3RG REPORT

Focal Report 7: Risk Analysis

Conceptualizing the Crisis Mapping Phenomenon: Insights on behavior and the coordination of agents and information in complex crisis

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Purpose: As part of a larger mandate, the Swiss Federal Office for Civil Protection (FOCP) has tasked the Center for Security Studies (CSS) at ETH Zurich with compiling 'focal reports' (Fokusberichte) on critical infrastructure protection and on risk analysis to promote discussion and provide information about new trends and insights.

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THE TASK

The analysis and evaluation of risks and threats relevant to the civil protection system is among the key responsibilities of the Swiss Federal Office for Civil Protection (FOCP). As part of a larger mandate, the FOCP has tasked the Center for Security Studies (CSS) at ETH Zurich with producing two annual 'focal reports' (Fokusberichte) on risk and vulnerability analysis.

According to this mandate, the focal reports are compiled using the following method: First, a 'scan' of the environment is performed with the aim of searching actively for information that helps to expand and deepen the knowledge and understanding of the issue under scrutiny. This is a continuous process that uses the following sources:

- Internet Monitoring: New and/or relevant publications and documents with a focus on risk and vulnerability analysis are identified and collected.
- Science Monitoring: Relevant journals are identified and screened, and relevant articles evaluated.
- Government Monitoring: Policy documents with relevance to Switzerland from various countries and from international inter- and nongovernmental organizations are identified.

Second, the material thus collected is filtered, analyzed, and summarized in the focal reports.[1]

1 Previous focal reports can be downloaded from the website of the Center for Security Studies (*http://www.css.ethz.ch*). The *www.crn.ethz.ch* website will cease to exist.

1 INTRODUCTION – RESILIENCE IN COMPLEX CRISES

Crises are processes brought on by technical, social, or natural hazards (i.e. events)[2] that interact with social systems. The less prepared that a society is to deal with a hazard the more likely that the crisis will be exacerbated. Yet managing crises is an increasingly complex process. In an age characterized by complex interactions, multiple actors and influences, surprises, inter-connectivity and dependency, states have begun to place more emphasis on enhancing societal resilience. As Goldstein states, this can be defined as building up the "community's ability to regain equilibrium and return to normal"[3] after a hazard is realized or, framed another way by Casicio, enhancing "the capacity of an entity [...] to withstand sudden, unexpected shocks, and (ideally) be capable of recovering quickly afterwards."[4] Norris et al provide an even more nuanced definition, noting that resilience is "a process linking a set of adaptive capacities to a positive trajectory of functioning and adaption after a disturbance."[5]

Such definitions imply that resilience is a process and adaption is the outcome. However, more research is needed to further conceptualize and understand this process. One under-explored entry point is to look at the ways in which coordination in complex crisis situations is changing and, in doing so, examine the contemporary behavioral attributes of communities under stress. Without a doubt, coordination is more challenging due to the multiple actors and stakeholders interacting during a crisis situation. In absence of strong coordination, the crisis can worsen and impinge the ability of a community to 'bounce back' quickly from an event.[6] Traditionally, government actors, such as first responders and crisis managers, have been largely responsible for communicating the crisis to the public, allocating resources, and quickly delivering relief so to mitigate losses – both in physical damages and loss in life. But such clearly defined roles are being challenged by today's changing dynamics. In one example, public services are increasingly delivered by a "network of multiple organizations that can come from any level of government, as well as from the private and nonprofit sectors".[7] Indeed, the privatization of industries that are critical to the delivery of public goods, and the challenges that emerge from that trend, has been a cornerstone of the critical infrastructure protection (CIP) debate and one that we have covered in numerous reports, particularly in our discussions about public-private partnerships. This development has had a major impact on crisis management protocol in that government agencies must partner and coordinate with stakeholders that, while outside of the public sector milieu, are important players in maintaining and restoring services. Another interesting example concerns the

2 In this context, such events can come in the form of a terrorist attacks (e.g. July 2011 armed attack and bombing in Oslo) or public protest (e.g. 2011 Arab spring and London riots), natural disasters (e.g. March 2011 earthquake-tsunami in Japan), or human error (e.g. 2010 BP Horizon oil spill in the Gulf of Mexico and 2008 financial crisis).

3 Goldstein, B. E. (2011). Conclusion: Communicative Resilience. In B. E. Goldstein, Collaborative Resilience: Moving Through Crisis to Opportunity (pp. 359–372). Cambridge: MIT Press.p. 360.

4 Casico, Jamais, 2009. "Resilience in the Face of Crisis: Why the Future will be Flexible," in FastCompany.com, 2 April. Available at: *http://www.fastcompany.com/blog/jamais-cascio/open-future/resilience*

5 Norris, F. H. et al (2008). Community Resilience as a Metaphor, Theory, Set of Capacities, and Strategy for Disaster Readiness. *American Journal Community Psychology*, p. 130.

6 The Latin word 'resilīre' means to spring back, rebound.

7 Gao, H., Wang, X., Barbier, G., & Liu, H. (2011). Promoting Coordination for Disaster Relief: From Crowdsourcing to Coordination. *SBP'11 Proceedings of the 4th International Conference on Social Computing, Behavioral-Cultural Modeling and Prediction* (pp. 197–204). Springer-Verlag Berlin, Heidelberg; Moynihan, D. (2005). *Leveraging Collaborative Networks in Infrequent Emergency Situations*. IBM Center for the Business of Government.

new media environment and its interactions with social systems, particularly during crises. Here we are referring to the growth and reach of mobile technologies and social media platforms that have given multiple actors a more vocal and active role in crisis situations. For example, as Procopio & Procopio have shown in their study of Hurricane Katrina, communities struck by disaster actively use online technologies to reduce uncertainty through the exchange of information, but also to seek and provide emotional support in crisis situations. The way new information technologies can be used to create social capital is a valuable resource during the "bounce back" of communities after a disaster.[8] Combined, these two examples illustrate the range of new actors and interacting phenomena that compound complexity and make dealing with and responding to shocks or crises a complex task, particularly given that today's crises tend to produce unforeseen behavior and outcomes.

In line with this discussion, our recent report "The Changing Dynamics of Crisis Communication: Evidence from the Aftermath of the 2011 Tsunami in Japan" examined the role that crisis coordination between public and private actors played in the (mis)handling of the multi-disaster, particularly as it related to the partial meltdown of the Fukushima nuclear plant and the release of radioactive material.[9] Yet, one interesting finding from this study was that while much of the international news coverage focused on the coordination pitfalls between government agencies and private companies (above all the energy company TEPCO), at the community level there was a so-called virtual or online convergence of information, material and human resources around the crisis.[10] People turned to new media and mobile technology to report, share, and exchange crisis information, largely over social media platforms like Twitter. This allowed a wide variety of individuals to partake in a decentralized form of crisis coordination and response whereby information, provided by a variety of sources, moved across multiple coexisting media systems, converging to construct a large portrait of the crisis.[11] This 'crisis portrait' was best illustrated in the dynamic crisis mapping effort that emerged only four hours after the tsunami struck. Crisis mapping, as defined by Dunn Cavelty and Giroux, is "both a process and an outcome that combines various streams of crowdsourced crisis information that is verified, categorized and visualized by volunteers using satellite imagery and open source mapping platforms."[12] In Japan, Sinsai.info was a crisis map initiated by a concerned citizen that sought to compensate for the lack of official information and response measures. Using the Ushahidi software, OpenStreetMaps, and a committed group of volunteers (based in and outside of Japan) who gathered, verified, aggregated and visualized relevant crisis information, Sinsai.info helped improve situational awareness, categorize needs and damages, provide transparency to the crisis, and connect affected communities with relief agencies.

Brought together, the Japanese case brings to light the novel coordination and behavioral characteristics that can emerge when disaster strikes. In particular, it highlights the resourceful, adaptive attributes of communities in today's post-disaster environment, and the growing role that crowdsourcing and new media tools play in such contexts.

