

Social media and disasters: human security, environmental racism, and crisis communication in Hurricane Irma response

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Social media and disasters: Human security, environmental racism, and crisis communication in Hurricane Irma response

Abstract

Social media has been widely recognized as key communication channel in disaster situations. However, there is limited empirical investigation on how the intersecting issues of social order, environmental impacts, and crisis communication unfold from the perspective of a social media user. This study examines 60,449 tweets to and from the news media in Florida during and immediately after Hurricane Irma in September, 2017. Based on a critical review of the literature coupled with an eight-category coding scheme (including second-hand reporting, reporting on self-experience, requesting help, coordinating relief efforts, and expressing well wishes), the article assesses the content and timing of tweets before, during, and after the storm. It finds that thematically, twitter coverage not only covers the storm itself but pressing social issues such as looting, price gouging, the privileging of elites in rebuilding efforts, environmental vulnerability, and abandoning pets. Temporally, the volume of different tweets peaked and dropped at different stages; for example, tweets about personal experience peaked when the hurricane hit the ground while requests for help peaked in the days after the hurricane. The study allows for a better understanding of the sociological, environmental, and even social justice impacts and related disaster response through the use of social media.

Keywords: Social media, tweets, disasters, content analysis, hurricane recovery

1. Introduction

Natural disasters are profound social affairs in addition to climatic or geospatial events (Quarantelli 1988; Quarantelli 1997; Dynes and Drabek 1994; Mileti et al. 1992; Mileti 1993). Sometimes, the human response to a natural disaster can exacerbate its impact, even more than the event itself. Kates et al. (2006: 14659), when writing about Hurricane Katrina, concluded that “because disasters tend to accelerate existing economic, social, and political trends, the trajectory for full recovery (preexisting population, economy, and infrastructure) is not promising.” To which, Bullard and Wright (2009: xxv) add “quite often, the scale of a disaster’s impact ... has more to do with the political economy of the country, region, and state than with the hurricane’s category strength.” Their statements underline a need to better understand the dynamics and social responses to natural disasters, especially since recovery efforts form an essential component of any global attempt to cope with both naturally occurring events as well as human-induced events such as climate change.

These disastrous events require coordination and establishment of robust response structures with efficient and timely communication among government agencies, local officials, organizations, and residents. How disasters are represented in the media, furthermore, can shape both the effectiveness and legitimacy of those messages (Comunello et al. 2018; Fraustino et al 2018; Martin 2013). With the introduction of social media in this century, new forms for communication during these extreme events have not only helped response efforts but also developed better understanding of social developments during the situations of crisis, emergency or disaster (Liu et al. 2016; Wang et al. 2019). In particular, the use of Twitter data during crisis and extreme societal events has become a legitimate source of news, and information has

recently captured scholars and practitioners' interests (Spence, Lachlan, Lin & del Greco, 2015; Sin & Kim 2013; Huang & Xiao 2015).

However, this is a space that remains understudied in two ways. First, considering that the physical and social impacts and damages are attached to the locality of each event, the effects of every natural disaster can be significantly different depending on the geography and nature of the disaster; thus, response structures have to continue to build capacity and robustness based on learnings of reoccurring and new events internationally. Particularly, as annual weather-related disasters have increased fourfold from forty years ago, and insurance payouts have increased by a factor of eleven over the same period, rising by \$10 billion per *year* for most of the past decade (Reddy and Assenza 2009). One team of researchers even found that due to climate change, average storm surge damages will likely rise from \$10 to \$40 billion per year in 2014 to possibly \$100 *trillion* by 2100, affecting up to 600 million people. Secondly, while social media data can be useful in understanding events, the volume of data can be analytically expensive, and manual or qualitative analyses may not offer the capacity to process tens of thousands of observations, in this case tweets, created with each single natural disaster. For this reason, we need to continue to innovate in our methods for content analysis of such rich data, particularly via automated data mining techniques, since these are proved to reveal new depths of understanding of large data sets.

In this paper, our contribution is twofold. We approach the topic of disasters from a conceptual framework—social order and crisis communication—that is able to both humanize and analyze people's response to incidence and severity of disasters. We also utilize a novel method for integrating machine learning and content analysis of social media data—the auto-detection and validation of themes and topics in Twitter contents. The paper utilizes Twitter data

from people's responses tweeted to local media to investigate public opinions from local communities toward natural disasters, specifically hurricanes. In this way, we attempt to contribute to the disaster and sociology literature in the following ways: 1) investigate key evidence that supports the analysis of issues of social order, crisis communication, and environmental impacts of hurricanes and 2) provide detailed methodology of using content analysis and machine learning on hurricane responses for future hurricane management and relief efforts.

Indeed, research from sociology has suggested that disasters offer a useful *litmus test* for social values and priorities but also as to how communities handle crisis. Boulianne et al. (2018) even term disasters as a “strategic research site” for “better understanding the conditions under which organizations, institutions, and value systems emerge and change.” They found that rather than merely being a prelude to tragedy, disasters can lead to emergent social networks and ties that aid disaster recovery and response. They note, however, that a missing thread within this literature is assessing the extent that social media affects pro-social or caring behavior. We agree, but in our study also reveal some of the darker sides of disaster recovery, insofar as it can lead to exclusion, racism, and a redistribution of risk.

Furthermore, our analysis of *social media* is apt because broader media coverage—how the mass media and public receive and reshape messages about a disaster—has been shown to have a direct impact on donations and the levels of aid relief (Brown and Minty 2008). Perhaps shockingly, Murthy and Longwell (2013) even found in Pakistan that social media outlets such as twitter were more valued by authorities and donors than convention media for being a legitimate and timely source of information about a crisis. Starbird and Palen (2011) note the centrality of twitter in pushing a vanguard of “digital volunteering” at the forefront of disaster

recovery in Haiti, agents they even termed “Voluntweeters.” We maintain that better understanding the dynamics of such social media processes, especially twitter, is both an essential but rarely studied aspect of disaster recovery.

The article proceeds as follow. First, we provide an overview of the literature around the use of twitter in disaster situations. Then we proceed to our theoretical framework and analytical strategy where we describe our multi-method approach to coding categories and the framework of analysis. Subsequently we present our results in a two-fold division focusing on the thematic representation of tweeter responses and also its temporality. This is discussed in relevance of social impacts of natural disasters, the use of Twitter and an empowerment tool for citizen participation and voices.

2. Literature Review and Background: Twitter and the Social Media Dynamics of Hurricane Irma

There is a growing interest in using social media such as Twitter to examine human behavior, attitudes, and interactions in real time and on a large scale. Despite several limitations, Twitter has the advantage of gathering a large sample size within a short period and real time, and the content is voluntarily produced by the tweeters, as opposed to conventional survey or interview data (McCormick et al., 2017). For this reason, the use of Twitter data during crisis and extreme societal events as a legitimate source of news and information has recently captured scholars, non-profit organizations and practitioners’ interests (Huang & Xiao 2015; Spence, Lachlan, Lin & del Greco, 2015; Sin & Kim 2013;). The most common use of Twitter is to act as an alert system or source of further information regarding breaking news (40%), and the most common device used to access Twitter is a smartphone (82%). Nearly 80% of Twitter users report that keeping up with the news is easier today than five years ago while only 62% of non-

Twitter social media users agree (Rosenstiel et al. 2015). Social scientists adopt Twitter to examine large-scale processes of information or opinions that have been applied in the areas of voting behavior, political analysis, anti-immigrant sentiment, public health, current events such as terrorist attacks and so on (McCormick et al., 2017).

Among other uses, Twitter has recently become a major channel for analyzing and updating natural disaster events (Ashktorab et al., 2014, Chen et al., 2018; Kryvasheyev et al., 2016; Huang & Xiao, 2015). Twitter is considered a potential system to improve disaster communication and relief in ways that traditional media are lacking. Bruns and Liang (2012) discuss crisis communication through Twitter, such as the mobilization of emergency services. These services have the capability to disseminate first-hand information to the public (i.e. through hashtags) promptly to avoid irrelevant or unnecessary panic. Particularly, characteristics that are present throughout most forms of social media, such as its dependability, ease of use, and geographic reach, have given it the edge over traditional media (Houston et al. 2015).

