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Crisis Mapping in Switzerland: A Stakeholder Analysis

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CONTENTS

ABBREVIATIONS

CTE	Steering Committee for the Coordination of Transport in the Event of Disaster [KOVE, Koordination des Verkehrswesens im Ereignisfall]
ENS	Swiss Federal Nuclear Safety Inspectorate [Eidgenössisches Nuklearsicherheitsinspektorat]
ESA	European Space Agency
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HOT	Humanitarian OpenStreetMap
ICT	Information and Communication Technology
NASA	National Aeronautics and Space Administration
NEOC	National Emergency Operations Centre [Nationale Alarmzentrale]
PPGIS	Public Participation Geographic Information System
P&S	Protection and Support Service [Zivilschutz]
SMS	Short Message System
SBB	Swiss Federal Railways [Schweizerische Bundesbahnen]
USAID	United States Agency for International Development
UN-OCHA	United Nations Office for the Coordination of Humanitarian Affairs
VCC	Virtual Crisis Convergence
VGI	Volunteered Geographic Information

1 INTRODUCTION

The way societies prepare and cope with natural, technical and man-made disasters has undergone significant changes in recent years. Probably the most pervasive trend has been a shift from the protection paradigm, focused on disaster prevention through strategic planning and effective command and control structures, to the resilience paradigm where disaster management is about adaption during and after a disaster. Based on the assumption that in a complex world, the timing, magnitude and form of future disasters can never fully be predicted, recent strategies emphasize principles of flexibility and redundancy as well as the self-organization of social actors. Handling crisis events becomes a challenge that involves a network of actors or, in other words, society as a whole.[1] Consequently, established structures of crisis management are being challenged by new forms of crisis engagement by different social stakeholders.

This trend to use the knowledge and capabilities from different parts of society to enhance crisis management has been significantly facilitated by the fast spread of information and communication technologies (ICT). Within this realm, social media platforms, such as Facebook and Twitter, open new opportunities to exchange information during crisis and organize collaborative action.[2] A particularly interesting example of ICT-enabled collaborative action during disaster is the phenomenon of crowdsourced crisis maps, which have become an increasingly frequent characteristic in responses to major crises in recent years. In general, accurate and timely maps are a pivotal resource in the wake of all kinds of disasters.[3] However, such a resource has historically been in the hands of, and utilized by, first responders and crisis managers. Crowdsourced crisis maps alter this paradigm by allowing anyone to organize and visualize information during a crisis. Such accessibility has led to crisis maps finding a local footing in various types of disasters as well as contexts. Yet despite the recent prominence of crowdsourced crisis maps, they still represent a 'new' trend that has yet to become a ubiquitous concept and tool. Moreover, beyond anecdotal evidence, little is known about the actual utility of crowdsourced crisis maps as well as the relationship between crowdsourced crisis maps and how they impact, assist or challenge professional crisis management.

1.1 Crisis mapping defined

Crowdsourced crisis maps emerged in the last decade as a series of civil society projects – often launched by small groups or even individual media users with the intention to collect and organize geo-referenced information from a large number of sources during crisis in order to make it useful for emergency managers as well as those people affected by the crisis. Most notably, in 2007 the Harvard Humanitarian Institute launched the project 'Crisis Dynamics and Crisis Mapping', which sought to "examine how mobile technologies, geospatial data, and citizen based

1 Goldstein, B. E. (2011): Conclusion: Communicative Resilience, in: Goldstein, B. E. (ed.): Collaborative Resilience: Moving Through Crisis to Opportunity, Cambridge: MIT Press, pp. 359–372.

2 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,* vol. 35, no. 1, pp.67–87; Veil, S.; Buehner, T.; Palenchar, M.J. (2011): A Work-in-Process Literature Review: Incorporating Social Media in Risk and Crisis Communication, *Journal of Contingencies and Crisis, Management,* vol. 19, no. 2, pp. 110–22.

3 National Research Council Committee on Planning for Catastrophe (2007): Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management, NRC Report, http://www.nap.edu/catalog/11793.html.

reporting are influencing humanitarian action and disaster response".[4] In 2008, a group of Kenyan citizen journalists launched a crisis mapping platform known as Ushahidi, the first of its kind, in response to the post-election violence following Kenyan elections. The Ushahidi team used Google Maps to post incident reports sent by users via e-mail or text (SMS) with the aim to verify eyewitness accounts and make humanitarian assistance efforts more transparent. Today, crisis mapping can be understood as a process and an outcome, one that combines various streams of "crowdsourced" information (coming from ICT, news, and social media) that is geo-coded, categorized, verified and finally visualized on mapping platforms (see figure 1 for the 3-step process).

More broadly, the rise of crisis mapping is part of a larger trend towards public participation in geo-information systems (PPGIS) that started in the 1990's and has since accelerated, now often referred to as volunteered geographical information (VGI).[5] While for many decades map-making had been primarily in the hands of professional geographers, there were mainly three interrelated technological drivers that proliferated the emergence of PPGIS and VGI, and thereby also of crisis mapping. First, in recent years, the technical infrastructure for fast and high-volume data exchange has developed quickly around the world. Second, GPS/GNSS receivers have become broadly available to the public at low costs, often already incorporated into mobile phones.[6] Finally, geo-referenced data (collected for example by individuals during a crisis) can be combined with existing online maps (such as Google Maps or OpenStreetMaps) or virtual globes (e.g. Google Earth, Bing Maps) to so-called map-mashups.[7] Together these technological advancements have fundamentally changed the nature of disaster and crisis mapping, leading to what Kamel Boulos refers to as the 'Wikification of GIS by the masses'.[8] Contrary to traditional mapping, crowdsourced maps typically rely on volunteers to collect, organize, verify, visualize and share geo-refer-

Figure 1: Crisis mapping process, illustrating the 3 main steps (source: own illustration)

4 Harvard Humanitarian Institute (2012): Program on Crisis Dynamics and Crisis Mapping, http://hhi.harvard.edu/images/resources/program%20on%20crisis%20dynamics%20and%20crisis%20mapping1.54.pdf.

5 Weiner, D.; Harris, Trevor M. (2008): Participatory Geographic Information Systems, in: Wilson, J.P.; Fotheringham, A.S. (eds.): The Handbook of Geographic Information Science, Wiley: London, pp. 466–480; Goodchild, M. (2007): Citizens as Sensors: The World of Volunteered Geography, *GeoJournal,* vol. 69, no. 4, pp. 211–221.

6 See also: Ryerson, R.A.; Aronoff, S. (2010): Why ‹Where› Matters: Understanding and Profiting from GPS, GIS, and Remote Sensing, Kim Geomatics, Lemmer.

7 Stark, H.-J. (2013): Personal communication with the authors, February 15, 2013.

8 Kamel Boulos, M.N. (2005): Web GIS in Practice III: Creating a Simple Interactive Map of England's Strategic Health Authorities Using Google Maps API, Google Earth KML, and MSN Virtual Earth Map Control, *International Journal of Health Geography,* vol. 4, no. 22.

enced information.[9] Depending on the context, these volunteers can be professional emergency managers, humanitarian activists, geo-information specialists or citizens with local knowledge of crisis areas.[10]

Crisis mapping is driven by the goal to make the idea of crowdsourced mapping useful for the prevention and mitigation of human crises as well as for the post-disaster learning processes. To these ends, crisis mapping can entail different forms and fulfill various functions in the wake of crisis. To note, a crisis map can involve the process of collecting and organizing information from within a crisis area with the aim to improve situational awareness (and effectiveness) of emergency responders.[11] Alternatively, crisis maps can be highly useful to filter and categorize crisis-relevant information from other media channels, in particular from social media, which are important communication means during all kinds of crises today.[12] Such tools provide users with easy and constant access to email, blogs and social media portals like Twitter, YouTube or Facebook. These communication portals offer myriad, alternative and accessible pathways to receive and share crisis information. In fact, it has become the norm for people to use new media to communicate the consequences of disasters.[13] Naturally, through this process, maps have become more dynamic, participatory and tailored – many providing the function of feeding information back to the crowd, otherwise known as "crowdfeeding", a "bottom to bottom" horizontal type of communication of the crowd, by the crowd and for the crowd.[14] In this sense, crisis mapping emerged as an expression of self-empowerment through self-organization during disaster. Instead of waiting for authorities to react and coordinate responses, citizens initiated grassroots collaborations to improve their situations.