8 Procopio, C. H., & Procopio , S. T. (2007). Do You Know What It Means to Miss New Orleans? Internet Communication, Geographic Community, and Social Capital in Crisis. *Journal of Applied Communication*, 67–87.

9 Doktor, Christoph and Jennifer Giroux (2012) "The Changing Dynamics of Crisis Communication: Evidence from the Aftermath of the 2011 Tsunami in Japan". Factsheet, Commissioned by the Federal Office for Civil Protection (FOCP), forthcoming.

10 In the context of the Japanese case, converging materials mainly included software, satellite imagery and cash donations.

11 Jenkins, H. (2006). *Convergence Culture: Where Old and New Media Collide.* New York : New York University Press.

12 Dunn Cavelty, Myriam and Jennifer Giroux (2011) "Crisis Mapping: A Phenomenon and Tool in Complex Emergencies" CSS Analyses, No. 103. Available at: http://www.css.ethz.ch/publications/pdfs/CSS-Analysis-103-EN.pdf

Yet, despite the increased interest in crisis mapping, little is known about the systemic processes of crisis maps. In particular, a theoretical underpinning is still missing that could bring together existing academic work on crisis maps, which has largely approached the phenomenon of crisis mapping using a case-based empirical approach. Going forward, we aim to fill this gap by conceptualizing crisis mapping as a process. To this end, we first draw on complex adaptive systems (CAS) theory to line out the *process* of crisis mapping as a whole. Yet this broad systems approach falls short in that it does not pay enough attention to the agents and their behavior within a complex (crisis) system. To fill this knowledge gap, we turn to the social convergence literature to capture the online convergence of information, people and resources during a crisis situation. By bringing together these theoretical strands, it is possible to depict how convergent resources are utilized when a system adapts to external pressures. Based on this conceptual framework, we argue that while crisis mapping first originated as the outcome of emergent processes between the interactions of various agents in a crisis system, it has since become a sign of adaption and one that is becoming increasingly institutionalized in social crisis systems today, a trend that will continue most likely in the foreseeable future. To illustrate this, section 3 presents two case studies that highlight the types of crisis maps that emerged from 2010 to 2011. In this discussion, we look systematically at the behavioral attributes of the agents involved in each crisis mapping case. This includes looking at behavior as well as agency strength. Finally, we conclude our analysis with a discussion of policy implications of our findings. In particular, we point out options for Switzerland to further address the phenomenon of crisis mapping. It is envisaged how analysis, strategy making and training could be fostered to prepare for the expected growing importance of crisis mapping in future.

2 THE CRISIS MAPPING PHENOMENON: INSIGHTS FROM ADAPTION AND CONVERGENCE

Crisis mapping is a phenomenon that has been increasingly featured in recent crisis contexts and – given the speed and reach of new media technology - will most likely become even more central in future crises.[13] Although it is still in its infancy, it exemplifies current and future developments in crisis management. To understand this as a process and how it intersects with today's crisis management frameworks (particularly in the response phase) we first need to conceptualize the process of crisis mapping. To do this we turn to complex adaptive systems theory, which provides insight into how emergent processes are incorporated and turn into adaptive processes and routines. In this respect, adaption refers to learning processes that allow a system to ensure its survival through change. Particularly important in this respect are emergent behaviors that are born out of a crisis system when "demands are not met by existing organizations, [when] traditional tasks and structures are insufficient or inappropriate, and/or [when] the community feels it is necessary to respond to or resolve their crisis situation."[14] However, while systems theory can explain overarching processes, it does not provide an in-depth understanding of agent behavior in crisis – or, in other words, *who* is doing *what* and for what purposes during a crisis. Theoretical insights offered by social convergence, which refers to the propensity for information, materials, and people to flow into and converge around a crisis (both in the physical and virtual realm), can actually help fill this gap and deepen our understanding on certain behavioral attributes within crisis zones. The conjoint analysis of convergent processes into crisis zones, on the one hand, and adaptive behaviors of those agents that work on the mitigation efforts from inside the crisis system, on the other, provides a comprehensive picture of coordination problems in crises situations as well as of novel coordination efforts to manage crisis situations in dynamic information environments.

13 For example, one of the more recent examples that show the growth of this area is the Cybermappr tool under development by the United Nations Institute for Training and Research / Operational Satellite Applications Program (UNITAR/UNOSAT) and the Citizens Cyberscience Centre (CCC). This is an experimental effort that begins to address a need by UNOSAT for converting the many photos and other media that appear during crisis periods into categorized and georeferenced data via crowdsourcing. For more information see: *http://blog.standbytaskforce.com/testing-the-cybermappr-tool*

14 Drabek, T. E., & McEntire, D. A. (2003). Emergent Phenomena and the Sociology of Disaster: Lessons, Trends and Opportunities from the Research Literature. *Disaster Prevention and Management*, p. 99; Bardo, J. (1978). Organizational Response to Disaster: A Typology of Adaptation and Change. *Mass Emergencies*, 87–104.

2.1 Adaption in Crises

Complexity is an important concept in various academic disciplines today. Originally, it started in the 1970s, when, influenced by Cybernetics and System Theory and in close connection with resilience thinking in ecology, Complexity Theory was developed. Soon, Complexity Theory began to make its way into the behavioral and social sciences. It provided a new framework in which to view a world where physical and social reality are interconnected and composed of interacting orderly, complex and chaotic phenomena. This new approach broke away from thinking on linear causalities and equilibria that had dominated science for centuries and opened new approaches to study complex phenomena such as ecological systems, neuronal processes and social interaction. Many of the studies have since looked at the mechanisms with which complex systems change in response to external pressures and shocks. Consequently, to summarize a major finding of this research, studies found that complex systems are able to adapt to their environments through self-organizing, decentralized processes.[15] Referred to as complex adaptive systems (CAS), there are no central elements within or outside such systems that steer these processes of system change. Thus, the analytical focus is on the performance or rather behavior of the system as a whole.[16] Framed within discussions on community resilience, the phrase 'the whole is more than the sum of its parts' implies that a "collection of resilient individuals does guarantee a resilient community."[17]

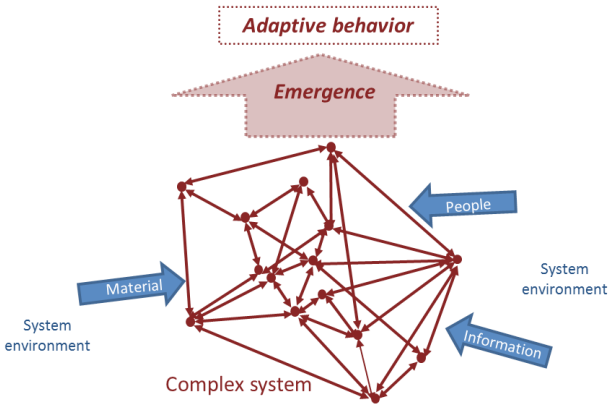


Figure 1: *Complex adaptive system framework, integrated with external (converging) environment*

Complex adaptive systems (CAS) are process dependent, self-organizing systems, containing constant feedback loops brought about by multiple, local interactions between actors, resulting in an overall process that influences future organization and outcomes.

To illustrate this process, figure 1 provides a generic framework for complex adaptive systems (CAS) in which there are **four notable traits** to highlight here. **First**, we have the presence of agents (or actors), which is the network illustrated in the center of the system – which, (depending on the system analyzed), could be a country, neuronal system, collective identity, organization, community, ecosystem, etc.[18] When talking about social systems, these agents are positioned along a broad spectrum of agency and proximity – from individuals within a community, business leaders, to government actors

15 This movement was especially influenced by research achievements made in the Ecology field. Holling studied the ecology of forests and observed that all forests have an adaptive cycle of growth, collapse, regeneration, followed by growth again. Holling, C. (1973). Resilience and Stability of Ecological Systems. *Annual Review of Ecology and Systematics*, 1–23.