In particular, Murthy and Longwell (2013) argue that social media offers a unique platform where victims of disasters can share their personal stories providing first-hand accounts, rather than mediated accounts, of the need for support. Boulianne et al. (2018) add that social media has the benefit of directly distributing news from the victims of disasters to a larger audience (new groups) which can lead to greater levels of empathy and heightened disaster response, while also strengthening social ties (within existing groups) by facilitating acts of caring, giving, and pro-social behavior.

Furthermore, Twitter (and perhaps social media in general) provides first-hand information of safety and casualty (Callcut, Moore, Wakam, Hubbard, & Cohen, 2017) and raises “situation awareness” among the public (Vieweg Hughes, Starbird, & Palen, 2010).

Twitter facilitates crowd sourcing and decision making by providing open and “democratized” information, because disaster response requires rapid actions, creativity, and flexibility (Mills, Chen, Lee, & Rao, 2009). This is perhaps why Twitter data has been used to gauge evacuation compliance (Martín, Lee, and Cutter, 2017) and inform utility companies of service repair (Mao, Thakur, Sparks, Sanyal, and Bhaduri, 2018).

More importantly, utilities, non-profit organizations and local officials have utilized social media data mining to improve accuracy and response time for relief operation. The effectiveness of using tweets have been demonstrated by improving situational awareness, disseminating advanced or real-time warning, monitoring and assessment of the disaster itself as well as mobilizing relief efforts (Hongmin, Caragea, Caragea, and Herndon, 2018, Kumar, Babier, Abbasi, & Liu, 2011; Kryvasheyeu, et al., 2016, Mandel, Culotta, Boulahanis, Stark, Lewis, & Rodrigue, 2012). Recently, ten biggest U.S. utilities have heavily relied on tweets to receive customers’ feedback or to inform power outage announcements, update estimated times of restoration for local areas and even serves as early detection of blackout locations, because storm-related outages restoration information may not be immediately available even with remote sensing and controlling system (Savenije, 2013).

In terms of tweet analysis, several scholars have categorized tweets by simply analyzing their content (Vieweg, Hughes, Starbird, & Palen 2010, Kongthon et al. 2012, Chew & Eysenbach 2010), while others have analyzed tweets in the context of the stage or phase of the disaster event. For example, Huang and Xiao (2015) categorized the phases of a disaster as preparedness, response, impact, and recovery, which correlates to the timing before, during, and after the event. Their coding schema, acting as a time reference, allows researchers or local officials to predict potential problems and prioritize needs and operations and for establishing

geographic situational awareness. Similarly, Qu et al. (2011) found that the most common types of disaster content on social media were: updates, expressing opinions, emotional support, and calling for aid. Of these categories, updates reached the widest audience in the shortest amount of time; the researchers also found a distinct shift in the frequency of each category depending on the stage of the disaster. Takahashi, Tandoc, and Carmichael (2015) examined Twitter users during and after Typhoon Haiyan in the Philippines, suggesting that the use of Twitter for relief coordination and communication came in the aftermath of the typhoon; yet the speed, flexibility, and range of Twitter could be useful for coordinating disaster planning and preparedness.

Researchers have found that the type or content of tweets during a disaster event is partially influenced by proximity to the event. Acar and Muraki (2011) found that during a highly devastating tsunami, which left Twitter as the primary communication tool, those who are directly in the disaster area tend to tweet about survival issues while those who are not directly affected tweet about personal safety and secondary results of the disaster, such as transportation or power outages. Even individuals who are far removed from a disaster could be influenced by the event through Twitter content (Binder 2012). Furthermore, some research focuses on the individuals themselves who tweet. Xiao, Huang, and Wu (2015) found that socioeconomic variables have increasingly high explanatory power in determining tweet volume and content during a disaster. Their newly-developed Mass, Material, Access and Motivation (MMAM) model showed that number of tweets was correlated to population size, as damage increases so does number of tweets, but more severe damage was associated with fewer tweets. Our study focuses on the changes of people's responses to during a disaster event.

Our study uses Twitter to examine Hurricane Irma, which was first detected as a threat in Florida on September 8, 2017. At the time it made landfall, it was a Category 5 hurricane. Storm

surge was the main threat of the storm, as the Florida Keys' highest elevation is approximately 18 feet above sea level. Therefore, any surge had the potential to flood the Keys in their entirety. One day later, on September 11, Irma approached Central Florida, reduced to a Category 1 hurricane with wind speeds up to 75 mph. This was a significant drop from the top strength of 185 mph which Irma had sustained. These winds extended 50 miles from the center, and tropical storm force winds extended 185 miles from the center. As Irma continued across land, it continued to weaken, but still brought significant rain levels and wind damages to the surrounding states of Alabama, Georgia, and South Carolina. By September 14, Irma was officially declared over. Irma sustained its intensity for the longest consecutive period of any hurricane or typhoon since satellite monitoring began (Chen et al., 2018).

From September 8 to 14, 2017, Hurricane Irma resulted in economic damages of up to \$100 billion, making it one of the costliest hurricanes of all time behind Hurricanes Harvey in Texas and Katrina in Louisiana (AccuWeather). While Irma was a larger storm, Harvey resulted in more deaths and economic damages. Some of these costs from Irma will be covered by insurance, but not all. 60% of Florida, approximately 6.2 million homes, were left without power. 40 million people were located within the five-day forecast zone, and 20 million were subjected to the Category 1 wind gusts of 75 mph. Due to Irma's impact on densely populated areas, many evacuation efforts were made. Florida ordered mandatory evacuation of 6.5 million people, and strongly suggested it for many more. As of September 23rd, 102 people had lost their lives. This extensive damages and losses are due to the massive size of Irma. At 300 miles, Irma was nearly twice as wide as Florida's peninsula. The size of Irma in combination with the slow movement pattern resulted in hurricane-force wind gusts that occurred over a time period of 12 or more hours, compounding the damage. In addition, Irma affected the prices of many

producers (and products) across America, because Florida is the second largest grower of produce (especially oranges!) in the country.

3. Research Design: Theoretical Framework, Analytical Strategy and Limitations

The primary goal of this research is to investigate the nature of tweets generated within the time span of a natural disaster, Hurricane Irma in 2017. For which, we ask the following three research questions:

RQ1: For what purposes did citizens affected by Hurricane Irma tweet? What were the most tweeted and retweeted contents during and after Hurricane Irma?

RQ2: What were the foci/themes of the tweets and retweets of each category? What are the differences and similarities in Twitter use before, during and immediately after Hurricane Irma?

RQ3: To what extent are tweets during a hurricane beyond their reporting of disaster status and damage? What broader social and environmental implications arise?

To answer these questions, the article employs content analysis and machine learning to examine what information was available during the prodromal stage, how this information developed and exchanged during the period of the event, and the implications that these patterns of public opinion and information may have for those attempting to manage a similar large-scale emergency.

In particular, we developed a multimethod approach to create the content categories from Twitter. First through a critical review of the literature, we derived a list of content categories based on the consideration of the information involved in progressed disaster phases including preparedness, emergency response, and recovery. These are shown in Table 1. Secondly, through manual coding of Twitter content, we developed and revised other categories and sub-categories,

and further examined the themes of each category to uncover public opinions and social issues during and after the hurricane. Finally, through data mining and manual coding processes, we further complemented the categories with potential new emerging topics or revised previous ones from existing studies. Consequently, this paper introduces a framework based on directed content analysis that can help mine and process large-volume social media data for disaster analysis at different stages.

----- Insert Table 1 Here -----

This section of the paper presents our theoretical framework, introduces our analytical strategy, and lastly reveals the limitations to the study.

3.1 Conceptual approach: Social order and crisis communication

As a conceptual approach, this paper utilizes social order theory and crisis communication frameworks to better understand the intersection between social order, physical and environmental impacts, and public opinions through Twitter. Sociologists argue that disaster prevention, preparedness, response and recovery are the multi-dimensions of social order (Kreps, 1984; Ritchie & MacDonald, 2010; Ross 1980; Chen et al., 2018). Numerous studies examine the role of social order in disasters. The overall “impact upon the social system” (Alexander, 1997, p. 290) is a defining component of a disaster, and as Alexander asserts, social order can be shifted or even suspended, and if the disaster is extreme, a new order can be imposed.

