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Examining Twitter Content of State Emergency Management During Hurricane Joaquin

Adam M. Rainear

Kenneth A. Lachlan

Anne Oeldorf-Hirsch

Christina DeVoss

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Those tasked with disseminating life-protecting messages during crises have many factors to consider. Social media sites have become an information source for individuals during these times, and more research is needed examining the use of specific message strategies by emergency management agencies that may elicit attention and retransmission. This study examines Twitter content concerning Hurricane Joaquin. Content analysis of tweets from state emergency management accounts was performed to provide an overview of the content and stylistic elements used in tweets associated with the event. The findings are discussed in the context of both past research on the matter and implications for emergency management agencies responding to high-consequence events.

Keywords: Content Analysis; Emergency Management; Risk communication; Twitter; Weather Communication

One of the central goals in the field of risk communication is to limit harm during an event and take steps to prevent future crises from occurring (Reynolds & Seeger, 2005). Reducing harm is possible when public warnings exist in a timely fashion, and

those who disseminate life-saving messages must consider various factors influencing how the message is received by an audience. Social networking sites (SNS) have emerged as a widely utilized source of information in the case of extreme disaster events (Sin & Kim, 2013). In weather disasters, individuals closest to the event can act as content creators or witnesses who share information (Dredze, 2012). Currently in the field of meteorology, many weather messages are disseminated without understanding how they are received, processed, and used to act (Morrow, Lazo, Rhome, & Feyen, 2015).

Risk Uncertainty and Social Media Amplification

SNS serve as ripe platforms for investigation due to their role as information sources, particularly during news and crisis events. Sixty-two percent of U.S. adults now get their news (including weather) from SNS. Twitter has grown as a news platform, with 63% of Twitter users getting news on the site, and more than half using it to follow live coverage. As a result, news media and other information-disseminating organizations use Twitter as a platform to distribute news and information to their audiences (Broersma & Graham, 2012; Gottfried & Shearer, 2016; Lasorsa, Lewis, & Holton, 2012).

During a crisis, unexpected risks lead to increases in uncertainty for individuals. Uncertainty reduction (UR) has been identified as a fundamental compulsion in a range of crisis and risk scenarios (Reynolds & Seeger, 2005). Uncertainty is an individual perception that arises as a state of discomfort, often encouraging individuals to seek reduction of that uncertainty. Following Uncertainty Reduction Theory, individuals will seek to reduce uncertainty if there exists some incentive for doing so (Berger & Calabrese, 1975). Given the likely drive toward UR, and the propensity toward amplification of risk, it may be the case that certain message elements, from different sources, may be effective in UR. For example, prior to an impending weather crisis, individuals may seek out information on the forecast to feel more comfortable about their safety. One strategy for UR in crisis situations is to actively seek information using media (Brashers et al., 2000) for protection from a threatening situation. More recently, individuals have turned to new media platforms to perform this UR, and weather risks receive considerable attention on SNS as news organizations often prioritize weather events over other stories. As SNS have emerged as a key source of information during past times of crisis (Sutton, League, Sellnow, & Sellnow, 2015; Sutton et al., 2014), they may also serve to amplify risk perceptions.

To address the propensity for risk perceptions to fluctuate, one can consider Social Amplification of Risk (SARF) for better understanding how risk perceptions may oscillate across receivers as information passes through various senders. Risks may become publicized dependent on the factors and norms individuals bring to communicating the risk. These beliefs drive some secondary risk-relevant process, such as economic decisions or changes in education (Kasperson & Kasperson, 2005; Kasperson et al., 1988). SARF illuminates a practice that SNS serve to enhance—

amplifying or attenuating risk through sharing information about the topic. A message that becomes highly shared (e.g., retweeted) could serve as an amplification of the risk because of the Twitter metrics that serve to increase its credibility. Yet past research has shown that retweets from official health accounts (as opposed to original content) are less credible when having more retweets, but a reverse pattern emerges for a layperson with similar metrics (Lee & Sundar, 2013). Additionally, the ripple effects (secondary impacts) that emerge could be a result of information acquired on SNS and in turn amplify or attenuate the risk perception.

Microstructure Elements and Language

Research on imperative and declarative language has recommended that warning messages contain a combination of imperative and declarative styles (Frisby, Sellnow, Lane, Veil, & Sellnow, 2013). Imperative sentences provide a command for an individual to act upon—for example, "You should evacuate now." Declarative statements are statements that provide information but do not request action, such as: "A tropical storm is likely to form." Sutton et al. (2015) determined that language structure played an important role in the serial transmission of crisis-related content. Examining tweets from the 2013 Boulder Floods during the precrisis stage, they found that a large majority (90%) of the tweets studied used declarative statements, and about 30% of the tweets used imperative style. A combination of both stylistic elements was used less than 30% of the time.