Though the Kenyan case was the first early example of crisis mapping, its breakthrough came during the Haitian earthquake in 2010. In the context of a massive disaster, a group of activists was looking for opportunities to employ their skills in crowdsourced map-making to help those affected by the disaster. Soon after the earthquake, it turned out that the distribution of immense international help as well as the coordination of the multitude of emergency and relief organizations posed a major obstacle to bringing effective help to the Haitain people. In response, within only few hours, the group of activists initiated a crisis mapping project that became one of the most significant disaster management resources for the event that was relied upon by various local and international actors present in Haiti. The Haitian crisis map included information from the affected population collected via SMS, which was then translated to English by members of the Haitian diaspora. This in-

9 Goodchild, M. (2007): Citizens as Sensors: The World of Volunteered Geography, *GeoJournal,* vol. 69, no. 4, pp. 211 – 221.

10 Stark, H.-J. (2013).

11 As Burke and his co-authors (2011) highlight, crowdsourcing does not automatically presuppose the active participation of those who provide the information, but can also function as so-called 'participatory sensing'. Following this approach, data generated by mobile technology devices (e.g. GPS sensors in mobile phones) are automatically transmitted to a database and used to "gather, analyse and share local knowledge" (Burke, J.; Estrin, D.; Hansen, M.; Parker, A.; Ramanathan, N.; Reddy, S.; Srivastava, M.B. (2006): Participatory Sensing, UC Los Angeles: Center for Embedded Network Sensing, http://escholarship.org/uc/item/19h777qd; see also: Kamel Boulos, M.N.; Resch, B.; Crowley, D.N.; Breslin, J.G.; Sohn, G., Burtner, R.; Pike, W.A.; Jezierski, E.; Chuang, K.Y. (2011): Crowdsourcing, Citizen Sensing and Sensor Web Technologies for Public and Environmental Health Surveillance and Crisis Management: Trends, OGC Standards and Application Examples, *International Journal of Health Geography,* vol. 10, no. 67.

12 Fraustino, J. D.; Brooke, L.; Yan J. (2012): Social Media Use during Disasters: A Review of the Knowledge Base and Gaps, Final Report to Human Factors/Behavioral Sciences Division, Science and Technology Directorate, U.S. Department of Homeland Security. College Park, MD, http://www.start.umd.edu/start/publications/START_SocialMediaUseduringDisasters_LitReview.pdf.

13 Procopio and Procopio (2007).

14 Dunn Cavelty, M.; Giroux, J. (2011): Crisis Mapping: A Phenomenon and Tool in Complex Emergencies, *CSS Analysis,* No. 103. Center for Security Studies (CSS), ETH Zürich: Zürich, Crisis Mapping: A Phenomenon and Tool in Complex Emergencies, http://www.css.ethz.ch/publications/pdfs/CSS-Analysis-103-EN.pdf.

formation was then verified and merged with other crisis-relevant information layers (in particular satellite and aerial imagery) to create a map of Port-au-Prince, more detailed and timely than any other map available at that time.[15] The outcome was a map that depicted the levels of damage, areas in urgent need of help, as well the location of important resources such as emergency shelters. Following the far-reaching experiences in Haiti, crisis maps have been initiated with increased frequency – for example, to alert about bushfires in the United States, Russia and Australia, to monitor human rights violations in Libya, or cope with hurricanes in the United States and the Philippines.[16] In the aftermath of Hurricane 'Sandy' in 2012, for example, a crisis map was set up to categorize the levels of damage in different coastal areas on the bases of high-resolution aerial imagery provided by the US Civil Air Patrol in order to support the recovery process in the disaster-affected regions.[17]

What would a crisis map look like in a Swiss context, how could it be organized and for what types of crises? Which actors would be involved and what role could government play?

Notably, all mapping projects mentioned above were largely created on an ad-hoc basis. What exact functions each crisis map offered and what kinds of actors were involved in setting up the map above all has been influenced by the specific context of each crisis situation. Yet, the lack of institutionalization and/or strategic frameworks does not imply that crisis maps cannot be encouraged by facilitating certain processes or structures. Indeed, this is an area of research that would be particularly relevant for countries like Switzerland where crisis maps have yet to emerge.

1.2 Scope of Study

The purpose of this study is not only to examine crisis mapping, but more importantly to place this phenomenon within a Swiss context. What would a potential crisis map look like in a Swiss context? Which actors would be involved and what role could governmental actors play? So far, crisis mapping projects have mainly been led and carried out by non-state actors (often volunteers). Originally, government actors often regarded crisis mapping with some skepticism as well as concern, because they feared negative impacts on institutionalized crisis management and communication efforts. However, as we have observed in another study,[18] in recent years, state actors have increasingly found a role in such processes. At the same time, despite their reported usefulness for mitigating the effects of disaster and speeding up recovery processes, to date little is known about how the phenomenon of crisis mapping could be brought in line with established procedures of disaster management.

These questions are not easy to answer, particularly in a country like Switzerland, which has rarely been affected by major disasters in recent years and has not yet witnessed a crisis mapping effort. This is not to say that crisis mapping is not discussed within Switzerland; in fact it is an emerging topic of interest

15 Heipke, C. (2010): Crowdsourcing geospatial data, *ISPRS Journal of Photogrammetry and Remote Sensing*, vol. 65, pp. 550–557; Clark, J.; Holliday, P.; Chau, R. ; Eisenberg, H. ; Chau, M. (2010): Collaborative geospatial data as applied to disaster relief: Haiti 2010, in: Kim, T.-H.; Fang, W.-C.; Khan, M. K. (eds.): Security Technology, Disaster Recovery and Business Continuity. vol. 122, Springer: Berlin, pp. 250–258.

16 See for example: http://google.org/crisismap/2012_us_wildfires; http://russian-fires.ru; http://blog.standbytaskforce.com/libya-crisis-map-report; http://google.org/crisismap/2012-tropical-system-isaac; http://www.rfs.nsw.gov.au/dsp_content.cfm?cat_id=683; http://emergencyjournalism.net/philippines-google-crisis-map-for-typhoon-bopha-pablo.

17 See: sandy.locative.us.; http://irevolution.net/2012/11/01/crowdsourcing-sandy-building-damage/

18 Giroux, J.; Roth, F. (2012): Conceptualizing the Crisis Mapping Phenomenon: Insights on behaviour and the coordination of agents and information in complex crisis, *Focal Report 7*, Center for Security Studies (CSS), ETH Zürich: Zürich, http://www.css.ethz.ch/people/CSS/DetailansichtPubDB?rec_id=2283.

in some policy and research circles.[19] To examine how crisis mapping in Switzerland could be organized, we suggest a three-step approach. First, we review several recent instances of crisis to identify key stakeholders that tend to play a decisive role in such processes. Based on our recent work on agency and behavior in self-organized crisis collaborations,[20] we develop a typology of stakeholders in crisis mapping situations. In a second step, we attempt to transfer the phenomenon of crisis mapping to the Swiss context. To this end, based on a real crisis situation experienced recently in Switzerland, we describe a scenario in which a crisis mapping project might emerge. In particular, based on several background interviews with experts from Swiss authorities, technology companies, academia and civil society,[21] we examine which social actors in Switzerland would likely be involved in such a crisis mapping project and how the collaboration among these actors could take place. Finally, based on the findings of the scenario exercises, we discuss possible future directions for crisis mapping in Switzerland.

19 See: e.g. Stark, H.J. (2010): Quality assessment of volunteered geographic information (VGI) based on open web map services and ISO/TC 211 19100-family standards, *Geoinformatics*, vol. 7, pp.28–30; to mention are further the 3rd International Conference of Crisis Mappers that was held in Geneva in November 2011 and co-sponsored by the Swiss Ministry of Foreign Affairs (EDA) (*http://crisismappers.net/page/iccm-geneva-2011*) as well as a workshop co-organized by the OECD and the IRGC on social media and crisis communication in Geneva in June 2012 (*http://www.irgc.org/event/social-media-workshop*).