Freudenburg (1997) points out disasters can increase victim anxieties as certain establishments are eliminated. When citizens lose a certain level of confidence in their trusted institutions, they can be difficult to regain (Freudenburg, 1997). Alipour et al. (2014) echoes this framework, finding that after a disaster, social vulnerability, social uncertainty, and lack of knowledge on

local social capital can all thwart the recovery process. Further, Zahran et al. (2009) studied two social order propositions in relation to natural disasters and crime, finding that disasters decrease property and violent crimes, but the impact on households during these crises increases domestic violence. Overall, disasters have a tremendous influence on social order in the affected communities.

According to Kreps (1989), social order can be characterized by specific entities that work to maintain social structure when it is in jeopardy (i.e. during a disaster). These units may be new or pre-existing, but they are shaped by human action. For example, Kreps (1989) states that, during a disaster, the police, hospital workers, or search and rescue personnel are all establishing and maintaining social order (p. 40). Drawing on the elements from Simmel Weber and Durkheim's interpretation of social order as well as previous disaster research, Kreps (1984) argues that forms of association enacted during disasters reflect sequences of four basic elements of social organization: domains (D), tasks (T), human and material resources (R), and activities (A) (p. 315). Based on this general framework, we analyzed the tweets during Hurricane Irma including the four main elements: 1) domain sources of tweets (domains); 2) preparedness, disaster recovery, and relief efforts (tasks); 3) social and environmental impacts (human and material resources); and 4) status reporting, help requests, complaints, expressing thanks and well wishes, and general comments (activities).

This paper also adopted the framework of crisis communication that is widely adopted in the literature of disaster responses. Social media has become a community-based platform for crisis communication (Spence, et al., 2015). Houston et al. (2015) suggest social media allows for "two-way mediated communication," unlike traditional mass media outlets of the past. Individuals become active consumers and producers of information in real time (Takahashi et al,

2015; Bruns & Burgess, 2014; Feldman et al., 2016). Crisis communication scholars have not fully incorporated social media in a formal theoretical framework (Takahashi, et al., 2015), thus, much of the theoretical work focuses on developing methods to better understand the type and use of tweets during times of crisis. Houston et al. (2015) developed a framework, outlining 15 different instances where social media can be utilized during and between their three definitive phases of a disaster: the pre-event, event, and post-event. During the pre-event, social media can be used to supply and receive preparedness information and disaster warnings. From pre-event to the event itself, it may be used to indicate a disaster is occurring. During the event itself, social media is used as a method to send and receive appeals for help or assistance and to both inform and learn about the status of others affected. In the transition from the event to the post-event, it may be used to gain information about the disaster, to deliver and receive news coverage, to provide disaster relief information, assistance method, resources for mental health and support, well-wishes and concerns, and comments and discussions on others' experiences. Finally, during the post-event: to discuss both the causes and implications of the event and to connect community members. Throughout the entire event, social media can be used to perform communication functions as used with traditional mass-media.

Relatedly, Takahashi et al (2015) sought to empirically test Houston et al.'s (2015) work in the context of Typhoon Haiyan in the Philippines. The researchers found that the top three most-tweeted content was: secondhand reporting (such as new reports or information from a government/agency), memorizing the affected, and coordinating relief efforts. News organizations, journalists, and government sources utilized Twitter for secondhand reporting, whereas residents and nonprofessionals used Twitter to express condolences, well-wishes, thanks or sympathy. Based on literature in crisis communication, this paper utilizes similar categories to

those established by Houston et al. (2015) and Takahashi, et al., (2015) in order to better understand the public's needs and concerns on environmental, social, and psychological impacts during Hurricane Irma. What is perhaps striking here is that Tweets can still reveal prominent or latent patterns of racism or discrimination despite the fact that they are a “public” form of communication, one that intuitively would be subject to “social desirability bias” (Fisher, 1993; Klačnja et al. 2018) and self-policing of users. This may suggest that the findings we reveal are more serious in other forms of private communication.

3.2 Analytical strategy: Machine learning and Twitter

In terms of our empirical strategy and analytical approach, 60,449 tweets were collected in Florida during Hurricane Irma. All tweets collected were checked, ensuring they had not been expired or deleted by users. This dataset consists of tweets tweeted to sixteen local news stations and tweets from local news station accounts to their followers. These tweets were collected to analyze the interactions between tweeters and local news stations. We chose local media because it often has the responsibility of reporting community events and situations as a priority, and it is often the most respected source of information locally, at least compared to some national or international outlets. Equally important, residents in those affected areas tended to engage with their local media for reporting disaster situations, requesting help, or making complaints. The sixteen local news stations were chosen by identifying the local news stations of the major areas of Florida. Because Hurricane Irma intensified into a hurricane August 31, 2017, tweets were collected from September 1, 2017 to September 30, 2017. Hurricane Irma officially dissipated on September 16, 2017. This time frame allowed the collection of tweets while the hurricane was affecting Florida and after the hurricane passed.

To obtain all instances of a specific news station, the Twitter handle of each local news station (“@TwitterHandle”, i.e. the username of the local news station) was entered into the Twitter Search tool. Table 2 shows the resulting list of sources covered. This search tool used criteria such as a username or search term to gather a set number of tweets or all tweets matching the criteria. Tweets that were sent out by the local news stations were kept in the dataset in order to analyze the responses from Twitter users. This also means that retweets were included in the files.

----- Insert Table 2 Here -----

To gather the tweets in the dataset, a Twitter developer account was created. Using OAuth and the Python Tweepy library, tweets could be accessed and stored in offline files. A user on GitHub created a tool that employs the Twitter Search Tool. These tweets were placed into a file with username, date, tweet body, retweets, likes, and hashtag. With our tweets collected, we then utilized directed content analysis consisting of the following components summarized in Figure 1. Essentially, this procedure involved four core steps.

----- Insert Figure 1 Here -----

First, we deployed manual coding of general tweet content. A thousand tweets were randomly selected from the total pool of tweets, and two undergraduate research assistants (RAs) independently coded those tweets in terms of their contents/purposes into our initial categories. RAs were also instructed to discuss the tweets that cannot be categorized anywhere and to create appropriate categories or subcategories for those tweets. The initial inter-rater reliability was 0.78. The tweets that were categorized differently by the RAs were thoroughly discussed by the research team and placed into an existing or new category. If one tweet seems to imply multiple categories, only the major category was recorded. Agreement was reached at the end of this step,

with an inter-rater reliability of 0.98. Table 3 shows the final tweet categories after utilizing the coding process of Figure 1.

----- Insert Table 3 Here -----

Second, we explored inductively the themes within each category. “Word frequency” searches were conducted within each category to determine the most used words for that particular data set. “Context search” was then conducted with every one of the top 10 most used words in each category, excluding the words that do not convey any meanings (e.g., http), to identify the embedded themes of each category. “Word tree” diagrams, which display the contexts frequently appearing before and after the designated word or phrase, were carefully examined by multiple research assistants and discussed. Figure 2 is a partial screenshot of the word tree diagram that was generated for the keyword “wind”, as an example. The diagram shows the context (i.e., the words and phrases that appeared before and after the keyword) and indicates the frequency of the contexts by ranking them in order and presenting them in different font sizes.

----- Insert Figure 2 Here -----

Third, we relied on automated coding of general tweet contents. Automated coding on the themes of all collected tweets was conducted with “automated insights” in NVivo 11. “Automated insights” is a completely data-driven process, without any premises about the observed phenomenon. It is recommended when the data sets are particularly large and/or the researchers have very limited time. It will produce “auto-coded themes” in the forms of words and phrases. However, this procedure can produce results that are less accurate (Nvivo Help), and therefore, in this study, we only used it for verification purpose. We performed “text search” with every one of the auto-coded themes and looked for topics that were not included in our

categories or themes by examining the generated “word tree” diagrams. Exploration of themes and topics of our tweet corpus was primarily conducted in an inductive manner; those themes and topics, however, could be fed to a supervised machine learning process for the purpose of categorizing new tweets deductively if warranted.

