

11-14-2019

The Use of Social Media in Emergency Management by Public Agencies and Non-Governmental Organizations: Lessons Learned From Areas Affected by Hurricanes Isaac, Sandy, and Harvey

Ryan Hamilton Kirby
Louisiana State University and Agricultural and Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_dissertations



Part of the [Environmental Sciences Commons](#)

Recommended Citation

Kirby, Ryan Hamilton, "The Use of Social Media in Emergency Management by Public Agencies and Non-Governmental Organizations: Lessons Learned From Areas Affected by Hurricanes Isaac, Sandy, and Harvey" (2019). *LSU Doctoral Dissertations*. 5108.

https://digitalcommons.lsu.edu/gradschool_dissertations/5108

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Doctoral Dissertations by an authorized graduate school editor of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.

**THE USE OF SOCIAL MEDIA IN EMERGENCY MANAGEMENT BY PUBLIC
AGENCIES AND NON-GOVERNMENT ORGANIZATIONS: LESSONS
LEARNED FROM AREAS AFFECTED BY HURRICANES ISAAC, SANDY,
AND HARVEY**

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor in Philosophy

in

The Department of Environmental Sciences

by
Ryan Hamilton Kirby
B.S., University of West Florida
M.S., Louisiana State University
December 2019

Acknowledgements

I would like to express my gratitude to Dr. Margaret Reams for her guidance and support throughout my years in the Department of Environmental Sciences at Louisiana State University, and to my committee, Dr. Nina Lam and Dr. Michelle Meyer, who provided invaluable advice and acceptance as a world-class research team. The brilliant minds of the ICAR research team has fostered an enthusiastic environment and a true sense of community.

This dissertation research was supported by three grants awarded by the United States National Science Foundation, including the Dynamics of Coupled Natural Human Systems (CNH) Program (Award No. 1212112), the Interdisciplinary Behavioral and Social Science Research (IBSS) Program (Award No. 1620451), and the Social Economic Sciences (SES) Program (Award No. 1762600). The opinions, findings, and conclusions or recommendations presented in this article are those of the authors and do not necessarily reflect the views of the funding agencies.

Table of Contents

Acknowledgments.....	ii
List of Tables.....	vii
List of Figures.....	vii
List of Abbreviations.....	viii
Abstract.....	x
Chapter 1. Introduction.....	1
1.1. Research Problem.....	1
1.2. Research Objectives.....	2
1.3. Study Areas and Events.....	6
1.4. Dissertation Organization.....	9
Chapter 2. Literature Review.....	12
2.1. Disaster Resilience, Communication, and Information.....	14
2.2. Social Media and Emergency Management.....	17
2.3. Social Media Use in Emergency Management Communication.....	18
2.4. Benefits of Social Media in Emergency Management.....	21
2.5. Challenges and Problems with Social Media Communication.....	23
Chapter 3. Data and Methods.....	32
3.1. Survey I: Hurricanes Isaac and Sandy Study Areas.....	32
3.2. Survey II: Hurricane Harvey Study Area.....	38
Chapter 4. Social Media Adoption, Utilization, Campaign Evaluation, and Barriers to Use.....	41
4.1. Characteristics of Survey Respondents.....	41
4.2. Extent of Social Media Use.....	42
4.3. Preferred Social Media Tools.....	54
4.4. Chapter Four Summary of Findings.....	58
Chapter 5. Obstacles and Strategies to Reduce Disparity in Digital Disaster Communication: Emerging Best Practices.....	61
5.1. Characteristics of Survey Respondents.....	61
5.2. Social Media Challenges.....	63
5.3. Social Media Campaign Evaluation and Awareness.....	69
5.4. Overcoming Obstacles with Social Media Communication Best Practices.....	74
5.5. Chapter Five Summary of Findings.....	81
Chapter 6. Case Study: The Role of Social Media Among Hurricane Harvey Responders.....	85
6.1. Introduction to Case Study: Hurricane Harvey and Social Media.....	85
6.2. Characteristics of Survey Respondents.....	92

6.3. Social Media Used to Assist Response and Rescue Efforts.....	94
6.4. Addressing Social Media Challenges.....	99
6.5. Recommendations for Improving Social Media for Disaster Response.....	103
6.6. Summary of Findings.....	109
Chapter 7. Conclusion.....	112
7.1. Summary of Findings and Research Implications.....	112
7.2. Research Contributions and Limitations.....	121
7.3. Future Research.....	122
Appendix A. Obstacles Reported in the Literature.....	124
Appendix B. Survey Instrument I: Hurricanes Isaac and Sandy Responders Survey Instrument..	125
Appendix C. Survey Instrument II: Hurricane Harvey Responders Survey Instrument.....	138
Appendix D. Improving Disaster Resilience with Social Media Text Responses.....	147
Appendix E. Exploring Communication Tactics Using Multiple Indicators of Responsiveness..	149
Appendix F. Testing Respondent Self-Classification Accuracy.....	150
Appendix G. Detailed Sampling Methodology.....	151
Appendix H. Coded Qualitative Responses Regarding “Other” Obstacles.....	158
Appendix I. Internal Review Board Documents.....	160
References.....	161
Vita.....	169

List of Tables

3.1. Hurricanes Isaac and Sandy Study Population Counts per Study Area Segment.....	35
3.2. Results of Survey I Invitation through Social Media Outreach.....	37
3.3. Hurricane Harvey Survey Response Rates per Study Area Segment.....	40
4.1. Potential Future Benefits of Social Media.....	48
4.2. Common Themes for Improving Disaster Resilience with Social Media.....	50
4.3. Phase Specific Response Scores of Reported Involvement in Risk and Crisis Communication across the Phases of Emergency Management.....	52
5.1. Common Themes of Other Challenges Not Listed.....	70
5.2. Social Media Policy Adoption Since 2012.....	78
6.1. Percent of Respondents from each Respondent Group who Received Rescue Requests through Popular Unnoofficial Channels Respondents.....	100

List of Figures

1.1. States and Counties affected by Hurricanes Isaac, Sandy, and Harvey.....	7
2.1. Obstacles for the Use of Social Media in Emergency Management, adapted from Luna and Pennock (2015).....	30
4.1. Survey Respondent Profile.....	43
4.2. Risk and Crisis Communicators on Social Media.....	44
4.3. Barriers to Social Media Use.....	45
4.4. Plans to Adopt Social Media Tools.....	54
4.5. Two-Way Communication Channel Preferences.....	54
4.6. Respondent Groups Support of Communication Channels.....	57
4.7. Channels Preferred by Survey Respondents.....	59
4.8. Communication Channel "Always" Supported by Respondent Groups.	59
5.1. Survey Respondent Profile.....	63
5.2. Adoption of Twitter for Emergency Communication vs. New Users.....	65
5.3. Roles of Social Media in Crisis Communication.....	67
5.4. Potential Benefits of Social Media.....	68
5.5. Concern Toward Common Obstacles.....	73
5.6. Obstacles of Least Concern.....	74
5.7. Reported Audience Behaviors Counts.....	75
5.8. Audience Behaviors Measured by Survey Respondents.....	76
5.9. Social Media Evaluation Metrics Counts.....	79
5.10. Reported Evaluation Metrics.....	80
5.11. Reported Information Validation Trends.....	81
5.12. Leveraging Additional Support for Social Media Crisis Communication.....	81

5.13. Communication Tactics of Government Agencies and NGOs.....	83
5.14. Policies Regarding Following Social Media Users.....	84
6.1. Hurricane Harvey Study Area.....	91
6.2. Percent of Operational Cell Sites in Counties with PSAP Disruption.....	94
6.3. Survey Respondents by Organization Type.....	85
6.4. Alternative Communication Channels used During Hurricane Harvey.....	98
6.5. Frequency of Typical Social Media Monitoring.....	102
6.6. Frequency of Social Media Monitoring During Hurricane Harvey.....	102
6.7. Organizations with Assigned Social Media Personnel.....	104
6.8. Reported Methods to Prioritize Social Media Rescue Requests.....	105
6.9. League City Police Department Facebook Post Coordinating Community Resources.....	108
6.10. Suggestions for Improving Twitter for Future Emergencies.....	110
6.11. Potentially Beneficial Social Media Tools Data Source.....	112

List of Abbreviations

ALI – Automatic Location Identification

Cell – Cellular

CDT – Central Daylight Time

CDC - Centers for Disease Control and Prevention

CAN – Center for Naval Analyses

EM – Emergency Management

DHS – Department of Homeland Security

FCC – Federal Communications Commission

FEMA – Federal Emergency Management Agency

FR – First Responder

GOV – Government-Related Agency or Office

ICT – Information and Communication Technologies

LA – Louisiana

NECP – National Emergency Communication Plan

NG911 – Next Generation 911

NIMS – National Incident Management System

NEMA – National Emergency Management Association

NEWS – News Media Organization

NOAA – National Atmospheric and Oceanic Administration

NGO – Non-governmental Organization

NWS – National Weather Service

PD – Police Department

PIO – Public Information Officers

PPD8 – Presidential Policy Directive 8

PSAP – Public Safety Answering Point

SLP – US House of Representatives Select Bipartisan Committee

SM – Social Media

SMWG – (Department of Homeland Security) Social Media Working Group

SMS – Short Message Service

S&T – US Department of Homeland Security Directorate on Science and Technology

TNRIS – Texas Natural Resources Information System

TS – Tropical Storm

TX – Texas

TxDOT – Texas Department of Transportation

US – United States

USGS – United States Geological Survey

Abstract

Natural disasters are increasingly costly for the United States. The literature suggests emergency managers may improve disaster outcomes and enhance disaster resilience by supplementing their official public-communications methods with more bi-directional communication tactics using social media. This study aims to understand how social media is used within the “whole community” of emergency management in areas affected by recent hurricanes. The first research objective examines how social media is used by governmental and non-governmental organizations across the four phases of emergency management (preparedness, response, recovery, mitigation). The second objective is to identify challenges governmental and non-governmental groups have encountered and strategies they recommend addressing these problems. The third objective is to examine how social media was used by disaster responders specifically during the response phase of Hurricane Harvey in 2017. We conducted a survey of 269 organizations in areas affected by Hurricanes Isaac and Sandy in 2012 to address research objectives one and two, and for the third objective, surveyed 64 organizations who contributed to the rescue and response efforts during Hurricane Harvey. The first survey found respondents representing government-related organizations use social media more during the response and the preparedness phases, while non-governmental groups report more social media activity during the recovery phase. This finding suggests that organizations performing primary and secondary roles in emergency management play complementary roles in risk and crisis communication with the public. The results also suggest that the emergency management community primarily uses social media to “push” information to the public through established communication networks and could benefit from additional efforts to “pull” information from their networks. Survey respondents report greatest concern about challenges external to their

organizations, with the accuracy of information found on social media to be most concerning. The third research objective finds generally high levels of social media use among Hurricane Harvey responders, but also evidence of technical challenges including an inability to convert web-based communications to dispatchable missions due to limited functionality of their 911 systems. The results of the study provide insights regarding uses, challenges, and strategies to improve social media for the whole community of emergency management.

Chapter 1. Introduction

1.1. Research Problem

As Atlantic hurricane seasons continue to produce more costly and damaging storms, and Americans increasingly prefer web-based communications, emergency management (EM) agencies and other disaster respondents must develop new strategies to reach preparedness and emergency communication goals. One suggestion to improve disaster outcomes is to involve all stakeholder groups, or the *whole community* to contribute to EM, throughout the four phases of disaster; including *preparedness*, *response*, *recovery*, and *mitigation* (DHS 2012a, FEMA 2011). Effective risk and crisis communication are key for the public to accurately perceive hazards and take life-saving precautions. Emergency broadcast systems deliver official emergency communication messages to populations at risk, but often may lack the ability to interact bi-directionally with the public and may fail to reach all citizens in a potentially hazardous area.

National level EM agencies agree incorporating two-way communication channels to supplement official messages can lead to better disaster outcomes, and that selecting popular social networks may help to extend the reach of risk and crisis communication (Fugate 2011b, DHS 2014a). Social media (SM) platforms offer a wide range of tools already in use by most Americans. However, the adoption of SM tools as unofficial communication channels supplementing traditional risk and crisis communication methods and protocols require EMs to formulate new strategies to overcome the challenges of maintaining two-way communication channels. These challenges may arise from both the inherent challenges of human communication and interaction, and from the continuously-evolving technologies where the human interactions occur.

As public preferences and the leadership of agencies and non-governmental organizations (NGOs) involved in EM continue to support the enhancement of risk and crisis communication through adoption of SM tools, it is important to evaluate progress in the EM field concerning use and realization of the potential benefits of SM. A systematic examination of how SM is used, for what purposes, and what problems have been encountered could help to inform investment and promotion strategies supporting national EM goals.

This study contributes original survey findings from two investigations: present utilization of SM by key EM institutions in areas affected by Hurricanes Isaac and Sandy in 2012, and the use of SM to assist rescue and response efforts during Hurricane Harvey in 2017. The research was supported by two grants awarded by the National Science Foundation and contributes to the work of ICAR¹ at Louisiana State University in Baton Rouge.

1.2. Research Objectives

An objective of emergency communication is to reach all citizens in a potentially hazardous area with a message that conveys information about a threat coupled with advice aimed to minimize loss of life and property. This study seeks to inform EM leadership at all levels with an aim to increase the efficacy of emergency communications with SM. The research objectives address the following three topics.

1.2.1. Research Objective I: Examining Social Media Adoption and Usage among EM Organizations

The first research objective is to provide researchers, EMs, and supporting organizations with new insights about risk and crisis communication conducted by key organizations through SM in areas affected by Hurricanes Isaac and Sandy in 2012. These include four types of organizations that represent the *whole community* of EM, including first responders, government-

¹ Interdisciplinary Computation and Analysis of Resilience (https://twitter.com/icar_lsu)

related agencies and offices, news media organizations, and non-governmental organizations. We examine the extent to which they use SM during the four phases of emergency management, including SM adoption rates, specific communication objectives, perceived benefits, preferred communication channels or SM platforms, and barriers to use among those not using SM for risk and crisis communication. The first objective addresses the specific research questions:

Research Question 1.1: What is the role of social media among public agencies and NGO respondents?

Research Question 1.2: Which specific social media platforms or channels do survey respondents prefer when communicating with the public?

These findings will provide insight into the adoption rates of SM in the EM community, the roles of SM in their organizations, their attitudes and perceptions of its usefulness, and barriers keeping some respondents from adopting SM tools. Knowing which types of organizations report lower SM adoption rates should help EM leadership to focus effort to encourage the whole community to participate in EM. Understanding the barriers keeping some organizations from adopting SM tools will provide additional insights for managers within these organizations. The research also will provide information to compare organizational adoption of specific SM tools and platforms with public preference trends. The Pew Research Center² suggests different population segments appear to prefer certain SM channels, meaning strategic organizational SM channel selection may help EMs broaden the reach of their communications. Knowing which types of organizations may have greater misalignment with public preferences provides information that could be used to help narrow potential disparities or gaps in the reach of risk and crisis communication to some members of the public.

² Pew Research Center. 2018. "Social Media Fact Sheet." Internet & Technology, 5 Feb 2018. <http://www.pewinternet.org/fact-sheet/social-media>. Accessed March 5, 2018.

1.2.2. Research Objective II: Examining Social Media Challenges and Strategies to Improve its Utility in EM

The second research objective is to identify obstacles and challenges to the use of SM among governmental and non-governmental organizations. We compare the challenges reported by government-type respondents to those reported by non-government responses to examine the potential effect of the National Incident Management System (NIMS) on the use of SM during emergencies reported by government organizations. Given the guidelines provided to government agencies through NIMS, we are interested in whether respondents from government organizations report fewer difficulties in implementing social media in their work with the public during emergencies.

We also are particularly interested in detecting new or emerging challenges that may not have been identified in earlier examinations of SM use among groups working in the emergency management field. In addition, the second research objective seeks to identify tactics and strategies respondents may be employing to overcome these challenges. Specifically, we pose the following questions:

Research Question 2.1: Which key obstacles are most commonly reported by survey respondents concerning the use of social media in risk and crisis communication?

Research Question 2.2: To what extent are survey respondents attempting to evaluate the effectiveness of their online communications?

Research Question 2.3: Which tactics and strategies do survey respondents report employing to overcome the obstacles they encounter in their use of social media for risk and crisis communication?

Awareness of emerging challenges is central to optimize investment and education strategies supporting the use of SM in the EM field. Evidence of growing or lessening concern about challenges reported in previous studies also may indicate the success of federal guidance

such as the Social Media Working Group³ (SMWG) discussed in greater detail in the following chapter.

1.2.3. Research Objective III: Social Media and Hurricane Harvey

While the first two research objectives offer insight into SM use in the EM field in areas affected by hurricanes in 2012, the third is a case study of how SM was used to aid responders during Hurricane Harvey in 2017. Based on a separate survey of organizations involved in the emergency response phase of this urban-scale flood disaster, we compare SM use among three groups, including first responders, government-related agencies and offices, and non-government organizations (including news media organizations).

The third research objective seeks to provide insight regarding the utilization of SM in assisting response and rescue efforts, and to shed light on strategies applied to overcome common obstacles of SM use during this recent disaster. Lastly, Hurricane Harvey responders offer suggestions to improve the utility of SM in future disasters. We address the following research questions:

Research Question 3.1: How did survey respondents utilize social media to assist response and rescue efforts during Hurricane Harvey?

Research Question 3.2: How did survey respondents address commonly reported obstacles concerning the use of social media during disasters?

Research Question 3.3: Which recommendations do responders suggest could improve the utility of social media in future emergencies?

Lessons learned from agencies and organizations involved in the response phase of an urban-scale emergency can help to guide and inform technology developers as they work to make features of SM more user-friendly. Also, the information should help EM leadership provide targeted support and guidance to improve rescue and response efforts in future disasters.

³ <https://www.dhs.gov/science-and-technology/smwg>.

1.3. Study Areas and Events

The US Counties and respective States affected by 2012 Hurricanes Isaac and Sandy defined through the Federal Emergency Management Agency (FEMA) disaster declarations form the study area investigated by the first and second research objectives. Each region of the study area also includes targeting a major metropolitan area to capture greater local-level participation in survey responses. The Sandy study area includes 93 counties in eight US States, the District of Columbia, and New York City. The Isaac study area includes 123 counties in four US States and the City of New Orleans. New York City and New Orleans serve as county-level geographic units due to their regional influence and high density of municipal-level public agencies and organizations. The Hurricane Harvey study area includes the nine counties forming the Greater Houston Metropolitan Statistical Area, the City of Houston (included at the county-level geographical segment), and responding public agencies and organizations corresponding with the State of Texas. Figure 1.1 illustrates the three study areas, including areas affected by Hurricane Isaac shaded green, the Sandy region shaded blue, and the Harvey study area shaded red.

1.3.1. Hurricane Isaac

Tropical Depression Nine formed east of the Lesser Antilles in the morning hours of August 21, 2012. The storm made landfall on Haiti and Cuba before entering the Gulf of Mexico. Isaac was classified a Category 1 Hurricane in the afternoon of August 28 about 75 miles south of the mouth of the Mississippi River, where it eventually made landfall on southeast Lafourche Parish of Louisiana with maximum sustained winds of 80 miles per hour. The storm re-entered Gulf waters and made a second landfall just west of Port Fourchon, Louisiana in the second hour of August 29. The storm slowed, continuing a northwest trajectory across Louisiana on August 29 and 30, impacting four US states with prolonged wind, coastal flooding, and flash flooding resulting in one death (NWS 2017).

The Hurricane Isaac study area encompasses four states and 123 counties including Alabama (8 counties), Florida (12 counties), Louisiana (55 parishes), and Mississippi (48 counties). The Isaac (counties) study area stretches over about 88,000 square miles with a total (counties) population of nearly 8.8 million and a population density averaging 111 persons per square mile (Census 2017, FEMA 2017e). The Isaac Study Area is the largest by area, most rural, and contains the most coastline of the three study areas.

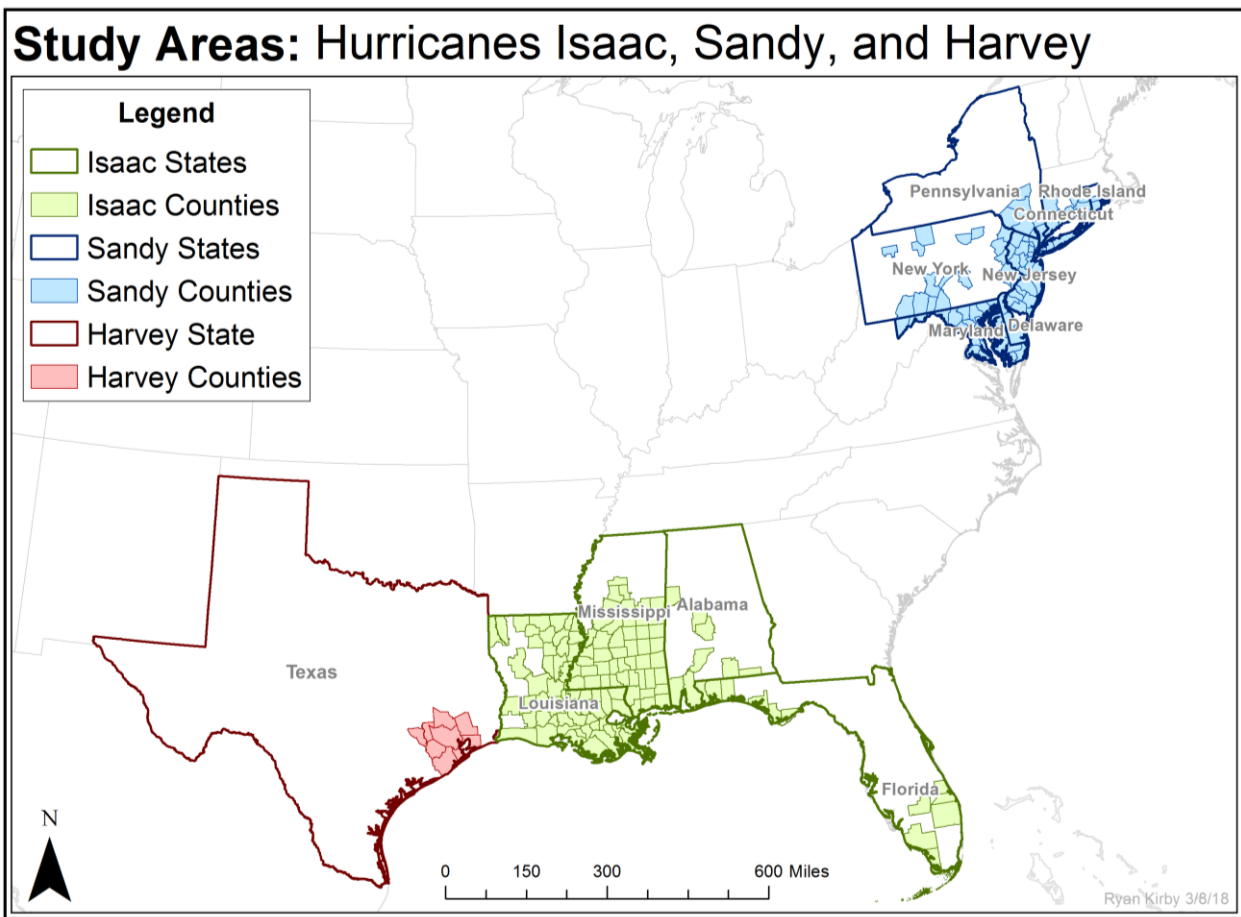


Figure 1.1. States and Counties affected by Hurricanes Isaac, Sandy, and Harvey.

1.3.2. Hurricane Sandy

Tropical Depression Eighteen formed over the Central Caribbean on October 22, 2012, intensifying to a Category 3 hurricane as it tracked north over Jamaica, Cuba, and the Bahamas. Sandy made landfall near Atlantic City, New Jersey as a post-tropical cyclone with sustained

winds of 80 miles per hour on August 29, causing catastrophic storm surge in coastal New Jersey and New York (Blake et al. 2013, NWS). The storm tracked west-northwest across southern Pennsylvania until it dissipated over Ohio two days later. Sandy claimed a total of 147 lives with 72 in the US Atlantic basin (Blake et al. 2013). The event was the second costliest cyclone since 1900 at \$65 billion (Blake et al. 2013).

The Hurricane Sandy study area encompasses seven states, 91 counties, and one territory including Connecticut (7 counties), the District of Columbia, Delaware (3 counties), Maryland (24 counties), New Jersey (21 counties), New York (14 counties), Pennsylvania (18 counties), and Rhode Island (4 counties). The Sandy (counties) study area reaches over 41,000 square miles with a (counties) population totaling about 36.2 million and resulting in an average population density of nearly 8,803 persons per square mile (FEMA 2017e, Census 2017).