16 Nolfi, S. (2004/5). Behaviour as a Complex Adaptive System: On the Role of Self-Organization in the Development of Individual and Collective Behaviour. *Social Modeling* , 195–203.

17 Norris, F. H. et al (2008), p. 128.

18 Bak, P. (1996). *How Nature Works: The Science of Self-Organized Criticality*. New York: Copernicus; Sellnow, T. L., Seeger, M. W., & Ulmer, R. R. (2002). Chaos Theory, Informational Needs, and Natural Disasters. *Journal of Applied Communication Research*, 269–292.; Also see: Snowden, D. 2008. Everything is fragmented—Complex adaptive systems at play. KM World, 17 (10), November/December. Available at: http://www.kmworld.com/Articles/News/News-Analysis/Everything-is-fragmented%E2%80%94Complex-adaptive-systems-at-play--51363.aspx

and the like.[19] Needless to say, while there are hierarchical structures within the network of agents, the system as a whole is characterized by its *decentralized* qualities (i.e. absence of central authority). **Second**, the arrows surrounding the system represent the external environment where information, people, and resources are moving in (and out) of the system, thus creating opportunities for new behavioral attributes, structures, and phenomenon to be born out of the system. As will be discussed later in this study, during a crisis such resources converge (flow into or gravitate towards) a crisis zone. What is important to note is how the interaction between the external environment and the network of agents can bring about new patterns of unforeseen behavior, or in other words emergent processes. Thus the **third** trait refers to the self-organizing tendency of the network, which, through multiple interactions and exchanges with the external environment, renders distributed cognition and new behavior that is powered from the bottom-up. The self-organizing capacity is typically supported by the existence of guiding principles or, as the literature suggests, internal rules.[20] Within a crisis situation, these rules can basically be understood as coping strategies that proved successful in previous crises and therefore become part of the systems repertoire. As Holland states, the "actions of the agent in its environment can be assigned a value (performance, utility, payoff, fitness or the like); and the agent behaves so as to increase this value over time."[21] Given that the agents in the network are constantly interacting and receiving information from the "external environment" as well as exchanging locally produced environmental knowledge the behaviors of the actors shift, produce new characteristics/tendencies and effectively adapt to the changing system.[22] This 'adaption' to the new environment is the **fourth** trait in a complex adaptive system.

Kapucu aptly notes that "the concept of CAS captures the processes of change in complex environments in which a set of interdependent units are capable of reallocating its resources and actions to achieve a stated goal under changing conditions."[23] Therefore, when a social system is confronted with hazardous events, the system's environment becomes stressed as the society attempts to deal with the unfolding crisis. Within this process there can be predictable and unpredictable outcomes. A predictable outcome might be emergency responders reporting to the scene of the crisis, for example. An unpredictable outcome, however, might be some type of new behavioral phenomena born out of the system. Such was the case in 2008 when Nairobi, Kenya erupted in post-election violence, sending local communities into crisis. Out of this system, individuals used online mapping platforms and reports of incidents sent from community members using a SMS (text messaging) on their mobile phones. Incidents were then visualized (mapped), thus giving much needed transparency to the crisis as well as a resource for responders to track and respond to violence. What became known as 'crisis mapping', this was an emergent outcome, one that was not predicted, yet demonstrated a unique, novel way in which the local community dealt with a crisis.[24] We

19 Axelrod, R., & Cohen , M. D. (1999). *Harnessing Complexity: Organizational Implications of a Scientific Frontier*. New York: Free Press.

20 Macy, M. W., & Willer, R. (2002). From Factors to Actors: Computational Sociology and Agent-Based Modeling. *Annual Review of Sociology*, 143–166; Beinhocker, E. D. (2006). *The Origin of Wealth: Evolution, Complexity, and the Radical Remakingof Economics*. McKinsey & Company, Inc.

21 Holland, J., & Miller, J. H. (1991). Artificial Adaptive Agents in Economic Theory. *The American Economic Review*, p. 365.

22 Duit, A., & Galaz, V. (2008). Governance and Complexity – Emerging Issues for Governance Theory. *Governance*, p.313.

23 Kapucu, N. (2009). Interorganizational Coordination in Complex Environments of Disasters: The Evolution of Intergovernmental Disaster Response Systems. *Journal of Homeland Security and Emergency Management*.

24 Crisis mapping was preceded by the emergence of publicly available mapping tools (notably Google Map Maker and the open-source platform OpenStreetMap) that created new opportunities to pool together info provided 'from the ground' to visualize and map crises.

illustrate this in figure 2 where we adapt our CAS framework to the crisis mapping phenomenon. In this figure we identify how volunteers (people) who provided and collected violent incident reports (sent by SMS messages/mobile phones from people in the community), information (both incident reports and mapping), and resources (donations in time and software) converged around the network of agents in the crisis system. These internal and external influences led to a new, emergent behaviour where, in absence of information about the crisis, certain agents in the system developed a crisis mapping effort.

Since then, and as we show in section 3, the knowledge of crisis mapping has spread and led to its emergence in other crisis contexts; no longer simply being the outcome of an emergent process but rather one that is being increasingly institutionalized and serving as a signal for adaptive behavior in crises. While this view of social interaction as a CAS is not particularly novel, couching the crisis mapping phenomenon within this framework is. However, while this approach allows us to understand the *process* as well as an explanation for the emergence of crisis maps, it does not provide enough insight into the role that human agency plays in such adaptive processes. In other words, to fully understand the crisis mapping phenomenon we need to look more closely at the network of key agents driving this effort forward.

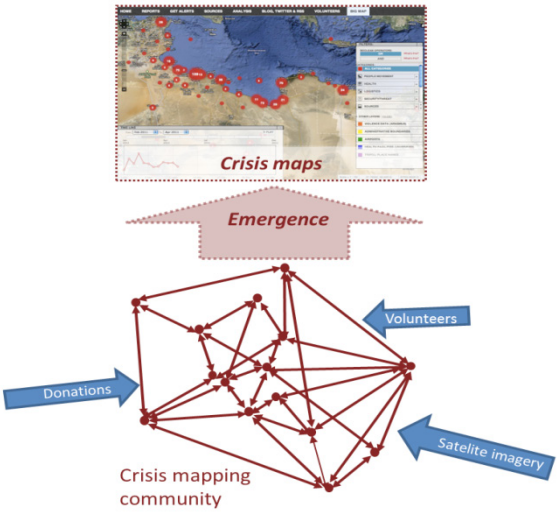


Figure 2: *Crisis mapping as a complex adaptive system*

Crisis mapping, while initially an emergent process, is now the evidence of adaptive behavior in crisis situations – showing how various resources, people, and information converge to help a community in the post-crisis period when providing quick relief is critical to mitigating effects.

2.2 Crisis Convergence in the Information Environment

According to a popular misbelief, in times of crisis and disaster people generally tend to behave irrationally and panicky.[25] A leap to correct this misbelief was taken by Fritz and Mathewson in 1957 when they released their seminal study on crisis behavior that identified a converging effect in different crisis situations that contradicts the picture of public panic. Based on aerial photographs from post-disaster sites as well as other empirical records, the authors analyzed the behavior of humans in crisis situations. As they noted: "The popular image of 'disaster' brings to mind a picture of a highly fearful or panicky mass of survivors fleeing from the scene of destruction," is an inaccurate conception.[26] Rather, large-scale crises/disasters have a converging effect, which encompasses different forms of centripetal social processes - mainly the movement of information (movement or transmission of messages), people (physical movement of persons) and materials (physical movement of supplies) towards a disaster-related zone (see Figure 3).[27] Another interesting takeaway from Fritz and Mathewson, along with subsequent studies on social convergence, is the 'identities' that emerge in a post-crisis environment, referred to as the "unofficial convergers".[28] Basically, these are social roles that individuals assume in crisis situations, such as "the helper", "the exploiter" or "the supporter".[29]

In contrast to pessimistic voices that believe that the Internet leads to a decline of social relationships and solidarity[30] we hypothesize that some of the abovementioned identities can also be found in contemporary online communication networks. In fact, recent studies have found that the emergence of mobile and web technologies coupled with the broadening of the media landscape in general has resulted in "similar forms of crisis convergence beginning to form online."[31] In other words, novel information technologies such as mobile phones, social media, micro-blogs, email, photo and video sharing, and online mapping platforms (i.e. Google maps) are transforming not only how "crisis management professionals interact with and disseminate information to affected communities in a crisis situation," but also how the community at large is able to participate in that process.[32] As Fritz and Mathewson showed, in the age of newspapers, radio and TV, the role of community actors in the communicative process was mainly limited to receiving messages from mass media or exchanging information locally during a crisis, however today's network-formed global media environment enable these actors to play more active roles in crisis communication. The new technological developments created a 'cyber-zone' that spheres around the existing zones of crisis in which new forms of convergence takes place.

