Community and Governmental Responses to an Urban Flash Flood

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ABSTRACT

In summer of 2014 the city of Münster experienced an urban flash flood not seen before with such intensity in Germany. This paper investigates the subsequent governmental and ad-hoc community response actions with a focus on the chronologies of Facebook and Twitter usage. Interviews identified drawbacks of coordinating volunteers in social media ecosystems. Possible solutions to overcome issues related to the interaction of community and official relief activities are identified.

Keywords

community response, Facebook, information flow, social media, Twitter, urban flash flood

INTRODUCTION

On July 28, 2014 the city of Münster experienced one of the most severe heavy rain events in Germany resulting in an urban flash flood with measured precipitation of up to 292 mm per square meter within 7 hours.

This major incident has called forth a massive community response. Citizens started organizing themselves and initiated community response actions. Despite those social media originated actions are no new phenomena to German disaster response, Münster's authorities were not capable of reacting to these community actions. Their contribution limited the degree of damages but was still lacking response power due to processes of establishing structures. In the later recovery phase issues of reputation and blaming occurred.

This research focuses on two central questions: (1) how did authorities and community perform in responding to flash flood and how did both groups worked together? (2) How can community response actions be supported and interactions with authorities enhanced for future scenarios?

RELATED WORK

German disaster response is characterized by decentralized structures on the administration level and comes with a division of operational competence across levels and issue areas (Hegemann & Bossong, 2013). Institutionalized non-governmental organizations play an essential role in public crisis management. However, the general public is not considered to be part of this system. After a disaster impact citizens use the social media ecosystem to seek information (Landwehr & Carley, 2014), to seek support (Oxendine, 2013), and to also report about the situation (Vieweg *et al.*, 2010). Social media provide opportunities to connect affiliated and nonaffiliated groups with each other (Crowe, 2012). Despite most organizations have recognized the importance and benefits of social media, they are currently not able to make use of this source or to build own tools. They do not have the resources, technologies, or organizational will necessary for an expanded use (Tapia & Moore, 2014). Due to the increasing awareness of the power of social media they are becoming more open to the "Connect and Collaborate" paradigm (Akhgar *et al.*, 2013). However, further integration of social media into internal processes also requires institutional changes (Vieweg *et al.*, 2014).

Merchant *et al.*, (2011) also emphasize social media cannot supersede or replace current disaster management infrastructures.

Data from social media is criticized for not fulfilling information assessment metrics applied to traditional sources (Merrick & Duffy, 2013). There is thus an urgent need to cross-reference this data and derive meaningful information. This time-consuming task is increasingly performed by volunteers working in Virtual Operations Support Teams (VOST). Those teams provide support in dealing with information overload (Cobb *et al.*, 2014) by conducting assessments, processing this data and handling outgoing communication. Social media outlets have an instantaneous desire of information updates. Providing approved information is extraordinarily difficult for emergency managers but necessary in order to reduce dissemination of misinformation (Crowe, 2012). Future applications for information assessment must be able to manage unstructured messages and to create automated summaries and analysis to allow easier sense making (Gao et al., 2011).

Assistance from non-professional volunteers for disaster response (hereinafter, volunteers) is often essential for disaster victims to recover physically and rebuild their lives (Haraoka *et al.*, 2012). Community response has already been reported in pre-social-media literature (Quarantelli & Dynes, 1985). However, most organizations are still lacking structures to incorporate them effectively into relief efforts (Sauer *et al.*, 2014). Social media outlets support communication of volunteers but do not provide sufficient tools for efficient collaboration (Reuter *et al.*, 2013). Facebook provides essential tools, but specific demands during a disaster scenario require an integration of further interaction mechanisms to overcome limitations (Kaufhold & Reuter, 2014).

A deeper understanding of how citizens engage in community driven disaster response is required to support those communities in interacting with each other and authorities. If coordination, guidance and integration are missing, people will organize themselves (Starbird & Palen, 2011).

THE RAIN EVENT IN MÜNSTER AND ITS RESPONSE

In contrast to flooding caused by rivers, flash floods are caused by excessive rainfall or sudden release of water. The rapid onset allows almost no time for preparedness and only limited opportunities for effective response (Hapuarachchi *et al.*, 2011; Marchi *et al.*, 2010). As such they can be characterized as no-notice disasters. Rainfall resulting in flash floods is tightly bound to spatial variations between 1 to 100 km² and temporal variation between minutes and hours (Smith *et al.*, 2007). Figure 1 shows the 24 hours sum of precipitation for Münster. The extent of the most affected area overlaps the administrative boundaries of the city of Münster in almost its entirety. Within 8 hours from 16:00 to 24:00 a weather station operated by the Institute of Landscape Ecology[1] recorded a cumulative precipitation of 131 mm with a peak between 17:20 and 18:20. A weather station operated by the North Rhine-Westphalia State Agency for Nature, Environment and Consumer Protection (LANUV)[2] registered a historic precipitation record of 292 mm within 7 hours (17:00 to 24:00) with highest values between 19:00 and 20:00. The long-term average denotes a monthly precipitation for whole July of