Fourth, we analyzed the most tweeted content. Manual coding was conducted on the tweets that have at least 100 retweets ($N = 229$, in the entire data set) in terms of their content and source (i.e., the tweet account types). The number of tweets and sources from the manual coding is compared with those from the automated coding to verify the types of tweets, and sources, which are most likely to spread amongst users during and after a major hurricane.

3.3 Limitations

Our first limitation was the need to sample. Due to the large volume of the tweets and the time constraint, only 1,000 randomly selected tweets were manually coded. To verify sample representativeness, automated insights were performed on both the entire tweet corpus and the selected sample, and the automated themes generated from them were compared. Out of the 57 automated themes generated from the entire corpus, 55 were covered by those generated from the sample. The two themes not covered were “car” and “zone”. Keyword in-text analysis was therefore conducted on each of the two words with the “text search” function in NVivo. According to word tree diagrams, “car” most often appeared with “gas”, “traffic”, and “crash”; “zone” always appeared with “evacuation”. All of which are covered terms in the automated theme list. The results indicate that the randomly selected sample is indeed representative of the entire tweet set.

The tweet population that we examined was limited to the tweets tweeted towards local media at a particular period. We believe those local tweets may contain more warnings, help

requests, damage reports, and action items relating to local communities for the first responders and government agencies because of the proximity, but in the meantime, we may be missing out a number of tweets expressing warm wishes, or discussing potential environmental causes and future management actions. Those tweets merit future studies with different foci. As researchers have noted, Twitter users are not representative of the general public (Tufekci, 2014); twitter users tend to be younger, males, more educated, and often from urban areas (Duggan, 2015; Greenwood et al., 2016; Mislove et al., 2011) and therefore the findings can only be generalized with restrictions. Moreover, research shows that political discussion in Twitter is mainly driven by citizens with extreme values in the ideological scale, reflected by the polarization of tweet contents (Barberá, & Rivero, 2015). To the best of our knowledge, however, there is no studies on how people tweeting about hurricanes/natural disasters may differ from people who do not tweet about those events. In fact, one study found that many people start to use twitter during an emergency event and stay as active users because they have experienced the usefulness of Twitter during the emergencies (Hughes & Palen, 2009). Another limitation to this study is that we did not extend the tweet collection time to very long (for more than two weeks) after Hurricane Irma dissipated. Some ramifications and discussions may not manifest themselves during this relatively short period. Future research may be benefited from mining tweets over a longer period, especially a period that witnesses multiple hurricanes.

4. Results: Ideographs and temporality in Hurricane Irma crisis communication

This section describes our results, organized inductively around the topic of ideographs (recurring substantive themes) and temporality (how tweets changed over time, and were then retweeted).

4.1 Ideographs: Safety, environmental security, and racist scapegoating

Ideographs generally refer to “meta-narratives” or recurring storylines that often occur across diverse narratives. Van Lente (2000) suggests that an ideograph intertwines ideology, power, social control and language—it becomes a “way of understanding what collective conviction means.” Ideographs are thus master frames that signify a baseline of public and political commentary, and often relate to common rhetorical tropes such as “freedom,” “quality,” “prosperity,” and “safety.” Here, in particular, our analysis of Hurricane Irma’s crisis communication revealed three dominant ideographs: safety and security, environmental risk, and racist scapegoating.

4.1.1 Self-reporting of safety and supply/service needs

By far the most common theme tweeted from the storm was first-hand accounts discussing personal experiences or updates about their safety or security in real-time. Expectedly, there was more focus in expressing a sense of concern and damages with users noting: *“We are the only home on our road so far not much flooding took this pic of outside we prepared for the worse to come later”* and *“I95SB near 10th Ave backed up. Looks like the left lane is shutdown ahead, I see flashing lights @CBS12.”* While some users also posted quick safety updates, simply stating, *“We r safe!!!”*; showing the value of social media in empowering individual voices, whether it is for self-reassurance of the user, his or her social circle or wider society, even in the event of extreme conditions.

Another common theme in the data, and one that is targeted to wider social spaces, is the expressed concern about the lack of, both, capacity to withstand and respond to the effects of the hurricane and also access to supplies and services throughout it. In this way, the evidence revealed tweets notifying the experienced lack of infrastructure capacity, *“@mysuncoast I*

evacuated 2 hrs ago from Myakka City. 1st, school-no pets. 2nd school-sorry we're full. 3rd school-sorry we're full. I'm home” and also reflecting on it, *“a tragic post-hurricane failure by @insideFPL this is insane how they're infrastructure was not at all prepared”*. Responses also addressed the difficulty in getting supplies such as water and gas: *“Strike out for water again at the Publix in South Vero Beach Square @CBS12”* and *“Gas stations near us show red on map, others don't answer phone, ones who did didn't have gas. Wish someone would report on gas status.”* Many residents also complained about power loss and a lack of power restoration, as in the following examples, *“I lost power, i am using the radio that i was going2give Eric listening2 Chris Farrell right now on 97.9”* and short updates like, *“No power here in Tamarac.”* The shortcomings of capacity and access to services created a sense of uncertainty and dissatisfaction: *“Over 26,000 people without power in Lake Worth right now. Yet there's not even a breeze outside. @WPTV”* and *“many stations in Sunrise have not had gas since Monday? Resupply is terrible why? @RickScottWatch @WSVN @FoxNews.”* Reiterating that, infrastructure capacity and infrastructure resiliency have yet to build a required level of robustness to withstand emergency situations, such as in the event of natural disasters.

Notably, many users expressed requests for immediate help (Table 3) or assistance during or after the event *“@JulieDurda @JaceyBirch PLEASE GET HELP TO MY COUSIN IN ST JOHN”, “Hallandale needs power in most apartments. Thank you,”* and *“@FOX13News: we need our lights back please help us.”* Many users also sought information for themselves or others: *“Where's the gas at in Broward? @wsvn #AskPhil”, “@wsvn #AskPhil where should we evacuate too?”* and *“@wsvn what time do they shut down the bridges to Miami Beach?”* Many users reached out to local news stations in these scenarios. While responses also evidenced a perception of individual and social needs, giving self-reflections on the impacts of the hurricane,

related to the needs of the people: “*More buses to get people out who didn't have means would help. More personal responsibility would've helped more.*” Interestingly, this sense on self-responsibility also suggested a call for personal accountability for safety, as opposed to solely attributing it to the authorities: “*I understand that; however, I don't place the responsibility for my survival, or those for whom I am responsible, upon the govt.*”

Finally, Twitter content also showed many users expressing thanks, well wishes, and memorializing (Table 3). Most frequently, people were offering prayers and hopes for safety: “*Ohh myyy goodness. Prayers.Sent*”, “*Vice President Mike Pence to Florida: “We are with you”*”, and “*Be safe #Florida.*” Many users also thanked news and utility workers: “*Thank You!!! @10NewsWTSP for providing us with the coverage we need so we know what's going on!! Great Job!*” Another user thanked Florida Power & Light Company for restoring 2.3 million outages in one day: “*Amazing work guys.*”

4.1.2 Environmental risk, storm severity and climate change

Perhaps unsurprisingly, the next salient category was second-hand reporting on impacts (Table 3), in this case, users discussed the extent of Irma’s impacts both on the environment and on social life. Frequently in this category, users discussed fallen trees, flooding, debris, and other damages: “*Floodwaters creeping toward these St. Lucie County homes off Okeechobee Rd. @WCPO @WPTV #Irma,*” and “*Manatee county 12:30 pm already massive tree uprooted laying on power line #Irma2017 @PaulFox13 @FOX13News.*” Another frequent theme in this data was store and school closings, much like this tweet: “*BREAKING Miami-Dade Public Schools to close Thursday, Friday ahead of #Irma.*”

On this thread, reporting also focused in human displacement as a result of the hurricane either during the mobilisation, “*People stuck in bumper to bumper traffic taking a pitstop in*

Orlando as the try to evacuate before the storm. #patience #Irma @news6wkmg pic.twitter.com/8kVRq5p7DU”, or after it, *“Parts of Florida left looking like a ghost-town as millions flee Hurricane Irma #HurricaneIrma telegraph.co.uk/news/2017/09/09/parts-florida-left-looking-like-ghost-town-millions-flee-hurricane/”*. The effects of displacement were noted to over-flow existing system, as above noted with the lack of infrastructure: *“We are now at #Palm Beach #Gardens Community High School where some 1300 people are seeking #shelter @CBS12 pic.twitter.com/Kfh4gp3DE8”*.

