Twitter Adoption and Use in Mass Convergence and Emergency Events

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ABSTRACT

This paper offers a descriptive account of Twitter (a micro-blogging service) across four high profile, mass convergence events—two emergency and two national security. We statistically examine how Twitter is being used surrounding these events, and compare and contrast how that behavior is different from more general Twitter use. Our findings suggest that Twitter messages sent during these types of events contain more displays of information broadcasting and brokerage, and we observe that general Twitter use seems to have evolved over time to offer more of an information-sharing purpose. We also provide preliminary evidence that Twitter users who join during and in apparent relation to a mass convergence or emergency event are more likely to become long-term adopters of the technology.

Keywords

Twitter, micro-blogging, crisis informatics, emergency, social media

INTRODUCTION

Social media—mobile and web-based applications that allow people to communicate and share information across multiple platforms—is experiencing rapid growth and is being adopted by many. How and why such technology diffuses is a question of current import, as it is adding new dimensions to human interaction. Our research addresses how social media is being used in emergency and mass convergence situations, where time frames are often compressed and routine life is disrupted or changed in some fashion. Our interest is in understanding the relationships between technology and social behavior during these non-routine situations.

This paper focuses on the features of Twitter use in emergency and mass convergence situations, and offers an examination of some Twitter-based behaviors during late summer 2008. Twitter[1] is a micro-blogging service that allows its users to share short messages up to 140 characters in length with each other. These short messages are referred to as *tweets* and can be sent and retrieved across a wide variety of media including email, text messaging, instant messaging, the Internet, and other third-party applications. Users may choose to share their tweets publicly with anyone, or restrict access to their tweets so that only users they give permission may view them.

Launched in October 2006, Twitter is estimated to now have over 3 million user accounts[2]. It is also ranked number 20 in popularity among all social networking sites globally, with it being ranked the most popular micro-blogging service[3]. Twitter attention and use is proliferating, with estimates that web traffic to the Twitter.com site has grown over 600% from November 2007 to November 2008[4].

With Twitter's ability to send messages with mobile devices and easily broadcast those messages to a wide audience, it would seem to be a natural fit for use during mass convergence and crisis events (provided that the service is available). In late October 2007, instances of Twitter use in the diffuse Southern California US wildfires to inform citizens of time-critical information about road closures, community evacuations, shifts in fire lines, and shelter information suggested its more purposeful and widespread use in the future (Sutton, Palen and Shklovski, 2008). More recently, Twitter was used by those in the area of effect to report on the events that took place in the Mumbai, India terrorist attacks on November 26, 2008 (Stelter and Cohen, 2008). Finally, as

[1] http://twitter.com

[2] http://twitdir.com. Retrieved November 7, 2008.

[3] http://alexa.com. Retrieved January 8, 2009.

[4] http://compete.com. Retrieved January 7, 2009.

an example of mass convergence that is not centered on a crisis event, Twitter Vote Report[5] provided a convenient way for Twitter users to document and report their experience at the polls on the US Presidential Election Day, November 4, 2008 (Rosen, 2008). Twitter's growing popularity is only making these occurrences more frequent, and so it is with this in mind that we conducted the research presented here.

This research examines how Twitter was used during four US events that took place during a short duration of time between August 21, 2008 and September 14, 2008 (see Figure 1). We examine Twitter activity during two major US political conventions: the Democratic National Convention (DNC) and the Republican National Convention (RNC). Twitter data was also collected around two Category 4 hurricanes that occurred as part of the 2008 Atlantic hurricane season at the same time of the conventions: Hurricane Gustav and Hurricane Ike. The concentrated occurrence of events yields much data over a short period of time (a little over 3 weeks) that allows stability in making interpretations of how Twitter was being used during this time. We then internally compare and contrast features of the behavior observed between events, as well as compare the data to tweets generated in the entire Twitter network during this same time period. Additionally, we can construct a sense for what Twitter use was like in late summer 2008, such that we might be able to compare it to future events and years (at the beginning of subsequent Atlantic hurricane seasons, for example) that will allow comparison of Twitter adoption longitudinally.