In figure 4, we overlay our agent network (extracted from our crisis mapping CAS in figure 2) on top of an adapted crisis convergence model inspired by the Fritz and Mathewson model. However, while we kept the crisis (internal) zone, we consolidated the other zones

25 Sheppard, B., Rubin , G. J., Wardman , J. K., & Wessely, S. (2006). Terrorism and Dispelling the Myth of a Panic Prone Public. *Journal of Public Health Policy*, 219–245.

26 Fritz, C. E., & Mathewson, J. H. (1957). *Convergence Behavior in Disasters: A Problem in Social Control*. Washington D.C.: Committe on Disaster Studies, Division of Anthropology and Psychology, National Academy of Sciences – National Reseach Council, p. 3.

27 Ibid, pp. 3–4.

28 Hughes, A. L. et al (2008). "Site-Seeing" in Disaster: An Examination of On-Line Social Convergence. *Proceedings of the 5th International ISCRAM Conference, F. Fiedrich and B. Van de Walle, eds.,* Washington D.C., p. 2.

29 Fritz & Mathewson (1957)

30 Nie, N. H., & Erbring , L. (2002). Internet and Society: A Preliminary Report. *IT & Society*, 275–283.

31 Liu, S., Palen, L., Sutton , J., Hughes , A., & Vieweg , S. (2008). In *Search of the Bigger Picture: The Emergent Role of On-Line Photo-Sharing in Times of Disaster. In Proceedings of the Information Systems for Crisis Response and Management Conference (ISCRAM 2008) (2008) Key: citeulike:7150985.*

32 Veil, S. R. (2011). A Work-in-Process Literature Review: Incorporating Social Media in Risk and Crisis Communication. *Journal of Contingencies and Crisis Management*, p. 110.

to the proximate zone, which essentially represents the external area (outside of crisis zone). We also added the cyber zone to represent the online dimension of this phenomenon and one that overlaps both the crisis and proximate zone. Combined, the center and the periphery of the system are connected through channels that allow the convergence of people, material and information between the periphery and the center, and vice versa. As in the original model, we differentiate between three different forms of convergence: First, people can be brought to the crisis zone. Due to the new information technologies, these converged human resources can be used in different functions during the mitigation and recovery phase of a crisis without being physically at the site of the crisis. Second, materials (i.e. any tool or commodity that supports the agents in the crisis zone, ranging from software over satellite imagery to financial resources) can converge from the cyber to the crisis zone and vice versa (i.e. information flowing out of the crisis zone to the cyber zone). Finally, the cyber zone provides a valuable reservoir of information that is able to converge in the case of a crisis. For example, among the convergent information that can be crucial in a crisis situation is that which identifies the origins and characteristics of a disturbance as well as recommendations for crisis behavior.

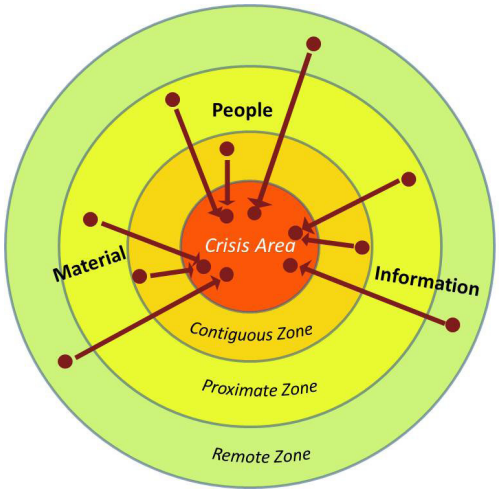
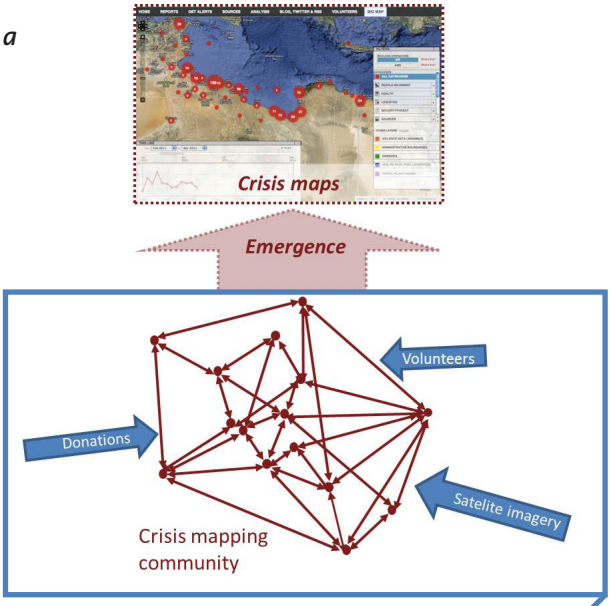


Figure 3: *Original Crisis Convergence Model: In this model, information, people and material flow into the crisis area.*

a



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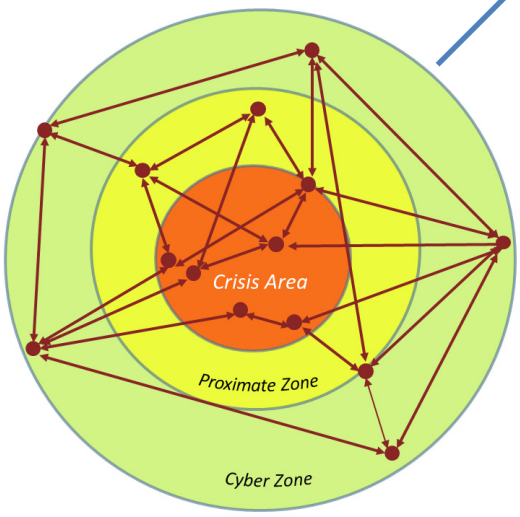

Figure 4: *Figure 4a is the Crisis Mapping CAS Model. Narrowing this analysis we focus specifically on the crisis mapping community (the network of agents) which is placed on top of the adapted crisis convergence model in figure 4b. Within the crisis mapping network, information, people, and materials are flowing into the crisis area and also between the zones.*

2.3 A Closer Look at Agents in Adaptive Processes

The major backdrop of system approaches to crisis situations is that they are largely ignorant of the *role* agents play in determining the behavior of social systems. The case of crisis mapping illustrates this point. While the tools of crisis mapping have received considerable attention from media and increasingly from academia as well, the behavioral aspects of these processes tend to be overlooked. Even though technology is admittedly important, it is the behavioral aspect that is most telling. As Manuel Castells notes, "[i]f mobile phones and other wireless communication devices are becoming the privileged tools of grassroots-initiated political change in our world, it is because their sociotechnical features directly relate to the major cultural trends underlying social practice in our society".[33] As we show in the subsequent analysis of crowdsourced maps, the array of social actors involved in adaptive behaviors in crisis situations is extremely broad, ranging from state and supra-state institutions over private business companies to grass roots activists.