1.3.3. Hurricane Harvey

Hurricane Harvey emerged as a tropical wave off the coast of Africa on August 13, 2017. The system was named the Tropical Cyclone Nine on the morning of August 17 and upgraded to a tropical storm that afternoon. Harvey impacted the Windward Islands August 18 and entered the Mediterranean where it weakened to a tropical wave, passing over the Yucatan Peninsula on the 22nd. Harvey rapidly intensified following re-entry into warm Gulf waters, tracking northwest and made a second landfall on San Jose Island on August 24 after achieving sustained winds of 130 miles per hour and storm surge reported of up to 12 feet, where it dumped over 16 inches of rain in 24 hours before re-entering Gulf waters one final time (Ehrlich 2017, NWS 2018). The downgraded tropical storm zigzagged eastward, eventually making its final landfall west of Cameron, Louisiana on August 30. Afterwards it took a north to northeast trajectory across Louisiana. Disastrous flooding in the Houston area claimed 82 lives (Moravec 2017).

The catastrophic event resulted in a cost double of Hurricane Sandy at \$125 billion (NOAA 2018).

The Hurricane Harvey study area includes nine counties in the State of Texas, known as the Greater Houston Metropolitan Statistical Area (MSA). The Houston MSA stretches over 8,500 square miles and is home to nearly 5.9 million residents, averaging about 687 persons per square mile (FEMA 2017e, Census 2017).

1.4. Dissertation Organization

The first chapter presented an overview of the three research objectives, the storm events, and the study areas. Chapter two offers a review of the related literature including the theoretical basis of the research, the findings of recent related studies, and guidelines concerning the use of social media during emergency events, including those promulgated by the federal government. The literature review constructs the conceptual framework of the study, suggesting better communication between information brokers and the public may lead to enhanced community disaster resilience through development and maintenance of durable communication networks and investment in social capital. Chapter two also includes a review of technical documents regarding communications in the EM field and a review of recent research concerning the SM communication preferences of the public. The chapter concludes with a summary of challenges and a visual conceptualization of these obstacles to social media use that have been reported in the literature.

Chapter three includes the methods used to construct both survey instruments, the pre-testing process, and survey distribution methodology. I discuss the method developed to identify the pool of potential survey respondents and classify their organizations into types. The chapter is structured to summarize the development and data collection for each survey instrument

independently but does not repeat the description of the sampling and classification methodology for the Harvey survey, as procedures were carried over from the sampling method developed for the first survey. The chapter includes a description of the data-cleaning steps that were applied to remove insufficient, unclassifiable, or low-quality responses received from the two surveys.

Chapter four presents the findings of the first research objective regarding the use of SM during the four phases of an emergency by public agencies and organizations that comprise the whole community of EM in 2018, sampled from areas affected by Hurricanes Isaac and Sandy which occurred in 2012. The goal is to understand how different stakeholder groups, including first responders, government-related agencies and offices, news media organizations, and non-government organizations use SM to supplement risk and crisis communication throughout the four phases of EM.

The fifth chapter includes findings from the second research objective. Findings were derived from the same survey as reported on in chapter four, investigating the challenges reported by survey respondents, and how they have addressed these challenges.

Chapter six presents the findings of the third research objective and reports the survey findings from emergency responders during Hurricane Harvey around greater Houston, Texas area in 2017. The case study examines specific SM tools used by the emergency responders during the response phase and how they addressed common obstacles to SM use during crisis events. The chapter concludes with recommendations for improving SM in future disasters.

The last chapter concludes the study by summarizing the findings presented in chapters four, five, and six. The findings drawn from each of the three research objectives provide a base from which I discuss the implications of the study and specific “take home” messages to help guide the efforts of EM leadership and relevant personnel, and for social media developers, who

may help to enhance overall community disaster resilience by working with EM communication specialists to improve the utility of social media to assist response and rescue efforts.

Chapter 2. Literature Review

Researchers examining sources of community resilience agree communication networks and social capital play an important role in how well communities can withstand and recover from large-scale disturbances (Adger 2000, Aldrich and Meyer 2015, Anderies and Janssen 2013, CARRI 2013, Holling 1973, 2001, Norris et al. 2008, Lam et al. 2016, Reams et al. 2012). Norris and colleagues found community resilience to disasters might be influenced by adaptive capacities and the extent to which they are robust, redundant, and rapidly accessible to stakeholders (Norris et al. 2008).

The Four Phase Model for Emergency Management is a framework suggested by FEMA for the development of emergency response plans (FEMA 1996, 2006). Following a disturbance to a community, the phases of the event may be conceptualized to include *response*, *recovery*, and *mitigation* before returning to *preparedness*. FEMA stresses that organizations and public agencies involved in EM should maintain bi-directional communication with the public throughout the phases.

In recent years, several federal government guidelines have been promulgated to encourage use of new technologies for greater stakeholder engagement throughout the four phases of EM. The 2006 Warning Alert and Response Network Act⁴ sought to establish a unified national hazard alert system, leading to Wireless Emergency Alerts⁵ becoming operational in 2012 (FCC 2017g). Wireless Emergency Alerts enhanced crisis communications through use of geographically targeted text broadcasts to mobile devices within a specified zone of emergency (FCC 2017g, US Congress 2006). Similarly, the National Emergency

⁴ H.R.5785 - Warning, Alert, and Response Network Act. 109th Congress (2005-2006). <https://www.congress.gov/bill/109th-congress/house-bill/5785/text>.

⁵ <https://www.fcc.gov/consumers/guides/wireless-emergency-alerts-wea>.

Communication Plan (NECP) of 2008 aimed to improve emergency communications following the 9-11 attacks of 2001 and Hurricane Katrina of 2005. The NECP highlighted communication deficiencies affecting responders' abilities to manage incidents and support response efforts (DHS 2006, 2008, National Commission on Terrorist Attacks 2004, SLP 2006).

The 2008 NECP reinvented US crisis communication approaches by emphasizing the need for ongoing communication among stakeholders during the four phases of a disaster. *Risk communication* became a mechanism for maintaining open dialogue among stakeholders. Although the 2008 NECP did not mention SM specifically, many government entities have since incorporated SM into risk and crisis communication plans and developed manuals to help standardize its use. By 2010, DHS acknowledged the utility of SM and pushed for development of SM communication best-practice strategies with the formation of the SMWG. By 2012, SMWG issued the first of eight guiding documents supporting the use of SM by responders. The Social Media Strategy states SM can serve as a vessel to deliver alerts and warnings to “more people, in more places, in less time” (DHS 2012).

The 2014 revision of the NECP emphasized enhancement of the communication capabilities of responders, including updated goals and recommendations to modernize communications following a whole-community approach to preparedness (DHS 2014). The Plan promoted more advanced SM activities, such as a tool to “enhance situational awareness, operational coordination, and decision-making” (DHS 2014). Despite central EM leadership support SM tactics to *pull*, or collect information from trusted SM networks, recent studies suggest the bureaucratic rigidity of NIMS may have complicated EMs abilities to embrace these more advanced SM communication strategies (Hughes and Palen 2012).

2.1. Disaster Resilience, Communication, and Information

2.1.1. Disaster Resilience

The resilience of social-ecological systems depends on many factors, including the ability to rapidly communicate risk and adapt to changing threat levels (Adger 2000, Anderies and Janssen 2013, Holling 1973, 2001, Norris et al. 2008b, Reams et al. 2012, CARRI 2013). We adopt Norris et al.'s (2008) definition of *community resilience* as “a process linking a set of capacities to a positive trajectory of functioning and adaptation after a disturbance,” (Norris et al. 2008) acknowledging resilience as a metaphor, a theory, a set of capacities, and with relevance to developing strategies for disaster readiness. A community may enhance its disaster resilience by investing in sets of *networked adaptive capacities*, including economic development, community competence, information and communication, and social capital (Norris et al. 2008). Further, adaptive capacities may be thought of as the combination of “both the resources themselves and the dynamic attributes of those resources (robustness, redundancy, rapidity)” (Norris et al. 2008). Authors suggest the networked adaptive capacities arising from *information and communication* include the narratives being shared, responsible media participants, professional skills and infrastructure whereby the information is shared with the public, and trusted sources of information. *Social capital* capacities include perceived social support among community stakeholders, social embeddedness or connectedness among the community members, organizational linkages and cooperation, citizen participation in collective endeavors, sense of community, and place attachment (Norris et al. 2008). Emergency managers investing in social capital may support durable communication networks by encouraging bonding or n bridging relationships across stakeholder groups, and linking stakeholders vertically by connecting politically-influential individuals with those within marginalized social groups (Aldrich and Meyer 2014, Adger 2010, Sherrieb, Norris, and Galea 2010, Putnam 2001).

In the resilience literature, *information* enables adaptive performance as a primary resource in technical and organizational systems (Comfort 2005), while *communication* refers to the standardization of meanings and understandings, and the existence of channels for members to articulate their needs (Norris et al. 2008). Community resilience requires good communication (Goodman et al. 1998), and information that is “accurate and accurately transmitted” (Goodman et al. 1998, Norris et al. 2008). Further, the Center for Disease Control (CDC) suggests choosing the correct communication method or channel is “crucial to the public’s health and safety,” and that “the public information official must select the right delivery method for a particular set of circumstances” (CDC 2014). Meeting these CDC recommendations may be complicated by the previously-mentioned restrictive dimensions of NIMs.

FEMA Director Craig Fugate advises EMs to utilize existing networks rather than forming new channels to interact with the community (Fugate 2011b). This advice encourages EMs to lead the effort in selecting appropriate communication channels to supplement their official communications with the public, and to tailor communications to those methods and channels that are most relevant to their constituents and audiences.

Covello (1992) defined *risk communication* as a “process of exchanging information among interested parties about the nature, magnitude, significance, or control of a risk” (Covello 1992). Risk communication occurs across all phases EM cycle (FEMA 2006). Risk communication often includes strategic messaging, persuasion, and presentation, and may appear less formal and urgent. We distinguish *crisis communications* as the nexus between managing information and managing meaning during the stages of prevention, response, and post-crisis learning (Sheppard, Janoke, and Liu 2012). Authors suggest crisis communication tends to focus

on organizational self-image and reputation restoration. While a risk may be continuous and constant, crises typically occur over a short period of time.

2.1.2. Social Capital

Similar to the variation in the definitions of community resilience, authors describe social capital as both a theory and capacity, with multiple definitions existing in the literature (Norris et al. 2008, Häuberer 2011). The concept of *social capital* is related to a sense of community and place attachment. The theory refers to individuals' abilities to invest and build capital in their social networks as a resource from which to draw for individual gains (Norris et al. 2008) in addition to the actual or potential capacity of resources supporting a durable communication network by way of "membership" into collectively-backed capital (Häuberer 2011).

Emergency Managers (EMs) may have the potential to enhance community resilience to disasters with investment in social capital and civic activity by maintaining partnerships with stakeholders in the community (Aldrich and Meyer 2015). Authors suggest the theory of social capital has been used to understand how communities cope during and after a disaster, based on levels of trust in EM, collective action, and other public goods (Aldrich and Meyer 2015). Individuals are more likely to listen and comply with public information messages such as WEAs when EMs establish and maintain relationships of trust in the community (Hughes and Chauhan 2015), which may lead to a reduction in time spent searching or milling for additional information before taking self-protective action (Wood et al. 2017). The concept of information milling is discussed in greater detail in section 2.5.

Therefore, we may deduce that risk and crisis communicators may have a positive influence on community resilience to disasters by investing in communication methods and networks preferred by community members. Upholding civic activity through ongoing risk

communication may help to establish credibility and build social capital, affecting levels of institutional trust in the community, which could raise the efficacy of public warning messages.

2.2. Social Media and Emergency Management

The abilities of EMs to meet their objectives in maintaining adequate situation awareness for accurate decision making are continuously tested during major disasters (Wukich and Mergel 2015), but web-based communication technologies such as SM tools provide opportunities to enhance communications by networking all stakeholder groups in a community quasi-public forum. We operationalize the term *social media* as referring to popular publicly-accessible information and communication technologies (ICT) allowing the rapid and multi-directional exchange of multi-media and text messages through web-based channels such as Facebook, Instagram, LinkedIn, Pinterest, Snapchat, Twitter, and Nextdoor.

Researchers have documented the use of SM in disasters by public agencies, NGOs, and by individual citizens. The literature mostly includes reports of SM as used for crisis and risk communication in terms of adoption rates, message content, common challenge or obstacles, and future opportunities of SM adoption (Wukich and Khemka 2017, Owen et al. 2017, Brady 2017, Plotnick and Hiltz Starr 2016, McCormick 2016, Wukich and Mergel 2015, Luna and Pennock 2015, Flizikowski et al. 2014, Wukich and Steinberg 2013, Su et al. 2013, Hughes and Palen 2012). The proceeding literature review presents benefits and common SM challenges for EM gathered from empirical studies investigating its use in the US. Observing the types of challenges reported by survey respondents also contributes clues toward the progress of SM campaign development as public agencies and NGOs progress toward the institutionalization of SM in the manner described by Mergel and Bretschneider (2013), who propose a three-stage model of SM adoption by government agencies. Researchers suggest during the first stage of

SM adoption, efforts are generally decentralized, experimental, and educational when SM is mostly used to broadcast information (Mergel and Bretschneider 2013). The second stage contains “coordinated chaos” when informal standards emerge from the lessons learned from experience gained growing social networks and increasing the presence of the organization within the community (Mergel and Bretschneider 2013). The third stage includes the materialization of clear guidelines defining behavioral standards and of new roles supporting the institutionalization of SM in communication strategies (Mergel and Bretschneider 2013).

2.3. Social Media Use in Emergency Management Communication

As introduced in the previous chapter, a primary objective of EM is reaching all citizens in a potentially hazardous area with a critical message in order to preserve human health and minimize property damage. The 2011 Presidential Policy Directive 8⁶ (PPD8) acknowledges weaknesses in the earlier US risk and crisis communication system, and encouraged DHS to lead the efforts to advance the National Preparedness System⁷. The DHS Directorate of Science and Technology⁸ (S&T) invests in the ongoing enhancement of emergency communications through development of the National Emergency Communication Plan (NECP).

While a “one-to-many” type broadcast messaging approach effectively delivers a single message to the public through official channels and traditional media outlets such as broadcast television or AM or FM radio, this approach may not reach all citizens in an affected area. Emergency managers often need delivery confirmation for critical messages and need to know whether their messages are effective, informative, and actionable (Revere et al. 2015).

Traditional one-to-many methods of information dissemination to the public have become

⁶ <https://www.dhs.gov/presidential-policy-directive-8-national-preparedness>

⁷ <https://www.fema.gov/national-preparedness-system>

⁸ <https://www.dhs.gov/science-and-technology>

antiquated and insufficient in meeting national EM and preparedness goals (DHS 2008, FEMA 2017d, Ripberger et al. 2014). While most EMs may agree that participating in online communication for risk and crisis communications may help them reach a broader audience, it also extends the duties of Public Information Officers (PIOs) or relevant staff member (Hughes and Palen 2012, Latonero and Shklovski 2011, Su et al. 2013). The addition of new tasks increases the workload of human resources who may be overstretched during an emergency.

Following the devastation caused by Hurricane Katrina in 2005, Federal Emergency Management Agency (FEMA) Director Craig Fugate advised “we need to take our planning and preparedness to a new level” (Fugate 2009) by taking less of a government-centric approach to EM to reach preparedness goals (Fugate 2011a). Fugate expressed urgency to enhance and evolve the capabilities of public safety answering points (PSAP), or 911 dispatch centers, originally designed to serve wired rotary phones. Incorporating support of text messaging for PSAPs would be fairly simple due to its likeness to conventional PSAP architecture, but developing a system capable of adapting to new technologies. Web-based communications offer an array of supplemental communication channels with advanced features such as image and video sharing and geolocation services available on nearly every web-based communication platform. The prevalence of smart devices allows the public to access these platforms over broadband and mobile network connections and provides opportunity for emergency managers to access their audiences nearly 24/7, as many smart device users keep their devices on their person.

FEMA suggests a whole community approach to EM may help to narrow the citizen-government information gap by participating in community engagement throughout all phases of the EM cycle. FEMA describes the *whole community* of EM as individuals, families, businesses,

faith-based and community organizations, nonprofit groups, schools and academia, media outlets, and all levels of government including state, tribal, territorial, and federal partners (FEMA 2017f). Involving the whole community of EM helps support the construction of durable communication networks and trusting relationships which may be leveraged in times when official EM resources become stretched thin.

The NECP aims to improve emergency communications with recommendations made in retrospective reports concerning national emergencies by focusing on communication deficiencies affecting responders' abilities to manage incidents and support response efforts (DHS 2008, 2006, 2004, Committee 2006). DHS engages stakeholders from federal, state, local, and tribal agencies to realize a central vision for emergency responders to communicate "as needed, on demand, and as authorized at all levels of government across all disciplines" (DHS 2008). The goals and objectives of the Plan aim to reach more citizens in less time with a comprehensive, multi-level approach. Recognizing that there is no "silver bullet" solution, the NECP "involves making improvements at all levels of government, in technology, coordination and governance, planning, usage, and training exercises" (DHS 2008).

Although the first release of the NECP (2008) did not mention SM specifically, personnel of many agencies had already begun experimenting with SM tools in their communications with the public. In 2008, only about 21% of Americans used SM, but subscription to SM platforms tripled by the release of the second version of the NECP in 2014 with 62% of Americans using at least one SM platform (Center 2018). Director Fugate endorsed SM as a tool to minimize gaps in communication through bi-directional communication and interagency information sharing (Fugate 2011b). Fugate proposed EMs could benefit most by engaging active networks rather than trying to bring the people to a new platform, and demonstrated support of SM adoption

through FEMA’s online offering of an independent study course IS-42: Social Media and Emergency Management⁹ through the Emergency Management Institute.

In 2010, DHS S&T established what is now known as the Social Media Working Group (SMWG) with the mission to provide guidance for the use of online communication channels. DHS S&T brings together representatives from all levels of government throughout the EM community to develop “best practice” solutions for emergency responders and supporting organizations during all phases of the EM cycle (DHS 2018). The Group has released eight guiding documents for public use in its first six years, covering a range of topics from SM adoption and development, to issues of greater complexity such as countering false information on SM during a disaster. The SMWG materials provide guidance for risk and crisis communicators in government agencies who wish to follow the leadership of “social media evangelists” as described by Latonero and Shklovski (2011) or “creative intrapreneurs” as described by Mergel and Bretschneider (2013).

2.4. Benefits of Social Media in Emergency Management

The growing use of web-based communication among the public provides an opportunity for EMs to access large and expanding audiences. From 2012-2018, SM use in the US grew from 18% to 77% (Smith and Anderson 2018), while US internet users grew from 83% to 89%. The American Red Cross found SM and mobile apps were the fourth most popular sources of emergency information during a disaster in 2010, with 79% of respondents reporting turning SM for weather conditions and warnings (ARC 2012). The Red Cross also found over three-quarters of survey respondents expect help to arrive within three hours when posting emergency-related requests on SM (ARC 2012).

⁹ <https://training.fema.gov/is/courseoverview.aspx?code=IS-42>

The literature suggests SM has potential to contribute positively to disaster outcomes. For example, Cooper et al. (2015) argues Twitter contributed to improved mortality and morbidity in the aftermath of the EF-4 Tornado that struck Hattiesburg, Mississippi in 2013, and suggests that Twitter provides a public and mental health value by connecting vital services and resources. More specifically, researchers suggest SM has “potential for information interconnectivity, reliability, and increasing breath for information all of which are important features for engaging the target population,” proposing that it may help to address disparity in access to reliable information during disasters (Cooper Jr et al. 2015). Hughes and Palen (2012) discuss the positive role of Twitter during 2008 hurricanes Gustav and Ike, suggesting Tweets contained more displays of information broadcasting and brokerage in such events than typical usage (Hughes and Palen 2009). Other works suggest SM has the potential to enhance disaster resilience by helping stakeholders to develop a trusting relationship with other members and organizations within their community before a crisis (Hughes and Chauhan 2015).

Drawing from lessons learned regarding SM use to promote public safety during Hurricane Sandy, the SMWG values SM for:

- Facilitating direct agency engagement within a community
- Maintaining situational awareness about emergency events and partnership opportunity
- Providing an additional method for disseminating emergency public information
- Providing a method for evaluating public information
- Providing a means for the community to engage in problem solving
- Providing a means to meet and manage public expectations
- Engaging individual connectivity and promote community resources
- Building and promoting agency or organization credibility
- Promoting and encouraging efficiency, credibility, and transparency
- Encouraging multidirectional sharing of essential information
- Encouraging behavioral change.

Source: (DHS 2013)

2.5. Challenges and Problems with Social Media Communication

Emergency Managers may face a range of difficulties when incorporating SM into communication strategies. Further, these challenges may change and evolve over time as public agencies adopt and integrate SM tools in their communication with the public (Mergel and Bretschneider 2013). Challenges arise from human interactions, technical limitations, and the interaction of the two in “socio-technical systems”. For example, communication challenges involving human interactions may include the concerns about the accuracy of the information being shared. Socio-technical challenges include issues arising from the indirect nature of human interaction through technology, such as how to handle anonymity of users encountered on SM. Challenges stemming from the maintenance of listenable channels (such as Facebook or Twitter) require EMs to develop bi-directional communication strategies including making investments to incorporate such duties in the job description of communication personnel. They also need to develop policies and protocol for addressing legal issues such as data storage, privacy, and access to SM technology (DHS 2012a, Plotnick and Hiltz 2016).

Channel selection has consequences for accessing adequate audiences, users’ ability to retain data, and information security. For example, Twitter data is made available for purchase, while Facebook generally retains the data generated on their platform. The interfaces of SM tools also vary in functionality, resulting in differing and often unclear information transmission and retention. Uneven information sharing contributes to information asymmetries and the potential for inaccurate information being shared (Wukich and Mergel 2015).

In addition, SM challenges may present themselves differently across the phases of the EM cycle. Members of the public are likely to expect quick informative responses from EMs who use SM. While some EMs may possess the resources necessary to incorporate additional

“as-needed” staff to monitor and respond to public information request which surge during a crisis, a large portion of local-level responders may lack the resources necessary to maintain listenability in non-emergency times. Providing intermittent or inconsistent listenability has the potential to limit the overall effectiveness of communications with potential to undermine institutional trust and erode public perception of official information brokers (Hughes and Chauhan 2015).

A long-standing challenge of crisis communications unfolds when citizens fail to engage in self-protective action immediately following receipt of a public warning message (Lindell and Perry 2012). Rather, citizens often take part in *information milling*, turning to their own social networks for information and guidance before re-defining the hazard and taking self-protection action (Wood et al. 2017, Mergel 2014). The key hazard of milling is delay or hesitancy to take self-protective action when individuals seek additional information to inform or re-define their understanding of an unfamiliar hazardous situation. They may receive poor advice offered by misinformed or unknowing individuals communicating within personal networks.

As members of the public increasingly use SM to communicate and access information (Shearer 2018, Shearer 2017), some researchers also note that the use of SM rises during a crisis (Austin, Fisher Liu, and Jin 2012). Individuals primarily use SM during a crisis to access information and check on family and friends (Austin, Fisher Liu, and Jin 2012), and in some situations they believe the information available on SM to be more credible than traditional news sources (Procopio and Procopio 2007). Citizens may also turn to SM when the crisis has freshly surfaced because traditional media has not yet covered the crisis (Austin, Fisher Liu, and Jin 2012). Participating in information milling might be negatively influenced by the information diffusion process, in which intermediate sources relay messages to ultimate receivers (Lindell

and Perry 2012). Here lies opportunity for responders to leverage SM tools to supplement citizens' informational needs with official advice and information aimed to reduce delay in citizens taking self-protective action. Official public warning providers may supplement and elaborate on public warnings by engaging the public through unofficial channels to provide updates and recommend alternative trusted information sources to guide citizens towards accurate information in hopes of avoiding the sharing of misinformation within affected communities. Public information providers may also affect the success of information transmission depending their ability to access the most used channels or networks among the populations at risk.

The following section focuses on the challenges of developing and maintaining SM campaigns for risk and crisis communicators with a sequential review of similar studies. The review discusses difficulties, obstacles, and barriers contributed in empirical studies, and reviews knowledge regarding the use of SM for US emergency management. We seek to understand how SM challenges have evolved in the literature and identify enduring or inherent limitations to social media use for emergency management.

2.5.1. Challenges of Social Media in Emergency Management in the Literature

Investigation into the use of SM tools for EM did not appear in the crisis informatics literature in great detail before 2011, the year following the formation of the SMWG. By 2011, one-half of the American population already used at least one SM platform, up from 5% in 2005 (Center 2018). The same year, Latonero and Shklovski (2011) presented a case study telling of a shift in risk and crisis communication to incorporate interactivity. Authors described innovative early adopters as social media evangelists who develop new solutions to enhance organizational communications capacities using ICT. Researchers suggested pockets of visionaries were using SM to enhance, and even change the nature of risk and crisis communication, by providing

listenability and bi-directional communication. Authors presented the case of groundbreaking use of SM by a Los Angeles County Fire Public Information Officer (PIO) Brian Humphry, who used Twitter to monitor and collect information, and Yahoo Pipes to validate the Twitter information without any formal education on the topic. Researchers found Humphrey faced financial, logistical, and organization challenges, including increased workload and potentially unstable support of SM from leadership attributed to a “disconnect” in organizational structure and Humphrey’s SM activities (Latonero and Shklovski 2011).