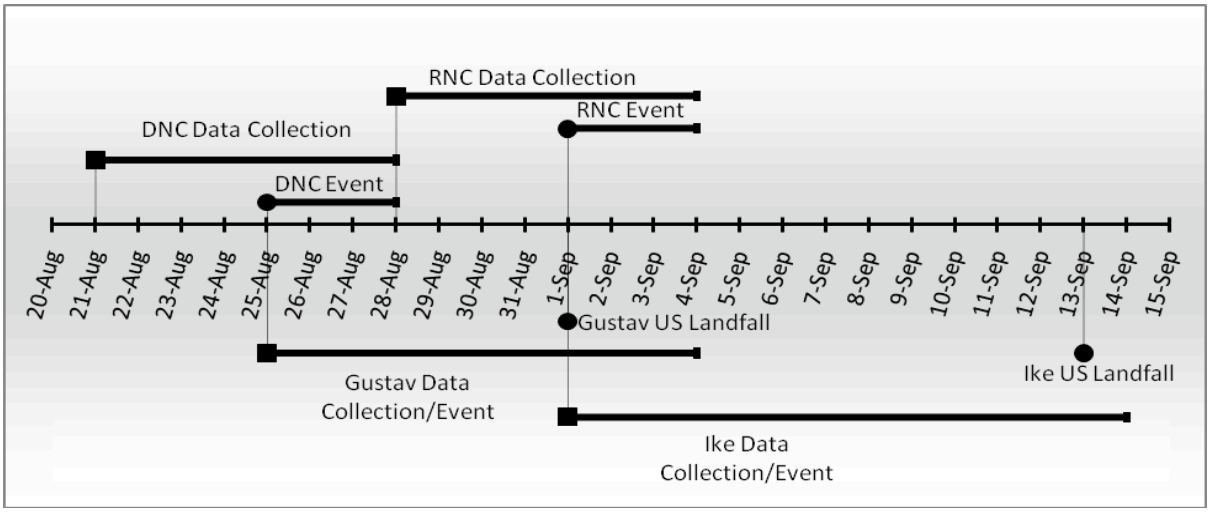

Figure 1. Timeline of the four events we studied from August 21, 2008 to September 14, 2008.

EVENTS OF STUDY

Both the DNC and the RNC are large conventions where the two major American political parties (Democratic and Republican respectively) decide who will represent their party in the United States presidential election. The DNC took place August 25-28, 2008 in Denver, Colorado with an estimated attendance of 50,000. The RNC took place the following week September 1-4, 2008 in Saint Paul, Minnesota with an estimated attendance of 45,000. Both conventions are designated as National Special Security Events (NSSE in which the US Secret Service takes primary responsibility for the security around each event. Though these conventions are not considered crisis events, preparation for and execution of these mass convergence events employs the same federal and local personnel and organizational structures used in disaster planning and response.

Hurricane Gustav began as a tropical depression in the Caribbean Sea on August 25, 2008. Gustav hit Haiti, Cuba, and several other Caribbean nations, claiming 78 lives before making landfall in the US on September 1 as a Category 3 hurricane. Nearly two million people evacuated the surrounding coastal areas for fear of a repeat of Hurricane Katrina in 2005. In the US, 25 deaths were blamed on the storm by the time it was officially declared over on September 4, 2008 (Lyons, 2008).

On September 1, 2008, Hurricane Ike developed as a tropical depression west of the Cape Verde Islands. Ike's outer bands passed over Haiti causing floods and mudslides that resulted in the deaths of 74 people. Later, on September 7, Hurricane Ike hit Cuba causing extreme property damage and seven fatalities. Hurricane Ike was a very large storm, so though it had lowered to a Category 2 hurricane by the time it made landfall in the US on September 13, it still had widespread geographical effect. Mandatory evacuations were in effect for the city of

[5] http://blog.twittervotereport.com

Galveston, Texas (an estimated 60,000 residents), and also for the low-lying areas of Houston, Texas (an additional 100,000 residents) (Mount, 2008). Flooding, torrential rain, and strong winds caused much damage and left millions of people without power. By the conclusion of Hurricane Ike on September 14, the storm was blamed for 92 deaths in the US (Lyons, 2008).

RELATED WORK

The body of research on Twitter is small but growing. The first few studies (Java, Song, Finin and Tseng, 2007; Krishnamurthy, Gill and Arlitt, 2008) describe general features of the entire Twitter social network, including categorization of users and their behaviors, topological and geographical properties of the site's network, and patterns of its growth. A more recent study (Huberman, Romero and Wu, 2008) goes into greater depth by examining social interactions within Twitter. By looking at the social network of friend and follower relationships between users in Twitter, Huberman et al. (2008) find that users only interact with a small subset of the friend and follower relationships users declare.

