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Social media data in the disaster context

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Social media (SM) are fast becoming a locus of disaster-related activities that range from volunteers helping locate disaster victims to actions that are malicious and offensive, from sincere expressions of empathy towards affected communities to consuming disaster imagery for mere entertainment, from recovery support funds being collected to online marketers preying on the attention afforded to a disaster event. Because of the diversity and sheer volume of both relevant and irrelevant information circulating throughout SM, prioritising an affected population's needs and relevant data is an increasingly complex task. In addition, SM data need to be interpreted as manifestations of social processes related to community resilience, diversity and conflict of interests, and attitudes to particular response strategies. The use of SM in disasters generates a growing need for domain-specific technological solutions that can enhance public interests as well as address the needs of both disaster managers and the affected population. This task requires integrating social sciences into the development of tools that enable disaster SM data detection, filtering, analysis and representation. The aim of this paper is to contribute to a critical-constructive dialogue between social scientists and developers of SM analytic capabilities. In the context of historical, anthropological and sociological research on disaster, this paper outlines concepts of the disaster paradigm, data as a product of social and representational practices, and disaster context, and discusses their heuristic significance for the analysis of disaster SM as a manifestation of social and cultural practices.

Introduction

Within a critical perspective in studies of society, science and technology, new media are approached as an element of a power–ideology nexus and as a vehicle for colonising the life world by the corporate world (Lievrouw, 2012; Mansell, 2012; Thurlow, 2013). Technocratic instrumental images of technology – manifesting in both corporate rhetoric and the media, and assimilated in designs – help re-shape end users' needs to conform to what technology has to offer (Mansell, 2012). However, the proposed technological solutions could conflict with public interests; technology can empower some groups while disempowering others. Resisting technological determinism requires – apart from revealing the limitations and biases of technologies – an understanding of how technological tools can be redesigned so as to enhance public interests and address the needs of specific users (Kellner, 2002; Resnyansky, 2010a).

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A critical-constructive intervention during development stages is particularly necessary when technology enters such areas as disaster management and response. Almost 20 years ago, in a discussion of ICT's implications for disaster planning and management, Quarantelli (1997, p.2) called for a balanced view on ICTs that does not ignore 'the negative implications of the ever developing computer-based systems available for monitoring, collecting, indexing, processing, analysing, writing, publishing, disseminating and retrieving data and information usable by disaster planners, managers and researchers'. Quarantelli maintains that such systems essentially create new kinds of problems for disaster managers. Thus, system breakdowns may yield high costs and extensive damage; the impact may disperse through space and time, cutting across formal community and organisational boundaries. Increased dependence on computational systems may contribute to social inequality as system breakdowns may cause more suffering to the most vulnerable communities. Regardless of the real-life effects of technological solutions, their providers may continue to benefit from unceasing and ever-increasing demand for system maintenance, upgrades, specialist training and so forth. Indeed, Quarantelli (1997, p.4) highlights the tendency to focus on problems that can be solved with the aid of technology, and to ignore those that cannot: he argues that the 'use of computer technology in the disaster area should … be determined by the problems that need solutions, and not vice versa'. This approach implies the need to assess critically the impact of information infrastructures and analytic capabilities on what counts as data, how data source credibility can be evaluated, and how available data can be interpreted and used by disaster managers.

The impact of information infrastructures on research around digital data (and SM data in particular) is becoming an important issue in the areas of critical data science (Kitchin and Lauriault, 2014), critical geographical information science (Leszczynski and Wilson, 2013) and e-science (Carlson and Anderson, 2007). Sociologists and social psychologists – including those who celebrate SM for allowing unprecedented and easy access to documented manifestations of social interaction, opinions and attitudes (Cointet and Roth, 2009) – are gaining awareness of the complexity of emerging epistemological, methodological and ethical issues (Hull *et al.*, 2010; Zimmer, 2010; Boyd and Crawford, 2012; Karpf, 2012; Alexander, 2013). Indeed, researchers highlight a trend to replace the concept of data as a theoretical and methodological construct with an information-centric concept of data and a preoccupation with technical aspects of data gathering and retrieval. Meanwhile, the ethical and socio-cultural implications of these practices often remain neglected. Since these issues cannot be fully addressed at the level of research design and ethical and legal regulations, it becomes necessary to assess the ontologies and algorithms integrated into the tools mediating data search, processing, curation, exchange, analysis and representation of analytic results (Resnyansky *et al.*, 2012; Driscoll and Walker, 2014). Such an assessment needs to be conducted *vis-à-vis* relevant epistemological approaches, theoretical models and methodological principles. However, many communities of practice are neither conceptually equipped for this sort of capability assessment (because they have been inclined to think in terms of usability), nor do they realise the need for it (because they have naturalised ICT-centric views).

Critical capability assessments and a constructive dialogue with technology developers are becoming relevant to disaster management because of the increasing use of SM during disasters – as observed in the 2010 Philippine typhoon, the 2010

Haiti earthquake, the 2011 Brazil flood, the 2011 Queensland floods, the 2011 Christchurch earthquake, the 2011 Japan earthquake and tsunami, the 2014 Chile earthquake, and so on (e.g. Acar and Muraki, 2011; Bruns and Burgess, 2012; Bruns *et al.*, 2012; Dugdale *et al.*, 2012; Shaw *et al.*, 2013; Antoniu and Ciaramicoli, 2013; Ahmed and Sargent, 2014). The use of SM in disasters has been accompanied by the development of such areas as crisis informatics and disaster SM analytics. Indeed, science policy and discipline-building papers (Lindsay, 2011; Computing Community Consortium 2012; Fraustino *et al.*, 2012; Hughes and Palen, 2014) emphasise that these areas should be seen as domain-specific fields because of the unique nature of social processes as well as the communicative and information behaviour of people in disasters. The social sciences need to become integral to the development of ontologies, filtering criteria and algorithms to be embodied into capabilities that enable disaster SM data detection, categorisation and analysis.

Indeed, SM and big data phenomena make it necessary to connect social sciences, media and communication studies, and ethics and humanities with engineering and computer sciences (Loader and Dutton, 2012). The social sciences and humanities can certainly provide a concept of data as a product of theoretical, methodological and interpretative practices (Crawford *et al.*, 2013; Knight and Littleton, 2013). However, the issue from the computer science perspective is that the social sciences and humanities do not deliver ready-to-use facts and formulae. According to Merton (1968, p.69), the desire of social scientists 'to convey all the rich fullness of the human scene' sways them towards lengthy discursive interpretations rather than generalisable concepts, with key assumptions often remaining implicit. Meanwhile, developers of computational analytic tools work with abstract concepts – such as entities (people, places, things, organisations, events) and associated attributes (actions, behaviour, locations, activities) (Sokol and Chan, 2013). Within the field of tool development, choice of conceptual frameworks is determined by computational and mathematical approaches. As a rule, domain-specific concepts are redefined and generalised in order to follow methods and techniques employed by tool developers.