Hughes and Palen (2012) interviewed 25 Colorado PIOs of sub-municipal to state-level law enforcement, fire, city government, EM agencies, and other related organizations. Open-ended interview questions posed during semi-structured phone interviews provided insight regarding how ICT such as SM affect the work of PIOs. Researchers found 80% of respondents used SM in their job. Respondents reported struggles with the rigidity of NIMS, expressing frustration with tasks such as gaining approval from leadership before sharing messages, who feared the novel approach to enhancing communications could introduce unforeseen negative consequences (Hughes and Palen 2012). Other PIOs reported great concern about the time and resources required to support a SM campaign (Hughes and Palen 2012). Their findings suggested that the role of the PIO was evolving from primarily that of a gatekeeper, to a translator, as online networks allow greater accessibility and interaction with citizens and news reporters. These findings provided evidence of the changing responsibilities and resource needs of agencies and organizations across the nation as they participate in the online community. Many of the PIOs interviewed sought to address these needs through the redistribution of tasks within their organization, which may require new specializations.

The following year, the Center for Naval Analyses (CNA) and National Emergency Management Association (NEMA) found that 100% of state level EM agencies used SM “in some capacity” with 68% of county level and 85% of local level EMs and emergency response agencies participating in the online community (Su et al. 2013). The study compiled the responses of 505 nation-wide representatives from EM agencies, public health, emergency medical services (EMS), government, law enforcement, fire, and other organizations at the state, county, and local levels. The study found seven barriers to the use of SM, with the primary challenge being a lack of dedicated personnel for SM campaigns (Su et al. 2013). While almost one-quarter of respondents reported no primary barrier to agency use of SM, the majority of respondents also reported difficulties stemming from a lack of leadership, funding, established procedures, training, and knowledge of SM (Su et al. 2013).

Next, Wukich and Mergel (2015) sought to understand how public agencies use SM to empower citizens across the four phases of EM, focusing on the extent of use by state-level EMs. Researchers highlighted several problems including information milling on SM limiting the effectiveness of official messages, information asymmetries emerging as messages are not shared uniformly within social networks, and the unknown accuracy of the information shared on SM (Wukich and Mergel 2015). They concluded that (1) a large portion of agency communications occurred concerning prevention, mitigation, and preparedness topics; (2) agencies push information to and request feedback via one-to-many messages; (3) agencies engaged in many-to-many modes of communication for rumor management (Wukich and Mergel 2015). Challenges include coordinating multi-actor networks, information asymmetries, inaccurate information sharing, and maintaining the resources required to for constant monitoring in order to preform rumor control. Authors recommended agencies build relationships prior to extreme

events to maximize the reach of their communications and trust of the community (Wukich and Mergel 2015).

Plotnick and Starr (2016) identified technical and organizational barriers to SM use in a two-part study of county-level emergency management agencies. They found that about half of EMs use SM, while another quarter of EMs actually prohibit its use. First, researchers mapped the barriers to SM use with information gained through eleven interviews with EMs across the nation resulting in six primary barriers. The barriers included a lack of time and personnel, lack of formal policies, prohibition of SM, lack of training, data accuracy, and information overload (Plotnick and Hiltz Starr 2016). The second part of the study included a large sample survey in which respondents indicated insufficient staff was the greatest barrier for both pushing and pulling information through SM (Plotnick and Hiltz 2016). The second and third top barriers related to pushing information were lack of guidance and policy, and lack of skills respectively (Plotnick and Hiltz 2016). The top technical barriers to pulling information through SM include trustworthiness and information overload when observing data streams exceed human capacity (Plotnick and Hiltz Starr 2016). They suggested formal policies and procedure related to SM were quickly evolving among their study participants.

Lastly, McCormick (2016) discussed internal and external challenges for the use of SM based on nineteen interviews of EMs in the US. The top internal challenges include staffing shortages, policies, and restrictive institutional infrastructure. External-type challenges included data verification, security of information, liability issues, and subjectivity that may affect the accuracy or validity of information gathered from SM, such as measuring the extent of damage virtually through SM information (McCormick 2016). McCormick hypothesizes that adoption of

SM by EMs is influenced by access to resources, acceptance by leadership, and the amount of prior exposure to SM tools (McCormick 2016).

2.5.2. Shifting Public Communication Preferences

Over the past decade, emergency managers have been encouraged to keep up with changing modes of communication in the US, including monitoring of SM streams (Su et al. 2013). Communication preferences have undergone dramatic shifts in the last three decades with integration and development of SM. Internet provider America Online may deserve the credit for changing the way we communicate through the development of Instant Messenger (AIM) in 1997. The retired desktop software application featured real-time exchange of one-to-one and many-to-many type messages to other users signed in to AIM regardless of their internet provider. At its peak in 2001, AIM was the most popular messaging service in the US with 100 million users, a value representing about 71% of total internet users in the US at the time (Neuman 2017, Live Internet Stats 2016). In the same year, Paul (2001) found internet users preferred interactive sources to fixed-information sources for disaster communication. The portion of Americans accessing the internet has nearly doubled since 2000, soaring from 48% to 89% in 2018 (Anderson, Perrin, and Jiang 2018).

A 2014 survey of American adults found text communications are preferred over voice communication, with only 10% of the population reporting using a home landline “a lot” (Newport 2014). While 77% of Americans carried a smartphone in 2016, 95% had a mobile phone of some sort (Pew Research Center 2017). The growth in accessibility to mobile devices has implications for both broadband internet subscription and desktop/laptop ownership, which have declined since 2016 (Pew Research Center 2017). Mobile applications and push notifications have shaped Americans’ relationship with information and communication by enabling near constant contact with social network, news, and entertainment. Although only 5%

of Americans used SM in 2005, Pew found 69% of US adults used various SM platforms in 2018, suggesting SM has potential to reach a large and growing audience greater than 227 million Americans (Pew Research Center 2018, US Census Bureau 2018).

Luna and Pennock's (2015) review of SM use in four disasters from 2005 to 2012 helps to classify common SM challenges, based on the primary division among social and technical challenges. Authors build on the four-phase knowledge contributed by Clayton Wukich, focusing on the conceptualization of SM challenges reported in the literature. Figure 2.1 illustrates an adaption of Luna and Pennock's (2015) organization of SM difficulties, splitting them into two groups, including social and technical with subgroups breaking down more complex challenges of SM use in EM, as well as an overview of community resilience theory and the role of SM in building social capital. Authors define *social challenges* as those caused by interactions: (1) among individuals, (2) between individuals and organizations, and (3) among organizations. Social challenges emerge with multiple interactions among stakeholders, including the dissemination of information, detection of irony, misinformation, and information verification and validation (Luna and Pennock 2015). *Technical challenges* are distinguished as difficulties stemming from "physical and logistical resources required to functionally support the development" in the EM community (Luna and Pennock 2015). While technical challenges may be primarily a product of policies, protocol, and a lack of investment in SM communication, social challenges tend to be more unpredictable and complex, such as detecting irony in the messages posted by individuals.

This chapter provided an overview of the key obstacles, barriers, and challenges reported in the literature. Challenges to the use of SM in the whole community of EM presented in the six studies discussed above are summarized in Appendix A including the study citation, condition

observed, study type, study size (n), respondent profile, and findings listing reported obstacles. This review of related research provided insights that we applied in the design of the survey instruments introduced in the following chapter. We apply Norris et al.'s (2008) community resilience framework as a theoretical base to investigate SM as a tool to increase the availability of accurate information and effectiveness of communication by the EM community, and thus, enhance overall community resilience to disasters. We focus on two capacities presented by Norris et al. (2008) including *information and communication* and *social capital*, to explore the use of SM as a pathway to enhance disaster resilience. Mergel and Bretschneider's (2013) three-stage framework of SM adoption by government agencies provides guidance to investigate how the reported challenges of SM communication in the EM community may indicate progress made toward institutionalization of SM.

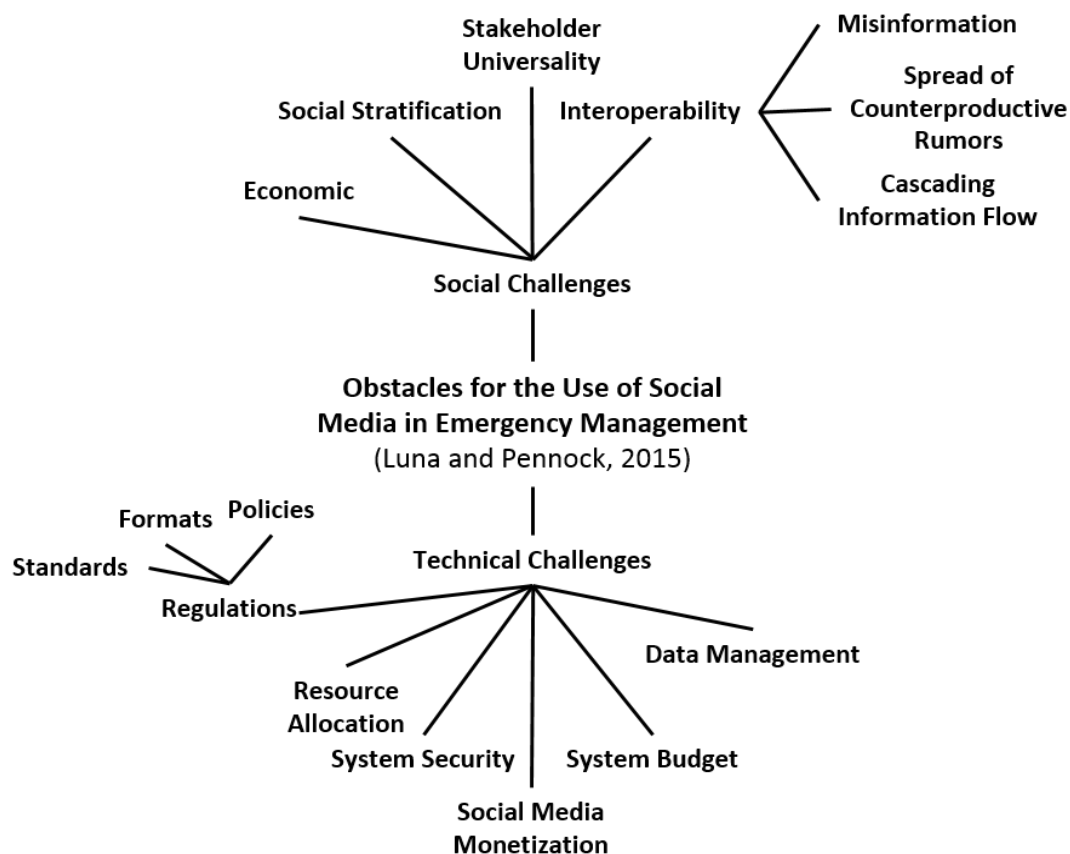


Figure 2.1. Obstacles for the Use of Social Media in Emergency Management, adapted from Luna and Pennock (2015).

Chapter 3. Data and Methods

The third chapter introduces two survey instruments, describes questionnaire development, and study population sampling for areas affected by the 2012 Hurricanes Isaac and Sandy and for Hurricane Harvey in 2017. The first survey was designed to gather information about SM use by members of the whole community of EM throughout all phases of EM in areas affected by Hurricanes Isaac and Sandy. The second survey focuses only on one of the four phases, the response phase, and examines social media use among governmental and non-governmental groups who were active during the response phase of Hurricane Harvey.

3.1. Survey I: Hurricanes Isaac and Sandy Study Areas

3.1.1. Population Sampling

The target audience includes public agencies and organizations associated with the whole community of EM within the study area. The sampling method reflects the local focus of the National Emergency Communications Plan (NECP) by targeting county/parish-level first responders (FR), governmental offices and agencies (GOV), news media organizations (NEWS), and non-governmental organizations (NGOs), and also incorporates regional and state-level and national-level organizations for a more complete sample of the EM community. Twitter was chosen as the SM platform from which to identify the study population. We identified potential survey respondents by first combining the names of affected counties/parishes with keywords *emergency*, *disaster*, *news*, *police*, and *fire* in the Twitter Search toolbar, then narrowing the search to “people”. Queries were repeated with state names, and then with state abbreviations.

Twitter accounts were included upon meeting three requirements:

1. Twitter account represents an organization assumed active in risk or crisis communication based on the definition of “whole community” of EM.
2. Twitter account corresponds with a county or state of the study area.
3. Twitter news feed includes greater than ten user-generated posts.

Next, the names and acronyms of agencies and organizations known for their involvement in EM were paired with study area place names, including:

- American Red Cross (ARC) – Queried as “Red Cross”
- Chambers of Commerce – Queried as “Chamber”
- Community Emergency Response Teams (CERT)
- Department of Homeland Security (DHS) – Queried as “Homeland Security”
- Emergency Management Agency (EMA)
- Emergency Operations Center (EOC)
- Federal Emergency Management Agency (FEMA)
- National Weather Service (NWS)
- Office of Emergency Management (OEM)
- Principle Information Officer (PIO)
- Salvation Army (SA)
- Special Emergency Response Team (SERT)
- United Way (UW)
- Volunteer Organizations Active in Disasters (VOAD)

Lastly, all keywords were queried into Twitter Search without geographic place names to identify national level organizations participating in risk and crisis information. If the search method did not return the Twitter profiles of any relevant agencies and organizations in a queried study area segment, we adopted Hughes’ (2014) assumption guiding their sampling procedure by accepting that the expected profiles we did not locate either did not exist at the time of sampling, or accounts were not optimized for discovery through basic Twitter Search queries (Hughes et al. 2014).

Twitter sampling resulted in identification of 1,668 organizations and agencies representing the whole community of EM operating within the Isaac and Sandy study areas. The study population is summarized in Table 3.1. The organizations are categorized as combined government-related (GOC-C) and combined non-government related (NGO-C). Data collected from the Twitter pages and linked websites contributed to survey distribution, internal coding, and population analysis. Data collection fields included organization name, organization type, estimated geographic range, Twitter network and activity statistics, age of account, and

indication of officially verified accounts. Linked websites provided email addresses and hyperlinks of Facebook pages and web forms. We used this information to contact the organizations directly and invite them to participate in the survey as described in section 3.1.3 below.

Table 3.1. Hurricanes Isaac and Sandy Study Population Counts per Study Area Segment

Hurricanes Isaac and Sandy Twitter Sample Accounts Summary			
Study Area Segment	GOV-C	NGO-C	Sum
National	29	11	40
Isaac State	27	89	116
Isaac County	114	148	264
Sandy State	73	188	260
Sandy County	503	486	988
Sum	746	922	1,668

3.1.2. Questionnaire Development

The first year of the study was devoted to the research and development of a questionnaire following a review of literature regarding the subjects of emergency management in the US, social media, community resilience, and the intersection of these subjects.

The survey instrument was developed over six months with the input of researchers from the ICAR researchers research team at Louisiana State University.

The final version of the survey instrument was 28 questions focused on the four components mentioned previously. Response formats included categorical multiple choice, Likert-type matrix tables, “yes/no,” and open response. The survey instrument was adapted for Qualtrics online survey software and prepared for pretesting, including the temporary addition of five evaluation questions. The survey instrument is included in Appendix B for reference.

Survey pretesting was executed in January 2018. The method selected for pretesting includes qualitative and quantitate feedback gathered through participant debriefing and expert

evaluation. Participant selection involved convenience and (restrictive) snowball sampling targeting a population of n=31. Feedback was offered by non-profits and other NGOs, news media organizations, communication experts, content experts, and ICAR Researchers.

Qualitative and quantitative evaluations were collected with in-survey evaluation questions and through email correspondence.

The five evaluation questions added to the end of the survey sought feedback regarding survey comprehensiveness, potential additional questions we should add, content sensitivity, survey length, and response likeliness if the participants were invited to participate in the study over SM direct messaging. Expert evaluation during one-on-one interviews provided various suggestions regarding visual aspects, missing content, ambiguity, and general wording within the questions and/or response options. The pretesting process resulted valuable insight regarding content, design, delivery, and the general appearance of the survey. These recommendations were used to make small changes to eight of the 28 questions. The refined survey was made available online in full and mobile formats to anyone with access to the survey link.

3.1.3. Survey Distribution

We distributed the survey instrument from February 2, 2018 through April 25, 2018 with the delivery of invitations via web form submission, email, Twitter Direct Message, and Facebook Messenger. Web forms often found on the “contact us” section of websites contributed 205 survey invitations. We emailed invitations to 984 potential respondents, of which 33 were returned. We sent three reminder emails to increase response rates, followed by a message thanking survey respondents for their contribution to the study.

Next, 101 personalized invitations were extended to potential respondents through Twitter Direct Message over several days. Messages directed to the corresponding public

Table 3.2. Results of Survey I Invitation through Social Media Outreach

Facebook pages located for 65% of the study population contributed the extension of 1,094 personalized invitations delivered over eleven weeks. Greater availability of direct messaging on Facebook pages suggesting greater potential to obtain survey responses existed through Facebook, while the majority of Twitter users do not Direct Messaging on Twitter. Finally, we sent reminder messages to 231 Facebook accounts indicating receipt of messages without reply. Table 3.2 provides a summary of social media outreach for survey distribution, and as an initial indicator to classify how the members of the whole community of EM use SM tools to communicate bi-directionally.

Table 3.2: Survey I Social Media Outreach Messaging Results

Survey Distribution: Social Media Outreach Messaging Statistics					
Channel	Messages Sent	Messaging Disabled %	Response Rate %	Mean Response Time (Hours)	Median Response Time (Hours)
Twitter Direct Message	101	94%	9.9%	81	0
Facebook Messenger	1,094	16%	10.7%	27*	1
*Disregarding one outlier response time of 3,166 hours					

3.1.4. Data Collection and Cleaning

The survey was made available from February until July 2018. We collected 309 total responses, of which 40 were omitted from analysis. Partially completed surveys were observed for analysis under the assumption that respondents may not have held their present role supporting SM communication in 2012, and thus were unable to answer questions about their organization's historic use of SM.

Data cleaning was necessary to reclassify ambiguous self-classifications and to arrange the data for analysis in SPSS 24 statistical software and Excel spreadsheets, where visualizations (tables and figures) were developed. First, responses with a completion rate under 24% were excluded from analysis, yielding an average of 90% completion rate on average among responses

retained for analysis. Next, respondents selecting *other* to the self-classification screening question were analyzed and sorted into one of four valid response categories based on text responses and investigation of identifying embedded fields. Verification of anonymous organization type using email address and Twitter handles resulted in the re-classification of 25 responses. Data cleaning resulted in a dataset of n=269 responses suitable for further analysis.

3.1.5. Survey I Data Analysis

The survey data was imported into Excel spreadsheets and arranged for visual examination with color coding to aid in the visual identification the categories of survey respondents. For the open-ended questions, common themes were noted and recorded, then organized by respondent groups.

An initial analysis was necessary to convert Likert-type responses into absolute values representing frequency. I examined the differences in reported SM communications across the four phases of EM by calculating average-weighted scores to indicate “level of use” of SM in each phase using a four-option Likert-type set of questions. The weights of frequency options include never = 0, sometimes = 0.25, most of the time = 0.75, and always = 1.0. I had provided respondents with definitions and examples of activities per phase, including:

- **Mitigation:** Preventing future emergencies or minimizing their effects (For example: conducting inspections of building safety).
- **Preparedness:** Preparing to handle an emergency (For example: stocking hurricane supplies).
- **Response:** Responding safely to an emergency (For example: checking official news sources before returning to an affected area).
- **Recovery:** Recovering from an emergency (For example: rebuilding stronger after a disaster).

Phase-specific response scores then were calculated for each organization type, per phase, where a greater value reflects more SM use. The sum of phase scores of respondents

served as a measure of their use of SM for risk and crisis communication across all phases of emergency management.

3.2. Survey II: Hurricane Harvey Study Area

3.2.1. Results of Population Sampling

The sampling methodology developed to identify potential survey respondents for the first survey was applied to the Hurricane Harvey study area by querying keyword combinations and direct searches into Twitter Search between December 2017 and January 2018. The Harvey study area is defined as the State of Texas, the nine counties of the Houston Metropolitan Statistical Area, and the City of Houston. The sample also contains the same national level organizations identified in sampling for first survey.

Information used to identify and classify data was collected from the biographical cards of Twitter pages including Twitter handles, organization names, location, and links to other web pages. Email addresses and Facebook profile addresses were collected from websites to provide alternative channels to invite potential survey respondents to participate in the study. Lastly, each potential respondent was classified into reference groups describing the nature of the organization. Sampling resulted in the identification of 299 potential survey respondents, of which 69% operate at the county or local levels. Corresponding Facebook pages were located for 220 cases, or about three-quarters of the Twitter sample.

3.2.2. Questionnaire Development

The second survey was developed between September 2017 and May 2018 with input from ICAR researchers. The final version of the questionnaire contained 23 questions, and is included in Appendix C for reference.

3.2.3. Survey Distribution

Survey distribution occurred in June 2018 by extending invitations to the study population through four channels. First, 60 invitations were submitted to web forms on interactive websites. Next, invitations were sent to 21 potential survey respondents enabling the feature, or about the 7% of the study population. Then, we extended invitations to 230, or 81% of the study population who enable Facebook Messenger. Together, these channels resulted in 74 survey responses from respondents clicking anonymous links provided in the invitation text. Finally, invitations sent to 113 email addresses of potential survey respondents resulted in the collection of 16 survey responses.3.2.4.

3.2.4. Data Collection and Cleaning

Survey responses were collected from the last week of June 2018 until the last week of December 2018, although only one survey response was obtained after the first week of September. We obtained a total of 90 survey responses but excluded 26 for problems including inadequate completion rates ($< 50\%$) and unclassifiable responses. Excluding three respondents taking more than three hours to complete the survey, the average response time was 10:42. The average completion rate was 95%. Local and county level organizations contributed the greatest response rates, followed by state, then national level organizations. Table 3.3 summarizes the origin of 64 survey responses used for analysis compared to the sum of accounts sampled within corresponding study area segments of the Hurricane Harvey study area.

3.2.5. Survey II Data Analysis

The analysis of the second survey results was performed in a similar manner as the first analysis. The cleaned dataset was imported into Excel spreadsheets and color-coded to aid the identification of the respondent groups.

This chapter presented an overview of the survey development, administration, and data collection. The next three chapters present the findings of the analyses conducted on the two surveys to address the research objectives of this dissertation.

Table 3.3. Hurricane Harvey Survey Response Rates per Study Area Segment

Hurricane Harvey Survey Response Rates per Study Area Segment				
Level	Description	Sample Count	Response Count	Response Rate
National	United States	40	5	12.5%
State	Texas	59	9	15.3%
Local/County	Austin	3	0	-
Local/County	Brazoria	19	4	21.1%
Local/County	Chambers	2	0	-
Local/County	Fort Bend	33	7	21.2%
Local/County	Galveston	25	6	24.0%
Local/County	Harris*	109	31	28.4%
Local/County	Liberty	0	-	-
Local/County	Montgomery	8	1	12.5%
Local/County	Waller	1	-	-
Local/County	Other	-	1	-
	Sum	299	64	21.4%
*Includes sample members queried as "Houston"				

Chapter 4. Social Media Adoption, Utilization, Campaign Evaluation, and Barriers to Use

The first research objective explores patterns of social media (SM) use for risk and crisis communication among public agencies and organizations active in emergency management (EM) in areas affected by Hurricanes Isaac and Sandy in 2012. Using the results of the first survey described in the previous chapter, the findings yield new insights on five topics including the extent of SM use, the functions and perceived potential benefits of SM, barriers to SM use reported by non-users, the specific channels preferred by respondents, and reported levels of SM communication activity across the four phases of EM.

4.1. Characteristics of Survey Respondents

Survey responses were analyzed in four groups to explore how first responders (FR), government agencies and offices (GOV), news media organizations (NEWS), and non-government organizations (NGO) each use SM for risk and crisis communication. Figure 4.1 illustrates the composition of responses by organization type in the large pie chart, and jurisdictional reach (local, county, state or national) for each respondent group. The first responders group includes fire departments, search and rescue services, law enforcement, emergency medical services (EMS), and the US Coast Guard. The government-related agencies and offices group includes EM agencies, emergency operations centers, and supporting offices such as administrative divisions, departments of transportation, and other offices with SM accounts used to issue public-service alerts or to interact with citizens. The news media group includes broadcast television news stations, talk radio, local periodicals, and community news pages. Non-government organizations include charitable organizations, chambers of commerce, religious groups, community organizations, and other non-profits known for contributing to risk communication and information sharing during recovery efforts.

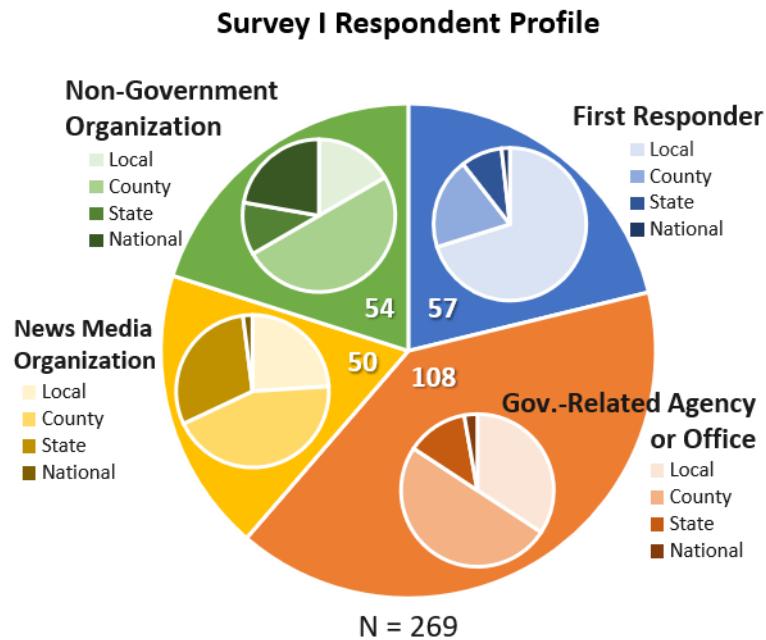


Figure 4.1. Composition of Survey Respondents by Organization Type and Geographic Reach. Data Source: Survey Questions 1.1, 1.2.