20 Giroux and Roth (2012).

21 In particular, we have spoken to representatives of Google in Switzerland, OpenStreetMap Foundation, Ushahidi, Opendata.ch, the University of Applied Sciences Northwestern Switzerland (FHNW), and the National Emergency Operations Centre (NEOC).

2 TOWARDS A TYPOLOGY OF STAKEHOLDERS IN CRISIS MAPPING SITUATIONS

Despite the growth and reach of crisis mapping, there are still many practical questions about its utility, the overarching process, and stakeholders involved. The most influential analyses that have addressed the issue of crisis mapping were undertaken by civil society activists or institutions directly involved in crisis management.[22] In most instances, these studies aim to make crisis mapping more effective, often focusing on the technological aspects of geo-informatics, crowdsourcing and crowdfeeding. Although these contributions are highly valuable to understand the dynamic practices of crisis mapping, there have only been a few attempts to systemically analyze the phenomenon of crisis mapping from a social science perspective.[23] Particularly little is known about the actors involved in crisis mapping. On a first sight, crisis mapping projects seem to be primarily in the hands of novel international non-governmental organizations, such as INSTEDD, MapAction, Humanitarian OpenStreetMap (HOT), Geeks Without Bounds, Ushahidi, Sahana or CrisisMappers. Some of these organizations have a humanitarian background, others have been developed in technology communities. At the same time, these organizations are rather loose platforms than distinctive entities. As will be shown below, crisis maps are based on a large number of collaborating individuals and institutions. Yet, questions over what types of individuals engage in crisis mapping or what social institution contribute to crisis mapping projects have remained largely unanswered to date, even though these points may be considered key to understanding the phenomenon of crisis mapping and possibly developing it further.

2.1 The dynamics of crisis convergence

In order to shed some light on those social actors that hold major stakes in crisis mapping processes, we suggest employing the concept of virtual crisis convergence (VCC), which we developed in a recent study.[24] The concept of VCC is based on the classic study of individual behavioral patterns during crises by Charles Fritz and John Mathewson and its adaption to the information age by Sophia Liu and her co-authors.[25] In their original study of different his-

22 E.g. Meier, P. (2012): Crisis Mapping in Action: How Open Source Software and Global Volunteer Networks Are Changing the World, One Map at a Time, *Journal of Map and Geography Libraries*, vol. 8, no. 2, pp. 89–100; American Red Cross (2010): The Case for Integrating Crisis Response with Social Media, ARC White Paper, http://de.scribd.com/doc/35737608/White-Paper-The-Case-for-Integrating-Crisis-Response-With-Social-Media. OCHA (2011): Disaster 2.0: The future of information-sharing in Humanitarian Emergencies, report, http://www.unocha.org/top-stories/all-stories/disaster-relief-20-future-information-sharing-humanitarian-emergencies.; Fraustino, J. D.; Brooke, L.; Yan J. (2012): Social Media Use during Disasters: A Review of the Knowledge Base and Gaps, Final Report to Human Factors/Behavioral Sciences Division, Science and Technology Directorate, U.S. Department of Homeland Security. College Park, MD, http://www.start.umd.edu/start/publications/START_SocialMediaUseduringDisasters_LitReview.pdf.

23 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, Springer: Berlin, pp. 197–204; Giroux, J.; Roth, F. (2012): Conceptualizing the Crisis Mapping Phenomenon: Insights on behaviour and the coordination of agents and information in complex crisis, Focal *Report 7*, Center for Security Studies (CSS), ETH Zürich: Zürich, http://www.css.ethz.ch/people/CSS/DetailansichtPubDB?rec_id=2283.

24 Giroux, J.; Roth, F. (2012).

25 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, *Proceedings of the Information Systems for Crisis Response and Management Conference*.

torical disasters, Fritz and Mathewson found that, in deviance from widespread belief, instead of simply descending into a state of panic and helplessness, people converged into groups during crisis situations. In other words, the authors observed a self-organizing quality that groups of people exhibit in crisis.[26] This convergence is characterized by the flow 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 1).[27] During this process of convergence, a social component is expressed in the formation of 'identities' that take shape in a post-crisis environment. These identities form patterns of behavior. For example, some people are or want to be 'helpers' or 'supporters' in a crisis, while others use a crisis for 'exploitive' purposes.[28] Linking this physical manifestation of social convergence, as developed by Fritz and Mathewson, Liu et al. (2008) also suggest that similar crisis behavioral patterns express themselves in the virtual world as well.[29] Mobile phones, social media platforms, text and email, photo and video sharing, etc., offer a parallel world for individuals (as well as information and resources) to converge during crisis. For example, during and following Hurricane Sandy people organized in volunteer units to deliver aid, provide assistance with clean-up etc., while in the virtual world people utilized Twitter and

Figure 2: (Top) Screenshot of #Sandy Twitter feed where individuals, news organizations, officials, etc. could share info and organize it using #Sandy. (Below) Screenshot of Facebook page of individual sharing official information from news reports as well as personal accounts and photographs (source: own illustration based on Twitter and Facebook websites).

26 Fritz, C. E.; Mathewson, J. H. (1957): Convergence Behavior in Disasters: A Problem in Social Control, Committee on Disaster Studies, Division of Anthropology and Psychology, National Academy of Sciences – National Research Council, Washington D.C, http://archive.org/details/convergencebehavoofritrich, p. 3.

27 Ibid, pp. 3–4.

28 Hughes, A. L.; Palen, Leysia; Sutton, Jeanette; Liu, Sophia B.; Vieweg, Sarah (2008):" Site-Seeing": An examination of On-Line Social Convergence, *Proceedings of the 5th International ISCRAM Conference*, Washington D.C., http://works.bepress.com/cgi/viewcontent.cgi?article=1019&context=vieweg, p. 2.

29 Liu, S., Palen, L., Sutto , 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.

Facebook to offer information (see Figure 2). In other words, in both the physical and virtual realm this converging behavior (i.e. to move towards the crisis via providing/sharing information, offering aid and assistance, etc.) is observed. Consequently, this moved crisis management professionals, such as the Mayor of NYC and NJ, into a space where they could interact with, and disseminate information to, affected communities and also receive information from the community that could be incorporated into more formal disaster mapping practices.

To understand how crisis convergence processes have changed due to the addition of the cyber element, we adapt the original model, as conceived by Fritz and Mathewson, to the new information environment. In Figure 3, we provide the original conceptualization of the crisis convergence as well as our adapted version. In our extension of the original model, we identify the crisis (internal) zone but consolidated the other zones to the proximate zone, which essentially represents the external area (outside of crisis zone).

We then add 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 to satellite imagery and 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

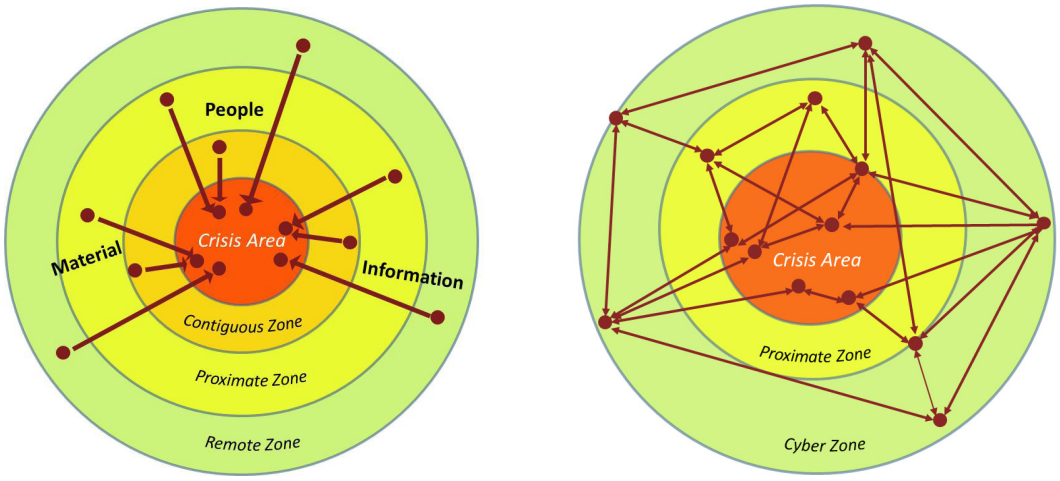

Figure 3 (Left) Original Crisis Convergence model, conceived by Fritz and Mathewson. The points in the graphic represent the different actors involved during crisis. The one-directional arrows show the converging materials, people and information to the crisis area, depicted in red colour. (Right) Virtual Crisis Convergence (VCC) model factoring in the cyber/virtual zone in green colour. The two-directional arrows illustrate constant exchange between zones that create a web-formed system between the agents (source: Giroux and Roth 2012).