This paper contributes to the integration of the social sciences and humanities into crisis informatics and disaster SM analytics through discussing the heuristic significance of disaster studies for the formation of domain-specific concepts of data, meta information and context. This discussion is preceded by an outline of existing research on SM in disasters, with a focus on the increasing role of mediating capabilities and the trend towards redefining and restructuring disaster-related phenomena in line with the logic of SM-centrism and information and computational sciences.

Social media in disasters: reframing disaster, replacing needs, redefining activities

> A year before, I had read an article of his in a review, written with an immense affectation of naïve poetry, and psychology too. He described the wreck of some steamer on the English coast, of which he had been the witness, and how he had seen the drowning people saved, and the dead bodies brought ashore. All this rather long and verbose article was written solely with the object of self-display. One seemed to read between the lines: 'Concentrate yourselves on me. Behold what I was like at those moments. What are the sea, the storm, the rocks, the splinters of wrecked ships to you? I have described all that sufficiently to you with my mighty pen. Why look at that drowned

> woman with the dead child in her dead arms? Look rather at me, see how I was unable to bear that sight and turned away from it. Here I stood with my back to it; here I was horrified and could not bring myself to look; I blinked my eyes – isn't that interesting?' (Dostoevsky, 1913, p.77)

The Western media, Thurlow (2013) maintains, are constantly reframing crisis events as SM events, including the most devastating disasters. Indeed, SM are becoming perceived as the primary locus of disaster-related activities, ranging from volunteers helping locate disaster victims to malicious and offensive actions, from sincere expressions of empathy towards affected communities to consumption of disaster imagery for sheer entertainment, from collecting funds for recovery support to online marketers preying on the attention amassed by a disaster event. This SM-centrism entails a preoccupation with unlimited analytic possibilities afforded by digital data, while concealing SM's implications for disaster communication and for disaster management and response.

Disaster communication and management: new challenges and needs

The traditional model of disaster communication is characterised by a definite number of participants (disaster management organisations, disaster victims, indirectly affected population, population at risk and the wider community), with participant roles and responsibilities clearly defined and rules of communication explicitly stated. Disaster communication genres (warning, instruction, emergency interaction) are linked to disaster types (rapid *versus* slow unfolding disaster), causes (earthquake, flood, hurricane, fire) and phases (before – impact – after). Interaction with the affected population is informed by studies of human behaviour in emergency and risk situations. Choice of communication channels and strategies is determined by the local conditions. These include infrastructure, language, literacy, social structure, political and administrative system, type of risk culture, and so on (Resnyansky, 2014). From a disaster management perspective, the media are more than just a channel of communication – they are actors that perform social functions, providing emotional support, companionship and communal connection (Perez-Lugo, 2004). This socio-centric concept of the media affirms the centrality of the impact phase in disaster communication and indicates the priority of the affected population's needs.

The use of SM causes significant deformation of the traditional model of disaster communication. The participant range may extend indefinitely to include non-human actors (bots) and loosely-defined global online communities that emerge and disappear, together with an information event. Here the level of noise and uncertainty increases dramatically, and basic rules of disaster and emergency communication become difficult to apply, which negatively affects trust and compliance. Both the affected population and disaster responders turn into SM users, who are involved primarily in finding and sifting through information or producing, disseminating and organising content.

A growing body of research on disaster focuses on types of SM users, their information needs and patterns of behaviour; on keyword-centred content analysis and thematic categorisation of messages; and on SM's functions in disaster *vis-à-vis* traditional media (Acar and Muraki, 2011; Yen, 2011; Bird *et al.*, 2012; Latonero and Shklovski, 2013; Shaw *et al.*, 2013; Ahmed and Sargent, 2014; Houston *et al.*, 2014; Imran *et al.*, 2015). Studies reveal that the public's use of SM in disaster

differs dramatically from SM use in normal life in terms of communication needs and patterns of information behaviour. For instance, there is a notable difference in SM use between professional disaster managers and the general public. Disaster managers use SM in order to develop situational awareness, coordinate response and conduct rescue activities, while the affected population uses SM to seek information and support, with distinctive patterns of communicative behaviour marking impact phase communication. So, SM has the potential to perform important social functions (such as increasing community resilience), provided that issues related to privacy, security and ethics are properly addressed (Crawford *et al.*, 2013).

In the meantime, prioritisation of the affected population's needs and related data becomes an increasingly complex task owing to the volume of relevant and irrelevant information circulating in SM. Disaster managers need to distinguish between true information and rumours in the SM space, prioritise genuine victim requests and witness reports over global 'conversations' sparked by an event, and locate the message sender in situations where people are unlikely to use geolocation apps because of shock, privacy/safety concerns or insufficient technological skills (Laituri and Kodrich, 2008; Mendoza *et al*., 2010; Acar and Muraki, 2011). In addition, disaster managers may need to work with data in different languages. Thus, use of SM in disasters generates a huge demand for automated tools that enable detecting relevant data, assessing information credibility, categorising messages, selecting messages that require first response and give necessary details, such as the nature of the problem (health, shelter, etc.) and victims' location (Castillo *et al.*, 2011; Abbasi *et al.*, 2012; Jie *et al.*, 2012; Zin *et al.*, 2013). Since complete automation of these tasks is difficult, volunteer help is required. This, in turn, entails a demand for systems that enable a coordination of volunteer efforts and agency activity (Gao *et al.*, 2011).

Technological solutions for mediated disasters: implications

It is not surprising that research on SM use in disasters focuses on auxiliary, intermediate and secondary (in relation to disaster management) activities and processes, such as using capabilities (filtering tools, crowdsourcing platforms, aggregation tools and geolocation apps), self-organising processes in online communities, and so on (Zook *et al.*, 2010; Gao *et al.*, 2011; Starbird and Palen, 2011; Dugdale *et al.*, 2012; Dufty, 2012; Antoniu and Ciaramicoli, 2013). These studies vary from independent evaluations of specific tools to developers' papers with more or less explicitly stated conflict of interests; from disaster response organisational reports reflecting real-life experiences to developers' descriptions of carefully set exercises simulating SM use in crises. Nevertheless, these studies indicate that SM use in disasters generates problems that cannot be fully addressed at the organisational level by developing SM implementation policies, adjusting disaster management work practices to incorporate SM, and training staff to use SM as a data source and communication channel. Indeed, the use of SM generates problems that require technological solutions.

It is necessary to understand, however, that technological solutions may encourage a SM-centric view of disaster, where SM use is presented as an aspect of the disaster event, along with type and cause of the disaster, geographical location and calculated damages. This creates a trend towards eliminating the qualitative difference between disasters that inflict irreversible losses, and disasters that cause mere material damages and temporarily disrupt the daily life of a community. Instead, the main difference between disaster events is seen in the SM platforms used, the

number of users and volume of generated content. As a result, monitoring of a disaster for the purpose of improving the awareness of disaster responders and assisting on-the-ground rescue activities can be replaced by monitoring of SM for the purpose of producing summaries and visual representations of thematic clusters, peaks of information activity, volumes of keywords used in a certain period of time, and so on.