Our research expands on these previous Twitter studies by looking at tweets within the context of mass convergence and emergency events. All known prior research has observed and reflected on the Twitter network as a whole. We want to know how Twitter is being used surrounding an event, following which we can compare and contrast how that behavior is different from more general Twitter use. Past research on Twitter (Huberman et al., 2008; Java et al., 2007; Krishnamurthy et al., 2008) has yielded important insight into how Twitter is being used in these more general cases.

This research also builds on a growing body of literature on *crisis informatics* (Hagar, 2009; Hughes, Palen, Sutton, Liu and Vieweg, 2008; Palen, Vieweg, Liu, Hughes and Sutton, 2009), which addresses social and technological concerns in emergency and crisis response. Here we consider indicators of Twitter technology adoption. During a two-year study following Hurricane Katrina (Shklovski, Burke, Kiesler and Kraut, 2008), displaced victims adopted new information and communication technology (ICT) to help with their response and recovery efforts. Interestingly, Shklovski et al. (2008) found that even after the crisis was over, continued technology use became incorporated into a number of the victims' lives and in some cases was even helping them rebuild a sense of community during the recovery stages. Our research attempts to understand how, and if, Twitter was adopted by new users, and whether sending tweets during a certain event (signifying some sort of involvement, or at least interest) influenced their adoption rate.

DATA COLLECTION

Using the Twitter search API[6] we collected publicly available tweets during the four events of study. As a security feature Twitter users can choose to make their profile either public or private. All tweets sent by a public profile are publicly available for anyone to view, even those without an account. These public tweets are also aggregated into a tweet stream called the *public timeline* (see Figure 2 for an example), which lets anyone view what people are tweeting about at a given time. If a user marks their profile as private, their tweets can only be viewed by other users that they have given permission to follow them, so these tweets are not ones we could sample.

[6] http://apiwiki.twitter.com/Search+API+Documentation

Figure 2. Example of the Twitter public timeline.

Data collection timeframes (see Table 1) for each event were determined by the nature of the event. Both the DNC and the RNC started on a Monday and ended on a Thursday. However, there were many pre-convention activities and so data capture began the Thursday before continuing until the last day of the convention, rendering eight consecutive days of data collection for each event. For the two hurricanes, data collection began the day each hurricane was officially named and continued until the hurricane was declared over. Table 1 also describes how many tweets were captured in each data set, including the number of unique Twitter users sending these tweets.

Event	Data Collection Timeframe	Search Terms	# Tweets	Avg. # Tweets per Day	# Users
Conventions					
DNC	21 Aug 2008 – 28 Aug 2008	denver, dnc	21,139	2,642	9,417
RNC	8 Aug 2008 – 4 Sep 2008	rnc, st paul, saint paul	17,588	2,199	8,613
Hurricanes					
Gustav	25 Aug 2008 – 4 Sep 2008	gustav, hurricane	38,373	3,488	14,478
Ike	1 Sep 2008 – 14 Sep 2008	ike, hurricane	59,963	4,283	20,689

Table 1. Description of the collection criteria and the data collected for the four events.

Tweets were selected using high-level, case-insensitive search terms (see Table 1). Ideally we would have included searches based on location but, unfortunately, the location field on a user profile is an editable field

that is only specified or updated if the user chooses to do so. We found that inclusion of a location search returned too many irrelevant tweets and so we did not use this information in the data collection.

Choosing appropriate search terms was not an easy task, with different choices resulting in limitations and advantages that had to be traded-off. For the DNC, the terms "dnc" and "denver" were used, but these terms were not without fault. "DNC" is not entirely unique; there remain other organizations and entities that use this acronym. We assumed that if a user's tweet included the word "denver" during the collection time frame that it could be relevant to the DNC, but there were of course cases where people were referencing Denver for other reasons. Furthermore, it is important to note that the terms we used were not inclusive of all DNC Twitter activity. For example, these search terms do not account for users who sent an initial tweet with DNC in the message, followed by subsequent tweets where readers could assume the DNC context. For the RNC, Saint Paul was the actual host city, but Saint Paul and its adjoining neighbor city Minneapolis are often referred to as the Twin Cities. We decided to only include tweets for Saint Paul to sample as best we could in relation to the Denver/DNC case, but searching for Minneapolis and the Twin Cities might have yielded additional helpful results. Search terms of "saint paul" and "st paul" were included for the very likely possibility of abbreviation. Finally, using "gustav" and "ike" as search terms for the hurricanes also captured other non-hurricane instances of those names, including perhaps names of users or people being tweeted about.