Of the 269 survey responses, 213 (79%) were submitted by agencies and NGOs representing local and county/parish jurisdictions. State-level respondents contributed approximately 15% of responses, followed by just 6% representation by respondents with national range or jurisdiction. Most of the respondents reporting a national reach were NGOs, including the Red Cross and Salvation Army.

4.2. Extent of Social Media Use

Research Question 1.1: What is the role of social media among public agencies and NGO respondents?

4.2.1. Social Media Adoption Rates

Ninety percent of respondents reported using SM for risk and crisis communication, a rate of SM use that is consistent with the recent findings of other researchers (Su et al. 2013, Plotnick and Hiltz 2016). Figure 4.2 illustrates the incidence of SM non-use by survey respondents (left) and the composition of respondents indicating non-use (right). While only 10

percent of the survey respondents report not using SM for risk and crisis communication, the rate of NGOs not using SM is nearly three times greater than the overall average. Almost 28% of NGOs report they do not use SM, followed by 14% of first responders, almost 4% of GOVs, and 2% of news media organizations.

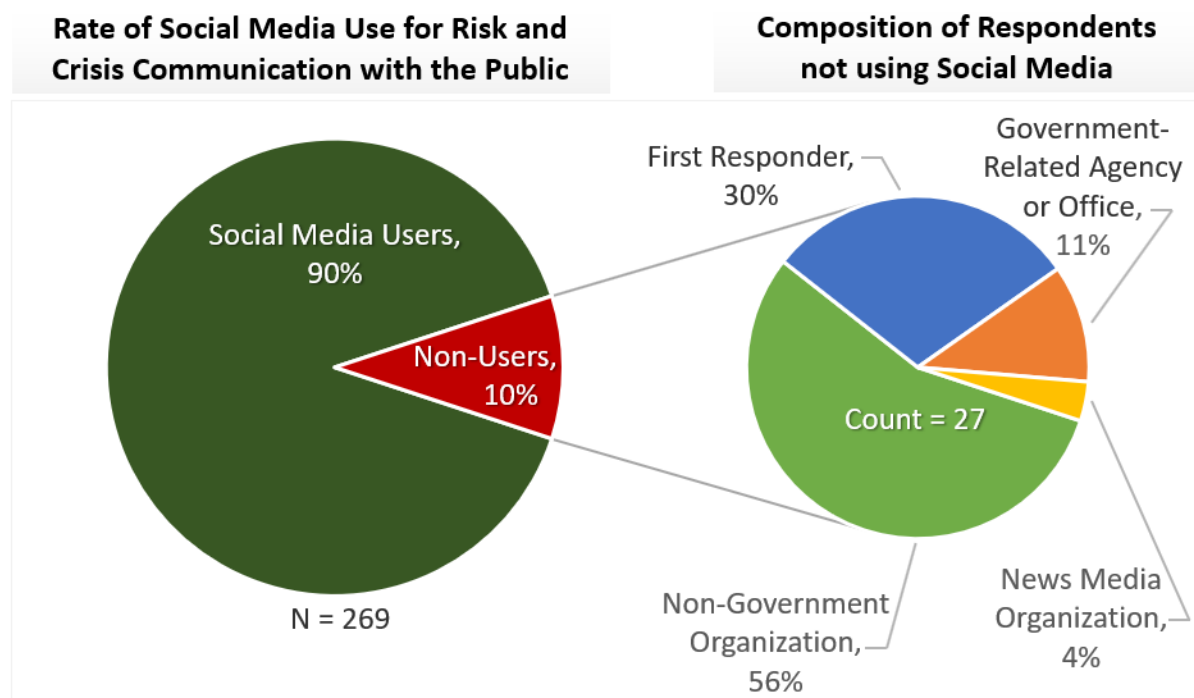


Figure 4.2. Incidence of Social Media use (left) and Composition of Respondents not Using Social Media (right). Data Source: Survey Question 1.4.

4.2.2. Attitudes and Expectations Concerning Social Media

The first step in understanding how respondents use SM is determining what they expect to gain from it. While the value of SM communication by public agencies and organizations may be limited by organizational resources (such as staff availability, hardware, policy, or protocol), researchers (Hughes 2014, Su et al. 2013) point out the importance of attitudes and perceptions in willingness to adopt and invest resources in the use of SM tools. For example, an individual with a positive attitude toward the usefulness of SM is more likely to benefit from it than users with a doubtful position concerning its potential benefits.

Survey respondents were asked to provide information regarding their expectations, attitudes and purposes for utilization of SM in their risk and crisis communication with the public. Respondents provided feedback regarding their agreement with six potential roles of SM in their organizations in a seven-level Likert-type response matrix, where 1 = strongly disagree and 7 = strongly agree. Figure 4.3 illustrates agreement concerning roles of SM among respondents, sorted by sum-of- mean Likert Scores. Of the six potential roles of SM listed in the survey, respondents reported the most agreement that SM will *play a greater role in the future*, followed by its ability to *supplement primary means of communication through other media outlets*, and its ability to *assist and inform official disaster-response strategies*. Respondents collectively report less agreement with the ability of SM tools to *collect information from the public through two-way communications* and to *serve as primary communications*. Respondents

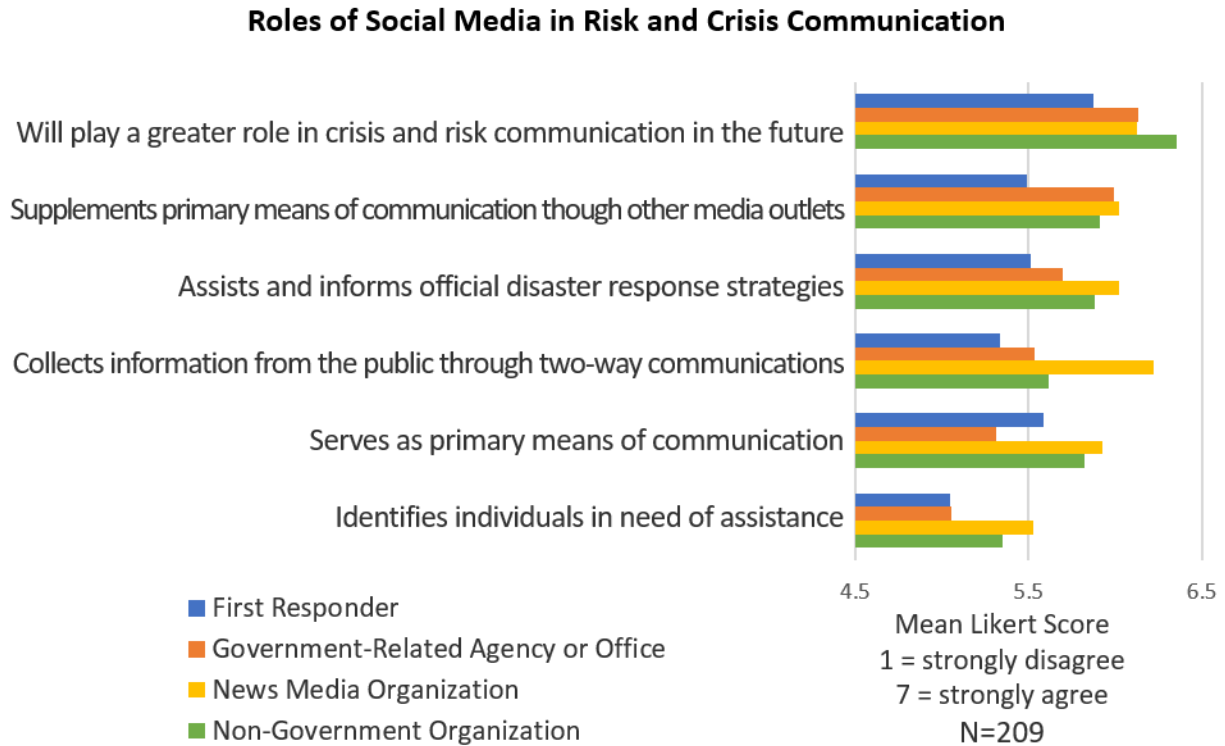


Figure 4.3. Roles of Social Media in Risk and Crisis Communication. Data Source: Survey Question 3.14. N=208

report the least agreement with the ability of SM tools to *identify individuals in need of assistance*, suggesting an important limitation of SM use in emergency- response efforts.

Overall, NEWS respondents reported the highest Likert scores in Figure 4.3 where a greater score indicates more agreement with the potential roles of SM, thus suggesting respondents place a greater value on these potential benefits. News media organization value SM most as a means for collecting information from the public through bi-directional communication. Non-government organization respondents reported the second-greatest agreement overall with the roles and potential benefits of SM listed above, and felt strongest of any group that it will play a greater role in the future of risk and crisis communication. Government-related respondents reported less potential value of SM as a tool to conduct two-way communication with the public or to serve as a primary communication method. First responders reported the least agreement with their organizations potentially benefiting from the five functions of SM overall, but also feel most strongly that it will play a greater role in their futures. These results may be partially explained by Plotnick and Starr's (2016) findings suggesting a quarter of EMs surveyed reported organizational prohibition of SM. Despite potential organizational barriers, both FR and GOV respondents agree that SM will play a greater role in the future of risk and crisis communication.

While respondents relying on the National Incident Command System (NIMS) (FR and GOV) report similar numbers of organizational objectives or purposes for SM, the responses from organizations independent of NIMS (NEWS and NGO) indicated greater variation. The reported variation suggests that NEWS and NGO respondents use SM for different functions, while FR and GOVs pursue and value similar functions of SM. Such variation in the responses may also be attributed to the differences among the respondents in terms of their organizations'

overall mission. These findings reflect optimism across all respondent groups for the enhancement of communications with SM in the future as supplementary public communication channels, but report greater reservation with its ability to identify individuals in need of assistance. These results illustrated in Figure 4.3 suggest fewer respondents may be comfortable with the more advanced SM activities recommended by EM leadership. Rather, SM appears to be used mostly to supplement other existing communication methods.

4.2.3. Anticipated Benefits

All respondent groups perceive SM as likely being beneficial to EM as a way to extend the reach of communications, increase public engagement, facilitate improving situational awareness and crowdsourcing information, and as a source of news and information. These findings are presented in Table 4.1. The most likely potential benefit reported by all respondent groups is to facilitate *increasing public engagement*. About one-quarter (24%) of NIMS-supported respondents also agreed the least-likely potential benefit of SM is being a tool for improving *situational awareness and crowdsourcing information*. Hesitation or uncertainty toward observing information or data collection on SM for decision-making is consistent with recent studies, which suggest public information brokers typically use SM tools to broadcast information to the public, but have limited involvement with data collection on SM due to complex issues including information accuracy and availability of human resources (Su et al. 2013, Hughes and Palen 2012, Luna and Pennock 2015, Plotnick and Hiltz Starr 2016).

About one in five (18%) of NGO respondents also reported uncertainty about the likelihood of SM to enhance their situational awareness and for accurate crowdsourced information. News media respondents indicated similar levels of uncertainty (19%) in two fields, including *providing means to reach more people than traditional media* and as a *source of*

news and information. While the finding may be expected from news media organizations, these finding are interesting as more than two-thirds (67%) of Americans reported getting at least some of their news from SM in 2017, with one in five sourcing news from SM “often” (Mitchell 2017).

Table 4.1. Potential Future Benefits of Social Media. Data Source: Survey Question 3.22. N=194.

Potential Future Benefits of Social Media	Percent Respondents Indicating a "Likely" Benefit			
	FR	GOV	NEWS	NGO
Providing means reach more people than traditional media	84%	84%	81%	94%
Increasing public engagement	92%	88%	92%	97%
Tool for improving situational awareness and crowdsourcing information	76%	75%	89%	82%
Source of News and Information	82%	76%	75%	91%
N=	38	86	36	34

4.2.4. Potential for Improving Disaster Resilience with Social Media

Respondents provided suggestions through their responses to open-ended questions concerning how to improve disaster resilience using SM. Open-ended response format allows respondents to make recommendations that could benefit communities even if such advice is beyond the organizational capacities of respondents’ organizations. Of the 47 text responses, 41 contributed meaningful feedback. Responses were coded and reduced to nine themes sorted by response count, as shown in Table 4.2. The most common recommendation among all groups coincides with advice of risk and crisis communication literature, which suggests vast benefits may result from organizational efforts to actively network and engage citizens on unofficial channels during all phases of the EM cycle. Emergency managers who build relationships in the community during the “quiet phases” of the EM cycle have the opportunity to develop credibility and a reputation for reliability among SM users (Hughes and Chauhan 2015, Janoke, Liu, and

Sheppard 2012). Public information providers may extend the reach of emergency communications by focusing on building trusting relationships with the public who may then perceive the information as valuable and are willing to share it among their personal networks (Wukich and Mergel 2015). Such social capital is valuable and may be accessed when organizational resources are stretched thin by leveraging citizens to crowdsource information and enhance situational awareness (Wardell and Su 2011, DHS 2012b, a, 2013, Aldrich and Meyer 2014, DHS 2014b).

Table 4.2. Common Themes for Improving Disaster Resilience with Social Media. Data Source: Survey Question 3.21. N=47.

Common Themes for Improving Disaster Resilience with Social Media					
Count	Description	FR	GOV	NEWS	NGO
9	Ongoing communication and community interaction to build credibility and reliability with networking and transparency	22%	19%	25%	25%
8	Increase social media subscription within member groups/audiences with advertising and outreach	11%	19%	25%	25%
7	Work with social media companies to prioritize official emergency management communications in news feeds	22%	6%	25%	25%
6	Full-time rumor control/improved accuracy and speed of information sharing with full time social media personnel	-	19%	13%	25%
5	Utilize and cross-post information across multiple social media platforms to reach broader audiences	11%	19%	13%	-
3	Use social media as a supplementary communication tool	11%	13%	-	-
1	Dedicated social media platform for emergency management	11%	-	-	-
1	Technology training	11%	-	-	-
1	Learn from lessons of past events to improve disaster resilience with social media	-	6%	-	-
N=		9	17	10	10

The second recommendation for enhancing disaster resilience with social media is to increase social media subscription in the community. A first responder suggested “we are not confident that we are reaching all residents who require emergency messages” despite ongoing promotion of their Facebook, NIXEL, and Twitter pages. Another suggests their audiences are

stubborn avoiders of SM, while others mentioned struggling with getting their elderly audience to adopt SM tools.

Fortunately, survey results published by the Pew Research Center suggest the pockets of Americans not using the internet continues to shrink. Researchers report only 11% of Americans did not access the internet in 2018, which is down four points in three years (Anderson, Perrin, and Jiang 2018). The same reports found 34% of seniors (age 65+) still avoided accessing the internet in 2018, although internet non-use among seniors has fallen eight points since 2015. Pew survey results indicate about 41% of seniors use Facebook, followed by 40% accessing YouTube (Anderson, Perrin, and Jiang 2018). Additionally, Pew reported Americans increasingly access news online (43% in 2017) as reliance on television (TV) news continues to fall. From 2016 to 2017, the gap between those accessing news via TV compared to the internet fell from 12% to only a 7% gap in news sources (Gottfried 2017). The following year, Pew reported 43% of Americans accessed news on Facebook alone, while 68% reported ever getting their news through SM (Masta 2018). Lastly, Pew reported 81% of Americans owned a smartphone in 2019, up eight and a half percent since 2015 (Taylor and Silver 2019). The findings suggest Americans continue to access the internet, social media, and smart phones at a growing rate. While online audiences and subscriptions to SM continue to grow, Americans are increasingly making the switch to internet-based news as reliance on TV news continues to fall. These trends suggest that while some individuals still abstain from web-based communication technologies, these pockets of individuals continue to shrink, thus offering a diverse and expanding audience to engage through unofficial communication channels such as SM.

The third recommendation seeks the partnership of SM technicians and program developers to make SM more user friendly and accessible for EM. The majority of responses

coded to this theme mention altering SM algorithms specifically in order to reduce competition and/or prioritize the placement of risk-related messages to the top of news feeds. Other respondents suggest improving and expanding existing features such as Facebook Safety Check could benefit response and rescue efforts. Other less common recommendations included increasing human resources to address rumor control and to improve the accuracy and speed of information sharing, cross posting information on multiple SM platforms, and using SM to supplement official communications. The full set of anonymized original responses may be viewed in Appendix E, including the number of coded common themes from Table 4.2.

The coded responses show similarities with SMWG materials, including all except one of the six “benefits of social media for public safety” in the *Social Media Strategy*, which allows the community to engage in solving problems. From *Lessons Learned: Social Media and Hurricane Sandy*, these themes coincide with six of the eleven suggested uses for social media. In addition to crowdsourced problem solving, SMWG found SM valuable for evaluating public information, providing a means to meet and manage public expectations, encouraging multidirectional sharing of essential information, and encouraging behavior changes to enhance public safety.

4.2.5. Four Phase Social Media Use

Survey respondents reported using SM most during the response phase, followed by the preparedness and recovery phases. All groups report the least amount of SM use during the mitigation phase. Table 4.3 lists the phase-specific response scores of each group, including a column with the sum of scores indicating an overall level of reported involvement and a row showing the total reported participation of all respondents in each phase.

Table 4.3. Phase Specific Response Scores of Reported Involvement in Risk and Crisis Communication across the Phases of Emergency Management (EM)

Reported Levels of Social Media Use across the Four Phases of Emergency Management						
Respondent Group \ EM Phase	Mitigation	Preparedness	Response	Recovery	Sum	Standard Deviation
First Responder	0.52	0.72	0.78	0.59	2.60	0.12
Government-Related Agency or Office	0.58	0.84	0.84	0.80	3.06	0.12
News Media Organization	0.44	0.68	0.75	0.72	2.59	0.14
Non-Government Organization	0.41	0.68	0.77	0.73	2.59	0.16
Sum	1.96	2.92	3.14	2.84		

GOVs report the highest level of SM use overall and during every phase individually. This finding may be attributed to greater awareness of risk and crisis communication practices among public agencies since they are more subject to the guidelines of the National Response Framework and plans like the NECP, highlighting the importance of ongoing communications across all phases. The majority of GOV respondents include local EM agencies, emergency operations centers, and public safety offices charged with “coordination and communications during incidents by disseminating alerts and warnings and operating emergency operations centers, among other key functions” (DHS 2014).

Since 2008, the NECP has prioritized the improvement of communication capabilities of law enforcement, fire, and EMS personnel to ensure access to “reliable and interoperable communications at all times in order to save lives, protect property and the environment, stabilize communities, and meet basic human needs following an incident” (DHS 2014). First responders report the second most involvement with SM overall, with the second greatest scores in prepared, response, and mitigation phases. First responders report the least SM use of any group during the recovery phase, possibly reflecting the response-centric nature of fire, law enforcement, and emergency medical personnel.

News media and NGOs similarly report the least amount of involvement with SM for risk and crisis communication. While NEWS respondents report slightly more SM use during mitigation and preparedness phases, NGOs report contributing more during response and recovery phases. These findings reflect the organizational missions and nature of each of the two groups. News media organizations continuously share risk-related information through regular newscasts and publications, while NGOs such as chambers of commerce or faith-based groups tend to be more active in community recovery.

4.2.6. Barriers to Social Media Use

One in ten survey respondents reported not using social media in the introductory screening questions, and thus were not asked to provide feedback regarding their use of SM. Rather, these respondents answered two questions before ending the survey asking why they do not use SM for risk and crisis communication, and whether they had plans to incorporate SM into their communication strategies in the future. Reasons for non-use of SM that had been reported in similar studies informed the eight multiple-choice response options (Su et al. 2013, Wukich and Mergel 2015, Plotnick and Hiltz 2016). The reported barriers to SM use by respondents are summarized in Figure 4.5.

The most-reported barrier to the use of SM among non-users was *not our organization's mission*. The majority of user suggesting it was not their mission to use SM for risk and crisis communication were NGOs, followed by FRs, the only NEWS respondent reporting non-use, and a GOV respondent. As the most common barrier to use of SM relates more to the attitudes and perceptions of respondents rather than a scarcity, this finding provides insight for EM leadership hoping to gain greater participation by key community stakeholders, or the whole community of EM. The second most-reported barrier *social media has a limited ability to reach our target audience*, an education or awareness-based barrier, and a *lack of human resources*, a resource-

related barrier selected exclusively by first responders. Lesser reported barriers included a *lack of policy or protocol regarding social media use, lack of training or skills, lack of technology resources, and uncertainty of information* on SM. Lastly, no respondents reported lacking financial resources as a barrier to adoption of SM tools. This finding suggests financial support is no longer perceived as a major barrier to SM use as suggested in the literature (Flizikowski et al. 2014, Su et al. 2013). The limited incidence of barriers found to be “major” in previous studies may suggest the challenges of EMs may be shifting as public agencies and organizations gain experience with SM, which is the topic of focus in the following chapter.



Figure 4.4. Reported Barriers to the use of Social Media among Non-Users. Data Source: Survey Question 1.5. N=29.

Finally, we asked SM non-users about their plans to adopt SM tool in the future. The findings illustrated in Figure 4.5 suggests most non-users plan to adopt SM tools despite reporting barriers previously. NGO respondents overwhelmingly acknowledge the desire to adopt SM, while the other three groups report less certainty.

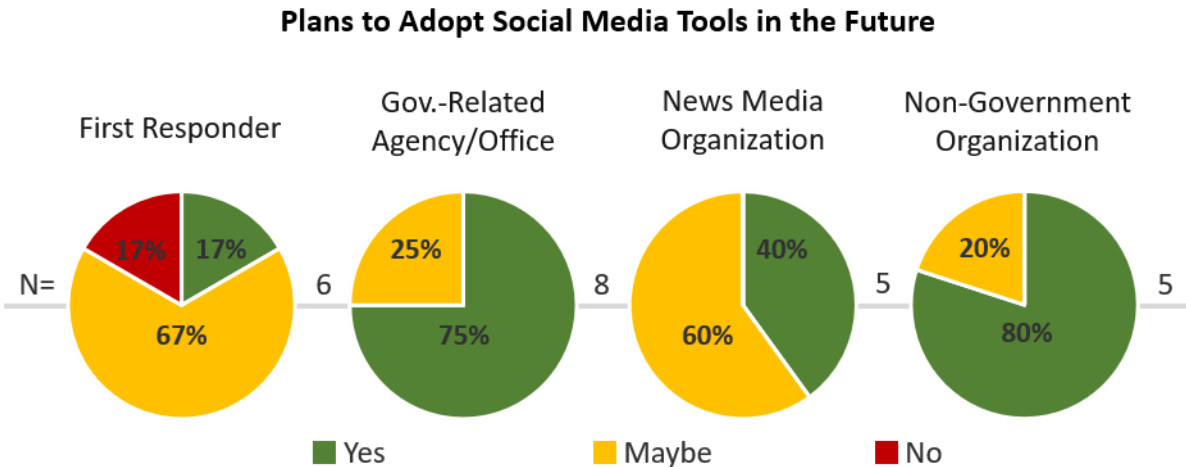


Figure 4.5. Plans to Adopt Social Media Tools among the Non-Users. Data Source: Survey Question 1.6. N=24.

4.3. Preferred Social Media Tools

Research Question 1.2: Which specific social media platforms or channels do survey respondents prefer when communicating with the public?

Survey respondents indicated their frequency of responding to public comments received through fourteen web-based channels, ranging from never to always. Figure 4.6 illustrates the channels respondents *ever* respond to public comments through based on binary classification of the frequency data to represent *ever* and *never* as a proxy of ownership. Excluding 36 respondents who skipped this survey question, the data reclassification demonstrates Facebook is the most popular of the fourteen web-based channels. Overall, 97% of respondents report responding to public comments on Facebook at least *sometimes*, including 100% of NGOs and 98% of GOVs. Behind email and website correspondence, the second most common SM tool used by respondents is Twitter, used by 84% of respondents. Twitter is most popular among NEWS respondents, with 91% indicating responding to public comments at least *sometimes*. Twitter was used to identify the study population, and may be falsely distorted to overrepresent utilization. Interestingly, Facebook accounts were located for only about 60% of the study population populated by searching Twitter. The third most-used SM channel is Instagram, with

52% of respondents indicating account ownership. The most common stakeholder groups on Instagram include 60% of NGOs and 57% of NEWS respondents.