The SM-centric perspective creates the possibility of re-shaping a disaster scene into a test ground for SM platforms and applications, and paves the way for re-cycling capabilities designed to be used in other situations and settings, such as political campaigns, social movements, online collaboration, and so on. For example, a crowdsourcing platform may be considered a good solution because crowdsourcing appears to be quite efficient for the activities of Web-based volunteers, such as information validation, editing and knowledge management. Indeed, common belief in the effectiveness of crowdsourcing as a problem-solving strategy is grounded in the 'wisdom of the crowd' idea, which implies that, in a complex world, a decentralised system can produce genuinely intelligent results, provided that everyone's information is aggregated in the system (Surowiecki, 2004). However, the value of crowdsourcing in a disaster cannot be taken for granted. As Mock (2012, p.576) maintains, SM's ability to provide real-time and ubiquitous reporting of a disaster may cause trauma, and globally dispersed volunteers may 'inadvertently do more harm than good because of their lack of awareness of the challenges and pitfalls of disaster management'. Global civic engagement – one of the phenomena most celebrated in market-driven Web 2.0 rhetorics (Thurlow, 2013) – can pose a threat to the security of aid workers on the ground (Gao *et al.*, 2011) and contribute to the vulnerability of the most helpless people by increasing the risk of violence, child abduction and so on (Mock, 2012).

To summarise, there is a substantial body of critical research warning against adopting SM-centric and technology-centric perspectives because of undesirable social and ethical implications. There is a growing understanding that development of capabilities enabling disaster SM data gathering and analysis needs to be domain-specific and to address broader social and ethical concerns. The required capabilities need to facilitate an approach to social media as a locus of processes related to social influence and production of social identities and order. The required capabilities need to enable an analysis of SM as a source of data on community resilience and on the attitudes of the affected population to particular safety measures, response strategies, international aiders, and so on. However, it is not enough to explicate the technology-driven trends and be willing to change them to more socially responsible and meaningful practices. It is necessary to understand how it is possible (if at all) to achieve this at the stage of capability development.

Capability development: drifting further away from disaster and social domains?

In the development area, the method rules. Thinking is shaped by conceptual systems of computing disciplines and bounded by the rigorous logic of quantitative methods and formal languages. In the process of translating human needs and socio-cultural meanings to a language accessible to 'digital intelligence', the behaviour of disaster victims, first responders and volunteers is re-described in technical terms related to information generation, transmission and processing. Disaster managers'

concerns about information overload and credibility are re-formulated as needs for solutions to managing unstructured messages, enhancing streaming data, fusing SM data with data from other sources and trust management. The concepts of data, meta information and context are derived from technical definitions grounded within information and computational sciences. Based on selected reading in the fields of crisis informatics and disaster SM analytics, the following sections attempt to reveal the heuristic potential and limitations of these concepts – as these may be envisioned by a social scientist.

The concept of data. Social implications of theoretical neutrality

In the social sciences, the concept of data is a theoretical and methodological construct. Within information science and knowledge management areas, data is understood as an entity defined in relation to other entities, such as information and knowledge. However, even this semantic approach is incompatible with computing (Capurro and Hjörland, 2003), where data is understood as pieces of information represented in a form suitable for processing. It is important to realise that this general, a-theoretical, neutral concept of data is linked to a particular – positivist – epistemological stance and to specific practices, such as business analytics, and, at a deeper level, to the use of statistics in bureaucratic practices:

> Statistical data (information) are of course gathered by mortals, but the pooling and analysis of them creates an implied-I that is disembodied and all-seeing … Computers do efficiently and elegantly what the state already long was doing: they make vast invisible aggregates intelligible and manipulable. (Peters, 1988, p.240)

The information-cybernetic concept of data opens up the possibility of viewing capability development as unconstrained by the logic of particular industry or professional activity. However, this view may result in offering tools that help answer questions nobody needs to ask (Resnyansky *et al.*, 2012). Clustering, summarisation and aggregation of data may turn into a meaningless manipulation of decontextualised bits of information, in particular in areas where data are closely linked to the conditions of production and consumption (Carlson and Anderson, 2007). Data aggregation and revealing a 'central tendency' is undoubtedly useful in many areas. In disaster situations, however, the positivist stance embodied in technological tools – or, rather, uncritical acceptance of the universal value of practices it enables and justifies – may have particularly undesirable implications. For instance, this stance may contribute to the practice of using disaster victims' messages as feeds for aggregated databases. Such a metamorphosis poses serious ethical concerns, from issues of consent to problems of power inequality (Crawford and Finn, 2015).

Cultural shaping of data-driven categorisation

In a world mediated by information infrastructure, data are shaped by categorisations embodied in search and analytic tools. Here, the most relevant distinction is between descriptive (bottom-up, data-driven) and analytic (theoretical) approaches to categorisation (Gibbs, 2007). The developers of filtering tools give a preference to a bottom-up, data-driven approach, considered more suited to the analysis of dynamic streaming SM crisis data (Imran and Castillo, 2015). Thus, Porto de Albuquerque

et al. (2015) argue that data-driven categorisation is necessary because the crisis context varies for each event, which means that categories developed in other cases may not be suitable for the case at hand. Indeed, the data-driven approach may result in specific combinations of categories related to different kinds of phenomena: the genres of disaster communication (warning, evacuation information, help request), information behaviour, the hazard, and so on [*cf.* categorisations in Vieweg *et al.* (2010), Starbird *et al.* (2012), Imran *et al.*,(2015) and Porto de Albuquerque *et al.* (2015)]. It is worth noting, however, that data-driven categorisations are shaped by particular assumptions about disaster, although these assumptions may remain implicit. As a result, the construction of datasets will be affected by the developers' theoretical and cultural biases. Specifically, a technocratic-functionalist perspective is most likely to be embodied in the tools, as it is believed to represent an objective, rational and scientific view of disaster.

Context in the big data world

'Content is king is a familiar refrain in media circles. In the Big Data world, context is king' (Mahadevan, 2013). In big data analytics, context is defined in relation to computational processes (data fusion, pattern recognition, machine learning); application areas (e.g. geospatial, business intelligence, biometrics authentication, biology); the nature of data (structured *versus* unstructured); and the kinds of sources (homogeneous *versus* heterogeneous). In some areas, the concept of context in big data analytics may be reminiscent of the idea of context as background knowledge. For example, development of tools that enable real-time (streaming) data analysis (*vis-à-vis* database analysis) is informed by a concept of context understood as an accumulated 'history' of previous transactions (Sokol and Chan, 2013). In other areas, context is approached as a specific kind of meta information. As Davenport (2013) argues, this trend results from the evolution of the big data world – specifically, from entering the stage characterised by decreasing monopoly of online companies over digital data and an overwhelming diversity of data sources. When it comes to the task of processing data from heterogeneous sources – a task that did not initially exist for the online companies that actually generated the big data phenomenon – it becomes necessary to define context as the conditions of data production and consumption (Davenport, 2013). The importance of meta information in the data production/consumption context has also been highlighted in such areas as e-science and computer-mediated research collaboration. It is acknowledged, however, that capturing all relevant meta information may not be possible because of its qualitative and socio-historical character (Star and Bowker, 2002; Carlson and Anderson, 2007).

