan Africa, but little is known about the long-term impact of drought (Webersik 2010).

Skidmore and Toya's underlying assumption is as follows: disaster risk reduces physical capital investment but at the same time provides an opportunity to update capital stock and thus fosters the adoption of new technologies. A good example is the 2011 earthquake and tsunami in Japan. It has been argued that the reconstruction of destroyed Japanese neighbourhoods offers an opportunity to create sustainable cities with an emphasis on green public transport, low-energy housing and the use of renewable energy for power and heating, just to name a few areas of intervention.

The authors use a sample of 89 countries and find a robust and significant positive relationship between climatic disasters and economic growth (Skidmore and Toya 2002). Though this finding gives the impression that disasters are actually good for development, this approach does not take into consideration the great differences in income within countries. This notion is captured by the term vulnerability, an important concept in disaster studies. This stands in contrast to authors who argue that natural disasters cause heavy losses in capital assets, disruption of economic and social infrastructure, affecting supply chains and hence production processes, thus undermining the capacity of affected people to cope with such a disaster. In addition, natural disasters “not only cause heavy losses to capital assets, but also disrupt production and the flow of goods and services in the affected economy, resulting in loss of earnings” (Ahrens and Rudolph 2006: 208). In the Philippines, agricultural crops, including those used for biofuel production, are frequently destroyed by tropical cyclone activity (Stromberg et al. 2011). Even where there is no physical damage, important infrastructure, such as ports, shut down when a certain wind speed threshold is passed, with negative economic consequences (Esteban et al. 2010).

More specifically, disasters do not affect people equally, even within societies. This for instance applies to gender. Neumayer and Plümper examined the impact of disasters on life expectancy and how disasters affect women differentially from men (Neumayer and Plümper 2007). The authors find that in societies where the socioeconomic status of women is low, disasters will kill more women than men. This can be explained with socially constructed gender roles. In these societies, for example in Sri Lanka, women were less likely to learn how to swim or more likely to wear clothes that hinder them from swimming. In events of flooding, or during the 2004 tsunami, they are less likely to escape. The authors argue that it is the "socially constructed gender-specific vulnerability of females built into everyday socioeconomic patterns that lead to the relatively higher female disaster mortality rates compared to men" (Neumayer and Plümper 2007: 551). This as well supports a vulnerability approach to disaster studies. Other studies show that younger persons are quicker in responding to disasters (Drabek 1999).

Once an emergency unfolds, the focus is on top-down relief and emergency management. Yet, the knowledge and capacity of local communities to prepare for and to respond to emergencies is greatly underestimated. Local communities are often well aware of their immediate environment and its associated risks; they have developed adaptation strategies to cope with hazards, such as selling off livestock in a drought situation or human migration to diversify incomes. Informal exchange networks, livelihood diversification and supporting networks are key coping strategies as noted by Hewitt (Hewitt 1997). This especially applies to countries with poor technological infrastructure, lack of trust in government institutions and lack of resources. In a nutshell, where local communities cannot rely on the state or private insurance schemes.

However, when a hazard turns into a disaster, risk perceptions of affected populations will influence how a disaster is managed, prepared for and mitigated. This depends on the cultural context, hence affecting the immediate disaster response and strategies to prepare for a disaster. Disaster warnings are often neglected and a first response in many cases is denial, as Drabek argues. Moving beyond denial, then a social process of debate is initiated in processing disaster warnings (Drabek 1999). In poor countries with large, poorly educated populations, communities often consider disasters as "acts of God" or attribute them to spiritual powers, thereby affecting the way these communities prepare and respond to disasters. (Misanya and Øyhus 2014) This should not mean that communities in poor countries act irrational while in industrialised countries, rational decisions dominate the assessment of disaster risk. Globally, all disaster risks should be placed in a social context, rather than seen as an independent outcome of a natural hazard or human erroneous behaviour. As Hewitt puts it: “[Disasters] depend primarily on the social order, rather than climate or, say, weapons potential. They express a success or failure in the shared responsibilities and expectations of public life.” (Hewitt 1997: 360). Yet, it is important to recognise differences in belief systems relevant for disaster management, to make ICT solutions work in different contexts. Chester et al. argue that faith-based explanations of disaster occurrence can be found in most African societies. In Eastern Africa, some communities attribute earthquakes to the dead

(Chester and Duncan 2009). In Eastern Uganda, landslides on the slopes of Mount Elgon have killed a few hundred people and displaced several thousands (Misanya and Øyhus 2014). The empirical findings of this study show several explanations for this landslide disaster: Excessive rainfall, volcanic activities, deforestation, and religious and indigenous explanations. The latter two cite the impact of local rainmakers, the Womaniala, and God's power causing the disaster. While others claim that disasters repeat themselves in regular cycles. Bearing the religious and indigenous explanations in mind, it becomes clear that this will affect the way, local communities respond to the disasters, including prayers, anxiety and misbelief, and community meeting. The lack of formal education may explain part of the non-scientific explanations, as local residents felt that their environmental impact was not strong enough to cause the landslides (Misanya and Øyhus 2014).