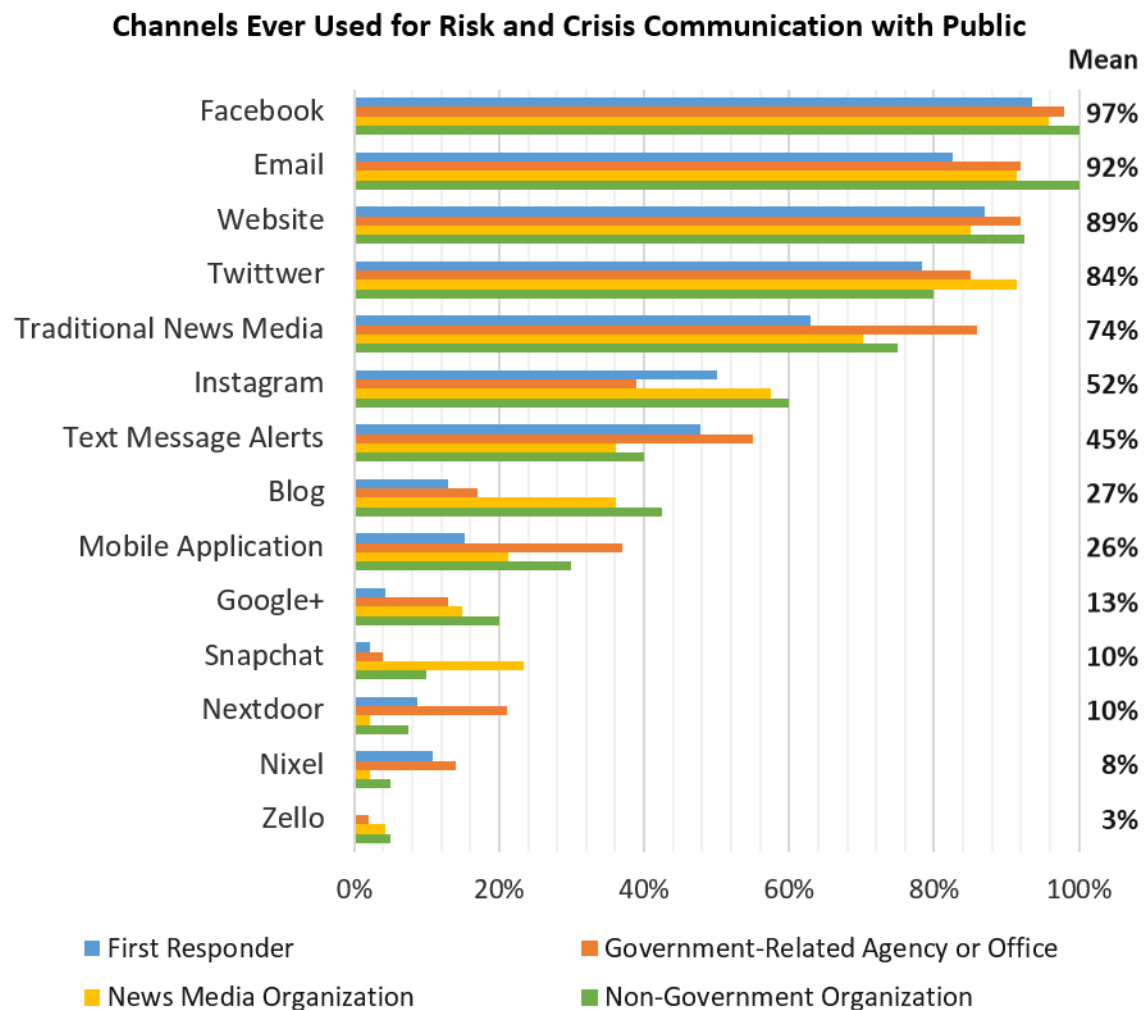


Figure 4.6. Channels Preferred by Survey Respondents. Data Source: Survey Question 2.7. N=229.

While many Americans may still prefer to consume television (TV) news rather than going online, public preferences appear to be shifting away from television and printed media. The Pew Research Center reports declining TV news and growing online news preferences have sharply narrowed the gap in news source preference from a 19% in 2016, to only 7% choosing TV over online news sources in 2017 (Gottfried 2017). While Americans aged 65 and older

report making the greatest shift online recently, ages 30-45 report the sharpest decline in preferring TV news (Gottfried 2017). As printed newspaper periodical subscriptions continue to plummet, so has traffic on the websites of periodicals between 2016 and 2017 (Barthel 2018). Approximately one half (43%) of Americans use Facebook to access news, a rate three times greater (12%) than Twitter (Masta and Shearer 2018). Pew findings suggest Americans increasingly choose web-based news, but not necessarily from the websites of traditional news media. These findings support Hughes and Palen (2012) findings of shifting “information pathways” in which the role of public information officers (PIO) shift from a role of gatekeeper to translator.

Knowing which channels are most likely monitored by organizations would help citizens gauge the likelihood of a quick response to questions or needs they may share. For example, nearly half (45%) of the respondents report always responding to questions from the public over Facebook. Additionally, about 37% always respond on Twitter, followed by about 16% on Instagram and 2% on Snapchat. Another way to visualize communication channel preferences of agencies and NGOs is to sort the survey responses by choice count ratios of respondents selecting *always* for each respondent group, as shown in Figure 4.7, where darker green illustrates more support for bi-directional communication and red indicates the proportion of respondents never using a channel within the respondent groups.

The findings illustrated in Figure 4.7 suggests some patterns in preference for SM channels or platforms exist among the respondent groups. First responders and GOVs both report always responding to questions via Websites most often, followed by Email and Facebook. These finding are somewhat consistent with the findings of Hughes and Palen (2014), who found first responders used websites most during Hurricane Sandy, followed by Facebook,

Nixel, and Twitter. First responders also report never replying 10% more often than GOV respondents, who report never responding to the public on the fourteen channels less than any respondent group.

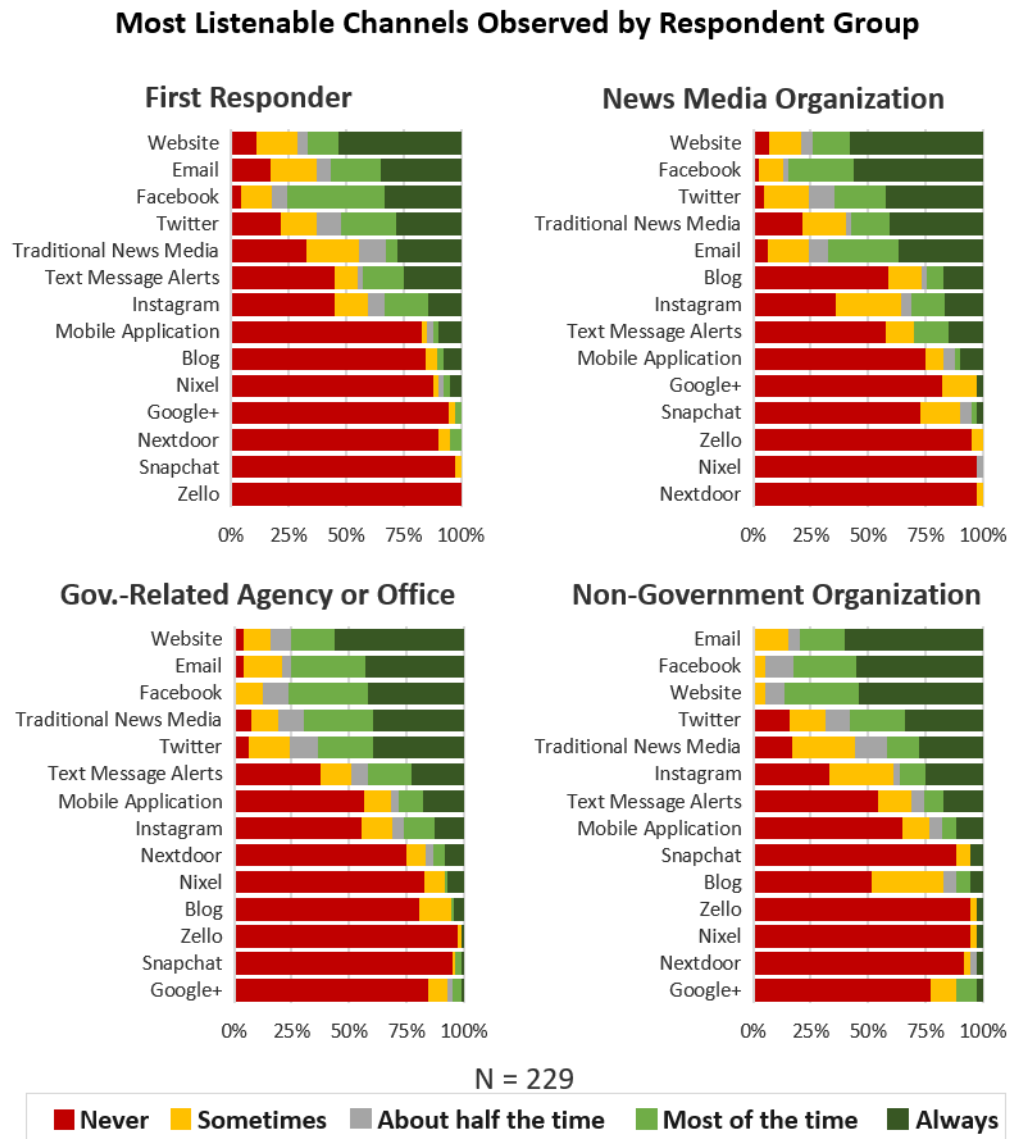


Figure 4.7. Communication Channel "Always" Supported by Respondent Groups. Data Source: Survey Question 2.7. N=229.

News media organizations indicate the greatest use of websites, followed by Facebook, and Twitter. News media preference to respond to questions and comments through websites was apparent through overwhelming support of easily accessible contact web forms on their

websites, making up more than half (54%) of the web forms in the study population. These findings support shifting trends of how Americans prefer to retrieve their news. A 2016 Pew Research Center survey found Americans access news via websites or web applications 36% of the time, followed by 35% using SM to access news (Mitchell, Shearer, and Lu 2017). These findings suggest news media organizations in our sample appear to prioritize communication strategies similarly to public preferences.

In general, NGO respondents are most likely to always respond, and second least likely to never respond to public questions and comments. The respondents from NGOs express the greatest support of their top three communication channels (email, Facebook, website) through the absence of never responses for the top three channels.

We also find NGOs are more likely to report always responding to public comments and questions. Respondents suggest the most-supported SM channels rank from most to least reports of always responding to the public using Facebook, at 45%, followed by 36% always responding via Twitter, and 16% always responding via Instagram. Our findings suggest that EMs may under-utilize the quickly growing audiences on SM, specifically Instagram. Besides its value as a tool for targeting younger audiences, Instagram is the fastest-growing SM audience, currently used by 35% of Americans (Pew Research Center 2018).

4.4. Chapter Four Summary of Findings

This chapter explored findings from the survey of agencies and organization in areas affected by Hurricane Isaac and Sandy in 2012, contributing knowledge about SM usage by members of the whole community of EM. Specifically, the research objective was to examine five topics including the extent of SM use, the roles and potential benefits of SM, barriers to SM use reported by non-users, the channels preferred by survey respondents, and reported levels of

communication activity across the four phases of EM. While 9 in 10 respondents reported using SM for risk and crisis communication, the remaining 10% of non-users most commonly report it is not their organization's mission to engage the community in risk and crisis communication.

All four respondent groups report the greatest level of SM use during the *response* phase, and the least amount of activity during the *mitigation* phase. Respondents directed by NIMS – by definition government groups – report the most activity on SM throughout the four phases of an emergency. Both NEWS and NGO respondents reported the most activity during the *response* phase followed by the *recovery* phase. These findings suggest public information brokers (FR and GOV) are more likely to advise their audiences of hazards during the *preparedness* phase. They also maintain a high level of SM communication through the *response* phase. Respondents holding secondary roles in risk and crisis communication (NEWS and NGO) report SM use during the *response* phase, but report being more active on SM during the *recovery* phase. In other words, these findings suggest organizations holding primary and secondary roles in EM may also play differential but complementary roles to in risk and crisis communications with the public across the phases of EM cycle.

The most preferred SM channel for responding to questions from the public among respondents is Facebook. Almost half (45%) of respondents report *always* responding to the public via Facebook, followed by 36% always responding via Twitter, and 16% always responding to Instagram communications. Survey findings indicated all respondent groups except NGOs report always responding to the public through interactive websites. Facebook is the top-supported SM channel by respondents and the public alike, but the findings indicate misaligned support exists for other popular SM platforms with rapidly growing audiences such as Instagram. This finding is consistent with Hughes and Palen (2012), who suggest the

bureaucratic dimensions of the National Incident Management System creates inflexibility for public information officers facing shifting information pathways, and is also a struggle expressed by FEMA Director Craig Fugate, a proponent for the development of Next Generation 911¹⁰ systems capable of adapting to new technologies (Fugate 2011b).

Researchers agree the quiet times between emergencies present the most opportunity for building relationship in the community to foster credibility and build public trust in risk and crisis information providers. Greater institutional trust may lead community members to follow the advice of public warning messages, thus reducing the amount of time spent milling for information in personal networks when individuals face an unfamiliar risk to public health (Hughes and Chauhan 2015, Janoke, Liu, and Sheppard 2012, Wood et al. 2017). The quiet time between emergency events includes the mitigation phase in FEMA's four-phase model of emergency management, the phase of lowest reported use of SM by the survey respondents to communicate with the public.

Other works suggest that building relationships with community members helps to facilitate the development of social capital, which is an important factor contributing to resilience to disasters (Aldrich and Meyer 2015). Respondents also suggest redundancy in number of communication channels supported by risk and crisis communicators could help to narrow the gap in citizen-government communication by reaching more individuals, which may be problematic for organizations following the restrictive nature of NIMS protocol.

This chapter presented results from the first survey and identified key attitudes and patterns of SM use by members of the whole community of EM. The following chapter examines challenges and strategies to improve the effectiveness of SM use by the respondents.

¹⁰ https://www.911.gov/issue_nextgeneration911.html

Chapter 5. Obstacles and Strategies to Reduce Disparity in Digital Disaster Communication: Emerging Best Practices

The previous chapter presented survey results that shed light on how SM is being used by the major groups of institutions that comprise the “whole community” of emergency management. Research objective II examines the challenges respondents report facing when using SM for risk and crisis communication, then explores tactics and strategies they employ to overcome such challenges. Throughout this chapter, I refer to first responders and government-related agencies and organizations combined as “GOV-C” and nongovernment organizations combined with news media organizations as “NGO-C”. Dividing the survey respondents into two groups helps to identify the potential influence of the National Incident Management System (NIMS) on some of the problems encountered in addition to the adaptive strategies implemented. The results reported here provide new knowledge about how key organizations address the various limitations and challenges of social media in their work with the public. This information enables researchers to begin to identify emerging best practices to make SM more effective in the field of emergency management.

5.1. Characteristics of Survey Respondents

The majority of responses used in this analysis came from the GOV-C group. Figure 5.1 illustrates the composition of survey responses per group in the center pie chart, and reported geographic reach is shown in the smaller outer pie charts. While GOV-C populate only 45% of the study population, the center pie chart indicates GOV-C respondents contributed nearly two in three survey responses. This suggests respondents operating under the guidance of NIMS may be more likely to engage the public on SM than NGO-Cs in the study area. The smaller outer charts of Figure 5.1 show that most responses (78%) were contributed by local and county level

organizations, with the majority of GOV-C responses submitted by local entities and majority of NGO-Cs representing from county-level organizations.

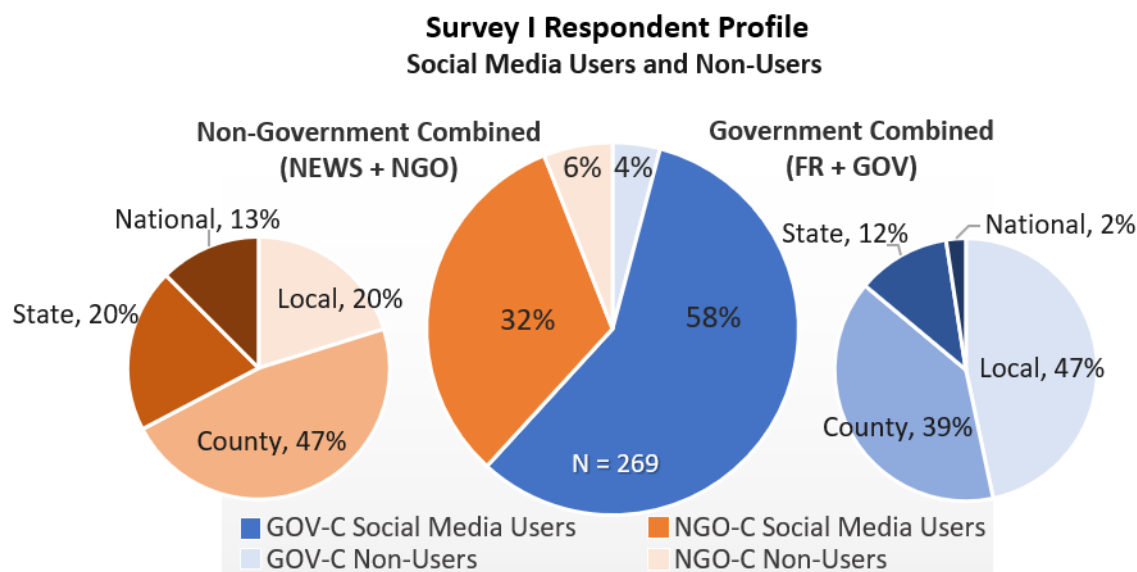


Figure 5.1. NGO-C and GOV-C Respondents using Social Media for Risk and Crisis Communication in full color Orange and Blue Respectively in the Center Pie, and the Geographic Reach of Respondents per Group in the Outer Pies. Data Source: Survey Questions 1.1, 1.2.

Research has indicated SM use may become easier over time as organizations gain experience and apply lessons learned to address and overcome challenges (Mergel and Bretschneider 2013). Researchers propose organizations using SM encounter three phases of adoption, or levels of activity before SM becomes “institutionalized” or fully integrated into the communication strategy of an organization. Therefore, the length of time respondents have worked with SM tools may be related to some of the challenges they may report. To examine this further, Figure 5.2 was constructed to illustrate the year respondents adopted Twitter on the left axis versus new users of Twitter among the general public reported in millions on the right axis. Here, we use the beginning year of Twitter use as a proxy for all SM use within the organization. It is interesting to note that the peak year of new adoption of Twitter by members of the general public occurred in 2012. Adoption of Twitter by NGO-Cs peaked two years after

that of the public, and three years later among GOV-C respondents. This lag time may suggest that aspects of NIMS may inhibit innovation in use of new SM platforms for EM communication with the public. Figure 5.2 also suggests many of the survey respondents did not adopt Twitter until after FEMA Director Craig Fugate’s public endorsement of Twitter as a tool to supplement risk and crisis communication in 2011, and 2012 Atlantic Hurricane season that produced Hurricanes Isaac and Sandy (Fugate 2011b).

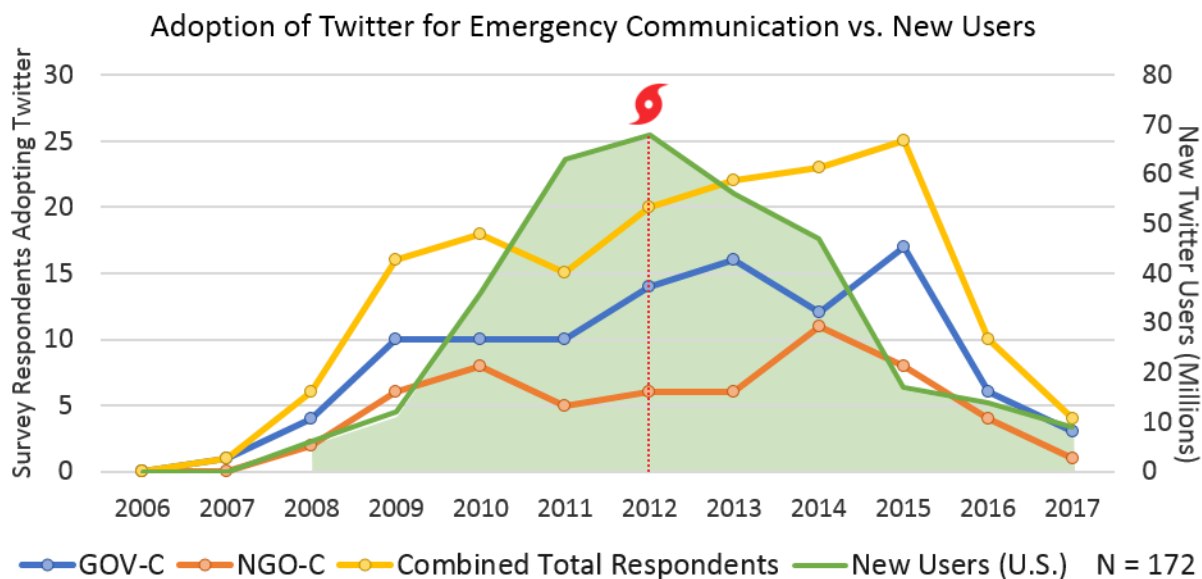


Figure 5.2. Adoption of Twitter for Emergency Communication by Survey Respondents vs. New Individual Twitter Users in the United States. Survey Question 4.24. New Users Data Source: (Wolfe 2018)

5.2. Social Media Challenges

Research Question 2.1: Which key obstacles are most commonly reported by survey respondents concerning the use of social media in risk and crisis communication?

Presenting the common obstacles reported by survey respondents contributes baseline information regarding the emergence of new challenges and progress made towards known major challenges of the use of SM. Better insights concerning the challenges to SM use by these organizations may help the leadership to fine-tune support efforts to enhance emergency

communications through adoption of SM tools. Additionally, gathering feedback regarding whether or not there is diminishing concern toward the specific challenges that were described as significant impediments and challenges in past studies would provide important information as to whether progress has been made toward the institutionalization of SM, as described by Mergel and Bretschneider (2013).

5.2.1. *Concern of Common Obstacles in the Literature*

Respondents indicated their levels of concern toward common obstacles when reaching out to disaster-affected communities in a Likert-type response matrix where 1 = not a concern, 2 = small concern, and 3 = major concern. Figure 5.3 illustrates mean Likert scores in descending order, with the obstacle of greatest concern listed first. Respondent groups reported somewhat similarly for the top three obstacles of concern with a greater level of concern reported by NGO-Cs. The most concerning obstacles include issues with the *unknown accuracy of information on SM*, *insufficient human resources to monitor SM*, and *anonymity of users*. Troubles with securing adequate human resources has been reported as a top concern in three similar studies since 2012 listed in Appendix A (Su et al. 2013, Plotnick and Hiltz 2016, McCormick 2016). These results also present the first instance of information accuracy being reported as the top concern of EMs in the literature. This finding suggests survey respondents have greater concern about external challenges, the types of problems commonly associated with more advanced levels of SM use, after they have overcome internal-type challenges.

While mean Likert scores may be ideal for comparing reported levels of concern between groups visually, Figure 5.3 lacks detail regarding the variation of responses within each group. Explicit response ratios presented in Figure 5.4 presents greater precision of response necessary to gather which obstacles were most often reported as *not a concern*.

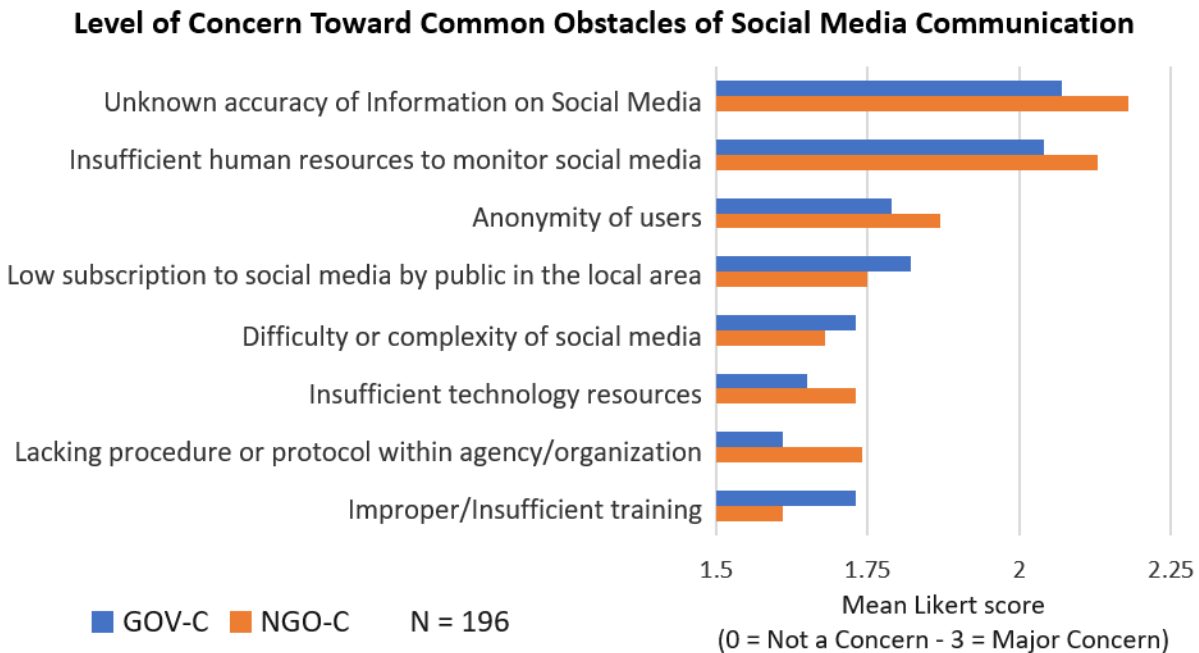


Figure 5.3. Concern Toward Common Obstacles. Data Source: Survey Question 3.18. N=196.