Data relevance and credibility: competing realms of context

The increasing need to assess the relevance and credibility of disaster SM data makes it particularly necessary to understand the limitations of the concepts of context used in the field of computing. In this respect, it is useful to highlight the competition between two streams in disaster SM analytics: development of tools that enable analysis of SM as a standalone source, and development of tools that enable analysis of SM data in relation to data coming from other sources (SM data in context). Proponents of the former approach believe that 'there are signals available in the social

media environment itself that enable users to assess information credibility' (Castillo *et al.*, 2011, p.675). For instance, the credibility of information related to a disaster can be assessed by analysing the correlation between certain types of messages and certain kinds of meta information. Castillo *et al.* state that a difference may be observed between 'news' (messages generated for the purpose of informing broader audiences) and 'chat' (messages intended for narrow groups of friends/followers and containing a section for comments/discussion). Indicators of social media credibility are linked to, or determined by, computational techniques and underlying mathematical/statistical methods. In the case of Twitter, these indicators include the users' emotional reactions, whether they question the information provided, the citation of an external source, popularity of cited source, user status measured in terms of the number of followers and previous tweets, and depth of the re-tweet tree. However, it is worth noting that the proposed credibility indicators may not be applicable to disaster communication. It is possible that genuine help requests will not fulfil the credibility criteria derived from analysing quantifiable difference between SM-mediated newsworthy events and social interaction that could be triggered by a disaster but actually happens in normal life. Rather, credibility assessment criteria need to be informed by an analysis of disaster-specific communicative genres as shaped by the affected population's needs, local conditions and cultural conventions.

Within the 'SM in context' stream, the credibility issue is addressed by using non-SM data as filtering criteria. For example, Porto de Albuquerque *et al.* (2015) argue that knowledge of a disaster's environmental conditions (derived from structured and institutionalised environmental data, such as sensor data, hydrological data, and digital elevation models) can be used to interpret tweet location metadata in order to filter tweets that potentially convey valuable geographic information. In the case of a flood, for instance, tweet relevance is closely linked to such environmental conditions as the messenger's proximity to the flood and the flood's severity in that particular area.

There is a growing understanding that disaster SM data need to be approached not only in relation to their original spatial and temporal coordinates (Derczynski *et al.*, 2013; Zin *et al.*, 2013), but also in relation to social and historical conditions, the local situation, and relevant organisational practices (Gao *et al.*, 2011). As Leszczynski and Wilson (2013, p.916) put it, disaster-related data need to be approached in relation to 'the variegated socio-cultural, historical, political-economic, discursive, technical/material, and philosophical contexts of their emergence, production, commercialization, assimilation and naturalization'. In order to overcome the limitations of information-cybernetic and SM-centric perspectives in crisis informatics and disaster SM analytics, the social sciences and humanities must be integrated into the development of ontologies, filtering criteria and algorithms that will be incorporated into capabilities enabling disaster SM data detection, categorisation and analysis. The participants in such an interdisciplinary project must be aware of the heuristic potential, limitations, and socio-cultural and ethical implications of the key concepts currently shaping the development of automated tools. They must also be aware of social scientific and domain-specific approaches to the key concepts – including data, meta information and context.

How can disaster SM data be approached as manifestations of social processes? What kind of meta information may be needed in order to support disaster SM data collection, credibility assessment and analysis? How can disaster context be defined in order to inform the categorisation, analysis and interpretation of SM data? The

rest of this paper considers these questions from the perspective of three kinds of disaster studies: methodological discussions aimed at conceptualising natural disaster as an object of social research; historical studies of disaster and climate change; and sociological and anthropological case studies of natural disasters.

Social media as data sources: insights from historians

SM are characterised by heterogeneity of documentary evidence, multiplication of content, spatial–temporal complexity and uncertainty, and a turbulent flow of decontextualised and recontextualised information. Within this polyphonic environment, it is difficult to distinguish between authentic human interaction and computer-generated imitation, let alone determine whose voices are authoritative and influential. Subjective opinions and objective information are constantly being mixed, modified and recycled in inconceivable combinations and within a multitude of contexts. In the SM realm, tentative suggestions may quickly turn into 'solid facts' as a result of unprofessional or unethical referencing practices. Thus, data that appear statistically significant may not necessarily represent the most important processes taking place in physical and social reality, and in people's minds.

Historians of climate and disaster work with data sources produced within different cultural and institutional settings – here, as in SM, historical documents may contain fragmented, incorrect or indirect evidence, subjective accounts of events, exaggerated claims and unsubstantiated gossip. So, historical studies may offer valuable insight into issues that emerge during the process of SM data collection, analysis and interpretation. Indeed, historians are aware that *data* is a blanket term for different kinds of evidence: direct (observation and measurements) and indirect (proxy), objective and subjective, primary and secondary (Brázdil *et al.*, 2005). Different data types entail particular, distinct rules for collection and analysis as well as generating specific issues; for instance, it may be useful to have indirect and subjective data on a disastrous event and its effects, especially when there is no, or limited, possibility of obtaining direct observations and measurement. However, identifying relevant data may prove difficult, even when the evidence is seemingly obvious, as in the case of earthquakes (Usami, 2002). The main issue for subjective data is their relative nature. For instance, Usami maintains that historical documents may contain two kinds of data related to earthquake intensity: description of feelings caused by the ground motion and description of the actual damage caused. Human accounts of feelings may be used as objective evidence because human sensitivity to ground motion remains unchanged. Meanwhile, data on sustained damage are relational, as damage is dependent on the vulnerability of structures.

Relevant data may also exist within sources that seem to be unrelated to a disaster. For example, information about droughts in early modern Spain could be obtained predominantly from records of rogation ceremonies contained in account books of local municipalities and religious authorities (Pfister, 2009). These records may be used as data that disastrous events occurred at a particular time and place; they may also be used as indirect data on people's suffering, since rogation ceremonies are intended to soothe people's anxieties and prevent social unrest. At the same time, official records in medieval Europe are not a credible source of data on human suffering as this was rarely mentioned in public documents. Indeed, these kinds of data are more likely to be contained in private letters, oral history, poetry, and so on. Literature, for example, may provide valuable insight into different

groups' attitudes to disaster and explanations of its causes. For instance, Gordon (1999, p.4) argues that eighteenth century Marseilles plague literature – a corpus of poems, novels, histories and medical treatises, which presents a form of social analysis – is a valuable source of data that may help 'reveal the nuances of different early-modern attitudes toward disaster as well as the competition among them to fix the meaning of commercial society'.

Documentary sources are characterised by diverse representational modes, including manuscripts, printed text, pictures and artefacts (Brázdil *et al.*, 2005). Additionally, documentary sources differ in genre; that is, social conventions and pragmatic purposes. Thus, documentary sources may include scientific papers and records in documents of the past (historiography) – written reports from annals, memoirs and chronicles, daily weather reports, personal and official correspondence, travel diaries, economic records, pictures, leaflet newspapers, early journalism, ship logbooks, epigraphic inscriptions, and marks on stones, rocks, bridges and buildings. Such generic diversity indicates that data need to be approached as products of specific documenting and representational practices.