Content analytic research on Twitter use has provided some insights on what information associated with crises and natural disasters can typically be found on Twitter. Spence, Lachlan, Lin, and Del Greco (2015) found that prior to Hurricane Sandy making landfall, information concerning behaviors was difficult to acquire due to the overwhelming amount of information being disseminated on Twitter. Lachlan et al. (2014a) also examined Twitter activity prior to Hurricane Sandy, using general hashtag search terms. Results from 27,000 tweets suggested that it was nearly impossible to locate actionable information from emergency management (EM) agencies and government organizations. Tweets were posted at an increasing rate but suddenly dropped off hours before landfall in New Jersey. As the crisis evolved to the peak crisis stage, information became more difficult to acquire as affective responses became dominant. This is consistent with other research suggesting that Twitter may be more of an instrument of emotional release and community galvanizing under fast-moving and equivocal circumstances (Papacharissi & De Fatima Oliveira, 2012). The authors later extended this research by comparing content retrieved using search strategies related to locally and nationally identified hashtags associated with a major weather event (Lachlan, Spence, Lin, Najarian, & Del Greco, 2014b), and results suggest similar patterns of findings. Twitter content was more commonly categorized as affective and less likely to be primarily informative in nature. These difficulties became even more pronounced as the storm approached landfall, as the relative proportion of tweets

containing useful information was subsumed by a massive outpouring of affective expression (e.g., fear and trepidation). However, content retrieved using the localized hashtag contained more information than that retrieved using the more general, nationwide hashtag. In both instances, humorous content and spam were relatively uncommon.

Microstructure elements of Twitter (such as hashtags and direct messages) play a pivotal role in how information is communicated. The "@" function on Twitter serves as a public message directed toward another individual, and the retweet ("RT") function has also gained attention and typically represents a recommendation or endorsement of some message (boyd, Golder, & Lotan, 2010), information that can be passed along across different social circles (Starbird & Palen, 2010). Both features afford individuals a method of either reception or transmission, which can be important during disasters.

In the context of a 2012 wildfire in Colorado, Sutton et al. (2014) examined retweets (serial transmission) of public officials, and the results indicated that most of the content tweeted out by their targeted accounts (16 public officials) was not most concerned with protective action but included a variety of actions that benefitted the larger audience. Similarly, tweets that relayed information about the hazard were most retweeted, whereas life-safety messages were less likely to be shared by the public. This suggests that the targeted public official accounts in this case were more likely to pass along information about broader informative constructs rather than focusing messages to a specific group under immediate threat.

While this information may be useful to emergency managers in a general sense, our understanding of the uses and functions of Twitter during emergencies has evolved since these earlier studies. It is unlikely that simple hashtag searches are the sole mechanism for retrieving information, and it is more likely that users are aware of specific agencies that they can follow for timely and useful information. Furthermore, while past content analytic work on widespread crises and disasters has examined the aforementioned variables and processes, it has not yet specifically examined the variables and content features identified by Sutton et al. (2014, 2015) as advantageous in eliciting serial transmission. An examination of the frequency with which EM agencies use communication strategies known to engender serial transmission (e.g., the use of imperative language) or elicit attention (e.g., the use of directed messages) may inform the development of best practices during crises. Further, the prevalence of actionable information and visual content may guide these considerations.

To that end, the following research questions (RQ) are proposed:

RQ1: *To what extent do tweets associated with EM agencies contain content that can be categorized as informative, affective, humorous, or spam?*

RQ2: *How common are image links and other graphic elements in these messages?*

RQ3: *To what extent do EM agencies use imperative, declarative, interrogative, and exclamatory language in their tweets with the public?*

RQ4: *How common are directed messages from EM agencies?*

Method

This content analysis sought to identify patterns in Twitter content concerning a weather risk, specifically focused on the question as to how EM agencies utilize the platform. A sample of tweets was collected using a Web-based program, TweetArchivist (www.tweetarchivist.com), which can collect the last 1,500 tweets of search term(s). TweetArchivist updates its archives hourly, pulling the most recent 1,500 tweets available with a given search term. When using a word search, the application will also include descriptive data about the user and the tweet. Tweets were collected from September 30, 2015, through November 14, 2015, though the primary focus of the present study was from October 1, 2015, through October 8, 2015. A total of 10,788 tweets were collected. After removing duplicate tweets and tweets not stemming from EM agencies, 7,970 tweets were included from predetermined accounts that focused on state EM agencies, using the EMA handles as search terms (@RhodeIslandEMA, @MassEMA, @CTDEMHS, @NYSDHSES, @ReadyNJ, @DelawareEMA, @MDMEMA, @VDEM, @NCEmergency, @GeorgiaEMA). State accounts were prechosen for Joaquin due to the relative geographic uncertainty of a potential land-falling tropical system (capturing all East Coast state EMs) and the ability for state-level EMs to communicate geographically targeted information to a population (rather than larger-scale, vague messages on a national level). Data for South Carolina were also collected but excluded from the present analysis due to the volume of tweets produced by the account during the time frame; South Carolina was hit by secondary system in the form of inland flooding and mudslides. It was determined that the unique situation in South Carolina constituted a separate event, and within the meteorology community the two were treated as distinctly separate events (Berg, 2016).