Tweets relating to second hand reporting on status (Table 3) focused on real-time updates of the hurricane. Users commented on the severity of the winds as well as the strength of Hurricane Irma, and this information was typically supplied by local news stations: *“Irma grows to Cat 4 hurricane with 130 mph winds. Coverage from @wcpo sister station @WPTV...”* This type of tweet was the most common in second hand reporting on status. Status tweets also provided the latest updates and weather alerts, a theme that was also quite prevalent in the data set: *“ST. PETE-CLEARWATER AIRPORT CLOSED: Friday at 11 a.m. until further notice, based on evacuation of Flood Zone A...”* Further, in the realm of weather updates, there were tornado warnings: *“Alert: A Tornado Warning has been issued for the Treasure Coast. Live stream on @CBS12 here...”*. This category provided a number of tweets regarding Irma’s location and where the hurricane would make landfall: *“Here is the latest advisory as Irma is about to make landfall in lower Keys...”*.

Among the entire tweet set, there are 142 (~0.23%) tweets containing the keyword of “climate change” or “global warming”. Among them, 98 tweets (69.01%) argued for the occurrence of climate change and some of them urged the government to take actions. For example, one tweet said *“It's time to wake up and smell the climate change y'all,”* and another

one said *“Isn't electing a GOP 'climate change denying' Governor, kind of like tugging on Superman's cape? You can do it, but...there's Consequences!”* At the same time, there were still 17 tweets (11.97%) calling to stop associating natural disasters, and in this case Hurricane Irma, with climate change, where one user expressed: *“The southeastern US has been getting hit by hurricanes for thousands of years. CLIMATE CHANGE HAS NOTHING TO DO WITH IRMA. Dear god.”* These calls further show the now heavily politicized nature of climate change in the US as another user noted: *“Stop supporting this left-wing liberal conspiracy. There is no storm!!!! Vandals and hose pipes made that!”*.

4.1.3 Racist scapegoating and classist discrimination

We also found a pattern in the tweets about looting and stealing behaviors that cannot be ignored, particularly as they often involved a racial connotation or direct content. In this case users criticized the potential media biases and instigation of looting stereotypes: *“Why does @WPLGLocal10 keep looping this tired story? Can they cover how young Black ppl are helping with relief efforts? Sheesh! #MediaBias”*, with others debunking stories, *“Those aren't looters those are members of the black lives matter trying to help that store renovate after the hurricane.”* The association of a looting stereotype reflects perhaps a racial sensitiveness in the US, where reports of looting tend to be directly associated with the racial background of a group of people. Here second-hand reports try to reaffirm perceived racial stereotype, *“Arent2 the ppl looting creating the stereotype?”*, while others trying to reverse it, *“OMG! Did you see all those white people looting?”*, and also including other groups, *“I've seen video of black, white, and brown looters”*.

Another stream of tweets questioned the higher social class being given or likely being given the priority in service restoration: *“@insideFPL seems you all are servicing rich*

neighborhoods first! How can grove isle have power!? In all 3 towers!?!?!?" "That's funny shit. Been on the road in 33024 and haven't seen one truck! Must be going to the rich neighborhoods." The tweets also commented on the unbalanced vulnerability of low-income, mid-income, and high-income neighborhoods, for example, *"Rich people don't flood baseball stadiums, it's middle income if you have it in abundance. This area doesn't have that, lacks corp support."* This stream of responses highlights the collateral impacts of natural disasters, in this case the Hurricane Irma, and how these have particular social effects.

4.2 Temporality: communication "peaks" over time and retweets

In addition to having common substantive elements, the tweets changed over time, and had interesting dynamics in terms of re-tweets. This section of the paper expands on both of these themes, namely the temporality of tweets before, during, and after the storm, as well as the specific dynamics of re-tweeting.

4.2.1 Tweet content about the hurricane over time

Figure 3 shows the frequency of different types of tweets, from when Irma was identified and announced as a threat to Florida (Sept. 8th), to its landfall (10th), and shortly after, within this randomly selected sample. It is clear that second-hand reporting about status and impact, personal experience, and expression of concerns and well wishes increased as Hurricane Irma approached, peaked as it hit the ground, and dropped when its impact waned. The trend was most salient with reporting of personal experience. Consistent with our expectation, tweets about preparedness dropped to close to zero after the landfall, while reporting on the recovery and complaints about utility services rose by about three times after the landfall. Requests for help stayed at the same level, while comments on government actions and discussions about the

causes remained scarce during the entire event. There were clear distinctions between the trends of different types of tweets. For example, the number of manually coded tweets about preparedness and the number of tweets about recovery changed differently from the 5-day-before-landfall period to the 5-day-after-landfall period, $\chi^2(2, N = 68) = 38.98, p < .001$.

----- Insert Figure 3 Here -----

Figure 4 shows the frequency of different types of tweets within September, for the entire month. Except for the patterns mentioned above, we see that reporting about recovery and complaints about utility services peaked in five days after Hurricane Irma and tailed off afterwards. There was a notable portion of tweets on Hurricane Maria in late September. Looking at the entire set of tweets, the daily number of tweets increased from Sept. 5th and peaked on 10th when Hurricane Irma made its landfall- almost four times more than the baseline level. After that, the number of tweets went down and leveled off after 15th. This can provide a sensible timeline of the response efforts and effectiveness following the landfall event across the different stakeholders, from emergency services to water and electricity supplies. In turn it may allude to the use of Tweeter for evaluation of disaster's response performance (as well as the event's impact) by extrapolating and measuring Tweeter responses across different natural disaster events: for example, the 5-day peak evidenced in responses, as well as the level of responses within such timeframe.

----- Insert Figure 4 Here -----

4.2.2 *Most retweeted tweets*

Within the entire data set, 229 tweets were retweeted 100 times or more. Figure 5 shows the categories that these popular tweets belong to. Most of the tweets were reporting the status or impact of Hurricane Irma, each accounting for over a quarter of the most retweeted tweets. These

types of tweets typically contained powerful images, such as those showing the rapid development of the hurricane, the hurricane eye, intense flooding, or a giant object (such as a crane) falling on the roof of a building. Those tweets were perhaps more likely to evoke intense feelings and get shared. Another type, accounting for about 20% of the most retweeted ones, was reporting on preparedness such as the availability of shelters and grocery products. Those tweets contained useful and sometimes critical information for the residents to cope with the emergency. Next, more than 15% of the most retweeted tweets described secondary impacts of the hurricane, mostly wrongdoings such as looting the stores and abandoning home pets. These tweets perhaps appealed to people's moral senses and people retweeted to express their own ethical stance on those issues. In addition, some of the most-retweeted tweets expressed thanks to, for example, the first responders working tirelessly, JetBlue providing free meals, and the local football team for building shelters. People were probably gaining courage, faith, and strength through retweeting those tweets. Lastly, a few tweets were popularly retweeted for their interesting and novel nature, for example, one tweet said, "*The #Santeras are out trying to shoo #Irma away,*" with a video attached. In general, the inclusion of either a picture or a video or both seems to be a characteristic shared by most of the popular tweets: 80 (34.93%) tweets contain a picture and 102 (44.54%) tweets contain a video; only 47 (20.52%) tweets do not have a picture or video. As expected, most of the popular tweets were sent from local news stations (70.74%), followed by reporters (20.96), confirming the important role played by the media in natural disasters.

The analysis of the content of responses, even at this high level, may provide other suggestions. Here we point to two levels: first that response initiatives to disasters should integrate the use of social media, both top-down (tweets from organizations) and bottom-up

(tweets from individuals) while designing and implementing response actions. For example, by unifying a delivery message, instead of disaggregating it across users. This means that instead of having authoritative figures tweeting individual messages, they could retweet the official relief effort actions. While the second suggestion refers to the content and delivery format of such initiatives, for example information on status, impact and relief efforts to be delivered in an image or video format, as opposed to text format.