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.

2.2 Key stakeholders in past crisis mapping processes

Although it seems impossible to predict exactly how future crisis maps will be organized, in past crisis mapping cases, there have been several types of social actors that have repeatedly participated in the mapping processes and which can be considered the key stakeholders in crisis mapping at the time of writing. Taking a closer look at the actors in past crisis mapping processes can be helpful in estimating what types of social actors might be involved in potential crisis mapping endeavors in the Swiss context. To start with and as already noted above, civil society groups such as Crisismappers, HOT or MapAction have played a prominent role in many major crisis maps in the past. Frequently, these groups are affiliated with research institutions, both from the natural and the social sciences. Most often, these groups use or collaborate with mass media outlets. Particularly important focus are social media companies like Twitter and Facebook, but interestingly, also more "traditional" media outlets like the New York Times, Los Angeles Times or the Guardian have been very active contributors to different crisis mapping projects. Further, private and public organizations specialized in geo-information such as ESRI, Google, NASA or ESA or national mapping agencies are almost always involved in crisis mapping processes. In recent years, also the broader crisis management community – encompassing professional crisis management authorities, non-governmental organizations as well as operators of critical infrastructure – has discovered crisis mapping as an instrument serving their goals. Organizations such as the USAID, the American Red Cross or UN-OCHA are increasingly taking part in crisis mapping. Finally, crowdsourced crisis mapping always involves (by definition) the participation of a large number of citizens inside and outside the crisis zone that contribute to crisis maps in various ways.

Interestingly, each of these actor types can fulfill alternative roles in the wake of a crisis mapping process. As a consequence, the organizational structures of different crisis mapping projects are highly diverse. In order to shed some light on these roles and structures, again inspired by the work of Fritz and Mathewson, we have identified six different types of 'on-line convergers', or 'identities', in a crisis mapping system: Initiator, coordinator, collaborator, multiplier, supporter, and user. Using this process of social convergence and 'identities' that form within it, we are able to compare the structures of different historical and hypothetical crisis mapping cases and identify the key stakeholders therein.

Key stakeholders in crisis mapping

- *Civil society groups*
- *Research institutions*
- *Mass media outlets*
- *Geo-information specialists*
- *Crisis management community*
- *Citizens inside and outside*

We recognize that each of these identities connote a more positive association with crisis mapping communities. However, it is not to say that there are not 'on-line convergers' that seek to exploit or disrupt such processes. While exploiters and disturbers occasionally play a role in all kinds of crisis, this is particularly the case in more politically sensitive crises, where political groups or individuals can have an interest in disrupting the process and integrity of the map/s by providing fake reports or attempting to take down the site where the map is hosted. To illustrate both the utility of this framework as well as the various types of contexts where crisis maps have emerged, we selected two recent cases: the elections in Sudan in April 2010 and the London riots in August 2011. In both cases crisis maps were deployed, but or-

ganized in different ways and the contexts are quite different. In the following, we explain each case and also apply the VCC identities framework.

The "Sudan Vote Monitor" was a crisis map created to monitor the elections.[30] This map was **initiated** by the Sudan Institute for Research and Policy (SIRP)[31], in **coordination** with the Asmaa Society for Development. **Collaborators** for this map included various Sudanese civil society organizations "who deployed certified election observers throughout the country to [provide] reports. These reports were then collated and uploaded to SudanVoteMonitor by designated staff members."[32] **Collaborators**, such as eMoksha.org, Ushahidi, and Khotawat Consultancy, also offered technical support, such as providing the software for the mapping effort. Average citizens and local and international groups active in Sudan served as **multipliers** in that they shared info about how individuals could report incidents via SMS and/or the project website. Organizations such as the African Center for Justice and Peace Studies, Save Darfur Coalition, and Open Society Institute served as additional **supporters** of the project. Finally, the **users** involved all relevant organizations, governments, etc., as well as those living in the community. Overall, during the election period, the site received a total of 564 reports from 419 locations, covering 26 reporting categories.[33] Yet, in respect to this case, one additional element bears mentioning. While we conceptualized this crisis mapping system using our identified VCC identities, there was also another group that emerged that submitted fake reports or attempted to take down the site.[34,35] Figure 4 shows the example of fake information submitted on Twitter, which was then reviewed by the crisis mapping volunteers (i.e. collaborators) and not admissible as the report could not be verified. In other instance, external influence led to the site being inaccessible for two days during the election period.

Typical social roles in crisis mapping processes

- *Initiator*
- *Coordinator*
- *Collaborator*
- *Multiplier*
- *Supporter*

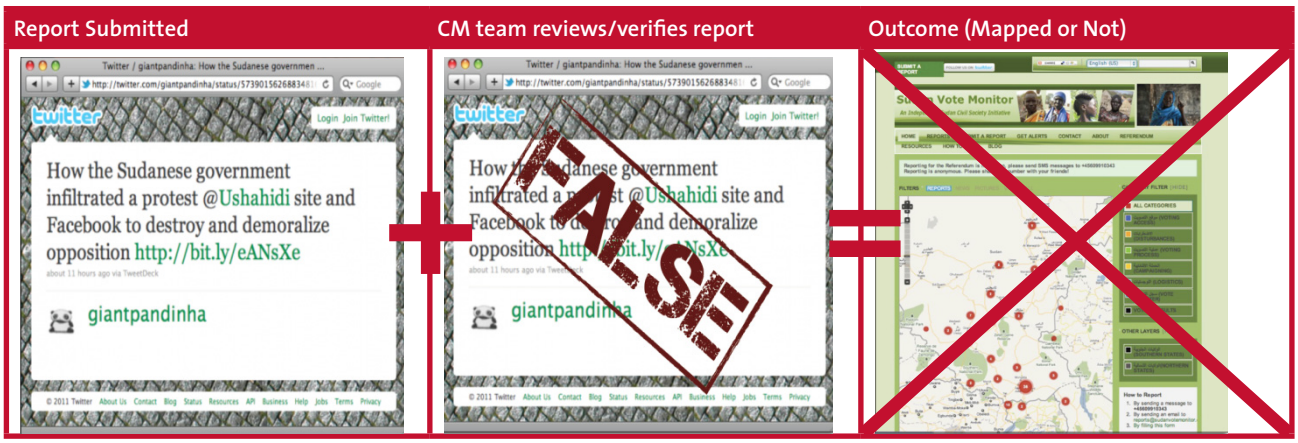

Figure 4: Example of fake report from a Twitter account. The crisis mappers examined this information and could not verify it. Thus it did not get placed on the Sudan Vote Monitor map.[35]

30 Meier, P. (2010): Report on Sudan Vote Monitor, *Ushahidi Blog*, 3 November 2010, http://blog.ushahidi.com/2010/11/03/report-on-sudan-vote-monitor.

31 See: http://www.sudaninstitute.org

32 Ibid

33 Ibid

34 Chamales, G. "Lives on the Chamales, G. (2011): Lives on the Line. Defending Crisis Maps in Libya, Sudan, and Pakistan, Online presentation, http://www.blackhat.com/docs/webcast/usa11preview_chamales.pdf.

35 Ibid

Figure 5: VCC model for the London Riots listing the network of main actors involved in the mapping system (source: Giroux and Roth 2012).

In another and contrasting example, crisis mapping in the 2011 London riots was much more decentralized, with multiple maps emerging out of the crisis system; with some simply 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 and community cleanup. For this case, the **initiators** of the maps varied from mainstream media groups like the Guardian, which launched its own map, to those initiated by local citizens.[36] Recalling the Sudanese case, which was initiated by an organization, the London case is different not only in the various initiators involved, but also that many maps can be created during a crisis. This shows that crisis maps need not have an institutional affiliation to be created. Moving on, the specific **collaborators** and **supporters** are more difficult to decipher given the decentralized characteristic of this case as well as lack of information on their identities. 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,"[37] 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.