When aggregating and interpreting descriptive documentary data, historians often encounter problems with copied observations and compilations. The author may not have witnessed the described events. Observations may be copied from other compilations, which may cause event misdating and multiplication. Historians emphasise the importance of being aware of such dangers as anachronism, decontextualisation and recontextualisation of data (Mauelshagen, 2009). For example, official disaster accounts are often characterised by use of exceptional discourse, as Favier and Granet-Abisset (2009) observe in their study of French floods during the sixteenth and seventeenth centuries. In this case, exceptional discourse emphasises that an event of such magnitude has never occurred 'within living memory'. This discourse may have been employed because of either the author's ignorance of world history or the need to convince the central authority (that provided material aid) of the event's extraordinary nature and thus protect local officials from future accusations.

Perhaps the historians' most important lesson is that the presence and frequency of certain themes do not necessarily indicate higher importance, and that documented facts and observations need to be interpreted as a response to undocumented events, views and actions. For instance, the almost exclusive presence of religious discourse in official records in the Middle Ages and the Renaissance may indicate only that, for early modern Christians, paying attention to a punitive deity was a duty, a ritual that had to be performed (Mauelshagen, 2009). At the same time, response strategies may be shaped by other cultural layers – secular, professional, local, and so on. So, disaster response strategies in traditional societies are based on ordinary people's experience as transmitted through undocumented practices, such as choosing different roads according to the seasons, methods of building houses and land management practices (Favier and Granet-Abisset, 2009).

Archival expertise: implications for defining meta information

The concept of data as a product of socio-cultural, institutional and representational practices can inform disaster SM data collection, aggregation and assessment of source credibility through defining types of required meta information. Specifically, it implies that disaster SM content needs to be categorised in two ways: first, in terms of representation modes (text, image, video) understood to be the means of

influencing the perception of content and source as true, objective and reliable; next, in terms of genre (as products of specific social and communicative practices), where genres are important indicators of data relevance and reliability. Development of this kind of analytical meta information may be informed by critical tradition within text-oriented and multimodal discourse analysis (Fairclough, 1992; Gee, 1992; Halliday and Martin, 1993; Kress and van Leeuwen, 1996), as well as research on computer-mediated and Internet-mediated communication and discourse (Cranny-Francis, 2005; Fitzpatrick and Donnelly, 2010; Lewis *et al.*, 2010; Resnyansky, 2010b; Papaharissi, 2012; McCosker, 2013).

Social media data: an anti-positivist stance

In social research, data are a theoretical construct. Social research is characterised by an anti-positivist epistemological stance represented, for example, by Weber's concept of ideal type. Ideal type does not refer to statistical averages. It is constructed 'by abstracting and accentuating certain conceptually essential elements' (Weber, 1949, p.100). Ideal type 'serves the investigator as a measuring rod to ascertain similarities as well as deviations in concrete cases' (Coser, 1971, p.224). In order to approach socio-historical reality, social scientists have been using, as analytical constructs, such ideal types as 'economic man', 'feudalism' or 'protestant' (Gerth and Wright Mills, 1948/1970). In order to approach SM as a locus of disaster-related social processes, ideal types of different views of disaster can be used as analytical tools. These can be called 'disaster paradigms', paradigm being understood as an 'array of assumptions, concepts, and basic propositions employed in a sociological analysis' (Merton, 1968, p.69). Disaster paradigms define the nature of the phenomenon (event *versus* process), explain its causes and effects, and provide rationale for decisions and coping strategies. Based on the works conceptualising natural disaster as an object of social research (Quarantelli, 1998; Hoffman and Oliver-Smith, 1999; Mauch, 2009), and on historical and sociological studies of disasters (Johns 1999; Rozario, 2007; Mauch and Pfister, 2009), the following kinds of disaster paradigm can be identified: irrational-fatalistic, metaphysical-religious, technocratic-functionalist, socio-historical and cultural-subjectivist paradigms (see Figure 1).

The irrational-fatalistic paradigm reflects the human experience of helplessness in the face of natural forces and a psychological perception of disaster as a threat to survival. In pre-industrial societies, natural disasters belonged to fears representing death; for example, the sea, darkness, plague, uprising and the devil (Favier and Granet-Abisset, 2009). The church re-categorised disasters as manifestations of God's wrath in an attempt to replace chronic anxiety about survival with a fear of divine retribution for sin (Mauch, 2009). Within the Western European metaphysical-religious paradigm, disaster is somewhat rationally justified by becoming ingrained in the history of relationships between God and humankind. Meanwhile, the metaphysical paradigm in other cultures may be grounded within the cyclical concept of time, instead of a linear-teleological concept of history. Within cyclical time ideologies, a cataclysm occurs at the close of every era. This belief provides a ground for fatalistic attitudes to disaster (Hoffman, 2002).

The age of scientific revolution saw natural disaster become an object of natural science. Within the technocratic-functionalist paradigm, natural disaster is seen as deviation from the norm, a sudden, destructive event caused by natural forces (Mauch, 2009). Within political history and demographics, disaster's effect on

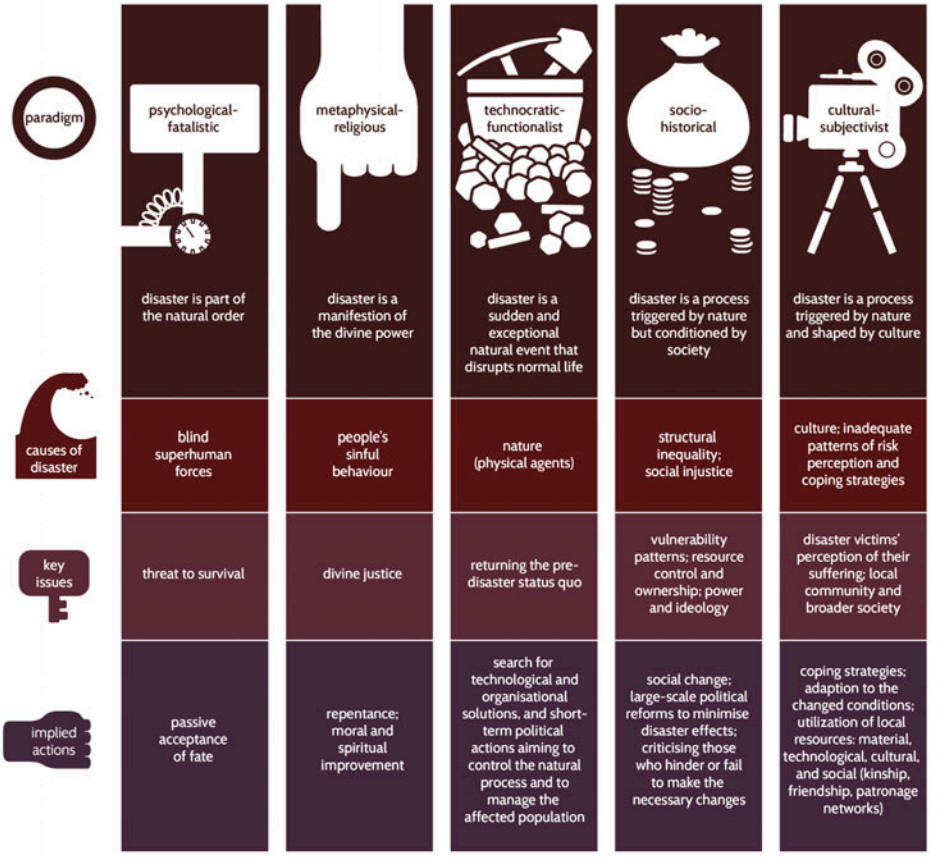

Figure 1. Disaster paradigms

populations is considered insignificant (with the exception of epidemics) (Mauelshagen, 2009). Within the functionalist approach in sociology, disaster is an event caused by physical agents. This approach focuses on ways to counteract these agents and manage the population's behaviour (Oliver-Smith and Hoffman, 2002). The technocratic-functionalist paradigm calls for technological solutions, risk management and, perhaps, short-term political action.