For the sake of a broad macro-perspective, most of the research on adaptive behaviors in crisis situations has not been occupied with the intentions, interests or identities of those social agents that constitute complex adaptive systems. However, for our understanding of social adaptive processes and resilience it is essential to disentangle the different agents that constituent the system (such as first responders, government, media, individual citizens), and attempt to understand what drives them and how their adaptive behaviors can be supported. Therefore, having already explained the process of crisis mapping as a whole, we narrow our analysis even more by 'unpacking' the network of agents involved in crisis mapping.

Inspired by Fritz and Mathewson, we have identified six different types of 'on-line convergers', or 'identities', in a crisis mapping system:

- **Initiator:** Initiates the crisis map
- **Coordinator:** Leads effort to bring together volunteers, resources, etc. for crisis map
- **Collaborator:** Joins crisis mapping process, assisting with mapping effort
- **Multiplier:** Disseminating info on where crisis info can be sent
- **Supporter:** Additional services or resources to support crisis mapping effort
- **User:** Uses the crisis map

Using these 'identities', in the following section we turn to our case studies where we are able to look at specific crisis mapping cases and analyze the network of agents involved in the process. We also measure their agency so to show another aspect of agent behavior and attributes. This allows us to compare across cases the types of agents that contribute at different stages to emergent behavior in crisis situations.

33 Castells, M. (2009). Communication Power. Oxford : Oxford University Press, p. 362.

3 CRISIS MAPPING CASES: EXAMINING AGENCY AND BEHAVIOR

Pulling from theoretical insights on convergence and adaption discussed in the previous section, in this section we flush out two crisis mapping case studies (the Haiti earthquake 2010 and the London riots 2011) and examine the agents within the respective crisis mapping networks. After performing a comprehensive review of the various crisis maps that have been created since its emergence in 2008, we selected these two cases as they represent two types of crisis mapping cases. On the one end of the spectrum, there are crisis maps born out of post-crisis environments where multiple agents come together to produce one, large crisis map. This was the case in Haiti. On the other end of the spectrum, there are other post-crisis environments where there are multiple crisis maps that emerge, oftentimes overlapping each other with the information they provide or filling in info gaps. This was case following the London riots.

These cases were also selected in order to examine the emergence of crisis maps following the breakdown of critical infrastructures to varying degrees, from local disruptions (London) to national catastrophes with major fallouts of critical infrastructures in multiple sectors (Haiti). These cases also provide real-life examples that illustrate two key trends. First, the trend for contemporary crises to attract experts in new media and information technology who volunteer their expertise for relief operations, as well as the tendency for the public at large to send information in and out of the crisis affected area. In other words, the crisis mapping phenomenon reveals the virtual convergence of people (volunteers to gather, process, and map crisis info), materials (the use of satellite imagery and mapping platforms to get an accurate picture of the crisis zone) and information (the multiple streams of crisis info coming from within and outside of the crisis zone via various individuals, resources and platforms). The second trend refers to the process of adaptive behavior that is born out of the interactions between agents in a crisis system and that is then incorporated through adaptive learning processes.

For this discussion on agents and agency in the crisis mapping system, we use our crisis mapping agent identities and then place these identities within our crisis mapping network (figure 4). We also attempt to categorize the type of agency of the most important contributors to each crisis map. We differentiate between contributors with strong and weak agency. Strong agents would have broad influence and power such as a government actor whereas a weak agent would be an individual or group of individuals within the public at large. A group of students, for example, would be categorized as a weak agent. What is particularly telling about the crisis mapping cases that we interrogate is that functions in crisis mapping processes can be fulfilled by very different agents Both, in the Haitian and in the British case, a crisis map is successfully launched during a complex crisis situation, even though the constellation of the agents involved diverges significantly.[34]

3.1 Haiti Earthquake 2010

The Harvard Humanitarian Initiative (HHI) served as the incubator for creating one of the top crisis mapping platforms, Ushahidi. This mapping platform was used in 2008 to map post-election violence in Kenya and was used successfully again on 12 January 2010

34 Admittedly, the sample of crisis maps in this study is biased towards successful projects. To balance this out, future research needs to include cases of unsuccessful attempts to create crisis maps as well.

when a 7.0 earthquake struck Haiti, immediately devastating its capital Port au Prince and surrounding areas. Consequently, over 300,000 people were killed, many more injured and a quarter, or roughly 2 million, of the population was displaced.[35] A considerable share of Haiti's critical infrastructure was affected by the catastrophe. Emergency responders faced a chaotic situation where damaged hospitals, impassable roads, busted gas and water pipelines, etc. stymied rescue and relief operations. However, as dire as the situation was, it also revealed interesting insights on convergence, adaptive behavior and the use of information technology in complex crisis response. To navigate through the dense movement of information, people, and materials flowing into Haiti "the emergency response required an unprecedented level of coordination among vast numbers of relief workers from all over the world."[36] To meet this need, a dynamic crisis mapping effort took shape just hours after disaster struck. It is important to note here that the quick build-up of crisis maps in Haiti was made possible only due to the priority that was given to the reconstruction of critical information infrastructure in the first hours and days after the earthquake. The crisis maps allowed for multiple agencies and actors to come together, coordinate capacity and response, and essentially improve situational awareness and facilitate relief. While some of these agents were already present in Port au Prince when the disaster unfolded (in particular UN organizations and humanitarian NGO's), other important agents (among others the mapping experts at Ushahidi and the volunteer mappers and translators around the globe) just converged to the crisis zone after the disaster had hit Haiti. Equally, the materials and information the Haiti crisis mapping project built upon came both from the crisis zone (e.g. the local radio stations) and from the outside (e.g. the Ushahidi software which was originally programmed for the Kenyan context). This leads to the question how these different forms of internal and external resources where streamlined and the actors involved coordinated to organize the crisis mapping project in an efficient manner. In figure 5, we provide two graphical representations of this process: one that outlines the network of agents within the adapted crisis mapping convergence model and another that measure the agent's behavior over time and their level of agency from weak to strong. While the mapping process is a dynamic one, with feedbacks between agents, there is some linearity involved in the sense that interactions between agents have forward-moving, causal tendencies that eventually lead to the creation of a crisis map.

In this case the **"initiator"** of the crisis map was Ushahidi, specifically led by Patrick Meier (Director of Crisis Mapping at Ushahidi) who, shortly after learning about the earthquake, contacted a colleague to begin developing the technical infrastructure of the Haiti crisis map. Ushahidi is a software company with weak agency in that it has little influence outside of its own internal operations. Soon after it was launched, the Emergency Information Service (EIS)[37], InSTEDD[38], Haitian Telcos & United States Government partnered with Ushahidi to become the main **"coordinators"** of this effort. In particular EIS and InSTEDD launched a SMS service for Haitians to text their location and needs – InSTEDD also set up a geochat instance to enable volunteers and info providers to chat and get alerts using mobile devices.[39] As we show on figure 4, such partners fall along different

35 "Haiti raises quake death toll on anniversary", CBC News, 12 January 2011. Available at: http://www.cbc.ca/news/world/story/2011/01/12/haiti-anniversary-memorials.html

36 Nelson, A., Sigal , I., & Zambrano , D. (2011). *Media, Information Systems and Communities: Lessons from Haiti.* Knight Foundation.