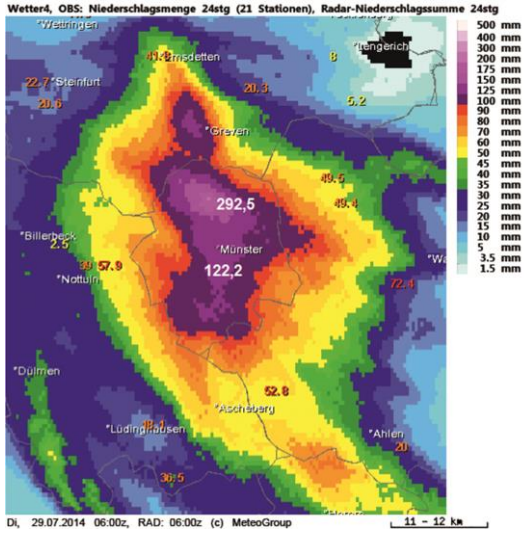

Figure 1: 24 hours sum of precipitation for Münster from Monday, 28.07.2014, 8:00 to Tuesday, 29.07.2014, 8:00 MEST. Source: www.unwetterzentrale.de, MeteoGroup.

[1] http://www.uni-muenster.de/Klima/wetter/klima_ms.html

[2] http://www.lanuv.nrw.de/veroeffentlichungen/presse/2014/2014_08_01_starkregen_muenster.htm

67 mm. Both weather stations are only about 5 km apart from each other, but intensity and timing of precipitation show very different characteristics and illustrate the high locality of the event. Weather stations in about 20 km distance have hardly captured any heavy rain. The urban flash flood caused two deaths and resulted in damages to public and private property of about EUR 100 million (Heuer, 2014).

The governmental response

The governmental response comprised units from local and remote fire brigades and aid agencies i.e. the Technical Relief Agency (THW), German Red Cross, and others. 3500 relief force workers were deployed on July 28 and the following three days (Heuer, 2014). The central information source was the emergency call 112. During the phase of heavy rainfall about 13,000 attempted emergency calls were recorded, of which 1,700 could be answered. Despite the sudden onset, governmental response recognized the extent and graveness of the incident in a timely manner. Due to the amount of emergency calls and their spreading over the whole city, the command and control center deployed all fire brigade units and aid agencies of Münster and quickly set up an operational command unit (Heu-er, 2014). However, the capacity of response units was not sufficient to handle the situation and additional pre-planned supra-local support from other counties and districts provided incoming assistance.

The community response

The first posts relating to the weather event appeared in the social web during the early afternoon (on Twitter and in some more general Facebook groups, i.e. "Münster[3]"). In the evening of July 28, a new Facebook group was founded, called "Regen in Münster"[4] (rain in Münster). This public group experienced a rapid growth in members to more than 3000 within 24 hours and peaked at more than 7000 (Heuer, 2014). Its content was publicly accessible, and it became the central information and organization hub for volunteers and citizens during the following days. Initially, there was a massive flow of multimedia impressions, which then gave way to help requests and offers of assistance. As this became a chaotic mingling, a coordination group was founded by some volunteers. This group sorted the requests and offers and started to coordinate deployments. In addition to the Facebook group the Volunteered Coordination Group (VCG) also established a helpline to increase their accessibility (M. Podlaha, personal interview, Dec, 2012). The central group stayed dedicated to the coordination aspects, whereas three more public Facebook groups were founded in the course of the following days with focus on donations[5] *("Regen in Münster – Spenden")*, general information[6] *("Regen in Münster – sonstiges")*, and grumbling[7] *("Regen in Münster – Ohren für Helfer")*.