The socio-historical paradigm approaches disaster in terms of relationships of agency and causality between man and nature (Prince, 1920; Pfister, 2009). This paradigm orientates towards focusing on how, under the influence of political and economic interests, some population groups are placed in more perilous situations than others, how ideologies work to enable their lifestyles, and how technology may contribute by both enhancing security and promoting vulnerability (Hoffman and Oliver-Smith, 1999; Johns, 1999). Within the socio-historical paradigm, key issues include: who benefits from placing affected population segments in a vulnerable situation; what circumstances contribute to a disaster and its consequences (e.g. patterns of resource control, landownership, local stratification); and what long-term and large-scale political reforms may prevent the disaster or minimise its effects.

Meanwhile, the cultural-subjectivist paradigm constructs disaster as both a collective and an individual experience, focusing on people's perceptions of disaster's effects: 'nature may supply a trigger for disaster, but whether we call a natural occurrence a catastrophe depends largely on our perception of its impact on humans' (Mauch, 2009, p.4). Anthropology adds a cultural dimension to the concept of disaster by revealing coping strategies that have been developed in different societies (Hoffman and Oliver-Smith, 1999). Within this paradigm, the key issue relates to how cultural systems adapt to their environments, including establishing routines to overcome challenges, as well as particular beliefs and ethos that shape perception of the disaster's risks and effects. The cultural-subjectivist paradigm infers that understanding a disaster's effects requires more than objective measurements and, hence, focuses on adjustment strategies. These include sharing the emotional burden, utilising local technological and material resources on individual and community levels, and using social resources (kinship, friendship, community and/or patronage networks).

Disaster paradigms shape perceptions of the disaster's effects and determine how the main questions – Who is to blame? and What is to be done? – are answered. For instance, the technocratic-functionalist paradigm may be used to divert public attention from social factors that contribute to certain groups' vulnerability and promote the idea that only short-term political actions are needed instead of structural and cultural changes (Prince, 1920; Walker, 1999; Duus, 2012; Samuels, 2013). Social actors may use different disaster paradigms to justify their decisions and actions. For instance, the 1930 Dust Bowl disasters were conceptualised as random outbursts of nature's fury, acts of God or effects of the political-economic conditions (Mauch, 2009). These explanations invited markedly different strategies: fatalistic escape (relocation to other areas); focus on moral–spiritual improvement; and demand for technological innovations and socio-political criticism. A disaster paradigm's spectrum and dynamics reflect social conflicts and change. Hence, revealing the paradigms may help understanding of whose vision is being promoted, whose opinions may be underrepresented or silenced, and in whose interests. For instance, the view of disasters as agents of progress may be used to support the quest for endless development and economic expansion, thus serving the interests of organisations that profit from generating feelings of vulnerability and the need for protection (Rozario, 2007).

Disaster paradigms: implications for the analysis of disaster SM data

The concept of the disaster paradigm may help formulate specific questions related to using disaster SM data to hypothesise about target audiences' interpretations of reported fact, the effects of given explanations, attitudes towards proposed courses of action and possible actions in offline reality. The disaster paradigms outlined above are analytical constructs that are grounded within different philosophical, religious and theoretical foundations. As Figure 1 demonstrates, disaster paradigms are closed systems of logically-connected views on the disaster phenomenon, its causes, the importance of certain issues and ways of addressing these issues. In real life, disaster paradigms may combine and manifest in different ways; for example, theological explanations of disasters may co-exist with political and social criticism, while traces of the fatalistic-irrational worldview may emerge in modern societies.

Diverse theory and ideology prevent the outlined disaster paradigms from intersecting. This makes them a useful intermediary framework for developing search and filtering criteria. Specifically, the proposed typology of disaster paradigms may inform development of disaster SM analytic capabilities by defining the social processes to be detected within the chaotic SM environment; identifying concrete activities that can be interpreted as indications of social processes; and providing repertoires of representational means that correspond to specific paradigms (lexis, grammar, themes, texts and patterns of communicative behaviour).

Disaster context

Disaster context may be described as comprising participants (who act and interact in order to achieve goals), socio-historical conditions (which shape the participants' perceptions of loss and damage, attitudes to relief and recovery activities, search for causes of vulnerability, and development of coping strategies), cultural resources (employed by participants in order to explain and cope with the disaster), and social mechanisms of meaning production and collective memory (see Figure 2).

Social research on disaster categorises participants in relation to the stages and aspects of the disaster process. During the disaster, participants are defined with regards to a hazard as being a destructive and uncontrollable force that destroys the cultural world and, thus, becomes a 'great equaliser' that curtails gender, class and racial differences (Walker, 1999). Hoffman (2002, p.121) maintains that, when a disaster occurs, '[b]oth nonindustrial and industrial people must once again deal with their fundamental grounding' – within this fundamental perspective, disaster is a collision between two participants: nature and man, a hazard and an affected population. The nature–man dichotomy may manifest in individual communicative behaviour, such as directly addressing the hazard or describing it in anthropomorphic terms (Morrow, 1997). However, 'normal' social divisions reappear as focus turns to the affected population's perception of disaster effects (Stallings, 2005). According to relative deprivation theory (Merton and Rossi, 1968), members of affluent communities are likely to suffer more than members of communities where suffering caused by natural disasters resembles everyday conditions (Zaman, 1999).