Through much experimentation we found the best way to get the desired tweets was to use simple search terms that would result in a large corpus of data, and to use similar types of terms across events to make them as comparable as possible. Our assumption is that noise in the data is comparable across events, such that what is left is relevant and representative. In summary, for the conventions we searched for the name of each convention ("dnc" and "rnc") and its corresponding city ("denver", "saint paul", and "st paul") and for the hurricanes we searched for the word "hurricane" and the name of each hurricane ("gustav" and "ike"). The analysis that follows rests on these decisions, meaning that we can compare activity across the events to detect patterns of behavior in relation to these non-routine events that occurred at the same time. We can also compare features with the total pool of public tweets that occurred during that time frame, but that were not necessarily tied to these events. The data do not report on the total number of tweets that occurred within an event.

RESULTS

We begin by examining general features of our data by looking at daily Twitter activity for each data set. Next, these observations are expanded upon as we compare specific features of the tweet messages we collected. Lastly, we look at new user activity to see what can be said about Twitter adoption.

Daily Twitter Activity

Twitter activity varied over the days of each event, with the graphs of this activity (see Figure 3) corresponding with the significant happenings of the events they reflect. For example, both the DNC and RNC show the number of tweets, according to our sampling method, was highest on the designated days of each convention—August 25-28, 2008 and September 1-4, 2008 respectively. Hurricane Gustav experienced the highest number of tweets according to our sampling method on September 1, 2008, the day it hit landfall in the US. For Hurricane Ike two spikes in activity appear, one when it made landfall in Cuba on September 8, and another when it made landfall in the US on September 13, 2008.