ANALYSIS

We performed a manual post-incident collection of posts in the social web and analyzed the data we could gather. Primarily sources included Twitter and Facebook. For Twitter the search keywords included: *"Hochwasser"* (flood), *"Regen"* (rain), *"Starkregen"* (flash flood), *"Münster"*, *"Überflutung"* (inundation), *"Unwetter"* (storm), *"Gewitter"* (thunder-storm), *"Wasser"* (water) and all combinations of those. For Facebook, the messages from the above-mentioned groups were considered. Figure 2 illustrates the timing analysis results of posts on Facebook and Twitter with a frequency of three-hour intervals. The first posts about the event appeared on Twitter in the early afternoon with thunderstorm warnings. The first posts reporting on the actual event as it unfolded were also posted on Twitter. This was at a time when the official command and control center had already set off full-alarm and deployed all governmental response units. In turn, it allows the conclusion of primary use of emergency calls rather than social media postings. The first posts in the existing Facebook group 'Münster' appeared at about the same time. Figure 2 indicates a clear emphasis on Twitter in the beginning, but also a rapid decrease in frequency in the course of the following days. During the same time the frequency of Facebook posts increased. During the first 3 hours after their founding, the central coordination group experienced more than 120 posts and a maximum number of more than 170 posts within 3 hours.

Table **1** summarizes the number of posts in the four Facebook groups and com-

[3] https://www.facebook.com/groups/2210080267/

[4] https://www.facebook.com/groups/1463757173875616

[5] https://www.facebook.com/groups/1512567372292144

[6] https://www.facebook.com/groups/676754479069035

[7] https://www.facebook.com/groups/687106808035888

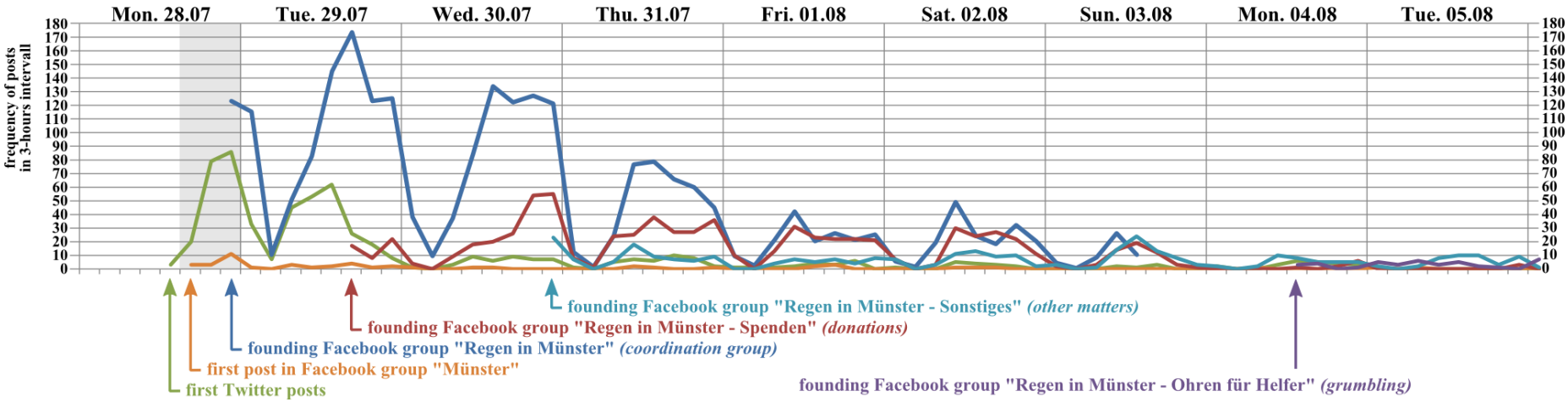

Figure 2: Timing frequency of Twitter and Facebook posts. Twitter posts are collected upon keyword search. Facebook messages originate from four groups. A fifth group was not accessible any more at time of writing.

pares it to the number of tweets on Twitter. The number of Facebook messages cannot be considered to be complete, as many messages have been sent privately or as a comment on posts. Further, posts have also been deleted due to coordination purposes (Podlaha, 2014). Nonetheless, traceable posts in Facebook exceed collected Tweets by more than factor six.

INTERVIEWS

To complement our analysis, we conducted two problem-centered interviews (Witzel, 2000) with one representative from each official and community response teams. The event from July 28 clearly exceeded the available capacities of Münster's disaster response resources. This is particularly true for the emergency hotline. Despite the overload of the emergency number for several hours, fire brigades still emphasize the urgency of this channel (B. Fritzen, personal interview, Dec, 2012). However, people also tend to call the emergency number to request information instead of help (Fritzen). To relieve the emergency hotline, official statements are increasingly published on existing platform and websites, but are rarely actively fed into social media. The fire brigade expressed hesitations for alternative gateways due to their confidence emergency calls need personal communication including structured assessment and inquiring by trained professional. However, alternative ways of expressing non-urgent requests for help can take load from emergency hotlines to allow immediate assistance of urgent requests (Fritzen).