In regard to disaster response and recovery, participants should be conceptualised as collective actors [such as wider society and the affected (local) community] whose relationships are not necessarily characterised by cooperation, help and solidarity. As Peacock and Ragsdale (1997) maintain, a post-industrial community is a loose network linked through division of labour and characterised by unequal access to resources. When disaster strikes, these relationships do not disappear. Rather, the recovery process is characterised by competition and conflicts – between profit and non-profit organisations, local and national governments, different population groups, and so on. In times of disaster, the wider society is believed to be a provider of help, resources and moral support. However, there is greater chance of timely and appropriate response when the wider society and the affected community share similar values and traditions. If this is not the case, the wider society may threaten the affected community's economic and cultural sustainability, either by introducing technologies that pose further threat to the affected environment or by destroying traditional lifestyles and value systems (Dyer and McGoodwin, 1999). Finally, there are indirect and distant participants, whose contribution and impact are mediated by various institutional practices. Thus, governments are always present in the community

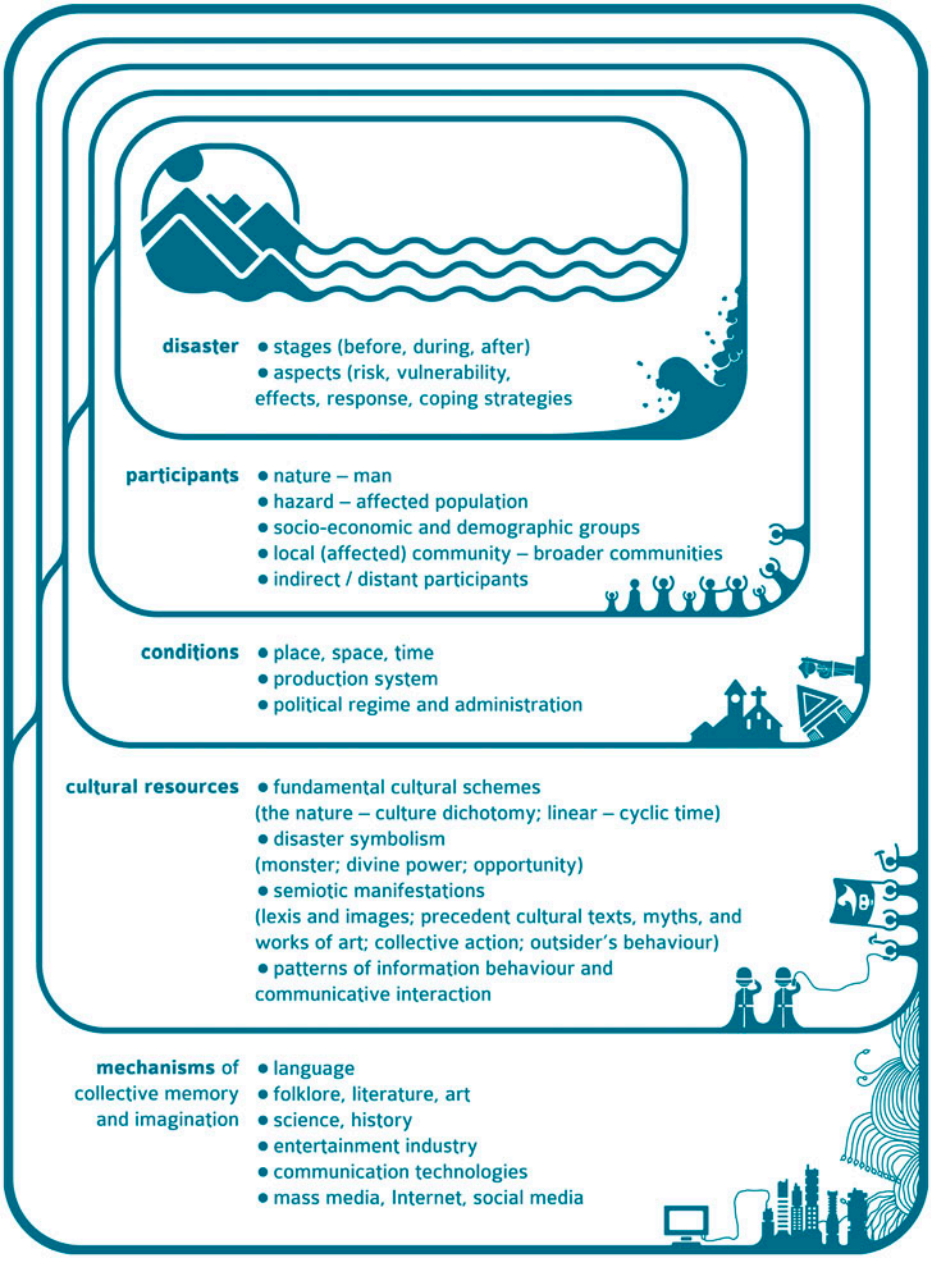

Figure 2. Disaster context

through mechanisms of conflict resolution and coordination (Curtis, 2012). This range of participants should include organisations that may increase the vulnerability of some population segments through mitigation failure (Peacock and Ragsdale, 1997).

Systemic-structural conditions are another important element of disaster, as they determine the patterns of vulnerability, perception of suffering, coping strategies and

disaster response. Dyer and McGoodwin (1999) state that natural resource communities are becoming more vulnerable to disaster because they have little control over resources as a result of intrusive market forces, transformation of areas and gentrification. The political regime may influence coping strategies by distributing responsibilities between local and central authorities. For instance, in his study of the Elbe River floods between 1784 and 1845, Pfister (2009) maintains that the shift from fatalistic to proactive coping strategies may be caused by the change from a late absolutist society (where a central power instructed local authorities) to a bourgeois society. Under new conditions, local officials were able to take independent initiatives in order to improve rescue operations and safeguard infrastructure.

Attitudes towards risk are closely linked with the production system. Post-industrial societies view risk differently from pre-industrial societies and rural communities (Favier and Granet-Abisset, 2009). The postmodern society is a risk-society characterised by a growing tolerance of risk-taking and increasing reliance on modern technologies (Beck, 1992). Expression of people's feelings and needs may also be shaped by cultural attitudes to risk and disaster (Bankoff, 2009). For instance, in the Far East, disaster is conceptualised as a permanent danger and an individual's everyday experience (Mauelshagen, 2009). Therefore, risk culture typology should inform interpretation of disaster witness reports and assessment of assistance requests from the affected population.

Cultural resources

The available cultural resources, such as disaster symbolism, shape perceptions of risk and disaster effects as well as participants' behaviour in the case of disaster. Disaster symbolism reflects social consciousness and strength of community resilience. Different types of society are characterised by different symbolic schemes. Thus, dualistic thinking characterises Western industrial societies, which see sharp distinction between culture and nature, humanity and animality, the orderly and the wild (Hoffman, 2002). However, a disaster's sudden destruction of a habitual socio-cultural world may cause an affluent Western community to quickly adopt certain pre-industrial concepts and behaviour patterns.

Within public consciousness, fundamental schemes are usually represented by concrete symbolic figures. According to Hoffman (2002), perception of disaster in Western society is often grounded within the symbolic figure of a monster. In an industrialised and urbanised society, the amorphous monster symbolises cataclysm. Monsters and disasters both prey on humanity, exposing the improbable about their victims and about society. Indeed, the monster metaphor may have important political consequences, as it allows some actors to impose control upon others. On the other hand, the monster is an outside enemy that causes people to unite. According to sociological, historical and anthropological studies (Hoffman, 2002; Rozario, 2007; Mauch, 2009; Duus, 2012), disaster symbolism can be manifested by choice of lexis and images to portray and explain the disaster; references to cultural texts and to mythological, literary or artistic roots (e.g. the metaphysical explanation of catastrophes as having a punitive and religious-instructive meaning can be represented by the story of Noah); collective action (rituals, maintaining space and time, purposeful activities and missions) that aims to culturalise the destroyed environment and lifestyle; and outsider behaviour, such as pilgrimage to the affected site in order to observe the sustained damage.