36 See: http://harrywood.co.uk/maps/london-riots; www.guardian.co.uk/news/datablog/interactive/2011/aug/09/uk-riots-incident-map; https://ukriotcleanup.crowdmap.com

37 The Guardian; London School of Economics (2011): Reading the Riots: Investigating England›s summer of disorder, report, http://www.guardian.co.uk/uk/interactive/2011/dec/14/reading-the-riots-investigating-england-s-summer-of-disorder-full-report.

3 CRISIS MAPPING IN SWITZERLAND

As noted in the introduction, crisis mapping in Switzerland is something that certain policy and research circles are familiar with, however, it has yet to be applied in an actual domestic crisis. Despite the lack of historical experiences, some of the preconditions for crisis mapping in Switzerland can be assessed nonetheless. On the one hand, we can observe a behavioral trend across countries that people increasingly use social media during crises.[38] Even though no large-scale crises have occurred in Switzerland in recent years, social media and mobile technologies are also increasingly used by Swiss citizens and authorities to communicate about risks as well as in crisis communication.[39] For example, in February 2012 the Swiss Federal Nuclear Safety Inspectorate (ENSI) relied on Twitter to inform the public quickly about an alleged malfunction at the nuclear plant in Mühleberg.[40] Also, Swiss citizens have used Twitter to share crisis-relevant information from individuals (crowdsourcing) with other media users, even though the crisis events have been comparatively small (crowdfeeding, see figure 6). Consequently, it appears reasonable to

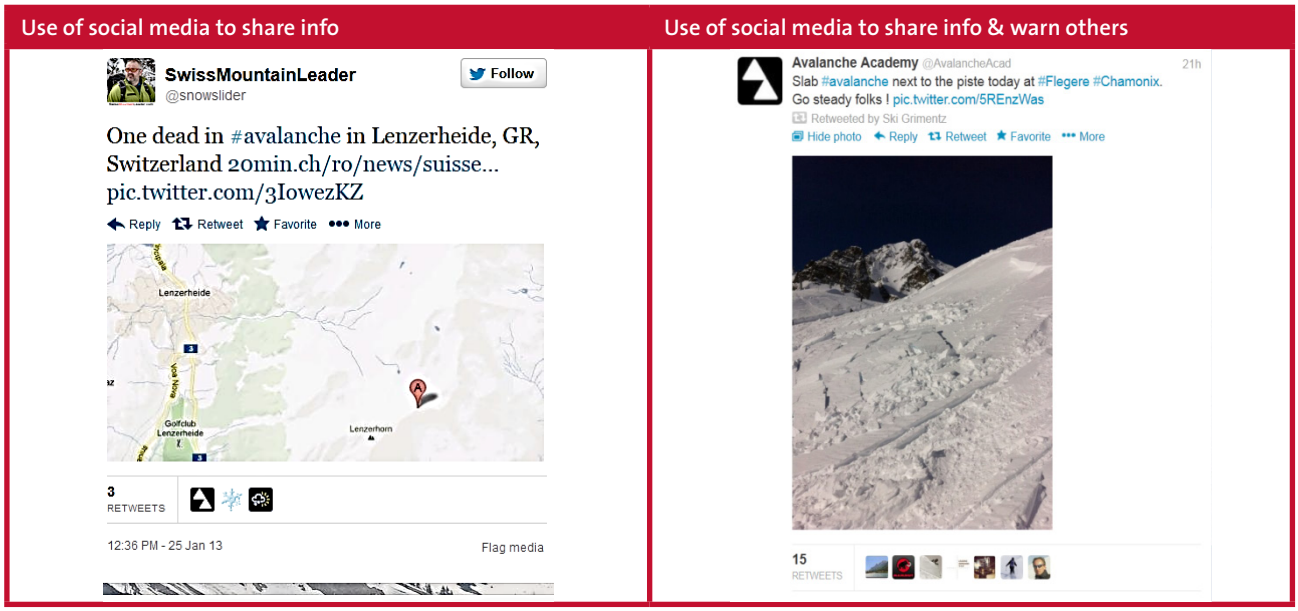

Figure 6: (Left) Twitter user sharing info on consequences of avalanche; (Right) Twitter user sharing pictures of avalanche and warning others to be cautious (source: own illustration based on Twitter website).

38 OCHA (2011): Disaster 2.0: The future of information-sharing in Humanitarian Emergencies, report, http://www.unocha.org/top-stories/all-stories/disaster-relief-20-future-information-sharing-humanitarian-emergencies.; Fraustino, J. D.; Brooke, L.; Yan J. (2012): Social Media Use during Disasters: A Review of the Knowledge Base and Gaps, Final Report to Human Factors/Behavioral Sciences Division, Science and Technology Directorate, U.S. Department of Homeland Security. College Park, MD, http://www.start.umd.edu/start/publications/START_SocialMediaUseduringDisasters_LitReview.pdf.

39 Roth, F.; Brönnimann, G. (2013): Using the Internet for Public Risk Communication, Focal Report 8, Center for Security Studies (CSS), ETH Zürich: Zürich, http://www.css.ethz.ch/publications/risk_resilience_reports.

40 See: http://www.ensi.ch/de/2012/02/08/reaktorschnellabschaltung-im-kernkraftwerk-muhleberg; https://twitter.com/ENSI_CH/status/169063382597644289.

assume that a considerable number of Swiss citizens would also use social media during a major crisis.

On the other hand, as will be shown in more detail below, there are plenty of social actors in Switzerland that are already engaged in crowdsourcing and crowdfeeding processes, many of them relying on social media. Even though it cannot be predicted in what ways these actors would actually collaborate in the wake of a major crisis in Switzerland, we argue that the capabilities held by these different stakeholders are an important precondition for any potential crisis mapping endeavor in Switzerland. To shed some light on potential crisis mapping projects in Switzerland, we subsequently introduce a hypothetical crisis scenario based on a recent real-world example, in which we assume a crisis mapping project would emerge.

In this section, we revisit a historical case which serves as the basis for our hypothetical scenario described below: the 2005 blackout which not only caused power outages, but also severe and costly disruptions to railway transit. On 22 June 2005, the power supply system of Swiss Federal Railways (SBB) suffered an outage that caused major disruptions to the country's railway system.[41] Making matters worse, the outage occurred at 17:45, during the evening rush hour commute. Maintenance work on two of the three power lines in the southern region led to a deficit in power that had cascading effects across the country – specifically overloading power circuits between Ticino and the German-speaking part of Switzerland. Over 200,000 passengers were stranded at stations and many more affected by the disruptions.[42] Aggravating the situation, temperatures reached 34 degrees Celsius at that day, causing health problems in particular for elderly people. To manage the crisis, authorities put additional buses and diesel locomotives into service and handled the travel and compensation needs of those affected. By 21:00 some services resumed from Zurich, Lucerne and other cities. While services resumed as normal the following day, the total reported cost of this 4 hour crisis was roughly 3 million CHF. Social media or mapping technologies played no significant role during this crisis, most likely because social media usage in Switzerland has only reached a critical level in recent years.[43]

But how would this case look like if it occurred in June 2012 or 2013 for that matter? Certainly some elements would be similar, such as the response by crisis managers to deploy additional buses to take commuters to the airport or other cities or the role of the firemen to provide water stations for stranded passengers. But one notable difference could be the role of social media and mobile technology. In addition to waiting for messages from authorities, many affected persons would certainly also turn to virtual portals to share experiences and frustrations on social networking sites like Twitter and Facebook, reach out to their network for assistance, and also provide information on available car-shares and alternative transit routes. While such information would normally be disaggregated and unstructured, in the following scenario exercise we deploy a crisis map that aims to visualize the crisis and structure information. We assume that a crisis map for this case has been specifically created by locally-based stakeholders to identify travel disruptions as well as to provide information on alternative travel routes, people offering shelter or rides, etc. Importantly, although the scenario situation itself is clearly hypothetical, the social actors introduced in the scenario description are all real. We are able to use the VCC model to identify the

41 Ligi, A. (2005): Swiss Rail System Halted Nationwide by Power Outage, Bloomberg, 22 June 2005, *http://www.bloomberg.com/apps/news?pid=newsarchive&sid=a8n1HpP3_tno*.