----- Insert Figure 5 Here -----

5. Discussion and Conclusion

The overall goal of this study was to investigate tweets tweeted to local news media within the time span (before, during, and after Hurricane Irma) in 2017. Based on disaster and crisis communication literature, we developed a list of content categories to better classify the information and detect major themes and patterns. Results of our analysis include the categories of second-hand reporting on (a) status (b) preparedness (c) impact (d) recovery and (e) secondary impact, as well as reporting own experience, emotions, requesting help, coordinating relief efforts, commenting on the government, complaining about utilities and other services, expressing well-wishes, discussing causes, commenting on news coverage, and the hurricane in Florida. The most predominant tweeting topics connected to ideographs about personal safety, supply and service needs, environmental risk, climate change and (surprisingly) racist scapegoating and social injustice. Most importantly, these categorizations can help researchers in the future better process social media data during different stages of a natural disaster.

These results highlight the perhaps obvious social effects of natural disasters, such as hurricanes, and the type of pressures it has on infrastructure systems of health, transport, service provision, etc. More importantly, however, the findings reiterate the value of social media in

empowering individual voices, whether it is for self-reassurance, the individual's social circles or wider society. Additionally, our study highlights a potential increase in citizen participation during times of emergency, whether it is in calls of help, alerts of precaution, raising social awareness of injustices, or even promoting or debunking social stereotypes as the ones related to looting. However, the content analysis also reveals a possible shortcoming in response capacity to natural disasters, whether it's in the lack of robustness of systems, such as the lack of mobility and displacement response capacity, or the lack of access to services during and after the disaster. The wide range of topics observed in tweets support the use of twitter as a legitimate source of hurricanes and maybe other natural disaster response information. Equally important, these results reveal that disasters such as hurricanes and floods magnify many other concerns that are not directly storm-related, including structural patterns of inequality and even impacts to non-humans such as pets, wild animals, and trees. In this way, disasters could serve as threat or issue multipliers that take preexisting social or economic attributes and multiply or morph them in significant ways.

We further examined the temporality of tweets, the frequency of different types of tweets over time (pre-event, during the event, and post-event). Second-hand reporting about the status and impact, reporting about personal experiences, and expression of concerns and well wishes increased as Hurricane Irma approached, peaked as it hit the ground, and dropped after the event. The most notable category in this trend was reporting personal experiences. Tweets about preparedness fell to zero after Irma made landfall, whereas content about recovery and complaints regarding utilities increased after landfall. Eventually these complaints trailed off after five days. Regarding the overall popularity of the tweets, status, impact, preparedness, and relief efforts were the categories of the most retweeted content. The top ten most retweeted

tweets contained content about the environmental impacts of Hurricane Irma, but also content about how animals were affected, which was a salient theme throughout the content analysis.

Most often, Twitter content also included media, such as a supplemental photo or video, particularly when reporting their own experience (e.g., power outage) or tweeting at news stations. Notably, the most popular tweets were typically sent from local news stations, and then by reporters, thus showing that the media has a strong influence in the dissemination of information during natural disasters. This also shows a degree of trust between people and the media in times of crisis, as Twitter users spread the content and updates provided by the media, and as stated previously, even sought answers and information over the course of the hurricane. This is an interesting concept that can be explored in future research.

However, the results also suggested something unexpected: utilities, new media, government agencies (like FEMA), and non-profit organizations all use Twitter during a hurricane to provide a sort of digital safety net of communication in a space otherwise devoid of mass media communication (Takahashi, Tandoc, & Carmichael, 2015; Hughes, St. Denis, Palen, & Anderson, 2014; Wang & Zhuang, 2017). Via Twitter, people can easily seek information from and interact with those agencies at Twitter to disseminate information, apply for assistance, and coordinate relief efforts. We believe tweeters are therefore actively participating in disaster responses and their tweets influence the dissemination of information, disaster management decisions, as well as service and assistance provision.

One troubling finding from our research concerns the extent that social order and crisis communication become tainted with, or at least shaped by, patterns of racial scapegoating or classist discrimination. This finding offers a cautionary antidote to studies noting only the positive force of disaster recovery for bringing communities together and cementing new

networks and social ties. Because it shows a breakdown of social order, disasters can also erode positive norms of respect, tolerance, and care as much as they can serve as a conduit for giving, donations, and community togetherness. There is an inherent dualism to the strategic site opened up by a disaster, with opportunities for conflict alongside cohesion. If true that tweets can shape immediate service provision, especially when monitored by the police or disaster recovery stakeholders, then this darker side of disaster recovery becomes a glaring concern.

Overall, this research is successful in systematically categorizing Twitter content during Hurricane Irma, and it provides future researchers with a framework for better analyzing social media content during times of crisis and disaster events. This research demonstrates the richness of tweet contents and the effectiveness of analyzing public opinions and concerns with social media data. More importantly, it contributes to disaster and environmental sociology literature and deepens our understanding of the intersection between issues of environmental impact, social order and crisis communication during disasters from Twitter users' perspective. In practice, it provides insights for community disaster recovery, infrastructure improvements, and related policies.

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Figures

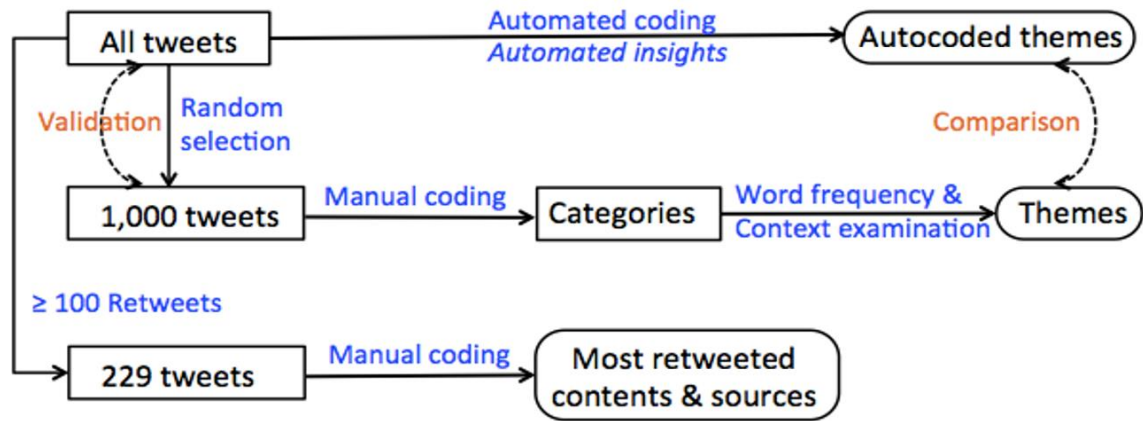


Figure 1. Analytical procedure for examining Hurricane Irma tweets

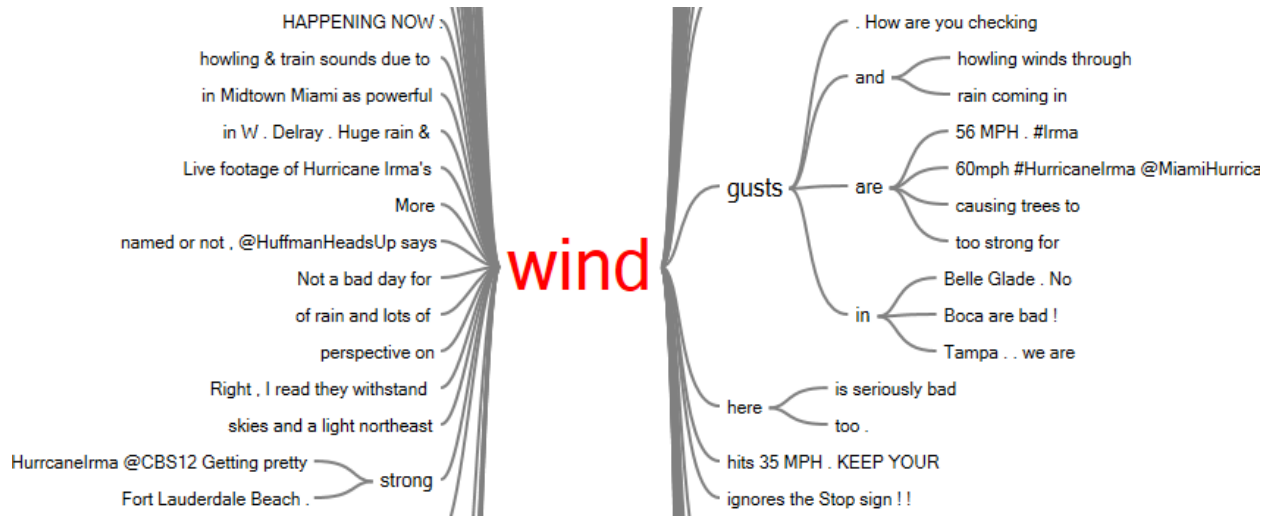


Figure 2. A screenshot of the word tree diagram for tweets about “wind”