37 EIS was a "project centered around the development and deployment of disaster and post-conflict journalistic tools built on top of InSTEDD's Riff collaboration and machine-based analytics software." It was first deployed in Haiti following the earthquake. For more see: http://instedd.org/map/eis_haiti

38 InSTEDD is an organization that "designs and uses open source technology tools to help partners enhance collaboration and improve information flow and knowledge sharing to better deliver critical services to vulnerable populations". For more see: http://instedd.org/about-us

39 http://geochat.instedd.org

levels of agency. During this process hundreds of volunteers joined the mapping effort to assist with the capturing, verifying, aggregating, and mapping of reports. These **"collaborators"** came from the Haitian Diaspora as well as students from Tufts University and, like Ushahidi, have weak agency. The Haitian Diaspora was particularly important in the process as they helped translate texts from Creole to English (80% of Haitians have mobile phones). The local radio station, with a medium agency level, served as a **"multiplier"** in that it was able to spread the word about the SMS service.[40] In many cases, the service was successful to direct life-saving information (e.g. requests for food and water at particular locations) from affected Haitians to the rescue and relief agencies. The campaign quickly went viral and texts began arriving every few seconds – with 40,000 useful text messages coming through the system in the first six weeks alone. Relating this back to the discussion on CAS, the response in Haiti revealed a complex system rapidly adapting and leveraging interactions within networks to find solutions. As Luke Beckman from InSTEDD noted "this was an ecosystem that sort of evolved and emerged out of thin air — and it was based almost entirely on personal relationships and trust... It was who-knows-who, who-can-find-who, and who can you text, who can you Skype, who can you tweet." Finally, the **"supporters"** and **"users"** of the crisis mapping effort included, in the former, Google, the United Nations Mission in Haiti (UNMIH), and the World Bank, and, in the latter, the various relief agencies working in and outside of Haiti, such as the UN Office for the Coordination of Humanitarian Affairs (UNOCHA) and the International Federation of the Red Cross (IFRC). The Haitian case is important as it was essentially a real-world laboratory that showed the promising role that interactive maps combined with crowdsourced crisis information could have for large scale disasters – effectively creating a dialogue between citizens and relief worker that helped guide search-and-rescue teams to find people in need of critical supplies.[41]

40 Nelson, A. «How Mapping, SMS Platforms Saved Lives in Haiti Earthquake», Media Shift, 11 January 2011. Available at: *http://www.pbs.org/mediashift/2011/01/how-mapping-sms-platforms-saved-lives-in-haiti-earthquake011.html*

41 Port of Prince is now one of the best mapped cities thanks to this effort.

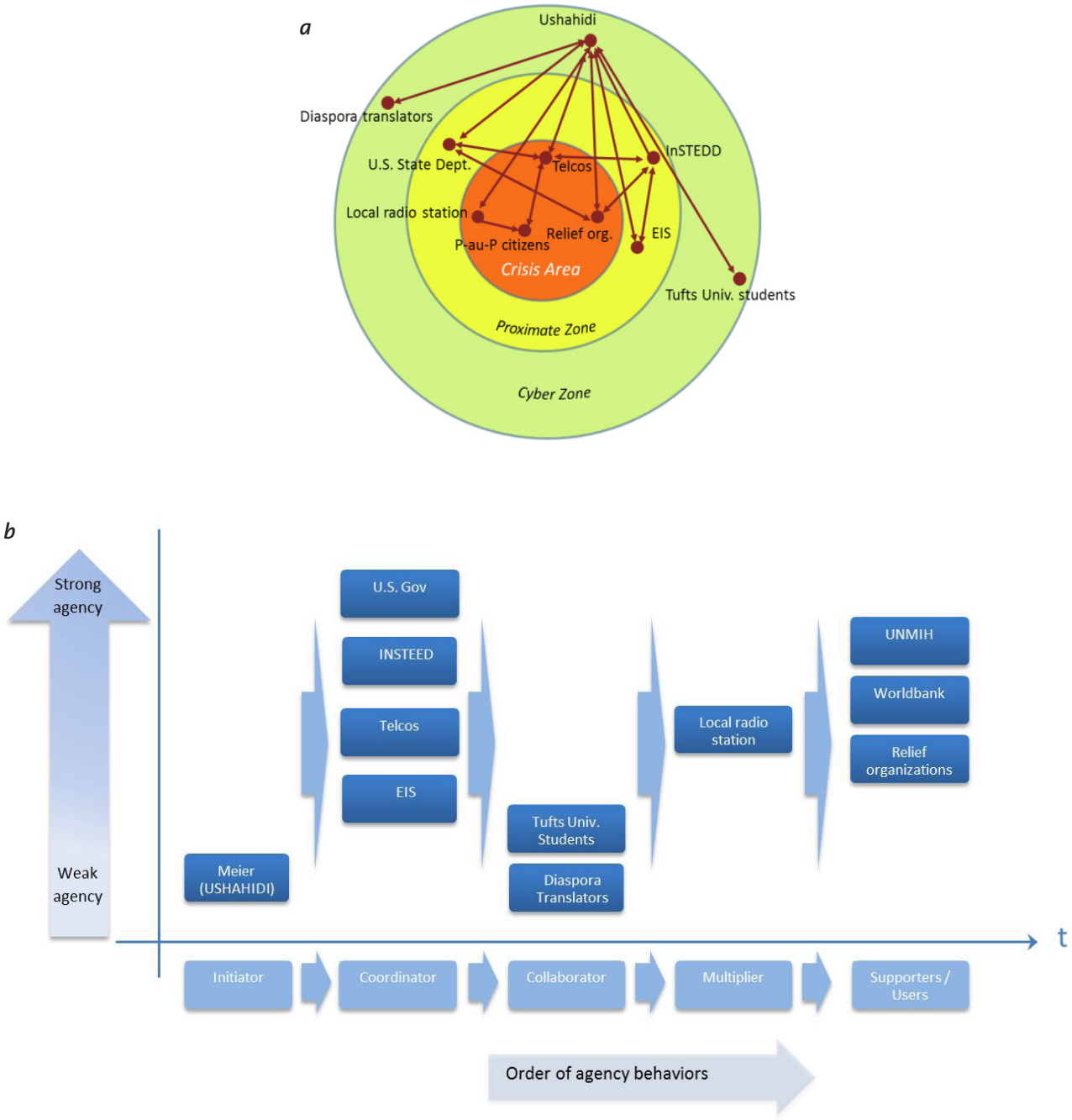

Figure 5: *Figure 5a is the Crisis Mapping Convergence Model for Haiti Case listing the network of main agents. In figure 5b the agents are represented in a different graphical way by weighing their agency and behaviour over time. Though the crisis mapping process is a dynamic one with feedback loops between the agents, there is a progression that allows the map(s) to be created.*

3.2 London Riots 2011

For our second case study, we turn to London where, in August 2011, peaceful protests against the police shooting of Mark Duggan in Tottenham north London quickly transformed into full-blown riots. Large parts of the affected infrastructure were local businesses that were looted or vandalized, but clashes between the police and rioters drove parts of London at least close to the breakdown of public order over a 4-day period. At the height of the unrest on day three, 8 August, 22 out of the 32 boroughs in London were affected.[42] As people debated the root causes that led to the sudden flashpoint of urban unrest, there was a broad consensus of the significant role that social media and mobile technologies played. On the one hand, some reports noted how social media and mobile devices were used to mobilize rioters and looters.[43] On the other hand, such tools and platforms were used to track incidents and categorize information on crisis maps. However, unlike the Haiti case, in the London context we found that there were a number of crisis maps that emerged out of the crisis system rather than one major crisis map. In other words, there were various mapping processes that occurred simultaneously, some of which overlapped each other in terms of content. A selection of crisis maps is listed below.