42 *http://www.gotthardbahn.ch/downloads/stromausfall_medienkonferenz2.pdf*

43 *http://de.slideshare.net/RelaxInTheAir/defining-social-networks-in-switzerland-20111*

crisis mapping system that could potentially emerge out of this crisis as well as identify the various stakeholders that might participate.

3.1 Power blackout scenario

Figure 7: Picture of Zurich main station during the blackout (source: http://www.flickr.com/photos/yahya/114391928)

When a major thunderstorm was moving across Switzerland on 5 August 2013, fallen trees led to a major blackout at 4.30pm in the Cantons of Zurich, St. Gallen and Schwyz. While power supply could be restored within one hour in all affected areas, the blackout severely disrupted the train network, which was in the middle of the evening rush. Due to a software problem in its steering unit, the power supply system of Swiss Federal Railways (SBB) failed to resume normal function until the following day. As a consequence, throughout the country, hundreds of thousands of passengers were unable to continue their travel, many stuck in overheated trains, as outside temperatures hovered around 30 degrees with high humidity.

Already half an hour after the blackout had begun, emergency services in the affected regions had to treat the first people with dehydration and heat exhaustion. Hardest hit was Zurich, Switzerland's largest city, which has over 380,000 people a day transit through its main station.[44] Over 40,000 passengers had to stay in the city involuntarily. In part due to the muggy weather, but also because SBB had little information regarding the length of the travel disruption, many people became angry and anxious. Although it was uncertain how long the train system would take to resume normal business, all hotels were at maximum capacity within minutes. The Protection and Support Service (P&S) had to take care of travelers in need by providing food and shelter. Supporting these efforts, a group called *opendata.ch* saw an opportunity to help structure, aggregate and visualize multiple streams of crisis information.[45] Only half an hour after receiving the first news of the power outage via Twitter, they decided to **initiate** a crisis map that would serve as a crisis information and assistance resource for the stranded commuters.

Opendata.ch was up to the task of creating a crisis map for the stranded commuters as they had created several online train maps at a "Hackday" in Zurich in March 2012 that visualized almost all trains in Switzerland on a map (Figure 8).[46] However, the group needed some assistance to customize their map to incorporate other layers of data (such as location of alternative travel routes, buses, and car-shares). To do this, they **coordinated** with Google, which has its

44 Switzerland is one of the main transit countries for passengers and goods traveling by rail from northern to southern Europe. Almost 27 million tons of freight was transported on the Swiss rail network across the mountain range that separates Italy and the Balkans from northern Europe.

45 Opendata.ch is the Swiss chapter of the Open Knowledge Foundation, a loose civil society organization devoted to the promotion of transparency and knowledge generation through the analysis and visualization of publicly available data. Several times a year, opendata.ch organizes so-called "Hackdays", where interested people collaborate to develop new data analysis and visualization tools.See: http://opendata.ch/events/

46 See: http://opendata.ch/2012/04/innovationsschub-fuer-den-schienenverkehr-verkehrsdienstleister-und-community-am-selben-tisch/

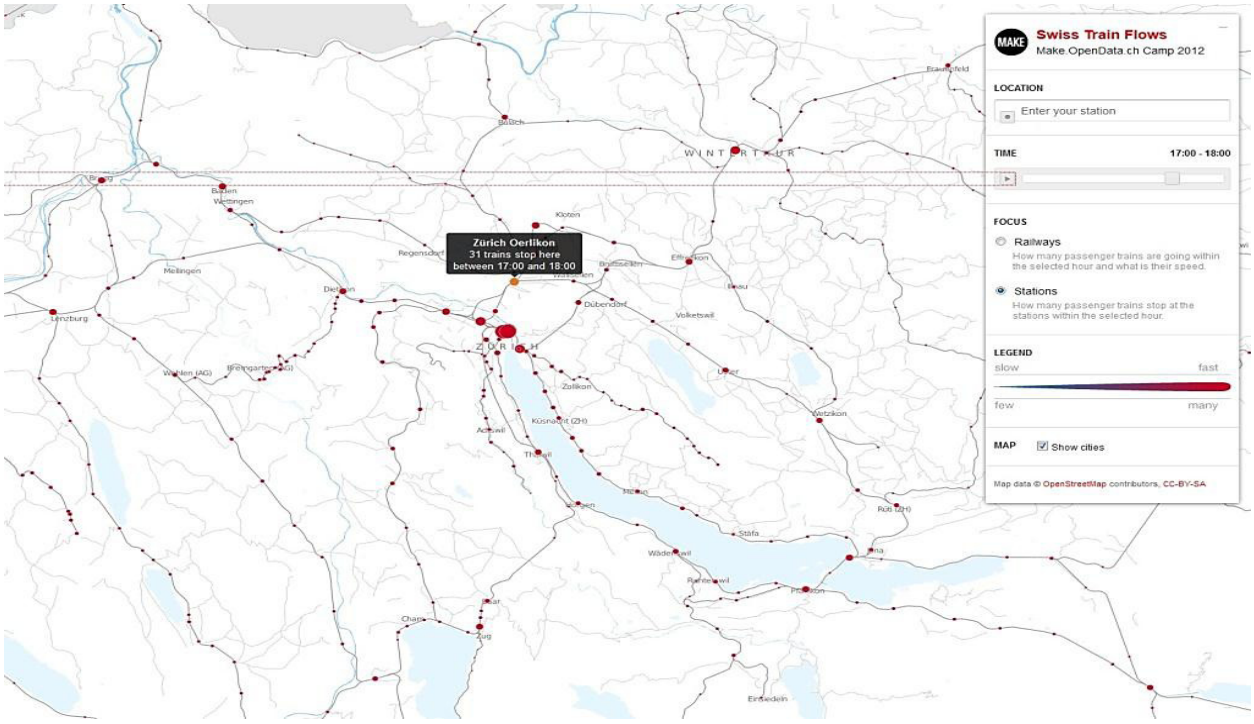

Figure 8: Snapshot of a dynamic map of train movements in Switzerland created at an opendata.ch Hackday in Zurich in March 2012 (source: http://flows.transport.opendata.ch).

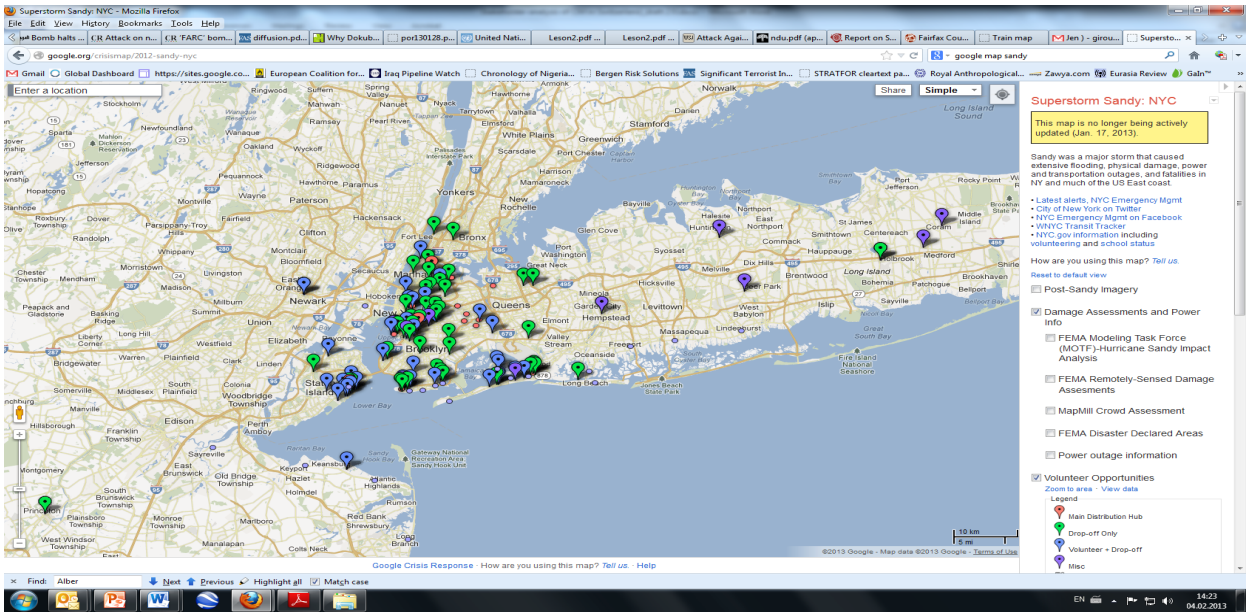

Figure 9: Image of Google crisis map for Hurricane Sandy (source: http://google.org/crisismap/2012-sandy-nyc).