In addition, local people, in the very communities that consider disasters as "acts of God", proactively relocated and engaged in tree-planting and improved farming methods. This makes it clear that disaster victims are not purely passive victims but also have knowledge, agency and capacity to adapt and to cope with natural hazards and their associated risks, such as droughts, floods and landslides. Considering vulnerability as a "passive" concept as Alexander proposes, perhaps misses the point that local communities have agency and deliberately take risks, rather than being passive victims of extreme weather, poverty, or political arbitrariness (Alexander 1997). And the answer to how to prepare, to respond and to manage disasters is linked to the active participation of those who are directly affected by natural hazards. As Hewitt puts it: "Reasonable and effective response will always incorporate understanding of the conditions of those at risk, or otherwise directly involved (Hewitt 1997: 358).

It is important to note that the answer to the question as to why a natural hazard turns into a disaster is very complex. In all societies, in addition to objective disaster risks, imaginaries of disasters form the way we understand, prepare for and respond to disasters. For instance the media, including the emerging importance of social media such as Twitter, has created and maintained disaster myths, such as the claim that chaos and panic rules in the aftermath of disasters, and rational social behaviour is the exception rather the norm (Kverndokk 2014; Tierney et al. 2006). A good example is hurricane Katrina featured in Tierney's article (Tierney et al. 2006).

Still, local knowledge is key, for instance for search and rescue missions. Research demonstrates that real-time information on disasters and response measures can be coordinated with the use of social media (such as Facebook and Twitter). Following the 2011 earthquake in New Zealand, first responders and local communities used a Google tool named "Person Finder" (Garcia 2011). This also applies to community-based early-warning systems. Friends and family members living in different time zones are able to warn and inform affected relatives and friends of a looming emergency using social media. The use of mobile communications devices is spreading rapidly, most notably in developing countries. Here, communities adopt technologies, such as the use of mobile and smart phones for banking (like in Kenya), without using a personal computer in the first place. Also in Eastern Uganda, local communities developed early warning signs, ways to interpret them and to alert government authorities of excessive rainfall, volcanic activities and cracks on the mountain. As Misanya and Øyhus state "Community leaders in Nametsi Parish acknowledged that in the digital age the most viable means of communication is through telephone calls. However, it is vital to note that use of telephones may lead to the demise of local communication systems such as drums and person-to-person networks involving physical contact." (Misanya and Øyhus 2014) Alexander argues along these lines by stating that "a fine balance must be struck between respect for local practices, without venerating them, and introduction of outside innovations, without exalting these" (Alexander 1997). This notion of leapfrogging, jumping one or several stages of ICT, is an important trend in developing countries (Bjørke 2011). Yet, poor countries often lack the appropriate infrastructure to implement ICT solutions for disaster preparedness and management. And even when resources and infrastructure are available, they need to be cultural transferable to make them work (Alexander 1997).

Moreover, to better understand where ICT are most needed and best suited to guide emergency management on the local and national level, a key issue is mapping vulnerable regions. Hot spot analysis using Geographic Information Systems (GIS) can help to guide policy makers to identify areas of intervention. Here, natural hazard risk mapping combined with spatial and temporal socio-economic indicators, such as population density, infant mortality rates, and economic activity can help to better understand where the use of ICT tools is most needed and most appropriate. With regard to climatic hazards, future projections of the impact of climate change, such as sea-level rise and changes in intensity and frequency of sudden-onset hazards, will amplify these existing social vulnerabilities. Recent research demonstrates that patterns of El Niño/Southern Oscillation (ENSO) are associated with a higher risk of armed conflict in the tropics in the past 50 years (Hsiang et al. 2011). Given developing countries' climate-sensitive economies and low adaptive capacity, they are at greater risk to be adversely affected by natural hazards and man-made accidents, such as chemical spills, as well as other types of large-scale emergencies. This idea is not new, vulnerability is the key determining factor, turning a natural or technological hazard into a disaster (Oliver-Smith and Hoffman 1999). However, the risk of conflict in the aftermath of a disaster is small, as chaos, looting, and other criminal behaviour hardly occur (Thomas and David 2003). One of the reasons why social violence tends to be in the focus in the aftermath of disasters is due to the role of the media. In the aftermath of hurricane Katrina for instance, the media reported incidences of looting and lawlessness creating disaster myths of social violence (Tierney et al. 2006). Likewise, the Norwegian media reported on chaos and violence in urban areas affected by hurricane Katrina, following disaster narratives shown on American television. (Kverndokk