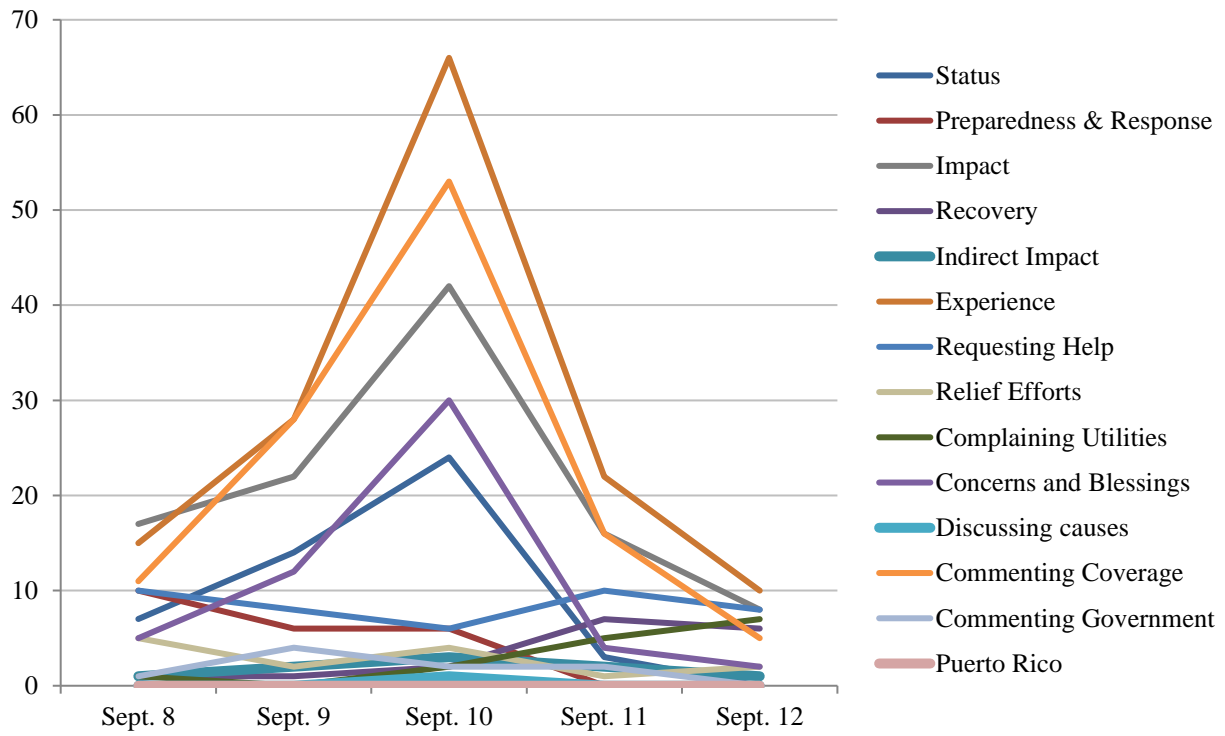


Figure 3. Frequency of tweet contents during Hurricane Irma, 2017

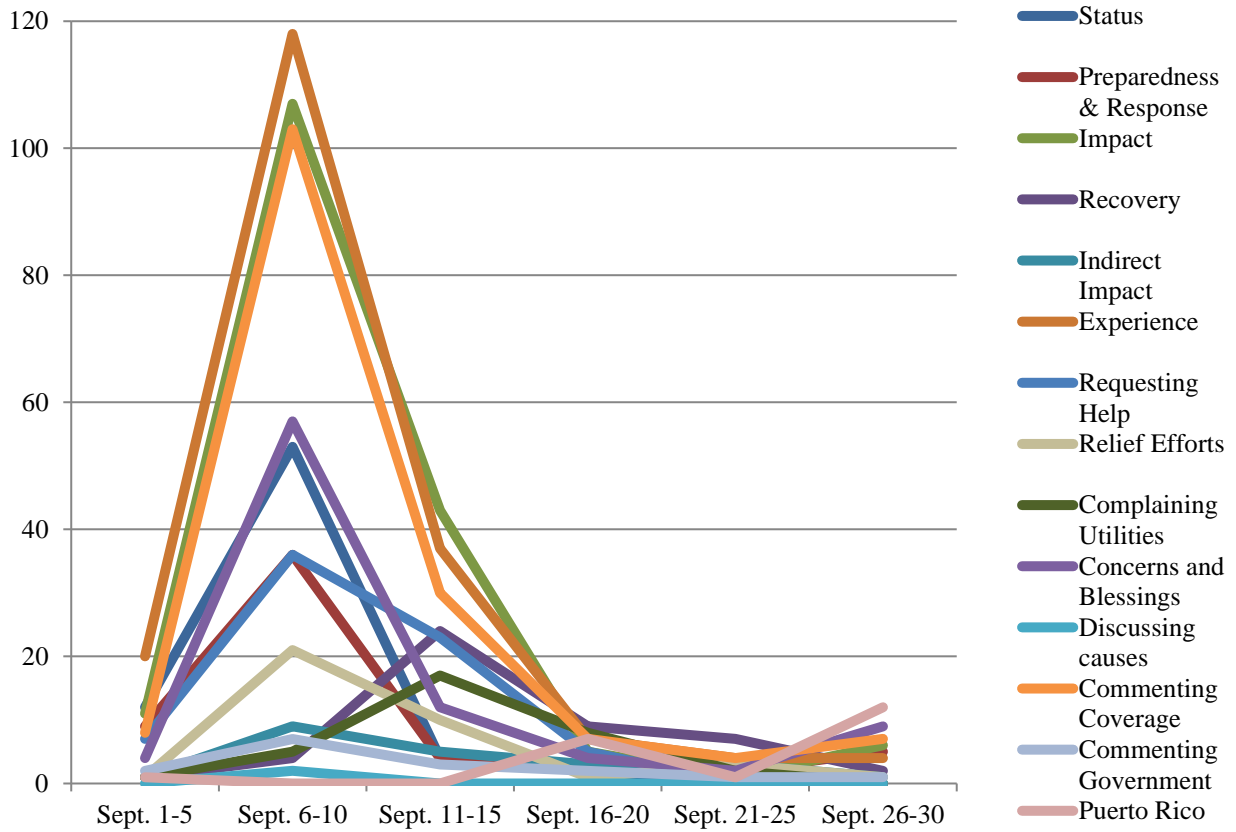


Figure 4. Frequency of tweet contents in September, 2017

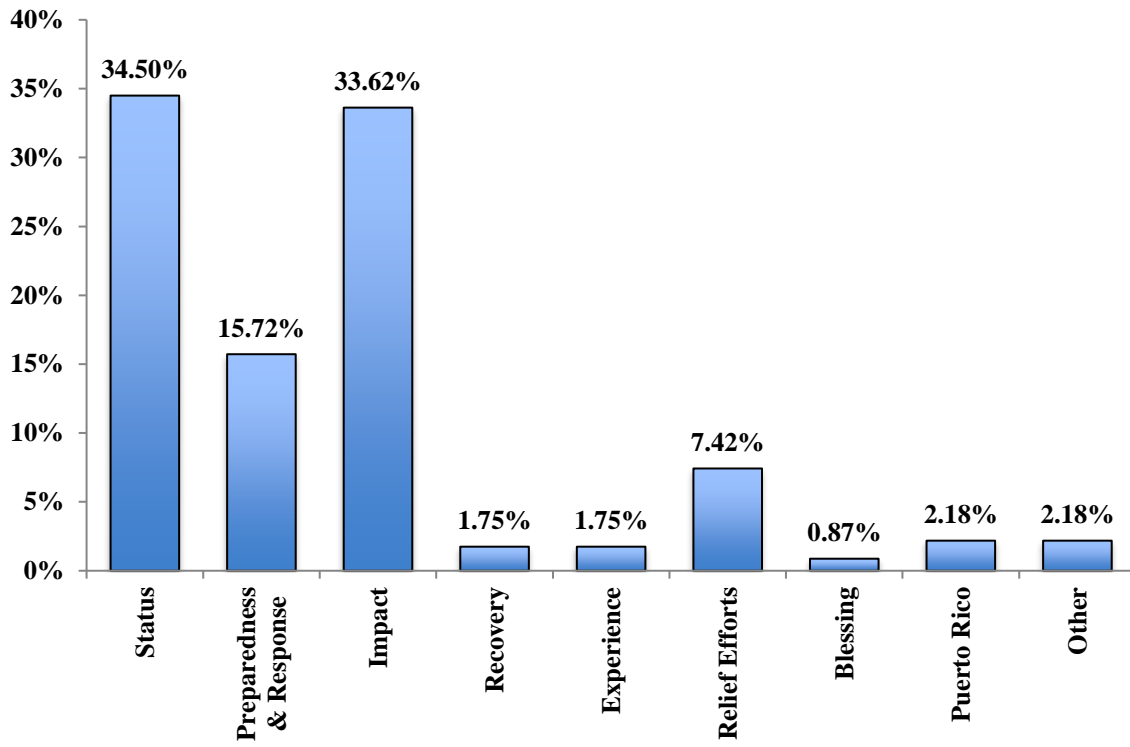


Figure 5. The categories of the most retweeted tweets for Hurricane Irma, 2017

Tables

Table 1: General tweet categories and sub-categories derived from Houston, etc. (2014), and Huang & Xiao (2015).

Categories	Definitions
Second hand reporting	Reporting on second-hand information about Hurricane Irma
-Status	Reporting on status and development of Hurricane Irma
-Preparedness	Reporting on how people prepared and responded before and during Hurricane Irma
-Impact	Reporting on the impact of Hurricane Irma on the physical environment, social life, etc.
-Recovery	Reporting on recovery from Hurricane Irma
Reporting own experience	Providing disaster preparedness (and development) information and disaster warnings from a personal perspective
Requesting help	Sending requests for immediate help or assistance during and after Hurricane Irma
Coordinating relief efforts	Raising and developing awareness of the event; donating and receiving donations; identifying and listing ways to help or volunteer; and providing disaster response information
Commenting on the government	Discussing the government's responsibilities; questioning government officials and actions
Complaints regarding utilities and other services	Complaining about power, gas, water, sewage, internet, and TV services
Expressing thanks, well wishes, and memorializing	Expressing emotions, concerns, well-wishes, gratitude; memorializing victims
Discussing causes	Discussions of scientific, social, and other causes that explain the event
Connecting community members	Discussing how individuals reconnected with community members after Hurricane Irma, as well as forging new community connections resulting from the hurricane

Table 2: List of local news stations in Florida

Local News Station	Twitter Handle	Location	Number of Tweets
WTSP	@10NewsWTSP	Tampa Bay Area	5502
WPEC CBS 12	@CBS12	West Palm Beach	8839
WALA Fox News	@FOX10News	Florida Gulf Shores Area	1089
FOX 13 Tampa Bay	@FOX13News	Tampa Bay Area	5867
WFLX Fox 29	@FOX29WFLX	West Palm Beach	378
WWSB MySuncoast	@mysuncoast	Sarasota Area	1432
News 6 WKMG	@news6wkmg	Orlando and Central Florida	2967
WCJB-TV20	@WCJB20	North Central Florida	453
WCTV Eyewitness News	@WCTV	North Florida	1363
WPLG Local 10 News	@WPLGLocal10	Miami Area	11050
WPTV 5	@WPTV	South Florida Area Florida Gulf Coast Area	6083
WSRE	@wsretv	Pensacola	63
WSVN 7 News	@WSVN	South Florida	15168
WUFT News	@WUFTNews @WVEN_WVE	North Central Florida	884
Univision Orlando	A	Central Florida	18
WXEL TV	@WXELTV	South Florida	93

Table 3: Categories emerging from manual coding for Hurricane Irma tweets

Categories	Frequency	Keywords	Themes	Example Tweets
Second hand reporting				
-Status	7.8%	Winds, category/cat, live, mph, now, storm, tornado, update, alert, track, landfall	Severity of winds; latest updates and weather alerts; tornado warnings; when and where Irma made landfall	“Hurricane Irma gets closer to #Naples as a category 3. @CBS12...”
-Preparedness	5.1%	Evacuation, gas, closing, prepared, water, sand bag, ahead, store, station	Evacuation orders and zones; status and location of gas, water, and other supplies; before the hurricane hits	“Residents in Tallahassee, Leon County fill nearly 10,000 sand bags...”