Map	Map creator	Content/aim
Guardian riot map http://www.guardian.co.uk/news/datablog/interactive/2011/aug/09/uk-riots-incident-map	The Guardian, a mainstream media group	Tracked and mapped incidents, based on the cross-verification of different sources, ranging from police reports to twitter feeds
London riot map http://londonriotsmap.appspot.com; http://harrywood.co.uk/maps/london-riots	Local Londoners (residents/citizens)	Used OpenStreetMap (OSM) to track and map incidents (similar to Guardian map)
MapTube Riots and Deprivation map http://www.maptube.org/map.aspx?mapid=118	Company/organization	Layered map to show correlation between violent incidents and deprivation to analyze potential socio-economic root courses of the riots
Brixton Incident Map https://brixton811.crowdmap.com/main	Local Brixton residents	Used Crowdmap (a subset of the Ushahidi software) to list reports on violence, looting, transport problems, etc.
Riots Clean-up Map https://ukriotcleanup.crowdmap.com/main	Local Londoners (residents/citizens)	Used the Ushahidi platform and served to connect those who needed help after riots with those offering assistance
DeLoot London Map http://www.delootlondon.co.uk	Individuals/business	Sought to assist the post-riot environment by mapping and promoting shopping at independent businesses that were victims of looting

42 The Guardian (2011). Reading the Riots: Investigating England's Summer of Disorder. Report Produced by the London School of Economics and the Guardian, p. 17. Available at: http://www.guardian.co.uk/uk/interactive/2011/dec/14/reading-the-riots-investigating-england-s-summer-of-disorder-full-report

43 For example, see: "Social media blamed for London riots", Global Post, 8 August 2011. Available at: http://www.globalpost.com/dispatch/news/regions/europe/110808/social-media-blamed-london-riots; Wingrove, J. "Alleged rioters singled out over social media following London unrest", The Globe and Mail, 18 March 2012. Available at: http://www.theglobeandmail.com/news/national/alleged-rioters-singled-out-over-social-media-following-london-unrest/article534680

As the table illustrates, the crisis mapping phenomenon in the London riot case was much more decentralized, with multiple maps emerging out of the crisis system. For one, the aims of the maps varied from listing reports of violence and damages to those that addressed the post-riot (or, in other words, post-crisis) phase so to assist with self-help, community cleanup. The multiplicity of crisis maps in a single crisis situation exemplifies how the phenomenon of crisis mapping had become institutionalized into social systems when the crisis took place in London. Due to the routines, but also the resources available during the London riots, convergent processes were mostly limited to the technical infrastructure of the crisis maps. In contrast for example to the Haitian case, apparently there was no large-scale convergence of information or people in the London case. Most actors involved appeared to be physically close to the zones of crisis. In terms of the levels of agency, this is also rather varied depending on the map. In figure 6, we attempt to illustrate both the network of agents in the adapted crisis mapping convergence model as well as measure the agent's behavior over time and their level of agency from weak to strong. The **"initiators"** ranged from mainstream media groups like the Guardian, which launched its own map and has a medium to strong agency, to those initiated by local citizens, with comparably weak agency. The specific **"collaborators"** and **"supporters"** are more difficult to decipher. In terms of the **"multipliers"** however, media channels played a role as well as social media. For example, people used Twitter to share clean-up related information, using specific hashtags (#) for the crisis maps so that such information would not only circulate throughout Twitter but also be integrated into one of the crisis maps. Considering that the "cleanup mobilization reached more than 7 million Twitter users – far in excess of any incitement tweet,"[44] the power of this multiplication effect was telling in the London case. Lastly, the **"users"** ranged from the General public, media, and local officials and businesses.

44 Reading the Riots (2011)

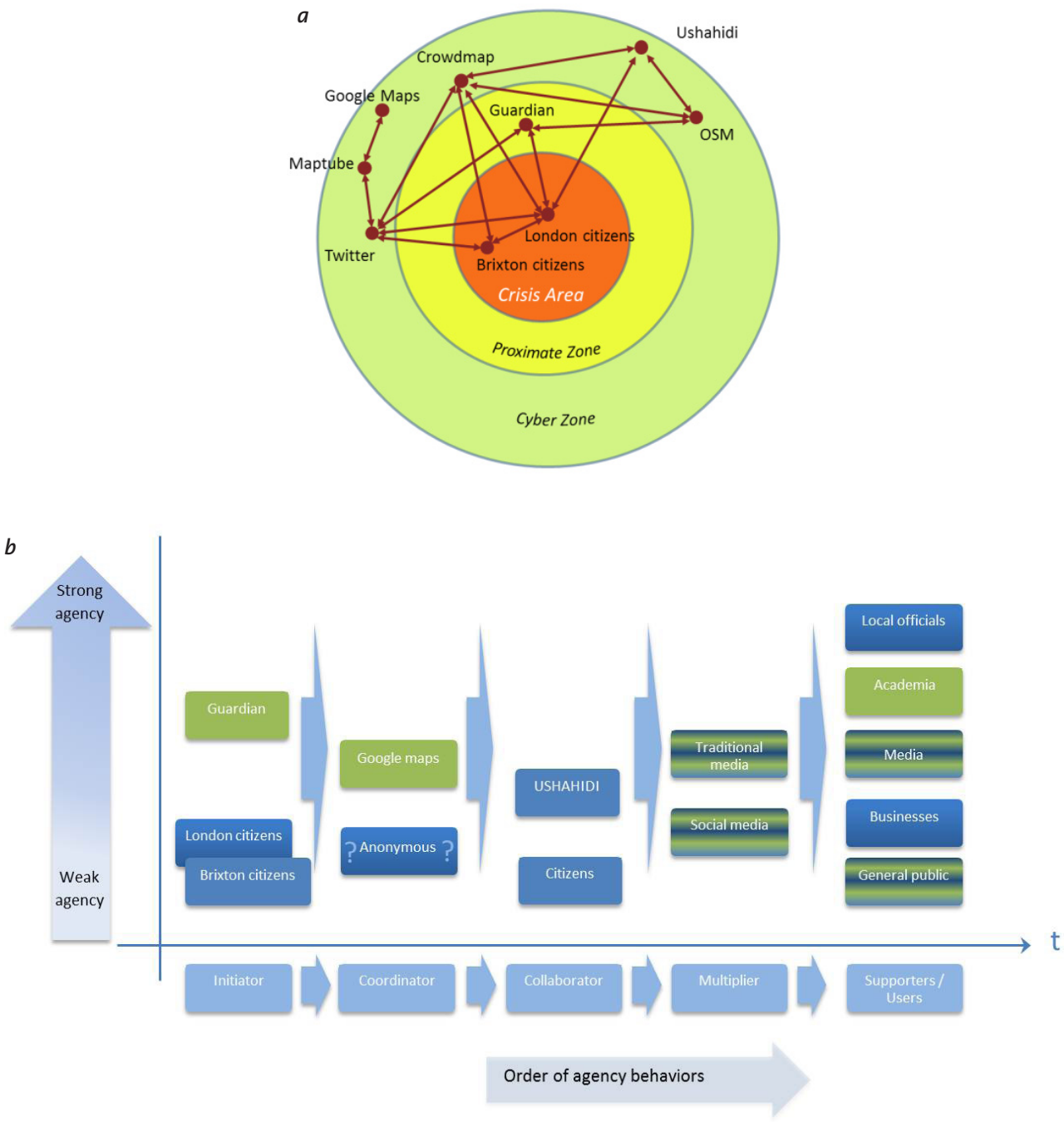

Figure 6: *Figure 6a is the Adapted Crisis Mapping Convergence Model for the London Case listing the network of main agents. In figure 6b, the agents are represented in a different graphical way by weighing their agency and behaviour over time. Depicted in green color is the crisis map initiated by the Guardian, in blue color are the maps created by citizens in London and Brixton.*

4 CONCLUSIONS

This report attempted to use the crisis mapping phenomenon as an entry point to examine the novel ways in which communities were coordinating and adapting in crises. We began with a theoretical discussion that sought to use insights from convergence and complex adaptive systems theory to unpack the process of crisis mapping. While this approach helped illustrate the overall process and present an argument for the emergence of crisis mapping, it did not say enough about the behavior or characteristics of the agents involved in crisis mapping. From there, we selected two contrasting crisis mapping cases which both illustrate the trajectory of this trend and its diversity in application. Within each case, we identified the key agents involved, their behavior and strength.