Hurricane Joaquin serves as an interesting case of risk, as the threat of an East Coast land-falling tropical system was well communicated and forecasted only to eventually miss the East Coast and travel out to sea. Separately, the National Weather Service advised of a separate "catastrophic flash flooding" event from rainfall primarily in South Carolina, but much media attention was directed toward the less-likely storm in Hurricane Joaquin. While not directly associated with a landfall of the storm, moisture associated with Joaquin required communicating a more localized risk while the uncertainty of a larger widespread threat existed (Berg, 2016).

Five research assistants were recruited to code the data and trained during two training sessions held within one week in September 2016. A random 500-tweet subsample was used to assess intercoder reliability, and reliability statistics were calculated using ReCal2 (Freelon, 2008). Only one variable required retraining of two coders to meet intercoder reliability, but after retraining, minimum intercoder reliability was achieved for all variables (.70 or higher; Krippendorff, 2004). The coding characteristics included both content and stylistic elements of the tweets, and all tweets are coded by who sent or retweeted the message (citizen, official, government agency, media, nongovernment, for-profit, or other) (π = .88). Tweet type examined the content of the message for containing information, affective content, humorous content, spam, or other types (π = .72; drawn from Lachlan et al., 2014a). Linking to an image was simply coded as a binary *yes* or *no* (π = .77).

If a message did contain an image (e.g., coded *yes*), the content was examined and coded to be either a map, informational graphic, damage, an image of a longer statement, or other content (π = .81). In instances in which multiple characteristics were present (e.g., visual elements or information types), coders were instructed to identify the *primary* intent of the tweet or link (see Lachlan et al., 2014a). Language usage was coded using the aforementioned imperative and declarative message style, and categories of interrogative (asking a question) and exclamatory (a more forceful statement) were also coded (π = .77; adapted from Sutton et al., 2014). For both tweet type and language type, coders were instructed to assign the code that best captured their perception of content, without consideration of word count or other markers. Finally, binary codes were also assigned for when the tweet was clearly flagged as a targeted message (e.g., beginning with "@"). Perfect agreement was reached on this variable. The entire codebook is available via an Open Science Framework Project (https://osf.io/x3h6v).

Results

Cross-tabulation analyses were used to examine the research questions under consideration. For RQ1, minor differences were detected across message sender in terms of tweet type, $\chi^2(24)$ = 111.10, $p < .001$, Cramer's V = .118; almost all (95%) of the tweets were identified as primarily informative in nature, including 96% of those sent by civilians, 86% by officials, 96% by government agencies, 92% by news outlets, 93% by NGOs, 93% by for-profit organizations, and 88% by "other."

RQ2 sought to examine the frequency of image links and graphic elements across this content. Results reveal that 31.9% of the messages transmitted linked to some sort of graphic element. Within those that featured some type of graphical element, cross-tabulation analyses across sender type revealed statistical significance, though the effect size was negligible, $\chi^2(6)$ = 26.32, $p < .001$, Cramer's V = .06. Table 1 presents the type of linked image across all sender types.

Further, cross-tabulation analyses examined the specific graphic elements used by various sender types, $\chi^2(24)$ = 143.57, $p < .001$, Cramer's V = .238. Within sender type,

Table 1 Type of Linked Image Across Sender Type

Sender Type	Map	Info Graphic	Damage	Longer Statement	Other	Total
Citizen	22.0%	1.4%	4.2%	25.4%	47.0%	100%
Official	12.0%	2.0%	5.0%	32.2%	43.6%	100%
Gov't Agency	12.7%	1.9%	2.6%	48.1%	34.7%	100%
News Media	21.2%	2.5%	7.6%	20.3%	48.3%	100%
NGO	15.0%	2.0%	2.0%	43.0%	38.0%	100%
For-profit	8.5%	1.4%	0.0%	45.1%	45.1%	100%
Other	12.1%	6.1%	0.0%	33.3%	48.5%	100%

Note. N = 2537.