-Impact	17.3%	Power, tree, winds, water, without, damage, storm, flooding, dies, nursing home, close	Magnitude of power loss; fallen trees, flooding, debris, and other damages; store and school closings	“Large trees down in Boynton Beach. @CBS12 (Pics from @BBPD)”
-Recovery	4.7%	Schools, back, open, still, county, get, news, resume, business, effects	Schools, businesses, and gas stations opened/closed status; time-related aspects of recovery; financial aspects	“Back to school: After Irma, Florida classes begin resuming.”
-Secondary Impact	2.2%	Dogs/pets, home, looting, stealing, charged, gouging	Outrage at abandoned animals; looting in context of race; stealing not in context of race; price gouging	“It's pouring rain, in a major hurricane, and these ghetto rats are looting a Foot Locker. Classy. #DarwinAwards #HurricaneIrma”
Reporting own experience	19.0%	Power, still, need, safe, seen, storm, back, home, time, area	Power loss and lack of restoration; perception of needs; lack of access to supplies/gas/water; safety updates; first-hand accounts	“We are the only home on our road so far not much flooding took this pic of outside we prepared for the worse to come later.”
Requesting help	7.1%	Help, please/pls, get, back, power, city, find, idea, residents, save	Requesting help from damage or information for themselves or others	“forget price gouging.....where can we find water???”

Coordinating relief efforts	3.7%	Shelters, help, people, county, need, pets, water, news, open, gas	Location, capacity, pet-friendliness, and other information about shelters; offers to help; availability of supplies and free meals	“@WPTV what mobile home park is Ty helping people at? I am ready for the storm and can head up there and help him, help others out.”
Complaining utilities and other services	3.3%	Power, fpl/@insidefpl, customers, get, outages, truck, work, back, duke help	Criticisms or questions directed at local power companies; typically, regarding power loss; announcements from utility companies to customers	“FPL moving too slowly for these guys.”
Expressing thanks, well wishes, and memorizing	8.8%	Thanks, safe, stay, hope, great, job, coverage, prayers, good, awesome	Thanking news and utilities workers; offering prayers and hopes for safety	“Stay safe! God bless you all!”
Discussing causes	0.2%	Climate change	Climate change	“Never underestimate Mother Nature. Global Warming is real!”
Commenting on news coverage	15.9%	Coverage, live, news, watch, station, thanks, game, football, power, radio	Praise or criticism of coverage; too much coverage of the event; restriction of non-hurricane content; radio coverage in event of power loss	“Y'all are doin a great job and all but I'm jus trying to watch some college football pls n thx @CBS12 @WPBF25News @FOX29WFLX”
Commenting the government	1.6%	Governor/@flgovscott/scott/rick, mayor	Praising or criticizing the officials; comments on government actions	“Awesome! Cuz @FLGovScott doesn't care about hungry people. FL not doing #DSNAP disaster food replacement program.”
Puerto Rico	2.1 %	Puerto Rico/#puertorico, #maria/#hurricanemaria, American, help, aid, food, pres , storm, team, caribbean	Status and requests for aid and relief after Hurricane Maria	“Aid flows to #PuertoRico but many still lack water and food...”