The obstacle of least concern for GOV-C respondents was *lacking procedure or protocol within agency/organization* for the use of SM, followed by *insufficient technology resources* and the *anonymity of users*. These findings may indicate growing support from leadership and investment in SM communication in recent years. Additionally, relatively minor concern over the *anonymity of user* may be a result of GOV-type organizations typically using SM for information dissemination as found by McCormick (2016).

The least concerning obstacles reported by NGO-Cs varied from GOV-Cs, with *improper/insufficient training*, *difficulty or complexity of SM*, and *low subscription to SM by public in the local area* of least concern respectively. This finding is likely due to the differences in the organizational structures in respondent groups, with GOV-Cs following the guidance of the NIMS under the National Response Framework. Reporting little concern towards these components of familiarity with SM tools may also be an indication of experience with SM as

organizations move towards more advanced levels of SM adoption, or institutionalization of SM tools.

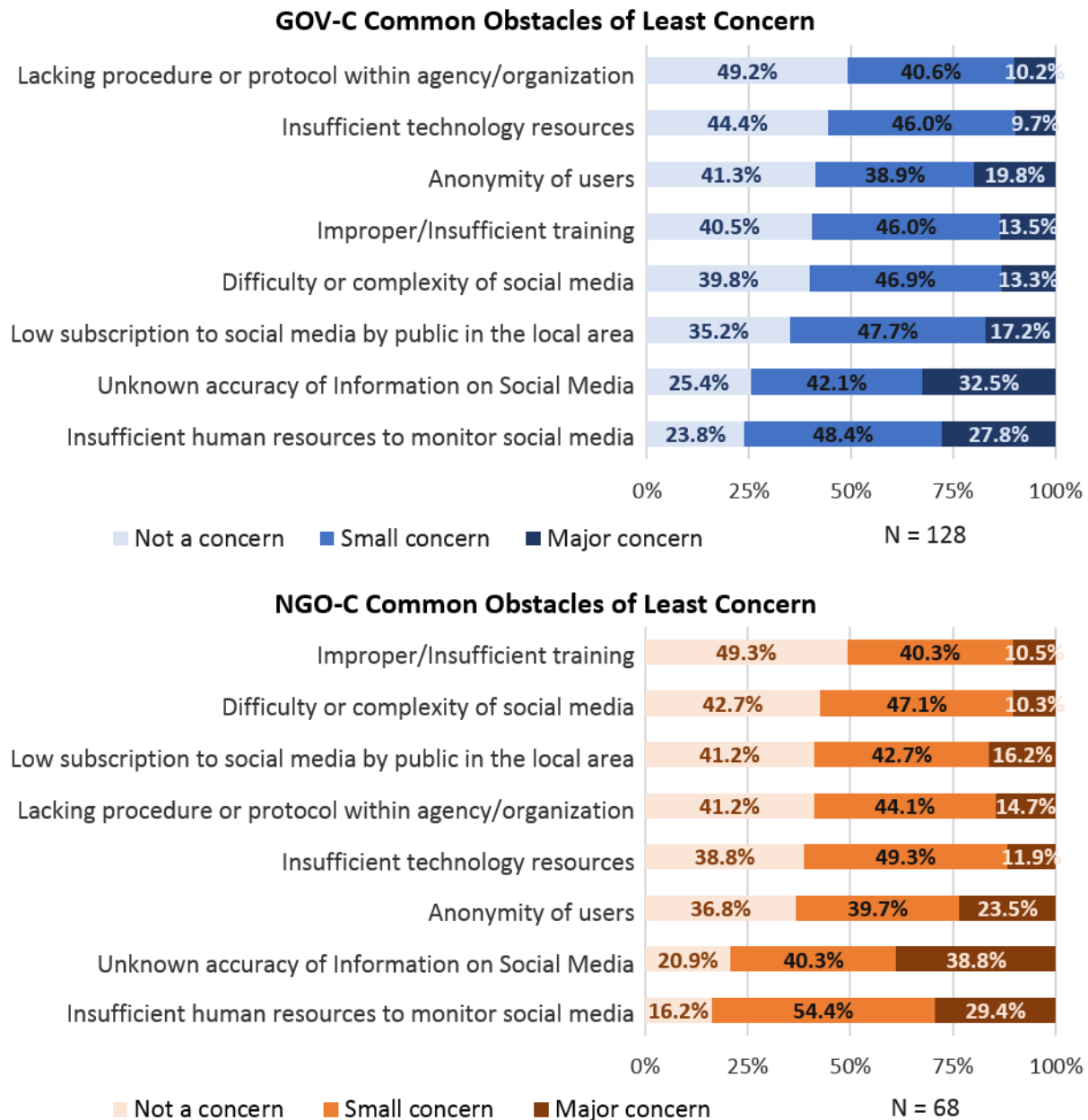


Figure 5.4. Obstacles of Least Concern. Data Source: Survey Question 3.18. N=196.

5.2.2. Other Obstacles

Survey respondents provided qualitative feedback regarding other obstacles when reaching out to a disaster-affected community that were not mentioned previously to help develop a comprehensive understanding and to detect the emergence of new challenges of SM communication in the EM field. Text responses to open-ended questions coded into ten common themes are listed in Table 5.1. These responses reveal GOV-Cs report a greater variety of challenges than NGO-Cs. The most reported obstacle by both respondent groups relates to an inability to access internet channels, coded as *infrastructure failure/connectivity issues*.

Accessing internet-based communications may be difficult following a catastrophic disaster, and could present barriers to maintaining operable communications. When Ohio Senator Sherrod Brown questioned FEMA Director Fugate regarding FEMA's efforts to provide public support for mobile communication in stricken areas in 2011, Fugate insisted "I have been pushing for a long time," mentioning Verizon was leading efforts to make charging stations available to disaster-affected communities (Fugate 2011b). Since then, mobile providers have made strides toward robust, disaster-proof networks. Although every disaster presents unique challenges that require case-to-case investigation, reports from the Federal Communications Commission (FCC) record propose connectivity may be improving in the wake of a natural disaster. For example, when Post-Tropical Cyclone Sandy made landfall in 2012, about one-quarter of cell sites went down (News 2012), but five years later in the wake of Hurricane Harvey only 4% of cell sites went offline (FCC 2017a, b, c, d, e, f). The memory of a crippled network may still be fresh in the minds of EMs affected by Sandy, but major network providers including AT&T and Verizon have stepped up to the challenge since 2012, preparing for Hurricane Harvey in 2017 (discussed in the following chapter). Both network providers reported engaging in preparedness activities before Harvey made landfall, including topping fuel for back-up generators, pre-positioning

mobile communication and command center assets, and rapidly inspecting damage with the aid of drones (ATT News Team 2017, Verizon 2017). Therefore, as the communication trends of the US public continue to shift toward greater reliance on mobile communications, network providers answer with robust and redundant solutions.

Table 5.1. Common Themes of Other Challenges Not Listed. Data Source: Survey Question 3.19. N=185.

Other Challenges Described in Text Responses			
Count	Description	GOV-C	NGO-C
14	Infrastructure failure and connectivity issues	33%	33%
7	User friendliness and limited functionality	7%	33%
6	Language and cultural barriers	15%	13%
5	Rumor control and information accuracy	11%	13%
3	No reported obstacles	11%	-
2	Scamming and phishing	7%	-
2	Insufficient human resources	7%	-
1	Reaching elderly and low-income residents	4%	-
1	Intra-agency coordination	4%	-
1	Practicing courtesy and respect for victims	-	7%
N=		27	18

The most-reported challenge described in text responses relates to the second top suggestion for improving disaster resilience with SM reported in the previous chapter coded as *user friendliness and limited utility for organizational use*. Difficulties with the design and operation of SM have been reported in the literature since 2015 when Wukich and Mergel described the information asymmetries and uneven sharing resulting from SM algorithms. Another study found public agencies operating under the guidance of NIMS face challenges related to the user-friendliness of SM in terms of account access and management, policies guiding operation, data management, privacy and security, and accessibility access security (Plotnick and Hiltz 2016).

The third top obstacle respondents described was *language and cultural barriers*, an obstacle not reported previously in the literature. This obstacle may only be realized through experience with SM and difficulties collecting information and interacting with the public. Respondents also described challenges similar to the pre-determined response options discussed previously, including *rumor control and information accuracy*, *insufficient human resources*, and *reaching elderly and low-income residents*, with the latter two reported only by GOV-Cs. Other challenges unique to GOV-Cs include *scamming and phishing* and *intra-agency coordination*. In addition, 11% of GOV-Cs reported having no obstacles. Lastly, one field unique to NGO-Cs was the challenge of *practicing courtesy and respect for victims*. Appendix G includes a full record of original text responses.

5.3. Campaign Evaluation and Awareness

Research Question 2.2.: To what extent are survey respondents attempting to evaluate the effectiveness of their online communications?

Observing audience behaviors provides users with metrics to determine how successful their communication strategies have been at reaching SM goals (Davis 2012). Next, we explore how respondents evaluate SM campaigns to contribute knowledge concerning the prevalence of proactive efforts working toward overcoming communication challenges to achieve EM goals such as enhancing risk and crisis communication with SM and expanding the reach of communication within communities. Respondents provided feedback regarding audience behaviors of interest and the modes of campaign evaluation.

The scholarly literature and guiding materials provided by the federal government agree the whole community of EM may gain the greatest benefits from the adoption of SM tools when they network and form relationships with community members during the quiet periods between disasters. Participating in public outreach and maintaining listenability between disasters may

help to build organizational credibility and develop trust within the community. It may also help to extend the reach of critical messages, which in turn, may help to narrow communication gaps and information asymmetries contributing to disparity in the receipt of risk and crisis communications.

5.3.1. Audience Behaviors of Interest

Respondents indicated their relevant audience behaviors of interest by examining five common behaviors proposed by Davis (2012) and through text responses to open-ended questions. While the individual response options selected by respondents may contribute the most commonly observed audience behaviors, we also explore an alternative method for gauging levels of involvement in SM campaign evaluation by gathering how many behaviors respondents report observing. We assume reporting observation of more audience behaviors may indicate a greater level of involvement with campaign evaluation.

On average, GOV-Cs reported observing 2.6 of six possible audience behaviors, while NGO-Cs selected 3.4. Figure 5.5 illustrates audience-behavior counts, including 8% of respondents reporting observing no audience behavior to about one in five (21%) respondents reporting observing either three and five audience behaviors. While GOV-C respondents report greatest likelihood of observing up to three audience behaviors, over half (56%) of NGO-C respondents report observing five audience behaviors. These findings suggest NGO-Cs may be more observant of their audiences, and potentially more interested in how their audiences interact with their SM.

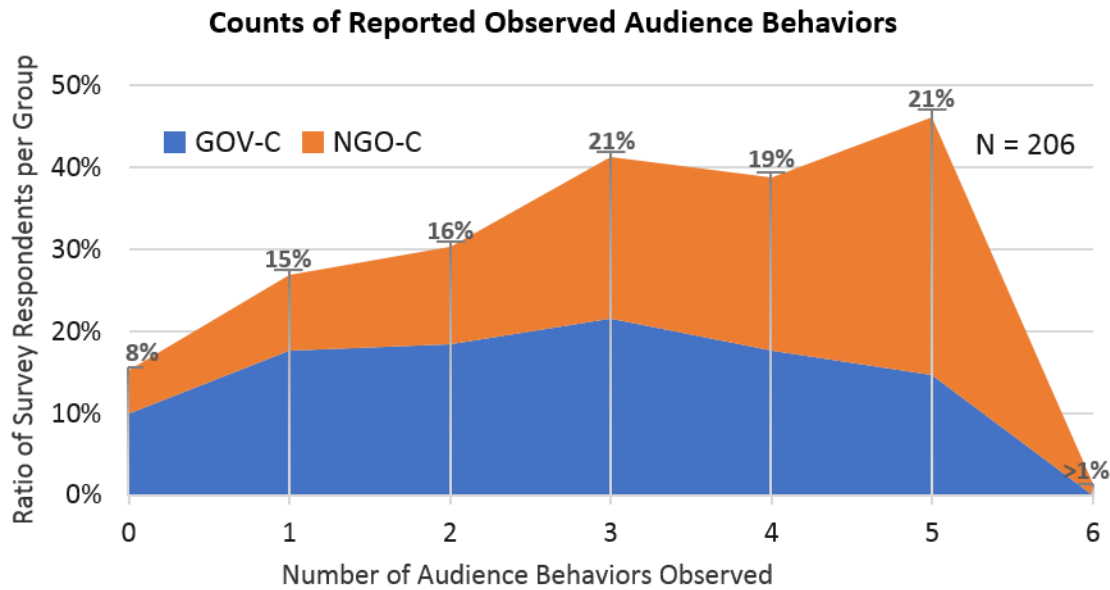


Figure 5.5. Audience Behaviors Observed on Social Media. Data Source: Survey Question 3.16. N=207.

Next, we explore the specific audience behaviors respondents observe. Figure 5.6 illustrates these findings summarizing audience behaviors of interest sorted by combined selection ratios. GOV-C respondents report greater interest in observing *audience awareness of (their) organization* (26%) and *public online engagement with (their) organization* (25%). A focus on measuring public awareness and engagement suggests GOV-C respondents have a desire to understand the reach of their messages and how their audiences interact with them. By contrast, one in ten GOV-Cs report not observing any audience behaviors; a rate double that of NGO-C respondents.

NGO-C respondents reported greatest interest in *clicks and shares* (23%) measuring traffic through SM pages to webpages, apps, and linked content. The second greatest audience behavior of interest is *online engagement* (22%). NGO-Cs reported greater interest than GOV-Cs pertaining to three audience behaviors, including *clicks and shares*, *new advocates and fans*, and *increasing (their) organization's online presence relative to other organizations*.

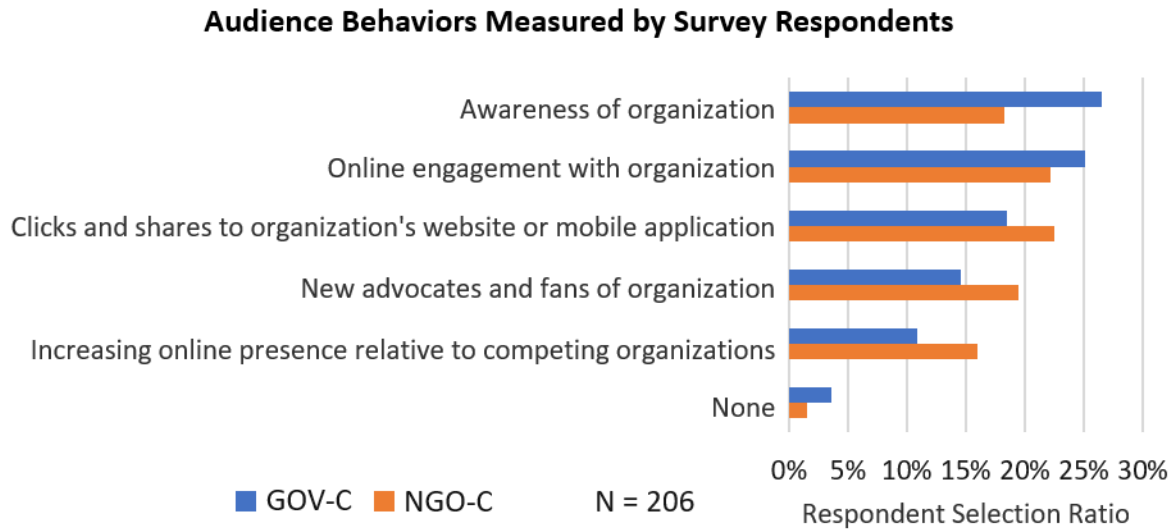


Figure 5.6. Online Audience Behaviors Measured by Survey Respondents. Data Source: Survey Question 3.16. N=207.

5.3.2. Social Media Campaign Evaluation Metrics

Gathering which campaign evaluation metrics and growth strategies respondents incorporate into SM efforts contributes insight regarding how organizations may be seeking to overcome various challenges. For example, organizations proactively working to expand the reach and effectiveness of their messages may be more likely to narrow information gaps and communication disparity among their constituents than those using SM more passively. Greater involvement with SM evaluation also may indicate progression through the three phases of SM adoption as described by Mergel and Bretschneider (2014). Figure 5.7 shows that one in four respondents observe two of the five pre-determined evaluation metrics. While GOV-C respondents are most likely to observe or use two measures, NGO-Cs report most likely to utilize three methods to evaluate the success of their campaign.

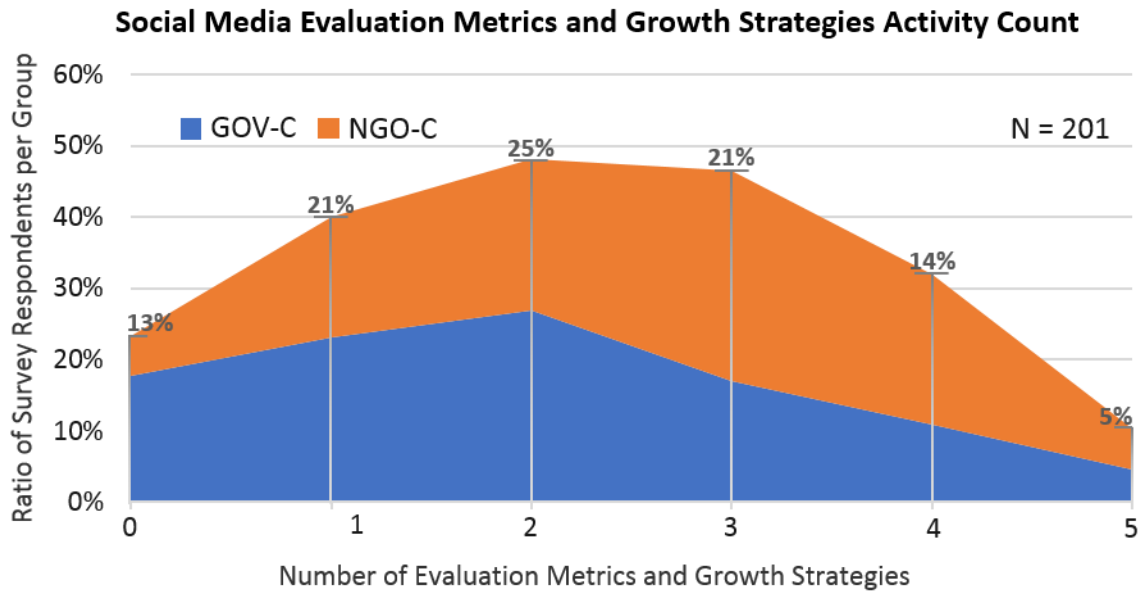


Figure 5.7. Social Media Evaluation Metrics Counts. Data Source: Survey Question 3.17. N=201.

To gain a better understanding of specifically which strategies are most commonly utilized among respondent groups, Figure 5.8 illustrates the findings ascending by selection choice. Overall the most commonly reported technique is to *monitor social media metrics with built-in features*, observed by a slightly greater percent of NGO-C respondents. The second, and only response choice selected more by GOV-Cs than NGO-Cs was to *gather feedback from public*. In all other response options, NGO-Cs reported greater utilization. Lesser-utilized evaluation and growth strategies include *using data collected from metrics to expand reach of messages* and *advertising or cross-referencing social media profile elsewhere*. The least-utilized evaluation strategy is *consultation with third party organizations*. These findings suggest respondents are most likely to utilize simple and low-cost evaluation and growth strategies. Overall, 13% of respondents reported utilizing no evaluation metrics or growth strategies, with GOV-Cs more than three times more likely to forego SM evaluation than NGO-Cs. Additionally, these findings indicate NGO-Cs are more likely to engage in campaign evaluation

activities, and are more likely to employ more campaign evaluation metrics and growth strategies, suggesting NGO-Cs could exhibit more advanced use of SM in Mergel and Bretschneider’s (2014) three-stage SM adoption process.

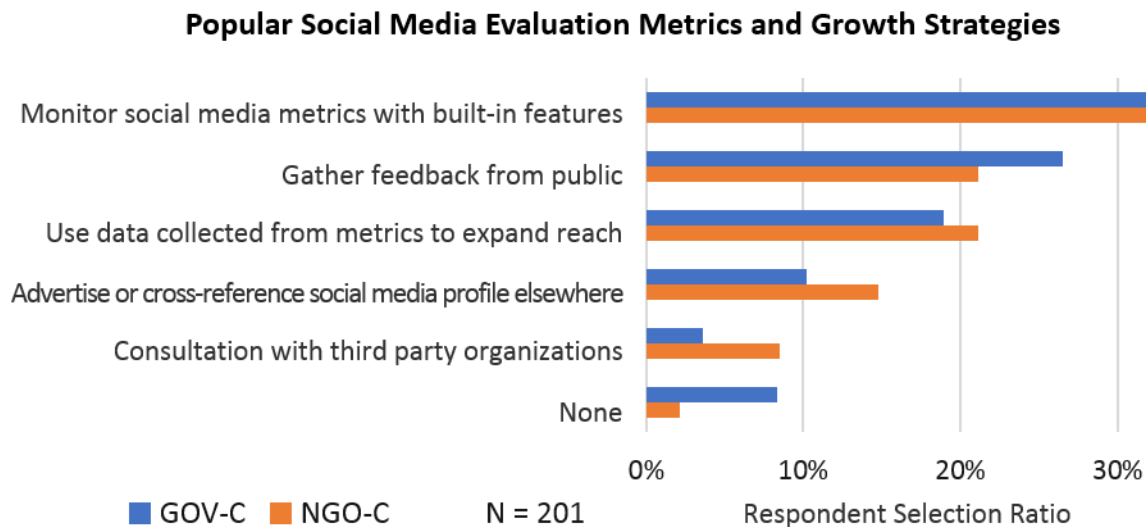


Figure 5.8. Social Media Campaign Evaluation Metrics and Growth Strategies Observed by Survey Respondents. Data Source: Survey Question 3.17. N=201.

5.4. Overcoming Obstacles with Social Media Communication Best Practices

Research Question 2.3: Which tactics and strategies do survey respondents report employing to overcome the obstacles they encounter in their use of social media for risk and crisis communication?

This section explores the application of some best-practice techniques for communicating through SM by discussing specific policies, procedures, strategies, and tactics used to enhance risk and crisis communications. First, survey respondents indicate advancement in the adoption SM communication strategies by reporting adoption of policies for SM use within their organization since 2012. Next, respondents report involvement with specific progressions, including developing target goals and a plan guiding SM use, incorporation of bi-directional communication strategies, employing dedicated staff, and maintaining continuous SM “listenability”. Policy adoption and campaign developments provide evidence of progression

along the three-phase process for SM use for maximizing the benefits of SM (Mergel and Bretschneider 2013). Then, we present findings regarding efforts for information validation (or accuracy verification) before sharing, followed by reports of specific methods used to validate information. Verifying the accuracy of information observed on SM before sharing is necessary to mitigate the risk of passing on inaccurate information. Next, survey respondents provide feedback regarding their efforts to leverage resources and staff to meet surges in communication demands during emergencies. We seek to understand how respondents engage audiences in terms of specific message types indicating involvement with push, pull, and networking tactics. Finally, respondents indicate their policies for “following” other users on SM, an activity that may extend the reach of their organization’s communications and their capacity to collect information from SM.

5.4.1. Development of Social Media Policies

Since 2012, 62% of GOV-C respondents report adopting policies to improve their SM communications, while near equal portions of GOV-C respondents report they are unsure or have not adopted new policies. NGO-C respondents report less policy development, with 31% indicating no change and only 56% acknowledging policy under development. Greater policy development among GOV-C respondents is likely due to the demands of centralized institutional guidance, such as NIMS, requiring public information brokers to advance SM communication strategies. Table 5.2 lists reported adoption of several specific policies aimed to overcome challenges of SM communication, with slightly greater growth reported among GOV-Cs in all but one category concerning employing dedicated SM personnel. Overall, the most-reported policy advancement of SM campaigns (for 34% of GOV-Cs and 33% of NGO-Cs) has been an effort to provide more rapid response to public comments and concerns. Fewer respondents, about two in ten from each group indicated developing target goals and a specific comment-

response plan for their SM use. About one in ten respondents of each group report monitoring SM every day around the clock.

Table 5.2. Social Media Policy Adoption Since 2012. Data Source: Survey Question 4.27. N=93.