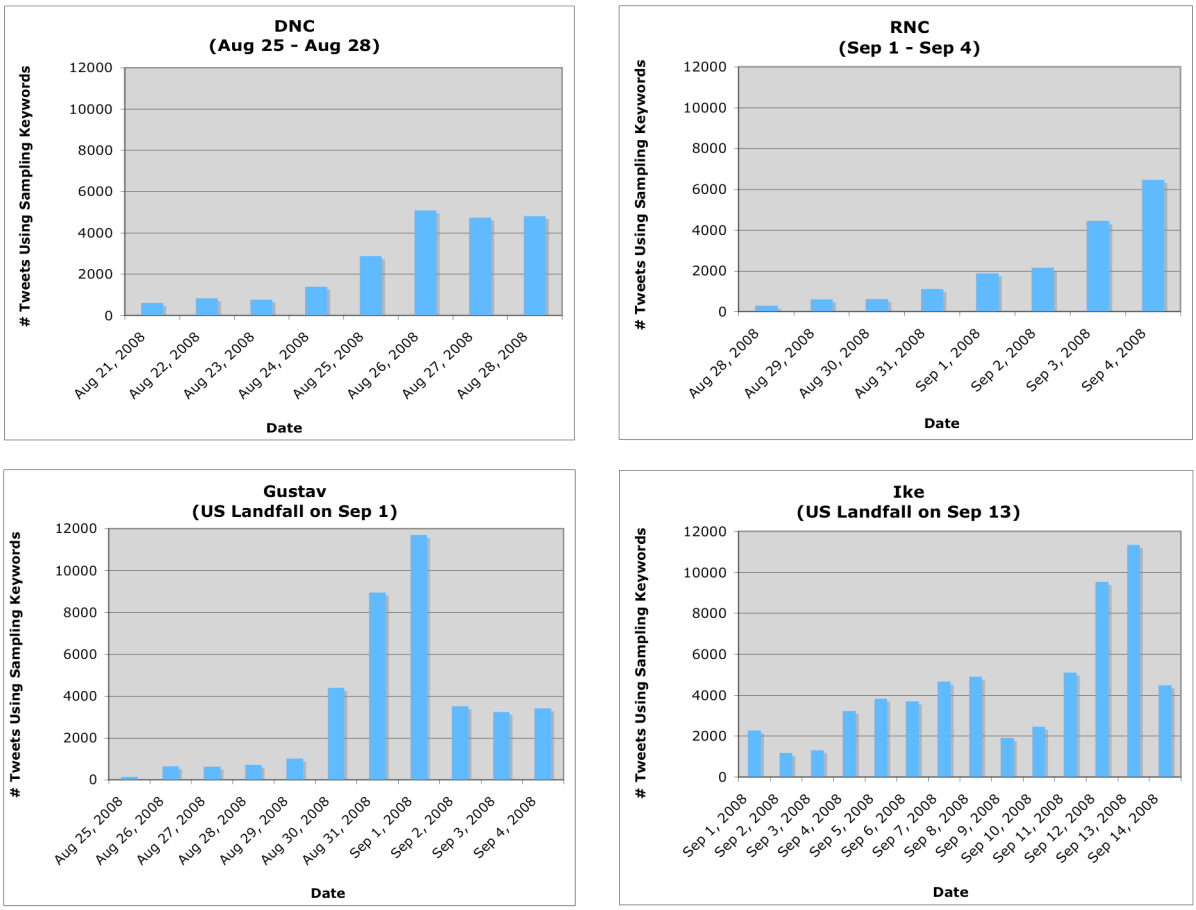

Figure 3. Graphs of the number of daily tweets our research sampled using specific keywords.

Similarly, the number of tweets collected for each event corresponds with the size and impact of each event (see Table 1). Tweets collected for the DNC, the larger of the two conventions studied, outnumbered those collected for the RNC by more than 20%. Hurricane tweet collection totals were far more than any of the convention totals due to the larger geographical impact of the Hurricanes. Comparison of the two hurricanes, shows that Hurricane Ike which had the larger impact, financially speaking—estimated $27 billion in damages (Masters, 2008b)—had much higher tweet activity than Hurricane Gustav—estimated $4-14 billion in damages (Masters, 2008a). Because we cannot be sure our search selection yielded completely comparable samples, we can only speculate that there is a correlation here. But these preliminary results suggest that the quantity of Twitter activity measured correlates to both size and significance of happenings.

Number of Tweets per User

To understand how many tweets each user in our data contributed to the Twitter conversation around each event, we determined the tweet count for each user. Users within each data set were then sorted according to their tweet count, after which we calculated the percentage of users who contributed one tweet for each event. We then performed the same percentage calculation for those who contributed two tweets up to seven tweets. We chose a limit of seven tweets because over 95% of the users in each of the four data sets contributed seven or less tweets to the Twitter conversation around each corresponding event.

Somewhat surprisingly, we found the percentage of users who sent a certain number of tweets to be consistent across events, which can be seen more clearly in Figure 4. This suggests similar patterns of macro Twitter behavior: that the number of Twitter senders decreases as the number of messages sent increases. This supports—but does not prove—the idea that people serve as "information hubs" (Palen and Liu, 2007) to collect and deploy information, but that many others "participate" in the event in a more peripheral fashion.