Collective memory and imagination

Cultural resources are maintained and transferred by institutions of collective memory and meaning production. For instance, language and folklore may transfer attitudinal and behavioural patterns *via* constructs of disaster and national character (Duus, 2012). In turn, science may promote a rational approach to disaster by focusing on its natural causes. History may serve as a collective memory of disasters (Bankoff, 2004). However, the postmodern society favours the media as its main institution for maintaining memory of disasters, and media interest in events is quick to subside. Hence, modern Western thinking about disaster is a-historical (Mauelshagen, 2009). The news media 'coverage of human suffering is limited by its lack of "newsworthiness" in the sense of ability to attract a paying or advertising-watching audience' (Barton, 2005, p.140). News stories lack temporal depth and use visual representations that create the effect of a simultaneous co-presence of events, rather than of their development. Further, the Internet environment re-affirms the Western a-historical stance and dulls collective memory.

Communication has always influenced people's perception of risk and the effects of disaster. For instance, in their study of recurring floods in eighteenth century France, Favier and Granet-Abisset (2009) note that the population had adopted rational explanations for the dangers and had developed technologies for managing threats. However, a feeling of growing vulnerability resulted as more information about floods circulated more rapidly. Today, new ICTs provide limitless means to satisfy collective interest in catastrophic events, while simultaneously contributing to a feeling of increasing danger and greater vulnerability. In this regard, Rozario (2007) argues that contemporary visual media play a particularly important part in turning disasters into entertainment for wider audiences.

Disaster context: implications for SM analysis

The disaster context implies that disaster SM users can be categorised in several ways, depending on the stage and aspect of the disaster process, with each categorisation enabling specific questions to be answered. For instance, categorisation grounded within the fundamental nature–man dichotomy may help assess the emotional state and community resilience of disaster victims. Socio-economic and cultural categorisations enable development of a relative scale for assessing actors' reports about the suffering and needs of an affected population. Further, the constructs of community may help interpret SM data as manifestations of social conflicts and tensions, or of solidarity and support. Since the wider community's response is determined by the degree of solidarity grounded within socio-cultural identities, revealing the social identities constructed in the SM environment may disclose why similar events and similar 'amount of suffering' generate strong sympathy and immediate action, or go unnoticed.

Perhaps one of the most important implications of the disaster context framework is that the participant range should not be limited to SM users who produce, disseminate and consume information online. Participants should include offline, background actors involved in disaster mitigation and response (e.g. insurance companies, builders, legislatures, and so on), who may be represented indirectly. Further, participants should include non-human actors (e.g. nature, climate, a particular hazard, technology) whose presence manifests in several ways. In this respect, the most characteristic SM feature is displaying photos and videos (often placed in

the 'no comment' category) of natural hazards and sustained damage. These kinds of data can be used for analysing an affected population's emotional state as well as for helping explore outsider attitudes.

The disaster context framework implies that meaningful interpretation of SM data is possible only once they are approached as manifestations of social processes that occur in an historically concrete dimension that comprises place (territory as a socio-economic and political-administrative entity) and space (environment shaped by systemic-structural conditions) (Dyer and McGoodwin, 1999), and that exists within various – social, industrial, geological – forms of time (Smith, 2005). Because of the semiotic nature of SM, development of relevant analytic capabilities may require adopting such concepts as Bakhtin's (1981) chronotope – a representation of time–space in literature and discourse. The Bakhtinian concept of chronotope draws upon the principle of historicity developed by Goethe in order to overcome the limitations of the abstract-rationalist ideology of the Enlightenment. Goethe emphasised the chronotopic nature of the concrete world of human space and history:

> There are no events, plots or temporal motifs that are not related in an essential way to the particular spatial place of their occurrence, that could occur anywhere or nowhere … Everything in this world is a time–*space*, a true chronotope. (Bakhtin, 1986, p.42)

The concept of chronotope has been used to analyse both traditional media and computer-mediated interaction, proving to be a valuable analytical device for studies of technology-mediated communities (Lorino and Tricard, 2012; Kumpulainen *et al*., 2014). Indeed, the chronotope helps link frames of representation to frames of participation within mediated semiotic processes (Agha, 2007).

Analysis of disaster SM data needs to be informed by repertoires of disaster symbolism and by the cultural and collective identities constructed both within and outside the SM environment. Accordingly, capability development needs to be informed by research on manifestations of disaster symbolism and participants' identities in a multimodal SM environment. Finally, the disaster context framework implies a need to remain mindful of the *lacunae* imposed by SM as a data sample. In disaster situations, those experiencing the most severe deprivation tend to communicate less (Barton, 2005). Some actors may not actively engage in mediated interaction, while others may offer responses that are distant in time and manifest through actions in offline reality. Therefore, analysis of disaster SM data needs to be conducted *vis-à-vis* models of disasters that are socio-culturally specific.

Conclusion

In order to develop capabilities that enable disaster SM data gathering and analysis, it is necessary to understand how the richness of social scientific knowledge of disaster can be translated into ontologies, filtering criteria and analytic algorithms. The present paper proposes a disaster data-in-context framework that can potentially inform this kind of interdisciplinary dialogue. A detailed technical description of the proposed framework's implications for developing capabilities that enable disaster SM data collection and analysis is beyond the scope of this paper. Rather, this paper looks at certain assumptions already evident among developers of information technologies and increasingly evident in areas of disaster management and communication. In the case of SM, these assumptions are: preoccupation with the

quantitative-thematic approach to SM content; information-centric and SM-centric worldviews; and ignoring the specific nature of mediated reality.

Specifically, the proposed framework assists with adopting an anti-positivist stance in relation to disaster SM data, and with approaching SM as a locus of social processes. It implies that the themes discussed in SM may not represent the full spectrum of public needs. A SM theme's prominence does not necessarily signify its greater importance from the perspectives of disaster management and affected populations. Data must be approached as products of social, institutional and representational practices. In order to approach SM as a locus of social processes, the focus of analysis needs to be shifted from information to representation and interaction. In this case, development of capabilities that enable disaster SM data analysis may be informed by such concepts as Goffman's (1981) response and Voloshinov's (1986) utterance, and may incorporate broader research on SM phenomena, such as performativity (Papaharissi, 2012), online semiotic identity (Resnyansky, 2010b) and digital drift (Goldsmith and Brewer, 2015). The concept of the chronotope may be particularly useful for approaching disaster SM data as semiotic representations of socio-geographical space and versions of the past, present and future that may have shaped participants' attitudes and opinions.

The proposed conceptual framework may assist disaster managers with their choice and evaluation of capabilities for supporting SM data filtering, categorisation and analysis. This framework can inform the work of capability developers, who feel that future technological solutions may benefit from social science knowledge, but find such knowledge 'too rich', 'subjective' and 'unstructured'. Although the disaster data-in-context framework needs further development before it can be integrated into tools supporting SM data use in disasters (as well as the assessment criteria), it can, hopefully, orientate technology developers in the domain-specific aspects of data, meta information and context. Additionally, this framework may aid disaster managers and capability developers in adopting a critical-reflexive stance towards SM and in approaching SM as a non-neutral participant of the disaster management process.

Disclosure statement

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