European Headquarters in Zurich. Google has experience in deploying crisis maps in different countries.[47] For instance, using Google Mapmaker, they created a crisis map in response to Hurricane Sandy (Figure 9) to structure and visualize various streams of crisis info.

While Google helped with customizing the map, teams from *opendata.ch* began to pull together crisis info and create the overall structure of the map. The main categories and subcategories were identified as depicted in Figure 10.

By 5.30pm, one hour after the crisis had begun, a map was up and in place with some information already visualized. Given that in recent crisis response scenario exercises responders had been taught about crisis mapping, gathering other collaborators was a relatively easy process. In particular, Swisscom and the Steering Committee for the Coordination of Transport in the Event of Disasters (CTE) – within the Federal Office of Transport – joined as **collaborators**. Swisscom had made good experiences with crowdsourced mapping during a collaborative project together with the city of Geneva in 2010. The project attempted to map people's movements in the city by analyzing mobile phone data.[48] As practiced in previous crises in other countries, Swisscom offered a text/SMS code that people could use for free to send crisis related info, which would be channeled to the *opendata.ch* team. Quickly, large amounts of information started to flow in via SMS from people inside and outside the crisis zones. In particular, as in earlier crises, local communities were eager to help with free meals and accommodation. To handle and organize the data influx, the *opendata.ch* team recruited volunteers with advanced software skills, mainly through Twitter and Facebook. Within

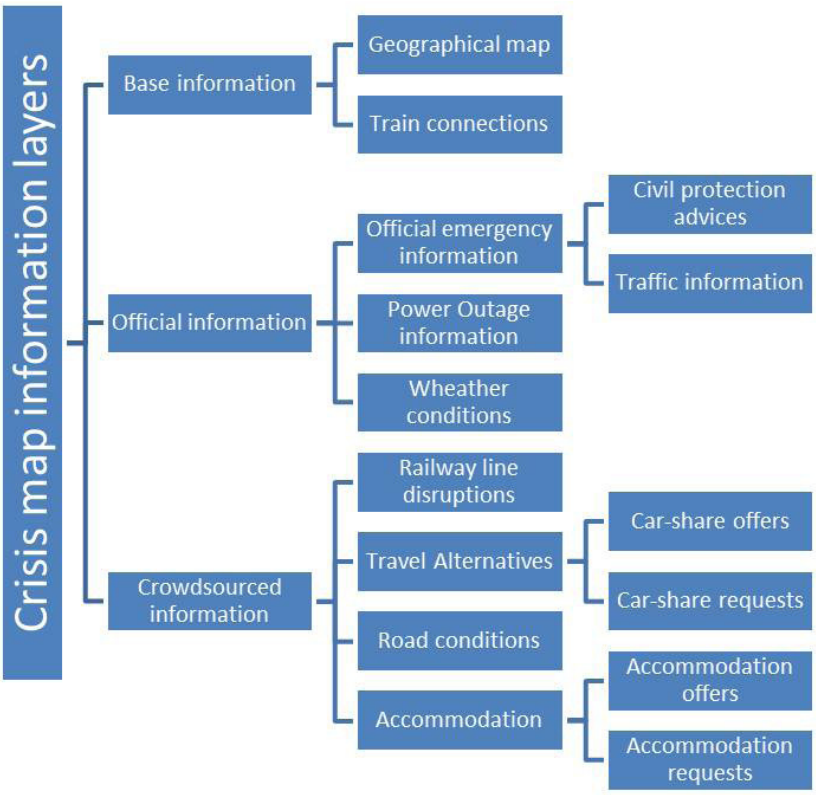

Figure 10: Structure of crisis map information (source: own illustration).

47 See: http://www.google.org/crisisresponse

48 See: http://villevivante.ch/#background

only two hours, over 50 volunteers – largely students from different Swiss and German universities – joined the *opendata.ch* core team. Meanwhile CTE authorities made sure to provide up-to-date, official crisis info (based on their exchanges with the SBB and authorities dealing with electrical repairs). Originally, the SBB had been hesitant to officially support the project, since like many other large organizations it regarded the publication of proprietary data primarily as a risk.[49] However, after consultations with its legal and communication departments, SBB's management realized that opposing the crisis mapping project could create reputation damage for the company and therefore decided to cooperate with the crisis mappers.

Media outlets played the main **multiplying** role to spread info regarding how the public could report info and access crisis info. In particular, the tabloid newspapers "20 Minuten" and "Blick", which have both drawn upon information sent in by readers for many years,[50] promoted the crisis map on the headlines of their news websites and asked their readers to contribute to the crisis map. Swiss authorities played a **supportive** role in the crisis mapping process. Especially the city of Zürich, which had launched an ambitious open data initiative just some months earlier[51] and cooperated with *opendata.ch*,[52] welcomed the crisis mapping project and offered parts of its server capacities to the organizers of the crisis map. Although the map was originally intended to serve the stranded commuters, effectively the **users** were not only confined to affected commuters, but also city authorities and the SBB itself which used the crisis map to raise its situational awareness during the crisis. It was not until the following morning, when service fully returned, and even later in the day, when commuter and transit issues were fully resolved. However, in hindsight, the mapping project helped to mitigate some of the hardest effects of the crisis. For example, in Zurich alone, over 5.000 persons offered free accommodation using the crisis map, by far outnumbering the actual demand. The crisis map thus served a core role during the crisis, but also authorities scrutinized the information following the event to see what type of information was submitted, the type of needs and overall crisis behavior of those affected.

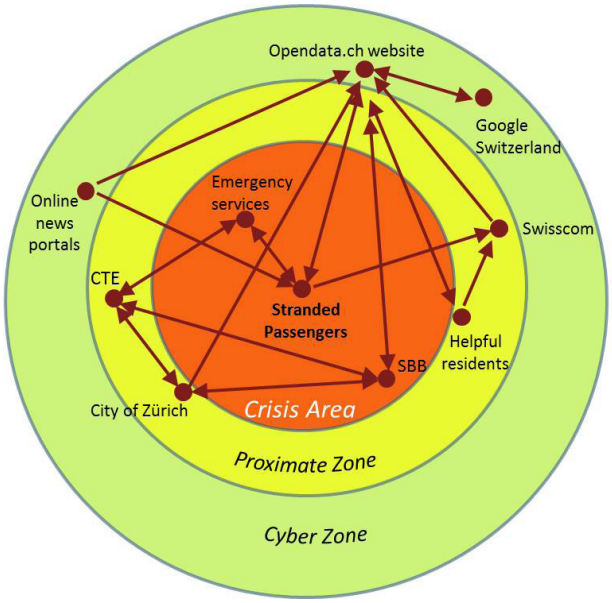

Figure 11: Zurich crisis mapping VCC model: The inner circle is the crisis area, understood in a geographical sense. Adjacent to the crisis area is the proximate zone, which includes all those actors that are geographically close to the crisis area. The outer layer represents all those actors and services that contribute to the crisis mapping process without any direct physical presence. The arrows depict the flow of resources and information between the different parts of the crisis mapping system (source: own illustration).