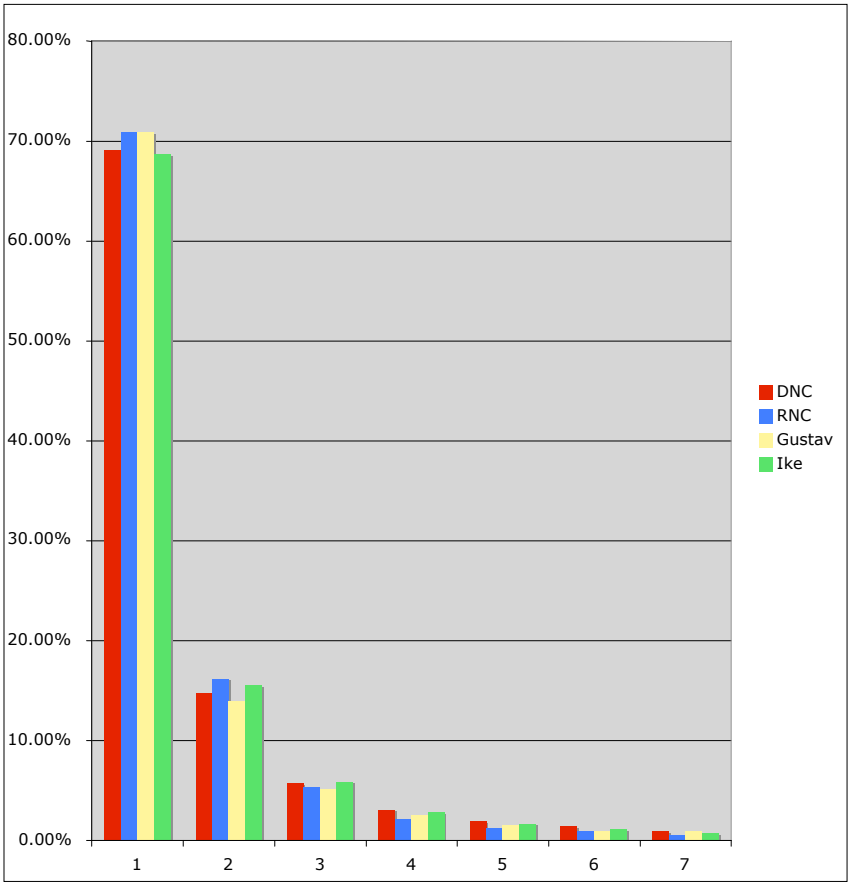

Figure 4. Graph of the percentage of users who sent a total of 1-7 tweets containing the search keywords.

Reply Tweets

Within the world of Twitter, a norm has evolved such that a sender can designate a tweet as a specific reply to another user, even when the tweets are publicly broadcast. Users begin these reply messages with the "@" symbol directly followed by the username of the person being replied to (ie. @KCTV5). The message is then typed after this reply signifier. Reply messages are a way of getting the attention of a specific user by directing a public tweet message that anyone can read to a specified recipient.

We compared how many reply tweets occur in our data sets with the number of reply tweets contained in a random sample of all Twitter tweets (including those around our events of study) during our entire data collection timeframe, August 21, 2008 – September 14, 2008 (see Table 2), to see if there were any differences. To begin gathering a random sample of all tweets, we discovered that approximately 27 million tweets were sent during the designated timeframe. Therefore, we set up a random sampling method designed to obtain a data set of roughly 27,000 tweets. However, when making requests, not all tweets are publicly readable. In fact, we found that roughly 30% of all the tweets we tried to collect are marked private; consequently, the actual sample is 18,308 tweets, despite making requests to obtain around 27,000 tweets.

Event/Data Set	Avg. # Reply Tweets per Day	Avg. # of Sampled Tweets per Day	Percentage of Reply Tweets
Conventions			
DNC	169	2,642	6.40%
RNC	166	2,199	7.54%
Hurricanes			
Gustav	202	3,488	5.80%
Ike	265	4,283	6.18%
Sample of the General Population Tweets During Same Time Period			
General	159	732	21.76%

Table 2. Percentage of tweets in each data set that are reply tweets.

Notably, the percentage of reply tweets found in the random tweets data sample was much higher than that of our convention and hurricane data samples (see Table 2). We hypothesize this could be for several reasons. The first is that more broadcast-based information sharing activities happen during mass convergence and crisis events, where the user is pushing information out to many users and not directing it toward one specific user. A second reason is that a reply implies that there is some prior context between the user sending the reply tweet and the user the tweet is directed to. In this case, the user sending the reply tweet may not repeat key contextual words like "dnc" or "denver" because the user they are directing their message to would already know they are in Denver at the DNC. Our Twitter search methods would not pick up a reply tweet like this one, which may have contributed to the lower event reply tweet percentages found in Table 2.

URL Tweets

Twitter allows users to include URLs in their tweets. This is useful for multiple reasons. Sometimes the 140 character limit for Twitter messages can be too constricting when a user wants to convey large amounts of information. Other times, tweets serve as pointers to resources that followers might find interesting or important. Readers of the tweet can then follow the URL to a website with a click on the link.

Again, we wanted to compare how many tweets in our data sets contain URLs with the number of tweets containing URLs found in a random sample of all tweets appearing in Twitter during our collection timeframe. Using the same sample of random tweets we collected in the last section we were able to make this comparison (see Table 3).