Social Media Policy Adoption Since 2012	GOV-C	NGO-C
Strive for rapid response to public comments and concerns	34%	33%
Staff or team member dedicated to monitoring our social media accounts	32%	33%
Developed target goals and a plan for communicating on social media	21%	19%
Social media accounts are monitored 24 hours a day, 7 days a week	11%	10%
N=	60	33

5.4.2. Addressing Information Accuracy on Social Media

Respondents previously reported the accuracy of information on SM is of major concern when interacting with the public. Developing protocol to validate, or verify the accuracy of information on SM before sharing it with the public helps to lessen the unintended circulation of misinformation. Figure 5.9 suggests nearly nine in ten GOV-C respondents *always* verify the accuracy of information before sharing. Unfortunately, NGO-C respondents may be more

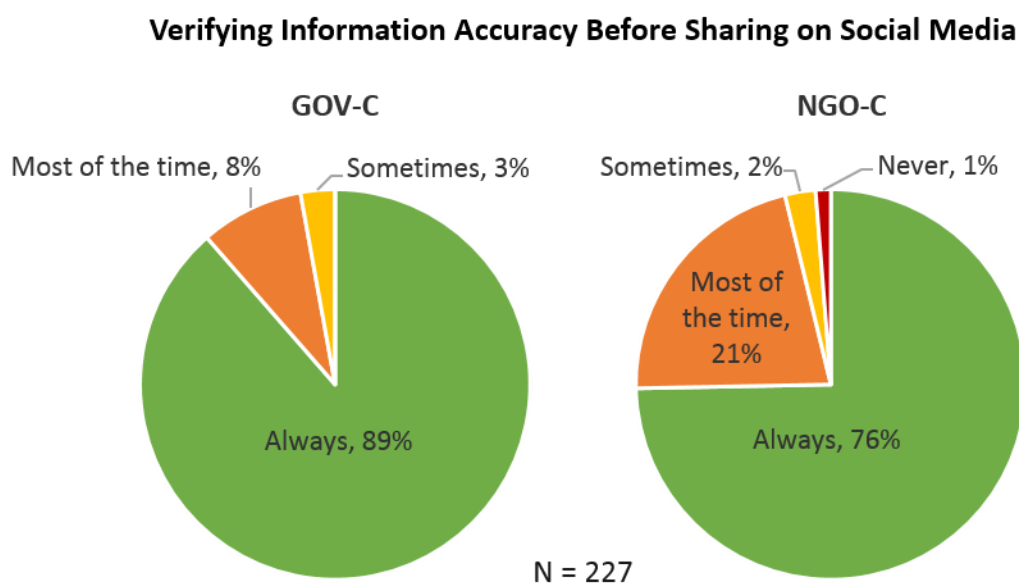


Figure 5.9. Verifying Information Accuracy Before Sharing. Data Source: Survey Question 2.9. N=227.

susceptible to spreading misinformation on SM, with only three-quarters of respondents *always* verifying information accuracy and even 1% *never* engaging in the behavior.

A follow-up question sought to understand the methods employed to verify the accuracy of information on SM. Figure 5.10 illustrates the selection ratios from respondent groups for the four pre-determined methods of information verification. The most common method reported by both groups is *sharing information only from official sources*, selected by 52% of GOV-Cs and 45% of NGO-Cs. This method helps to prevent spreading misinformation on SM. About 4% of survey respondents from each group even reported having *no policy regarding information sharing on social media*, which may potentially provide opportunity for the spread of misinformation within network. These less favorable information sharing criteria include *first person accounts from persons on the ground*, selected by 28% of GOV-Cs and 31% of NGO-Cs, and sharing information only from Verified Accounts (Twitter), selected by 16% of GOV-Cs and 21% of NGO-Cs.

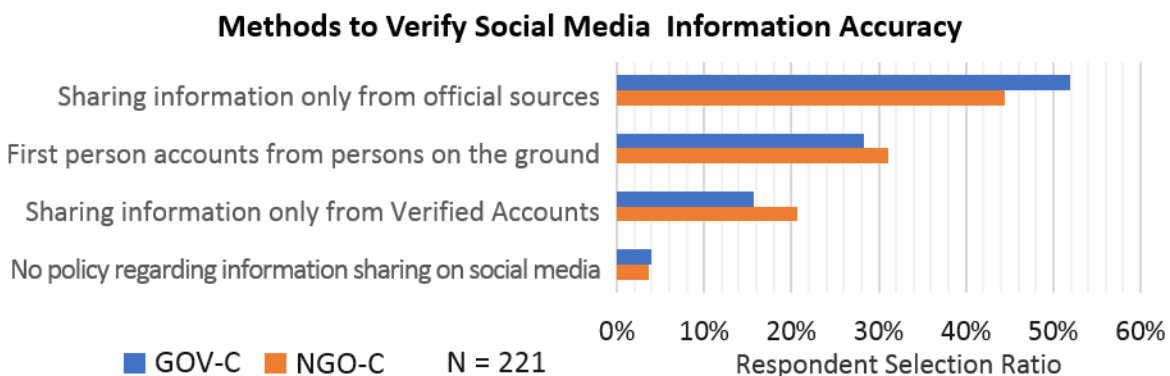


Figure 5.10. Methods to Verify Social Media Information Accuracy. Data Source: Survey Question 2.10. N=221.

5.4.3. Planning to Meet Informational Needs on Social Media during Emergencies

Another practice aimed to enhance the effectiveness of communications is to provide additional support to address surges in public-information requests. In addition to enacting

mandatory recalls of personnel to bring full organizational communication capacities during a crisis, responders can benefit from maintaining online engagement with response partners, community organizations, and volunteer groups before and during a crisis to extend communication capacities when resources are stretched (DHS 2014c). Figure 5.11 indicates both respondent groups report similar capacities to enhance communications during a crisis, with GOV-C respondents reporting slightly greater robustness (64% versus NGO-Cs reporting 58%) in abilities to leverage additional communication support. While one in five GOV-Cs report not having a plan to leverage additional support to monitor SM during an emergency, over one quarter of NGO-Cs (26%) report the same.

Respondents Leveraging Additional Support for Social Media During Emergencies

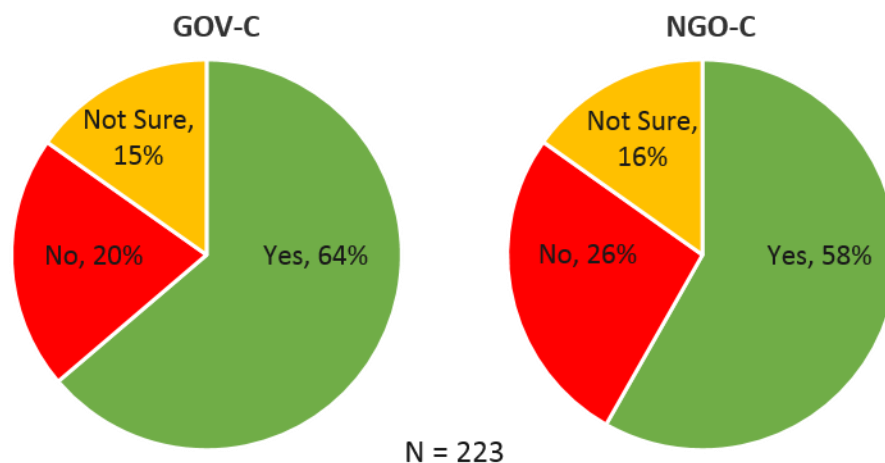


Figure 5.11. Leveraging Additional Support for Social Media During Emergencies.
Data Source: Survey Question 2.12. N=223

Survey respondents indicate the most common method to enhance social media communication capacities is to divert resources from within their organization. Figure 5.12 shows about half of GOV-Cs and 44% of NGO-Cs have plans to enhance communication capacities with internal resources. The second most common method for 21% of GOV-Cs to enhance

communications is to leverage third party organizations. Slightly more NGO-Cs (23%) report planning to leverage volunteers during an emergency.

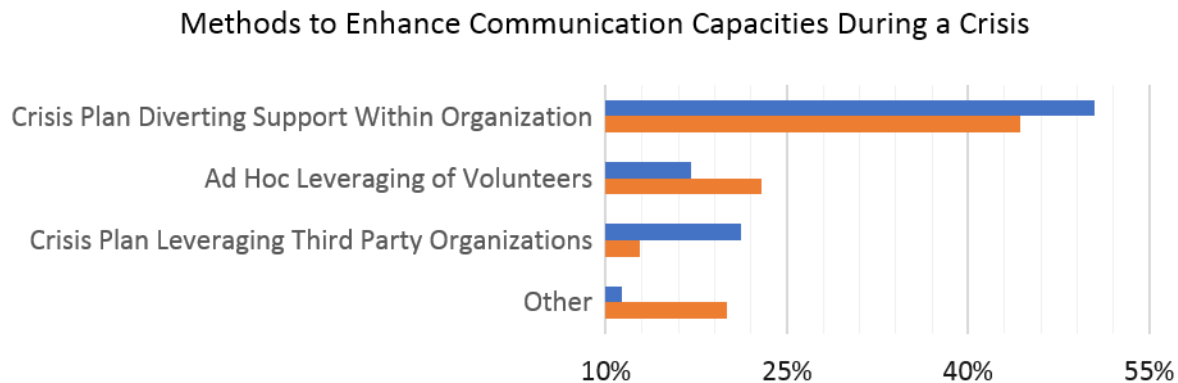


Figure 5.12. Methods to Enhance Communication Capacities During a Crisis. Data Source: Survey Question 2.13. N=133.

5.4.4. Outreach and Community Engagement

Outreach and community engagement findings relate to expanding the reach of communications, types of messages shared with the public, and whether respondents “follow” other users on SM. Agencies and organizations of the whole community of EM share various types of messages and at various phases of EM. For example, *crisis* communication involved *push* alerts in *preparedness* or *response* phases, while *risk* communication is typically less urgent, and may seek to educate or to *pull* information from audiences. Risk communication may occur during each phase of the EM cycle. Mergel (2014) discussed best practices for the use of SM by GOV-Cs during a crisis, and the values of sharing various types of messages including traditional *one-to-many* approaches to *push* information to the masses, *one-to-one* approaches to *pull* information by engaging individuals, and *many-to-many networking* tactics in which officials become part of the online community and conversation (Mergel 2014). Figure 5.13 suggests NGO-Cs may help to “fill the gap” in risk and crisis communication by outpacing

GOV-Cs in two of the seven listed message types. GOV-Cs report greater involvement with push tactics than NGO-Cs, sending more *local updates, alerts, or warnings* and *responses to media organizations*. NGO-C respondent send more messages in one category of push messages, including *retrospective or after-action reports*. This finding is consistent with the literature suggesting GOV-Cs primarily use SM to broadcast public information, but also suggests NGO-Cs may help to supplement push communication after the fact. Respondent groups report sharing "*send us your pictures*" or "*Let us know*" pull-type messages similar, though GOV-Cs report sharing *call to action* message more often, seeking audience participation in activities such as clicking a link to read more. Reported activity related to networking tactics are split, with GOV-Cs reporting sharing more *interactive community engagement and networking* messages such as *replying to individual users, acting as a part of the community*, and NGO-Cs report *retweeting citizens' messages* more often.

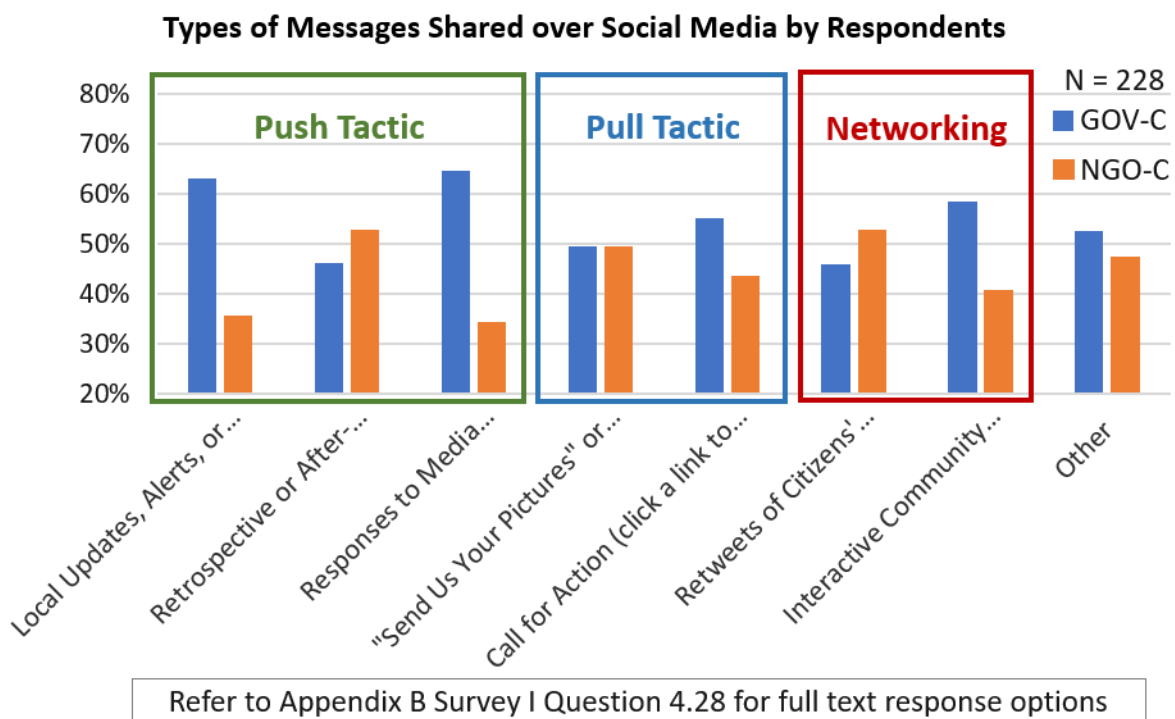


Figure 5.13. Types of Messages Shared over Social Media. Data Source: Survey Question 2.8. N=228

When collecting information from SM, a larger network may not always yield the most valuable publicly-sourced information. On the contrary, choosing not to follow community members may limit public agencies and organizations abilities to generate adequate situational awareness. Figure 5.14 suggests GOV-C respondents may be more likely to follow reputable sources of crisis and risk information while NGO-Cs may possess greater access to local networks by following SM users in the local area. Three times the number of GOV-C respondents report following SM users is not the focus of their campaign.

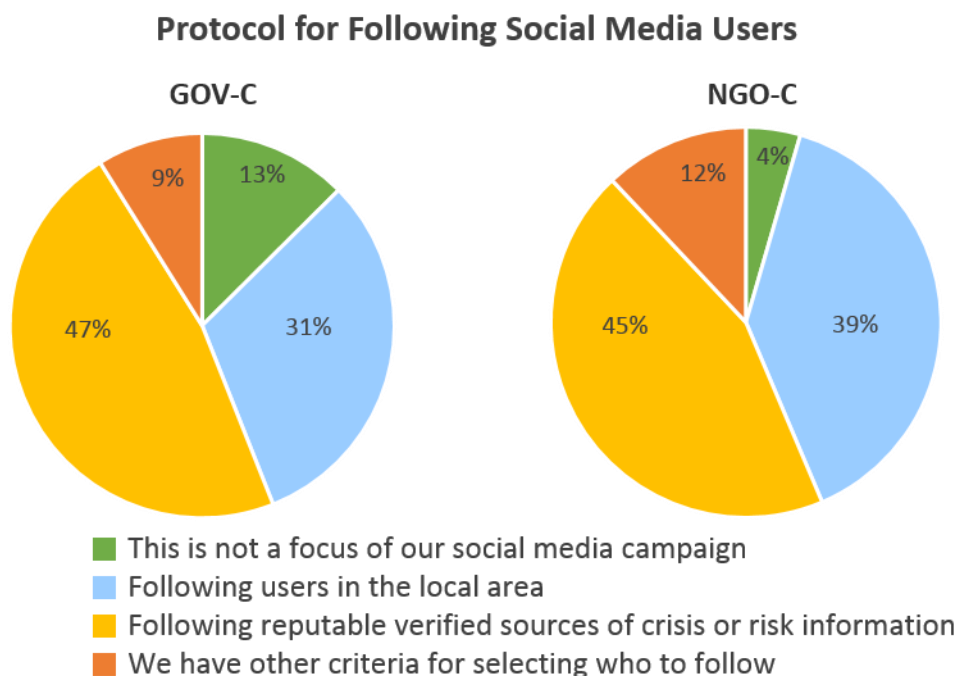


Figure 5.14. Protocol for Following Social Media Users. Data Source: Survey Question 3.15. N=206.

5.5. Chapter Five Summary of Findings

The second research objective aimed to examine the challenges faced by survey respondents, whether these issues are similar to those reported in earlier research, and how respondents address the problems they encounter. We focused on potential difference among survey respondents operating under the guidance of federal government EM practices and

guidelines, such as NIMS, and those that are not subject to these guidelines. Therefore, we compared first responders and government-related agencies, referred to as GOV-C, to news media organizations and non-government organizations, referred to as NGO-C.

Respondents indicated their level of concern toward obstacles commonly reported in the literature when communicating with the public using SM. Both respondent groups were most concerned about the accuracy of information they encounter when communicating with the public. The second most concerning challenge reported by respondents was obtaining adequate human resources to monitor SM. Both top concerns of survey respondents are consistent with the findings of related studies (Plotnick and Hiltz 2016, Wukich and Mergel 2015). We found the least concerning common obstacle reported by GOV-Cs to be the lack of specific procedure or protocol for the use of SM. The common obstacle of least concern for NGO-C respondents was the lack of SM training. Both common challenges of least concern were reported as major concerns in other recent studies, suggesting concern about earlier identified, specific challenges in the EM field may be shifting as public agencies and organizations gain experience with SM. Respondents also provided text responses concerning *other* SM challenges they are facing. Both respondent groups perceive the greatest challenge when reaching out to a disaster-affected community is the stability of the technical network infrastructure and issues with connectivity, followed with difficulties related to the user-friendliness and accessibility of information on SM for emergency managers during a crisis. Both of these *other* reported obstacles are new to the literature and appear to suggest survey respondents have concern for challenges and obstacles that are external to their operations.

The remainder of the chapter explored how survey respondents report addressing common challenges of SM communication. In terms of audience behaviors of interest, the

survey results found GOV-Cs are most interested in determining the level of public awareness of their organizations, followed by online engagement with their organization, which was the top interest of NGO-Cs, tied with clicks and shares to websites and mobile applications. Both respondent groups most commonly evaluate the success of their SM campaigns through observation of built-in SM metrics and features. The second most common evaluation strategy of GOV-Cs was gathering feedback from the public, while NGO-Cs reported using data collected from metrics to expand the reach of their messages. In terms of policies adopted since 2012, both respondent groups aim for more rapid response to public comments and concerns. The second most common policy adoption for both groups since 2012 is employing dedicated SM personnel within their organization.

Survey results found GOV-Cs are more likely to verify the accuracy of information before sharing on SM, and that only 1% report never verifying the accuracy of SM information before sharing. Related results include that when following other users, GOV-Cs report only following reputable and verified information sources on SM at a greater rate than NGO-Cs. In terms of following users in the local area, NGO-Cs are more likely to do so. While GOV-Cs are most likely to plan to leverage additional support to monitor SM during an emergency, both respondent groups are most likely to divert resources from within their organization to meet surges in public information requests. The second most common method reported by GOV-Cs to meet demand surges is leveraging third-party organizations, while NGO-Cs report ad-hoc leveraging of volunteers. Lastly, the most common types of messages shared by GOV-Cs are responses to media organizations, while NGO-Cs report greatest sharing of retrospective or after-action reports.

As organizations move toward the institutionalization of SM as described by Mergel and Bretschneider (2013), they develop policies and allocate resources to support their SM campaign objectives. The experiences and lessons learned as SM is used more widely in emergency management help to make challenges of SM communication more predictable and more likely for EMs to overcome. Through this process of SM campaign development, the challenges that are internal to the organizations may be reduced or mitigated. The survey findings indicate both GOV-Cs and NGO-Cs report greater concern toward external-type challenges, with NGO-Cs reporting more concerned with external-type challenges. When asked about any other challenges of social media communication in an open-ended question, only 13% of the responses described internal-type challenges. Additionally, the findings suggest the guidance offered by NIMS has been successful in helping governmental organizations and agencies address common obstacles associated with SM use during and after emergencies. These results indicate that the SM campaigns of respondents generally have matured into the “institutionalization” of SM as both groups report less concern toward internal-type challenges such as human resources and SM competence.

Chapter 6. Case Study: The Role of Social Media Among Hurricane Harvey Responders

6.1. Introduction to Case Study: Hurricane Harvey and Social Media

The first two research components identified patterns of social media (SM) use and strategies to improve its utility for risk and crisis communication across the four phases of emergency management (EM). This chapter shifts focus to investigate the use of social media (SM) during the response phase of a large-scale crisis on the Texas Gulf Coast, when Hurricane Harvey caused widespread flooding in the Greater Houston area in 2017. This case study is based on original survey findings from a survey of first responders (FR), government-related agencies and offices (GOV), and a combination of non-governmental organizations, including news media, faith-based and other charitable organizations (NGO-C) who used SM to either conduct or support rescue and response efforts following landfall of Hurricane Harvey. Survey respondents reported on the objectives or purposes for their SM use and the specific SM channels or platforms they preferred. In addition, respondents offered insight regarding their organizational resources used to monitor Twitter, and how they handled the information they received through SM. Survey respondents also shared their thoughts on potential lessons learned from the use of SM, including the overall usefulness of SM for assisting rescue efforts, and how Twitter and other ITC could be improved for better risk and crisis communication during future urban-scale disasters.

Despite the growing support for risk and crisis communication enhancement and diversification of methods by agency leaders and employees within the EM community, responders continue to struggle to convey timely, useful information to the public about hazardous conditions and may miss opportunities to receive valuable citizen feedback (Wukich and Mergel 2015). Hurricane Harvey illuminated the limitations of antiquated 911 systems still

used in Houston and much of the country in 2017. At the peak of the emergency, Harris County, Texas public safety answering points (PSAP), more commonly known as emergency dispatch centers, received about 80,000 calls within 24 hours (Kelly 2017). Dispatchers worked around the clock to respond and clear the calls, as wait times for high-water rescues increased from an average of 3.5 hours on August 26, to over 20 hours the following day (Harden 2018). The 911 call log shows one Houston resident who was rescued by a civilian in a tractor trailer would have waited almost three days before first responders would have arrived at her address (Harden 2018). While the Houston 911 system featured support for short message service (SMS) or text messaging, it still relied on the legacy wired phone network. These wired networks cannot support advanced features such as rerouting calls to neighboring PSAPs, rich-text processing, and improved information accuracy, of enhanced web-based dispatch systems such as Next Generation 911 systems (FEMA 2017a).

As stated above, the objective of this case study is to develop a clearer understanding of how SM was used to support response and rescue efforts during Hurricane Harvey. We propose three main research questions to examine how FRs, GOVs, and NGO-Cs worked together to coordinate and execute rescue missions with the aid of SM following the landfall of Hurricane Harvey in the Greater Houston area.

6.1.1. Research Questions

Research Question 3.1: How did survey respondents utilize social media to assist response and rescue efforts during Hurricane Harvey?

Research Question 3.2: How did survey respondents address commonly reported obstacles concerning the use of social media during disasters?

Research Question 3.3: Which recommendations do responders suggest could improve the utility of social media in future emergencies?

6.1.2. Hurricane Harvey

Hurricane Harvey made landfall three times in August 2017, passing over the Yucatan Peninsula, then coastal Texas, and making a final landfall in western Louisiana, moving quickly northward as it deteriorated. Harvey was the first “major hurricane” to hit the Texas coast since Hurricane Brett in 1999, a designation given to storms making landfall with a Saffir-Simpson intensity rating of category three and greater (NWS 2018).

The following discussion regarding Hurricane Harvey and the research study area refers to Figure 6.1. The map includes Harvey’s track and intensity labeled in Saffir-Simpson categories downloaded from the National Hurricane Center¹¹. Accompanying timestamps show the location of the center of the system at midnight local time (Central Daylight Time). Figure 6.1 also illustrates areas enduring immense property damage sourced from the FEMA Damage Assessment model¹² and released two days following Harvey’s northward departure from the map frame across Louisiana. Grey hatching and labels over Texas Counties indicate counties where at least one Public Safety Answering Point (PSAP) experienced disruptions between August 26 -31, as reported in daily FCC Communication Status Reports. Figure 6.1 also illustrates a map of east Texas and the research study area used to preform study population sampling, including the State of Texas, nine counties forming the Houston metropolitan Statistical Area (MSA), and the City of Houston. The reference map includes locations of surface water bodies, city boundaries, and major roads over the Texas County boundaries collected from the TNRIS data catalog¹³ and TxDOT Open Data Portal¹⁴.