2014). Natural hazards are one of the many challenges, people in developing countries face, and as Hastrup argues often do not appear as something extraordinary (Hastrup 2011).

Towards an Integrated Operations View on Emergency Management

The fundamental design premises that address the above shortcomings and challenges were discussed in a paper on the design of Dynamic Emergency Response Management Information Systems (DERMIS) (Turoff et al. 2004). The DERMIS design premises, objectives and requirements are applicable to all types of crisis and emergency situations, whether natural, man-made, industrial or humanitarian. It is precisely the lack of situation dependency that makes an emergency response system such a powerful tool. Turoff et al. (2004) further argue that any supporting databases, containing information such as the location and availability of specific resources, hazardous materials, buildings, etc. can be located anywhere. The only prerequisite is that local responders are aware of them and know how to use them if needed given the very different cultural contexts.

Confronted with the realities of global emergency response, emergency management stakeholders should rethink the role of ICT support and seriously consider an IEM approach. The design, development, use and evaluation of such systems must take a prominent place on the agenda of stakeholders worldwide (Van de Walle and Turoff 2007). Effective IEM will require mobilizing stakeholders and resources from several locations enabled by different forms of ICT support. The challenges of virtual collaboration across geographical, cultural and organizational boundaries include developing a shared understanding of the problems, establishing effective mechanisms for communication, coordination and decision-support, and managing information (Dubé and Robey 2009; Powell et al. 2004). The ad hoc nature of emergency management also poses challenges in building trust among participants, overcoming issues of denial, the imprecision of information and other social constraints (Drabek 1999). For instance, local communities can assess risk of natural hazards and man-made disasters (United Nations International Strategy for Disaster Reduction 2012) but distrust local government. Public goods are instead provided by the private sector or non-governmental organisations. The involvement of local communities and governance in emergency planning and management is therefore paramount. Whilst different stakeholders and local communities may bring relevant experience, the unique nature of emergency situations requires a different configuration of participants, many of whom have little or no history of working together, and with different cultural backgrounds. This requires ‘swift starting virtual teams’ (Munkvold and Zigurs 2007), that are capable of immediately structuring their interaction through sharing information on the background and competence of the team members, discussing actions and deliverables, defining roles and responsibilities, and agreeing on the preferred communication media. For global IEM operations, cultural diversity (national, organizational and professional) and the cultural context may also represent a challenge for communication, decision-making and role understanding (Munkvold 2006). Overall, virtual collaboration boundaries should be understood as being dynamic, having different consequences in different virtual work contexts (Watson-Manheim et al. 2012). This again implies the need for a flexible collaborative IT infrastructure (Evaristo and Munkvold 2002).

A key challenge in Integrated Operations is developing functional methods for analysing the large volume of real-time data from different human and non-human sensors and process control systems. This involves providing advanced support for data management, visualization and analysis, and defining a functional collaborative work environment. Finding the optimal design of operation centres requires experiential learning. For example, ConocoPhillips, an Integrated Operations pioneer, is moving away from centres that use large, shared data screens focusing common awareness, to rooms with individual work stations in smaller clusters. Similarly, IEM centres will need to be configured to support awareness and effective data processing of the data received both from rescue operations and from citizens (Palen et al. 2007; Palen and Liu 2007).

As with research on both virtual collaboration and Integrated Operations, IEM research should adopt a multi-disciplinary approach, including human computer interaction, information systems, computer science, cultural studies, behavioural psychology and organization science. This also implies a multi-method approach, combining case studies (Zook et al. 2010), experiments (Tyshchuk et al. 2012), action research (Harnesk et al. 2009; Meum 2014), design-oriented research (Palen et al. 2010; Turoff et al. 2004), and research in regions that need effective emergency management the most: the poor and underprivileged.

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