Event/Data Set	Avg. # URL Tweets per Day	Avg. # of Sampled Tweets per Day	Percentage of URL Tweets
Conventions			
DNC	1,143	2,642	43.25%
RNC	805	2,199	36.59%
Hurricanes			
Gustav	1,827	3,488	52.38%
Ike	2,136	4,283	49.87%
Sample of the General Population Tweets During Same Time Period			
General	180	732	24.57%

Table 3. Percentage of Tweets in each data set that contain an URL.

We found the percentage of tweets containing URLs to be notably lower in the general sample than that of our convention and hurricane data samples (see Table 3). This observed behavior supports the idea that users are serving as information brokers, and distributing web-based information resources to others during times of non-routine events. Also notable is the difference in percentage of URL tweets between the two conventions and the two hurricanes. Roughly 40% of the convention tweets contained URLs, while around 50% of the hurricane

tweets contained URLs. What could explain this difference is that emergency events have higher information demands than mass convergence but non-emergency events.

Adoption of Twitter

To better understand Twitter adoption, we collected information about all the new users in each data set. New users are those user accounts that were created during the data collection timeframe for each event. We compared the hurricane-based or convention-based new user data to the general pool of Twitter users, with a random sample of all new Twitter users from August 21, 2008 to September 14, 2008.

We examined how many tweets each new user has sent since the time of the original data collection to understand the adoption patterns of these users. To do this, we queried Twitter to find out what the updated tweet count for each new user was on January 8-9, 2009. Using these recent tweet counts we could determine how many of these new users could be considered *active users*. By active users, we mean those users who have contributed one or more tweets every week since the events took place. The elapsed time since the end of the original data collection period (September 14, 2008) to the point of retrieval of updated tweet counts (January 8-9, 2009) is about a period of 17 weeks. Therefore, those users who have a tweet count of 17 or more we call active users. Conversely, low-active or inactive users are those users who have contributed less than one tweet every week—new adoptees during the hurricane and convention events with less than 17 status updates in the 17 weeks since that time.

Event/Data Set	# New Users During Data Collection Time Period	Remaining # In- and Low-Active Users (<1 update/wk)	% In- and Low-Active Users	Remaining # Active Users (1 or more update(s)/wk)	% Active Users
Conventions					
DNC	619	258	41.68%	361	58.32%
RNC	565	274	48.50%	291	51.50%
Hurricanes					
Gustav	1983	1342	67.68%	641	32.32%
Ike	2376	1286	54.12%	1090	45.88%
Sample of the General Population Users During Same Time Period					
General	3541	2957	83.51%	584	16.49%

Table 4. Percentage of new users who have become low-active/inactive and active users.

The percentage of active and inactive users in each data set appears in Table 4. Our collected data shows that there are more accounts who became active users in our hurricane- and convention-event data sets than there are in the general sample. If we define "active user status" as adoption of Twitter technology, then we can see that more users in our data sets (who specifically sent at least one twitter about one or more of the events) adopted Twitter, than a general sample of the new users to Twitter during the same time period. This suggests that when faced with a need and having important and direct experience of usefulness with it, people are more likely adopt a new technology for the long term.

CONCLUSIONS

In this paper we have seen indicators that Twitter messages sent during emergency and mass convergence events reveal features of information dissemination that support information broadcasting and brokerage. This can be seen in the presence of fewer person-specific reply tweets and greater inclusion of URLs in the hurricane- and convention-tweets as compared to the general tweet pool.

However, we note that overall, the inclusion of URLs in tweets is on the rise. Java et al. (2007) reported that their data set of tweets obtained from the Twitter public timeline April through May of 2007 had URLs in about 13% of the tweets. Our general Twitter tweet sample had URLs in 24.57% of the tweets, which seems to suggest that over time Twitter users have begun including URLs in their tweets with a higher frequency. Twitter seems to have evolved over time to offer more of an information-sharing purpose, with more users sharing URLs, and this behavior appears to be more evident in non-routine situations.

Lastly, this paper provides preliminary evidence that those new Twitter users who join during and in apparent relation to a non-routine event are more likely to become long-term adopters of the technology. More research

investigating this phenomenon in greater detail for the Twitter case is necessary, and for other social media technologies as well.