The official response was accompanied by ad-hoc community response actions. A cooperation between the official command and control center and the VCG only occurred in a later phase by providing material to volunteers, e.g. personal protective equipment. No firm or continuous cooperation was established, though, despite potential benefits. For example, the VCG representative reported about difficulties in coordination. Setting up a private helpline required obtaining an SIM-card and disseminating the number into public, which delayed efficient coordination (Podlaha). Authorities could have helped via a prepared hotline in stand-by based on a mobile phone with prioritization in cellular networks (Fritzen). An exchange of liaison officers as operational support would also be conceivable, during the coordination (Fritzen).

The coordination of deployments through Facebook turned out to be problematic.

The high velocity of incoming posts during the first days has temporarily overloaded VCG's coordination abilities. Additionally the order of posts in a Facebook group is activity driven. Liking a post with a help request moved that post in first place again even when help had already been provided. This resulted in double processing, needless re-deployments, and in turn frustration of volunteers onsite. As a result posts in this group were deleted[8], and the coordination moved to an offline approach, decoupled from Facebook. Many requests were also sent as private messages to members of the coordination group because people did not want to post publicly. The public accessibility of the group also incurred the risk of thefts. Another issue arose due to defamatory posts, which negatively affected coordination (Podlaha). Nevertheless, the Facebook group constituted the primary interface between volunteers and acted as the communicational hub.

Table 1: Number of posts on Facebook and Twitter between July 28 and August 5, without posts of the Facebook coordination group 'Regen in Münster'.

Facebook						Twitter
coordination	donation	other	grumbling	Münster	total	Tweets
2491	751	322	40	49	3653	584

DISCUSSION

During the flash flood and the following response and relief actions, we counted 3653 traceable posts in five Facebook groups dedicated to this event. We assume actual numbers are higher as many posts could not be counted, i.e. due to deleted posts and private messages. Tweets summed up to 584, accounting for less than 16% of the Facebook posts. The analysis and interviews showed Facebook was the central communication medium in the social web, confirming general usage statistics of both services (Twitter, 2014; Facebook, 2014). Facebook posts outnumbering Tweets by far contradicts research findings for prior use-cases mainly focusing on North-America (St. Denis *et al.*, 2014; Hughes *et al.*, 2014), but corresponds to research on Twitter usage during the Elbe flood in 2013 (Herfort *et al.*, 2014; Kaufhold & Reuter, 2014) and Germany in general (Leetaru *et al.*, 2013).

Furthermore, the communication through social media was accompanied by traditional channels. Many support requests or offers were expressed through the official emergency call and the helpline established by the VCG. Along with problems in using Facebook for information assessment and coordination similar scenarios in the future require an independent platform. This may be decoupled from Facebook or any other social media outlet, but still serves them and utilizes their penetration to reach out to the population. It must also be designed for operation by untrained laypeople.

In addition, authorities need to improve their preparedness and capabilities to support those groups. This VCG spent much effort in setting things up, which delayed coordination. Developing prepared set of tools, methods, and guidelines and making them available to volunteering community groups during their foundation can shorten the time until operational readiness. Such support by authorities holds great potential to enhance community response and in turn benefits authorities as well. However, this requires authorities to engage more into the social media ecosystem and to be more attentive and appreciative about the formation of such volunteering community structures. Nevertheless, authorities may also be prepared about their offers to be rejected during the next events. The given circumstances (timing during the year, the social structure of the city, and the curiosity about "something new") had a major positive influence on the community response. It seems much less likely that there would have been the same response e.g. during the winter season (Fritzen).

This research focused on Facebook and Twitter as social media outlets, but other outlets also contain potentially useful resources. A manual search on YouTube identified more than 100 different videos related to the flash flood. Further research is required to erode their applicability for information assessment in disaster scenarios.

Besides major use of social media outlets, this use case also demonstrates the need to not ignore traditional means of communication. The governmental response solely used emergency calls as the information gateway. Many requests and offers for support at the VCG have also been expressed through phone calls and in second place through Facebook posts and messages. This underlines the importance of combining traditional and new means of communication if disaster response shall be holistic.

The 2014 Münster flash flood demonstrates the need for a more in-depth understanding of how citizens engage in community driven disaster response and how

[8] Those deleted posts could not be included in the analysis.

those communities interact with each other and authorities. From the technical aspects, an intermediate layer for information assessment and coordination actions is required to connect authorities and citizens.

CONCLUSION

During the flash flood, social media has proven once more their potential in accompanying governmental response and relief actions by providing the communicational field. The community actions organized through social media have limited the degree of flash flood damages (Heuer, 2014). Though social media platforms like Facebook supported the communication, they also revealed limitations for structured information assessment and coordination of actions. Future systems are needed to be operated by laypeople and independently from these platforms, but using them to reach out to citizens.

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