4.1 General Policy Implications

Overall, our analysis brings to light at least three points, all of which have direct policy implications:

- **First**, in many crisis situations, convergence of people, material and information towards the crisis zone can be observed. New information technologies foster three different forms of convergence from the cyber zone to the crisis zones: First, materials such as software programs or satellite imagery converge and are able to facilitate the coordination of crisis mitigation and recovery. Second, additional human resources can be mobilized in crisis situations which do not have to be physically at the location of the crisis, but can theoretically be anywhere in the world. These human resources can be utilized for example to coordinate relief efforts, analyze satellite imagery or translate content in other languages. Third, useful information from the cyber zone can converge around a crisis. Particularly useful are information that can guide the behavior of the agents in the crisis zone. In sum, new information technologies such as crowdsourced online maps have the potential to open new opportunities to enable collaboration in crisis situations and overcome coordination problems. The application of these technologies can activate additional valuable resources and speed up information collection and dissemination in complex emergencies. Thereby, it can function as an important tool to increase systemic resilience.
- **Second**, as previous research has shown, complex systems – whether ecological or social – affected by adverse events are able to self-organize during a crisis without a central steering actor. Our analysis revealed that the same can be observed in online communities where users converge in crisis situations and contribute to mitigation and recovery processes. However, although resilience relies on button-up processes and cannot be prescribed from the top level downward, agency nevertheless plays a decisive role. As the cases in this study show, different kinds of agents can play varying roles when dealing with a crisis, particularly in the area of coordinating resources and information. While in some crisis situations strong agents (such as governmental institutions or established NGO's) are important, in other emergencies weak agents (e.g. loosely connected groups of activists) shape the way collaborative resilience takes place. The analyzed cases showed how different actors depending on the situational context fill the central roles in adaptive processes. Particularly interesting are those agents who initiate the crisis mapping processes, be it in the form of an idea that is spread or a technical tool that is being developed and used. The particular

capabilities and interests of the initiating agent often give the emergent process a specific direction or twist that cannot be explained sorely on a systemic level, but that instead demands the inclusion of the agent level into the analysis. The level of agency at this step of process showed a high variation between the cases analyzed, e.g. while in the Haiti case this part was played by an individual activist. As crisis mapping projects grow after their initiation, so too does the necessity for coordination among the different agents involved. Although complex adaptive systems are by definition self-organizing, the analyzed cases showed that organizational tasks such as coordinating the system's resources are not equally fulfilled by all agents. Rather in most crisis situations, a coordinating agent comes to the fore that specializes in these kinds of tasks. Another type of agent that is particularly pivotal to the success of adaptive behavior in crisis situations is the agent that serves as a "multiplier", such as the radio station in the Haitian case. This plays the role of attracting broader parts of the system to participate in the activity that helps a group or community cope more effectively with a crisis.

- **Third**, even though collaborative action is sometimes depicted as an alternative model of governance that bypasses state institutions, governmental actors still play an important part as facilitator, supporter or multiplier. While governments are increasingly calling for more resilient societies, the relationship between self-organizing crisis management and public actors is not straightforward and probably even carries risks for the latter. On the one side, emergent behaviors in crisis situations can support and complement governmental action. Certainly this can be perceived as a challenge for government as emergent behaviors are by definition unexpected outcomes within a system, thus challenging planning. However, by adopting a more flexible and open stance government can be in a better position to catch and facilitate new phenomena, such as crisis mapping, when they emerge. Of course, on the other side, government actors, regardless of whether at the local or federal level, only have limited means to steer emergence at the community level, since resilience is by definition achieved through self-organization. Governments certainly have a role in such processes but cannot assume that they will be able to control or predict it - rather they could play a role as facilitator, supporter or multiplier. Needless to say, since it appears that non-state actors will continue to play myriad roles in crises, there are few alternatives for state actors but to develop strategies that treat social stakeholders as partners. In fact, governmental actors in many countries have recognized the necessity to join forces with other social actors. This particularly is the case with private business companies that own and control critical infrastructure or fulfill other important social functions.[45] Yet, as our analysis has shown, myriad of actors can play important roles in coping with crises and strengthening social resilience. In order to tap all the available resources for building social resilience, governmental actors need to develop new approaches how to integrate the multitude of involved social stakeholders into governmental strategies of risk and crisis management.

45 Cavelty, M. D., & Suter, M. (2009). Public-Private Partnerships Are No Silver Bullet. An Expanded Governance Model for Critical Infrastructure Protection. *International Journal of Critical Infrastructure Protection*, 179–187.

4.2 Implications for Switzerland

Coordination and collaboration are essential elements of crisis management strategies. However, contemporary approaches to crisis management mainly rest upon strong agents such as first responders, traditional media or private business companies. At the same time, new information technologies such as crowdsourced online crisis maps open new opportunities for new, often only loosely organized social actors to contribute valuable resources (such as ground information and local knowledge) to the management of complex crisis situations. To date, instances of online self-organization in crisis situations have remained a rare phenomenon in Switzerland so far, probably due to the fact that Switzerland did not have to cope with large-scale crises in recent years. Nonetheless, it is to be expected that with the further spread of ICT, crisis mapping will become of increased importance in the next years. Yet, given that emergent, self-organizing processes in complex systems are generally hard to predict or even to steer, the constitution and effects of crisis mapping must appear almost incalculable beforehand. Consequently, in order to tap the resources of social self-organization in the most efficient way, it appears most auspicious to focus on the preconditions for emergent social behavior in crisis situations. To incorporate emergent dynamics into crisis management and develop future-oriented strategies, the following issues deserve particular attention:

a **Analysis:** Today's knowledge of self-organizing processes in crisis situations remains limited. Why do people or groups of people in some cases self-organize and in other not? What motivates people to engage in self-organizing processes? And how can emergent processes in crisis situations be encouraged and synchronized with governmental crisis management? A first step to find an answer to these questions could be to conduct a screening of social actors that potentially could *'converge'* people, material or information to emergent processes in crisis situations. In a way, this could be similar to a stakeholder analysis where you would identify the various social groups and individual assets within a community. Recalling the cases examined in this report, one finds that converging actors included media groups, technology or software companies, local to federal government actors, individuals, etc. For example, such assessments can be done at the cantonal level and then incorporated into trainings and exercises. What are the major assets of these actors, what are their interests and what obstacles could probably hinder their convergence?

b **Strategy:** Based on a comprehensive analysis of potential partners and stakeholders in future crisis mapping scenarios, emergent processes could be integrated into crisis management dialogue and strategies at different administrative levels. In line with the emphasis on *resilience* that Swiss civil protection strategies, such as the Federal Council's Basic Strategy for Critical Infrastructure Protection released in 2009,[46] emphasis should also be placed on the emergent and self-organizing processes that are born out of crisis situations.

c **Tools and Training:** Finally, steps could be taken to prepare public agencies, private business actors as well as other social entrepreneurs for crisis situations by facilitating the convergence of people, material and information. Specifically, this could mean for example to clarify legal issues that relate to the sharing of satellite imagery which have repeatedly delayed or even impeded the convergence of these important information in crisis situations in the past. Further, a specialized training

46 Swiss Federal Council. "Federal Council's Basic Strategy for Critical Infrastructure Protection", 18 May 2009. Available at: http://www.infraprotection.ch

program on the use of new ICTs in crisis situations could be valuable. Tailored towards the specific demands and interests of first responders, critical infrastructure operators (e.g. telecommunication companies), but also other social stakeholders and the more general public, such trainings could promote the collaborative uses of important technologies like geo-referencing systems and micro blogging services by different social agents and thereby would enhance social resilience in Switzerland.

In sum, these focus areas are expected to strengthen the communicative structures available in crisis situations, while keeping these structures flexible and adaptive at the same time. As Sellnow and Seeger (2002) note, such a flexible approach to crisis communication can contribute to societal resilience. "Maintaining flexible, responsive and resilient channels of communication during disasters clearly should be a priority of crisis managers. Moreover, emergency managers should understand the role of such systems in crisis logistics, in re-establishing normalcy and community, and as a force in subsequent self-organization."[47] However, in order to achieve substantial resilience on the societal level, it appears not enough to include a more flexible approach to crisis coordination and communication in the handbooks and practices of professional crisis managers. Rather, it is necessary to explore ways to encourage other social actors such as private companies and community representatives to participate in resilience building efforts.

47 Sellnow, T. L., Seeger, M. W., & Ulmer, R. R. (2002). Chaos theory, informational needs, and natural. Journal of Applied Communication Research, p. 289.

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