Here we have tried to offer a descriptive account of what micro-blogging (specifically Twitter) looks like in terms of activity across high profile, mass convergence events—two emergency and two planned. Our initial findings suggest that technology adoption seems to be correlated to the occurrence of crisis and mass convergence events. An important lesson from this research is that emergency management could begin using Twitter and similar micro-blogging technology as a way of getting information to the public. We expect that this will further fuel personal technology adoption and set a precedent for future use in emergency warning, response and recovery situations.

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REFERENCES

1. Hagar, C. (2009) The Information and Social Needs of Cumbrian Farmers During the UK 2001 Foot and Mouth Disease Outbreak and the Role of Information and Communication Technologies, In Döring, M. & Nerlich, B. (Eds.), *The Socio-Cultural Impact of Foot and Mouth Disease in the UK in 2001: Experiences and Analyses*, Manchester University Press.
2. Huberman, B. A., Romero, D. M. and Wu, F. (2008) Social Networks that Matter: Twitter Under the Microscope. Dec. 5, 2008. Available at SSRN: http://ssrn.com/abstract=1313405.
3. Hughes, A. L., Palen, L., Sutton, J., Liu, S. B. and Vieweg, S. (2007) "Site-Seeing" in Disaster: An Examination of On-line Social Convergence, *Proc. of the 2008 ISCRAM Conference*, Washington, DC.
4. Java, A., Song, X., Finin, T. and Tseng, B. (2007) Why We Twitter: Understanding Microblogging Usage and Communities, *Proc. of the Knowledge Discovery and Data Mining (KDD)*, San Jose, CA pp. 56-65.
5. Krishnamurthy, B., Gill, P. and Arlitt, M. (2008) A Few Chirps About Twitter, *Proc.s of the First Workshop on Online Social Networks*, Seattle, WA, pp. 19-24.
6. Lyons, S. (2008) Hurricane Season 2008, *The Weather Channel*, Retrieved Dec. 18, 2008 from http://www.weather.com/newscenter/hurricanecentral/2008/gustav.html.
7. Masters, J. (2008a) Hanna Still Wandering; Ike Nearing Hurricane Strength, *Dr. Jeff Masters' Wunder Blog: Weather Underground*, Retrieved Jan. 9, 2009 from http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=1059.
8. Masters, J. (2008b) Ike Finally Dies, *Dr. Jeff Masters' Wunder Blog: Weather Underground*, Retrieved Jan. 9, 2009 from http://www.wunderground.com/blog/JeffMasters/comment.html?entrynum=1085.
9. Mount, M. (2008) Weather Service Warns of 'Certain Death' in Face of Ike, *CNN*, Sept. 12, 2008, Retrieved Jan. 7, 2009, from http://www.cnn.com/2008/US/weather/09/11/hurricane.ike.texas/index.html.
10. Palen, L. and Liu, S. B. (2007) Citizen Communications in Crisis: Anticipating a Future of ICT-supported Public Participation. *Proc. of the Conference on Human Factors in Computing (CHI 2008),* San Jose, CA, pp. 727–736.
11. Palen, L., Vieweg, S., Liu, S. B., Hughes, A. L. and Sutton, J. (to appear 2009) Crisis in a Networked World: Features of Computer-Mediated in the April 16, 2007 Virginia Tech Event, *Special Issue of Social Science Computing Review on E-Social Science*.
12. Rosen, J. (2008) Web Hands Voters Power, *The Baltimore Sun,* Nov. 3, 2008, Retrieved Jan. 10, 2009, from http://www.baltimoresun.com/business/bal-te.to.votertech03nov03,0,143943.story.
13. Shklovski, I., Burke, M., Kiesler, S. and Kraut, R. (2008) Technology Adoption and Use in the Aftermath of Hurricane Katrina in New Orleans, *Position paper for the HCI for Emergencies workshop Conference on Human Factors in Computing (CHI 2008)*, Florence, Italy.
14. Stelter, B. and Cohen, N. (2008) Citizen Journalists Provided Glimpses of Mumbai Attacks, *The New York Times,* Nov. 29, 2008, Retrieved Jan. 9, 2009, from http://www.nytimes.com/2008/11/30/world/asia/30twitter.html.
15. Sutton, J., Palen, L. and Shlovski, I. (2008) Back-Channels on the Front Lines: Emerging Use of Social Media in the 2007 Southern California Wildfires, *Proc. of the 2008 ISCRAM Conference*, Washington, DC.