Table 2 Type of Language Usage Across Sender Type

Sender Type	Imperative	Declarative	Interrogative	Exclamatory	Multiple	Total
Citizen	9.3%	69.4%	0.5%	2.6%	18.1%	100%
Official	5.1%	63.7%	0.6%	3.5%	27.0%	100%
Gov't Agency	11.6%	64.7%	0.6%	3.1%	20.1%	100%
News Media	6.9%	71.0%	0.9%	2.1%	19.0%	100%
NGO	10.4%	58.7%	0.0%	3.1%	27.8%	100%
For-profit	5.9%	52.6%	0.7%	5.9%	34.9%	100%
Other	11.0%	58.9%	1.4%	1.4%	27.4%	100%

Note. $N = 7603$.

citizens (22.0%) and news outlets (21.2%) were more likely to send tweets containing maps, while government officials (41%) and government agencies (48.1%) were more likely to use representations of longer, more detailed statements concerning the storm.

RQ3 investigated language usage across the sample and found that declarative language was most commonly used (67.3%), followed by combinations of different strategies (19.7%), imperative only (9.6%), exclamatory (2.8%), and interrogative (0.6%). Cross-tabulation analyses revealed differences in language use across sender type, $\chi^2(24) = 88.78$, $p < .001$, Cramer's $V = .108$. Table 2 presents the type of language usage across sender type.

RQ4 explored the frequency of targeted message use, or the presence of "@" identified in the tweet content. Across the entire data set, about 30% of the tweets were marked as directed. Cross-tabulation analyses reveals differences in language use across sender type, $\chi^2(6) = 23.72$, $p < .001$, Cramer's $V = .168$. Government officials (52.1%), citizens (48.6%), and for-profit organizations (41.8%) were likely to send targeted messages. By way of comparison, 36.8% of tweets sent by government agencies and 27.7% from news outlets were directed.

Discussion

SNS function as useful tools for disseminating information about weather risks and are also important for investigation by researchers as well. The results here may inform emergency managers/agencies about what practices are occurring during these types of weather events and may be used to compare their own response strategies. One would anticipate multiple stakeholders having differing goals and communicate with those goals in mind. Media organizations are often tasked with information dissemination, while individuals and EMs are often part of the direct response and recovery and even serve as citizen journalists in place of media organizations (Veil, Buehner, & Palenchar, 2011). The results paint an interesting picture of the Twitter content generated when performing searches related to state EM agency handles. In summation, during this crisis event, EM agencies engaged in interactions

that were primarily informational (as opposed to affective), textual (as opposed to graphical), and declarative (as opposed to imperative) and not directed at specific users.

In contrast to the findings of Lachlan et al. (2014a, 2014b), little noninformational content was detected. It appears that the government agencies sampled utilized more informational content compared to a sample of the general population. Future investigators may seek to understand this finding with respect to stages of a crisis. Specifically, Joaquin was a complex and uncertain storm, but as the potential landfall date approached, it became more certain that it would not directly affect the United States. These patterns of informational content across time may differ and could be examined across individual stages of a crisis.

In comparison to research relying on hashtag searches, the data harvested herein were generated by searching for EM Twitter handles. The resultant differences suggest that the possibility of using more sophisticated search strategies (e.g., knowing where to find content from EMs) could generate more actionable information. This is indicative of the importance of information literacy and the necessity for those affected to know *how* to best use Twitter to maximize exposure to useful information. Future research could possibly test this within the same storm to better understand potential differences across risk events. EM agencies may also wish to consider proactive campaigns aimed at getting at-risk audiences to know how to locate such information, considering the differences between content retrieved from general hashtag searches and that retrieved from focused searches on EM agency handles.

At the same time, there are still identifiable areas for improvement in terms of the messages disseminated by EM agencies. Past research has suggested that imperative messages may be more effective than declarative messages at motivating people to mitigate against risks and are more likely to be retweeted (Sutton et al., 2014). Only about one-third of the messages stemming from government officials and response agencies used imperative language alone or combined with another strategy. This provides individuals with important and life-saving strategies and commands, but it could leave a user asking "why?" when being told to act.

Furthermore, the past research by Sutton et al. (2014) has suggested that government agencies should engage in dialogue through the medium. The data suggest that progress may be taking place in this regard, as over half of the messages stemming from government officials and a substantive number from response agencies were directed in nature. While not directly analyzed here, there is evidence that state EMs are beginning to engage in dialogue with those affected by crises and disasters. Given past research suggesting the effectiveness of these language strategies, and the current data indicating their presence in the dialogue, state EM agencies may wish to continue working toward this dialogic approach while bolstering the use of imperative language and graphic elements in their tweets with the public. The effectiveness of these strategies should be directly addressed in research examining the effectiveness of these strategies in other crisis contexts.

While the current study is informative, it is not without its limitations. It may be the case that users other than an official feed emerge as change agents during these

events. Network analytic research may be useful in identifying organic opinion leaders in the network during weather events; content analysis of these tweets may prove equally useful. Future research in crisis informatics should examine language usage and serial retransmission of the sources so that they may be leveraged in the management of crises and disasters.

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