49 See the statement of an SBB official at Opendata.ch's "Hackday" http://www.netzwoche.ch/News/2012/03/30/Mehr-offene-Daten-fuehren-zu-besserem-Verkehr.aspx?pa=2

50 http://www.20min.ch/community/leser_reporter

51 http://data.stadt-zuerich.ch/content/portal/de/index/ogd.html

52 http://opendata.ch/2012/05/opendata-ch-2012-konferenz-detailprogramm

4 FINAL REMARKS AND RECOMMENDATIONS

The dearth of severe recent crises in Switzerland means that there is little data about the application of social media and other emerging ICTs in crisis contexts. This lack of empirical information necessitates a proactive approach to potential developments relevant to civil protection in Switzerland. In the previous section we developed a hypothetical crisis scenario for Switzerland, illustrating that the actors and resources needed to make crisis mapping a potential part of future crisis situations are available. At the same time, it is important to note that a single scenario can never represent all potential collaborations that could lead to a crisis map in Switzerland. For example, instead of using Google Maps as the main visualizing platform for the crisis map in our scenario, it would also be possible to develop a crisis mapping scenario based on OpenStreetMaps or official Swisstopo maps, for example using the Ushahidi platform. Equally, by choosing a rather moderate blackout crisis scenario that mainly affected and could be handled by the SBB alone, crisis and disaster managers at the cantonal or federal level played no central role in the hypothetical crisis mapping process. These limitations were mainly due to one the study's central aims to develop a scenario close to a real-world event, as recently experienced in Switzerland to have a scenario as realistic as possible. Likewise, it may be expected that in case of a more severe crisis, governmental authorities would likely play a more prominent part and possibly also collaborate in a crisis mapping process proactively. But in particular equitable partnerships between authorities and other social actors may gain in importance.

In our view, such collaborations do not undermine the responsibilities of disaster management authorities, but rather support officials to fulfill their mandates effectively. Also, strengthening collaboration among the different pre-identified stakeholders is not opposed to the concept of self-organization, which is central to the idea of crisis mapping. To the contrary, knowing the needs, interests and capabilities of other social actors can decisively facilitate self-organization during crisis. In order to foster such collaborations between different social actors in Switzerland the following points appear important to address:

Ways to prepare for crisis mapping

- *Start a stakeholder dialogue*
- *Clarification of legal obstacles*
- *Initiate joint crisis exercises*
- *Foster risk mapping projects*
- *Include ICTs in training and education strategies*

- **Start a stakeholder dialogue:** Often, a main challenge is to bring together actors from different parts of society and establish informal networks and mutual trust, which are key preconditions for successful collaborations in crisis contexts. For example, professionals in the domains of geography and geodesy have sometimes been skeptical towards crowdsourced maps, because they feared that the accuracy and precision of maps could suffer from the use of low-cost GPS devices.[53] Despite such legitimate concerns, in order to make the broadest use possible for geographic information during crisis, it seems an important task to overcome such disciplinary cleavages. In the Annex, we highlight some of the key stakeholders in Switzerland that could be included in crisis mapping dialogues, which would not only help to familiarize them with concepts (such as virtual convergence as discussed in this study), but also strengthen the communication structures

53 Stark, H.-J. (2013).

available in crisis situations, while keeping these structures flexible and adaptive at the same time.

- **Initiate joint crisis exercises:** A promising way to enable an open dialogue between all relevant stakeholders can be the conduction of collaborative crisis exercises. Such projects can also bring together crisis mappers with the established crisis and risk management community. An important issue would be to elaborate ways to use the resources and expertise of professional crisis management to make crisis mapping processes more effective. In turn, strategies still need to be developed how the information gained from crisis maps could be utilized in professional crisis management. A currently unresolved question in this context is who could lead such exercises. Although initiatives from civil society should be particularly fostered, also Swiss crisis management authorities could play an active role by bringing stakeholders together for crisis exercises. The frequent emergency exercises conducted by Swiss civil protection agencies appear as a suitable framework to foster such exercises for professional crisis managers.

- **Foster risk mapping projects:** In addition to crisis exercises, it appears also feasible to initiate pilot mapping projects outside of crisis contexts.[54] Particularly promising appear approaches that aim at stakeholder participation in risk mapping.[55] One promising approach can be to promote collaborative projects that make use of both the expert knowledge of professional geographers (and related disciplines) and the "wisdom of the crowd" for mapping risks.

- **Include ICTs in training and information strategies:** In terms of training, 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. Further, a specialized training program on the use of new ICTs in crisis situations could be valuable. An interesting field of attention could be the development of capacities in the area of crowdsourced post-crisis analysis.[56] This might also involve carrying out a pilot program in a specific canton or community that frequently experiences some type of hazard and then analyzing the development and utility of the crisis map/s created. Even more broadly, tailored trainings and information programs could be developed that meet 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.

Together, these measures could promote the collaborative use of important technologies like geo-

54 The focus on these measures is supported by recent research. For example, a study by the U.S. National Research Council Committee on Planning for Catastrophe has found that training, coordination among agencies, sharing of data and tools, planning and preparedness are critical factors that need to be addressed in order to increase the effectiveness of future mapping procedures, see: National Research Council Committee on Planning for Catastrophe (2007): Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management, report, *http://www.nap.edu/catalog/11793.html.*, p.2.

55 See for example: White, I.; Kingston, R.; Barker, A. (2010): Participatory geographic information systems and public engagement within flood risk management, *Journal of Flood Risk Management*, vol. 3, pp. 337–346.

56 Kerle, N. (2011): Remote Sensing Based Post-Disaster Damage Mapping – Ready for a Collaborative Approach? *Earthzine.org*, *http://www.earthzine.org/2011/03/23/remote-sensing-based-post-disaster-damage-mapping-%E2%80%93-ready-for-a-collaborative-approach*.

referencing systems and micro blogging services by different social agents, foster new partnerships and ultimately increase the flexibility of disaster management and crisis communication in Switzerland. 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."[57] 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. The above-mentioned points can serve here as a starting point.

57 Sellnow, T. L., Seeger, M. W., & Ulmer, R. R. (2002). Chaos theory, informational needs, and natural disasters. *Journal of Applied Communication Research*, pp. 269 – 292: 289.

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http://newsroom.redcross.org

Center for Satellite Based Crisis Information (ZKI)
http://www.zki.dlr.de/mission

Center for Security Studies, Swiss Federal nstitute of Technology Zurich (ETHZ)
http://www.css.ethz.ch

City of Zürich Open Government Data Portal
http://data.stadt-zuerich.ch/content/portal/de/index/ogd.html

Crisis Mappers Network *http://crisismappers.net*

Emoksha *http://www.emoksha.org*

ENSI Twitter Account *https://twitter.com/ENSI_CH*

Geeks Without Bounds *http://gwob.org*

Google Crisis Map of Wildfires in the United States
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http://hhi.harvard.edu

Humanitarian OpenStreetMap (HOT)
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INSTEDD *http://instedd.org*

International Risk Governance Council
http://www.irgc.org

Institute of Geomatics Information, University of Applied Sciences and Arts Northwestern Switzerland (FHNW) *http://www.fhnw.ch/habg/ivgi*

iRevolution *http://irevolution.net*

London Riot Map *http://londonriotsmap.appspot.com*

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Open Knowledge Foundation *http://okfn.org*

Russia Fires Map *http://russian-fires.ru*

Sahana Software Foundation
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Standby Taskforce Map of Libya *http://blog.standbytaskforce.com/libya-crisis-map-report*

United Nations Platform for Space-based Information for Disaster Management and Emergency Response *http://www.un-spider.org*

UK riots clean-up map
https://ukriotcleanup.crowdmap.com

Ushahidi Project *http://www.ushahidi.com*

Ville Vivante Project Geneva *http://villevivante.ch/#*

ANNEX

Potential crisis mapping collaborators in Switzerland

- Civil society groups
  - Opendata.ch
  - Ushahidi

- Research institutions
  - Geomatics (FHNW)
  - Social sciences (CSS)
  - UN Spider
  - International Risk Governance Council (IRGC)
  - Misc. universities (ETH, UZH, etc.) and universities of applied sciences

- Mass media outlets
  - Social media (such as Twitter, ...)
  - Tabloid newspapers (such as 20min.ch, ...)
  - Radio/TV stations

- Geo-information specialists
  - Swisstopo
  - Google
  - Openstreetmap
  - ESRI
  - Microsoft

- Crisis management community
  - Civil protection authorities from federal, cantonal and communal levels
  - First responders (Protection & Rescue, Police,etc.)
  - Critical infrastructure operators (SBB, telecommunication companies, energy suppliers)