¹¹ <https://www.nhc.noaa.gov/>

¹² <https://data.femadata.com/NationalDisasters/HurricaneHarvey/Data/DamageAssessments/>

¹³ <https://www.tnris.org/data-catalog/>

¹⁴ <http://gis-txdot.opendata.arcgis.com/>

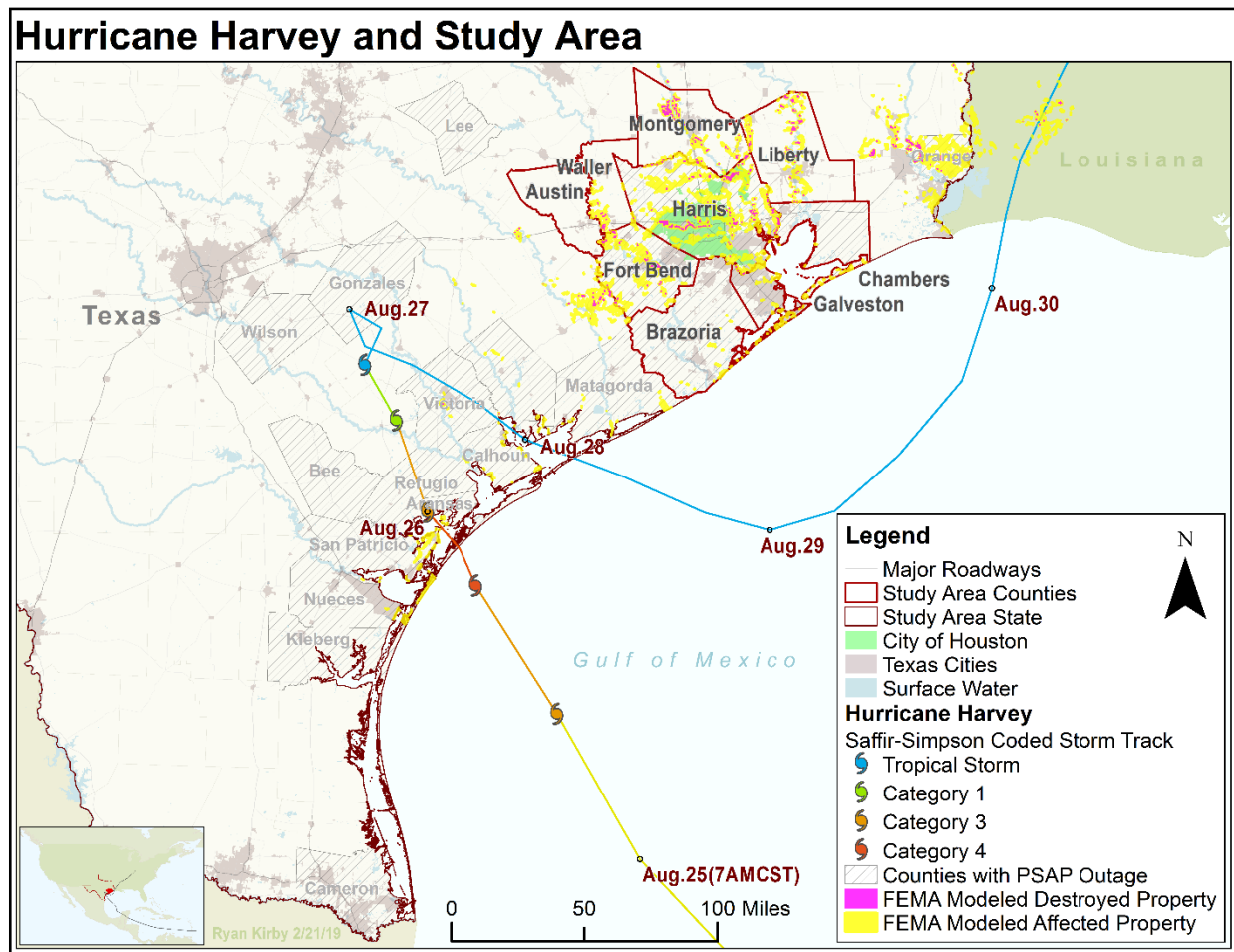


Figure 6.1. Study area Hurricane Harvey Track and Intensity, Public Safety Answering Point Counties Outages, and Modeled Damage.

Hurricane Harvey Development and Progression

Hurricane Harvey emerged as a tropical wave off the coast of Africa on August 13, 2017. The system was named Tropical Cyclone Nine of the 2017 Atlantic season on the morning of August 17 and upgraded to a tropical storm (TS) that afternoon. Harvey impacted the Windward Islands August 18 and entered the Caribbean Sea, where it weakened to a tropical wave and passed northward over the Yucatan Peninsula the morning of August 22. Upon re-entry into the warm Gulf waters, the system rapidly intensified, tracking northwest towards the Texas coast, where Texas authorities issued three extreme wind warnings. Hurricane Harvey

battered the Texas Gulf coast with winds up to 132 miles per hour and storm surge as high as 12 feet. Harvey crept inland, dumping enormous amounts of rain before re-entering the Gulf once again. Before the event was over, areas of southeast Texas received close to 60 inches of rain. Appendix H includes a timeline of the storm evolution, impacts on Texas, and detailed reported communication concerns associated with rescue and response efforts.

Hurricane Harvey Aftermath

Hurricane Harvey claimed 88 lives, with 82 in the Houston area (Moravec 2017). FEMA reports local, state, and federal responders rescued 122,331 people and 5,234 pets with the help of over 31,000 deployed National Guards (FEMA 2017c). The catastrophic event resulted in a cost of \$125 billion, double that of Hurricane Sandy (NOAA 2018). Harvey was the most significant rainfall event on US record, with totals exceeding 60 inches over eight days in southeast Texas (USGS n.d.). About one-third (43%) of greater Houston streamflow sensors detected peak stages exceeding local ground elevations, with the greatest calculated flood depth of 14.2 feet above ground level in the 6 PM hour of August 30 at the Trinity River, Northeast of Beaumont, Texas (USGS n.d.).

FEMA estimates that 98% of damaged properties are located within Texas, and over two-thirds (67%) of modeled Texas damage exists within Greater Houston with an average inundation depth of three feet (FEMA 2017b). One retrospective report estimates over 204,000 home and apartment buildings were damaged in Harris County alone (Hunn et al. 2018).

6.1.3. Hurricane Harvey and Communication Networks

Hurricane Harvey was described as a “viral storm” (Scalf 2017), in which individual citizens converged in mass on SM as digital volunteers with hopes of connecting victims with responders by combing SM for requests for rescue. These SM communication efforts extended

the potential of the whole community in contributing to response efforts when 911 systems became overwhelmed.

Hurricane Harvey highlighted deficiencies in PSAPs when a total of 30 PSAPs experienced disruption in 20 Texas Counties and one Louisiana Parish between August 26 and August 31. In all, Harvey contributed 73 station-day disruptions in the six days, averaging over 12 disruptions per day (FCC 2017b, c, d, e, f, a). While Nueces County, Texas experienced the greatest number of station-day disruptions (Port Aransas PD all six days and Robstown PD three days), San Patricio County had the most disrupted PSAPs with three points of contact experiencing seven station-day disruptions, including Portland PD, Mathis PD, and Ingleside PD. In all, affected counties and one Parish experienced two station days without re-route, one station-day without Automatic Location Identification (ALI), 13 station-days in which calls were re-routed with ALI, and 16 station days in which calls were re-routed without ALI.

By contrast, cellular (cell) networks proved more reliable most of the affected areas. The slow-moving nature of Harvey allowed network providers like AT&T and Verizon to prepare for the damaging effects by taking part in activities such as filling generator tanks and staging resources before Harvey's landfall (ATT News Team 2017, Verizon 2017). Figure 6.2 illustrates cell site outages, indicating the percent of operation cellular signal broadcasting stations in counties also experiencing PSAP disruptions. Clustered lines near the top of Figure 6.2 indicates many cell sites remained operation in the days following Harvey's landfall in South Texas, suggesting the cellular networks provided critical redundancy to communication networks despite disruption of PSAPs, which allowed disaster victims to utilize the robust mobile signal to communicate and receive information. Cell service in counties experiencing PSAP disruptions are listed as of the percent of operational cell sites per county per parish per day, where counties

are ranked on the right axis from least to most average outages, including Cameron (LA), Cameron (TX), and Kleberg, which remained 100% operational through the observed timeframe.

Rate of Operational Cell Sites in Counties with Public Safety Answering Point Disruptions

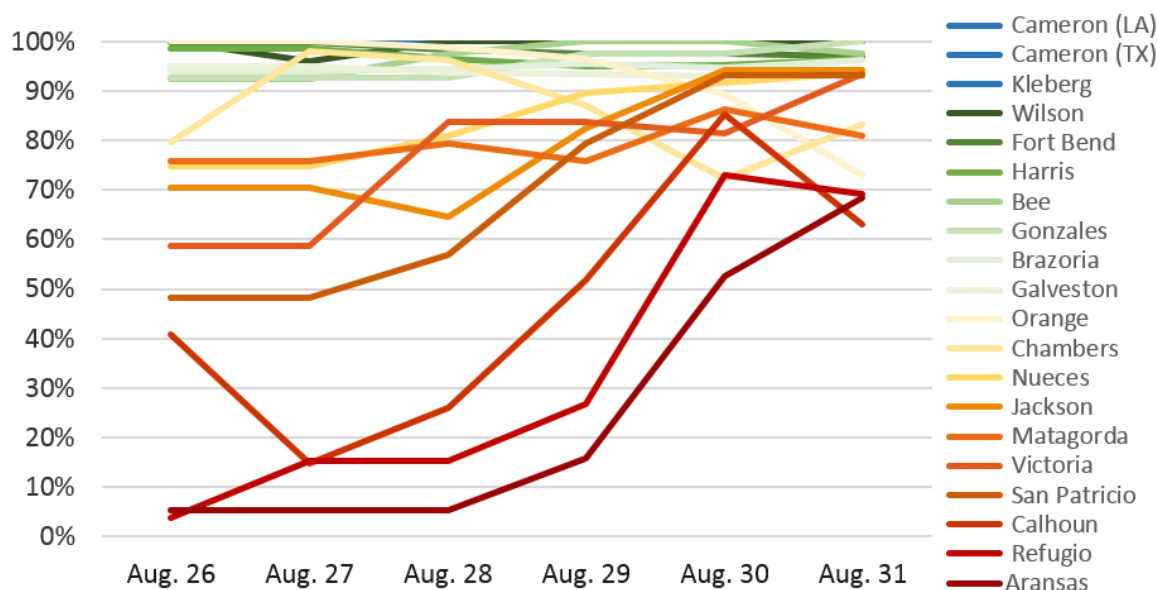


Figure 6.2. Percent of Operational Cell Sites in Counties with PSAP Disruption

Daily cell site outages averaged less than 18% within the PSAP-disrupted counties and parish between August 26 and August 31 (FCC 2017a, b, c, d, e, f). Cell site disruptions were greatest in Aransas County, Texas, where the greatest wind velocities of Hurricane Harvey were reported. Winds as great as 132 miles per hour reported near Port Aransas (NWS 2018) brought all but one of the 19 cell sites offline for August 26 and 27 (FCC 2017a, b).

Robust performance of the cell network may suggest the incorporation of mobile-enabled communication platforms such as SM could help responders extend the reach of communications and public assistance when primary channels (PSAPs) become inoperable.

6.2. Characteristics of Survey Respondents

The results present original survey findings based on the analysis of SM use among three stakeholder groups contributing to the whole community of EM during Hurricane Harvey in 2017. These are first responders (FR), government-related agencies and offices (GOV), and non-governmental organizations combined (NGO-C). While survey distribution efforts yielded 90 responses, 26 were omitted from analysis due to problems including low completion rates and unclassifiable responses. Figure 6.3 illustrates the composition of the 64 survey responses per respondent group (left) and geographic reach or jurisdiction (right).

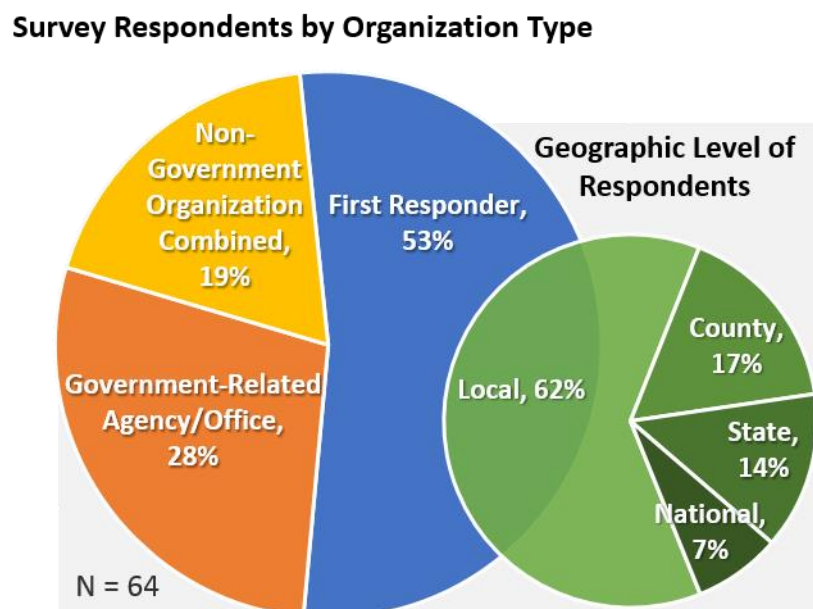


Figure 6.3. Survey Respondent Profile by Organization Type (Left) and Geographic Reach (Right). Data Source: Survey Question 1.

While FRs populated fewer than one-quarter (22%) of the entire study population, they expressed the greatest response rates, contributing over half (53%) of the survey responses. The majority are fire departments, followed by law enforcement agencies, emergency medical services, and search and rescue associations. Almost three in four (74%) FRs represent local agencies, with the remaining quarter split between county and state-level jurisdictions.

Nearly one in three (28%) survey responses were contributed by GOVs. Almost half (47%) of the respondents from the GOVs group operate SM for municipal communication offices. About one-fifth (21%) of GOVs represent emergency management agencies and several correspond to public health offices; all of which operate between local and state levels of organization. Lastly, one GOV respondent represents a national-level fact-finding public research agency.

Non-government respondents include local chambers of commerce, sub-state level news media organizations, local and national charitable organizations, and faith-based organizations with national reach. Over half (58%) of NGO-C respondents represent organizations with local and county-level reach within Houston MSA. While these supporting organizations populated nearly half (44%) of the study population, they exhibit the lowest response rates relative to FR and GOV respondents.

Nearly nine in ten (89%) of survey respondents report having a SM account. The high rate of SM adoption is comparable to findings in previous research components. All respondents reporting non-use of SM belong to the FR group, primarily at the local level, in which one in five (21%) report only using radio and 911 dispatch to communicate with the public. These findings are similar to a recent study where researchers found about a quarter of EM agencies actually prohibited the use of SM (Plotnick and Hiltz 2016).

More than four in five (83%) survey respondents report being directly involved with emergency rescue efforts during Hurricane Harvey, including 100% of FRs, 78% of GOVs, and 42% of NGO-Cs. The 17% of survey respondents who were not directly involved in rescues filled secondary roles in the response effort, such as monitoring SM sharing pertinent information with rescuers. The findings in the following sections contribute knowledge from

experience and lessons learned by the responders both directly and indirectly involved with emergency rescues, contributing to a portrait of the whole community of EM responding to Hurricane Harvey.

6.3. Social Media Used to Assist Response and Rescue Efforts

Research Question 3.1: How did survey respondents utilize social media to assist response and rescue efforts during Hurricane Harvey?

About four in five (81%) survey respondents used the web to assist rescue operations during Hurricane Harvey, including 93% of FRs, 83% of GOVs, and half of NGO-C respondents. Nearly all (95%) of survey respondents who used the web also used SM. First responders most commonly reported (16%) accessing the internet without using SM, followed by (7%) of GOVs who used ITCs excluding SM. All NGO-Cs using the web to assist rescue efforts also used SM, while NGO-Cs (33%) were the only group reporting using SM to assist rescue efforts without using other aspects of the web. Given 89% of respondents reported having a SM account, these findings indicate some respondents with SM accounts did not use SM during Hurricane Harvey.

6.3.1. Preferred Social Media Tools

Respondents indicated their level of use concerning twelve communication channels, including eight SM platforms in a five-option Likert-type response matrix identical to that used in the first survey of EM organizations in areas affected by Hurricanes Isaac and Sandy. Figure 6.4 indicates the most common unofficial communication channel utilized during Hurricane Harvey was Facebook, used by nine in ten FRs and all respondents representing GOVs and NGO-Cs. The second most-used channel was websites, followed by emails. The second most common SM platform used during Harvey was Twitter, favored by (94% of) GOVs.

In terms of frequency of use, survey respondents reported utilizing Facebook more than any other SM platform. While the second overall most-used channel was websites, the second most-preferred platform among FRs is email, Twitter by GOVs, and websites by NGO-Cs. The top six channels preferred by survey respondents are consistent with the preferences reported by survey respondents in areas affected by Hurricanes Isaac and Sandy.

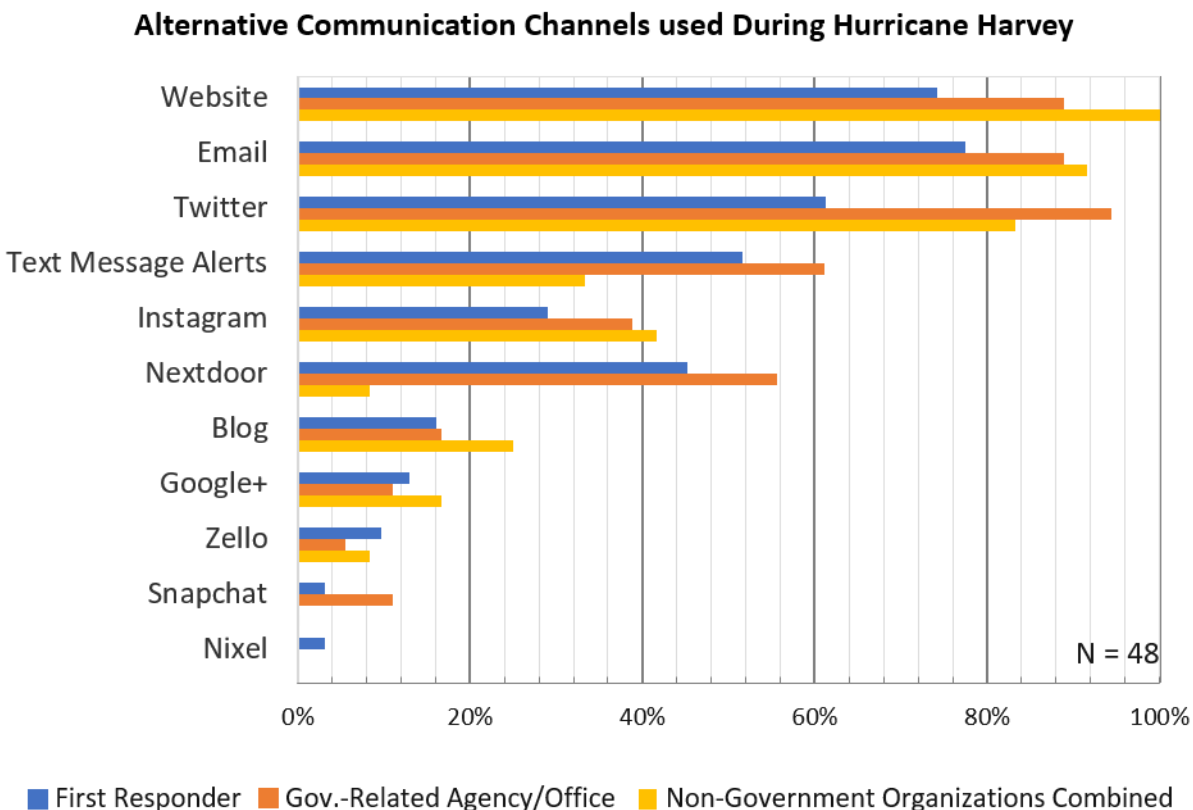


Figure 6.4. Alternative or Unofficial Channels used to Communicate with the public During Hurricane Harvey. Data Source: Survey Question 6. N=48.

Adopting multiple communication channels allows risk and crisis communicators to reach broader audiences, potentially extending the reach of communications. Over one-third (36%) of GOVs report utilizing three SM channels, followed by 29% supporting two channels. By contrast, over one-third (36%) of FRs reported using only one SM channel during Harvey

rescue efforts, followed by 29% reporting that they used two channels. One-third (33%) of NGO-Cs report using only one channel while another third reports using two.

Nearly nine in ten (89%) of respondents reported receiving requests for rescue assistance. Survey respondents reported receiving requests on an average of 2.2 channels, and on as many as five channels or platforms. GOV respondents reported receiving requests on the most channels, who received rescue requests on an average 2.4 among those who reported receiving any requests, followed by an average 2.2 channels by NGO-Cs, and 2.1 channels by FRs. The difference in channels responders received requests through is likely closely related to the number of channels they accessed. Most respondents reported receiving rescue requests on Facebook, followed by phone and radio, email, Twitter, websites, word-of-mouth, then Zello. Table 6.1 lists how each respondent group received requests, sorted by selection ratio (frequency a response option was selected by all respondents) listed in the last column.

Table 6.1. Percent of Respondents from each Respondent Group who Received Rescue Requests through Popular Unofficial Channels Respondents. Data Source: Survey Question 14. N=37.

Channels through Rescue Requests were Observed				
Respondent Group	FR	GOV	NGO	Selection Ratio
Facebook	62%	77%	89%	71%
Phone/Radio	46%	38%	22%	40%
Email	31%	38%	44%	35%
Twitter	27%	54%	33%	35%
Nextdoor	23%	8%	0%	15%
Website	4%	23%	22%	13%
Word-of-Mouth	12%	0%	0%	6%
Zello	4%	0%	11%	4%
N=	26	13	9	Sum = 48

While each group reported receiving requests via Facebook more than any other channel, the second-top channel through which requests from the public were communicated differed for the three groups. Phone and radio were the second-top channel through which FRs received rescue request. Twitter was the second top channel for requests among GOVs, and NGO-Cs reported email was second most common channel for which they received rescue requests.

Other FRs reported being unable to dispatch responders without receiving the request via PSAP 911 dispatch. This finding suggests that some responders may observe requests for help on their SM accounts but are unable to convert a web-based message to an actionable dispatch of assisting personnel. One NGO-C respondent mentioned receiving a Google spreadsheet containing a database of people in need of assistance compiled by individuals searching social media.

We received rescue requests via Facebook Messenger (and email) but are only equipped to dispatch emergency requests via 911.

-Local Level First Responder

6.3.2. Rescue Request Channels

The range in number of requests for rescue that the survey respondents received is very large. This is to be expected since not all of the organizations represented in the survey are directly involved in rescue activities. Survey respondents in the Houston area reported receiving between 2 - 32,000 rescue requests on SM. On average, responders reported receiving only about 3% of the number of their total rescue requests through Twitter, with the majority received through Facebook. The combined average number of reported requests was 2,001 per organization, with FRs reporting an average of about 2,879 per organization, GOVs reported an average of 217, and NGO-Cs reported an average of 382. Additionally, one local-level quasi-governmental organization reported over 4.3 million total organic impressions (a metric

describing the number of times content is displayed, whether clicked or not) over 8 days on Facebook, Twitter, and Instagram by posting information about local conditions and resources available to flood victims.

6.3.3. Frequency of Checking Social Media

We were interested in how often respondents with dedicated SM personnel checked their Twitter accounts during regular use, in addition to during Harvey. Respondents acknowledging employing dedicated SM personnel were asked “how often does he or she monitor the Twitter activity?” Then, “how often did your organization use Twitter during Hurricane Harvey?”

First responders report checking their Twitter more often than GOVs and NGO-Cs, with 95% checking multiple times per day. While just over three-quarters (76%) of GOVs check their Twitter multiple times each day, all FR and GOV respondent report checking at least once per day. NGO-Cs report checking their Twitter less often, as 22% report checking their Twitter accounts less than once every week, and only about half check Twitter multiple times each day. Figure 6.5 illustrates how respondents monitor SM with three levels of frequency ranging from less than once every week to multiple times per day. This finding suggests first responders and

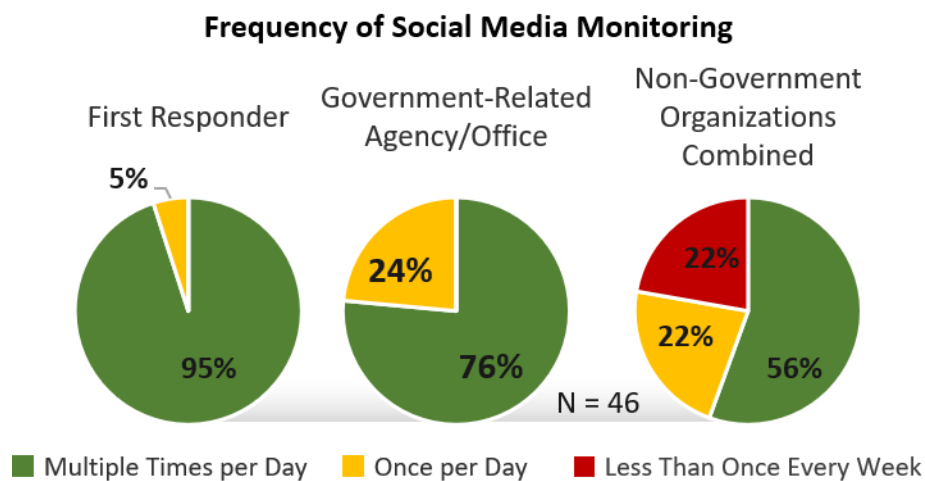


Figure 6.5. Frequency of Social Media Monitoring. Data Source: Survey Question 9. N=46.

government-related agencies and offices may offer the greatest listenability, while fewer NGO-Cs keep close contact with SM audiences.

Survey respondents reported less certainty regarding the frequency they monitored Twitter activity during Hurricane Harvey, indicated by grey shading in Figure 6.6 below. The FRs survey respondents reported the most uncertainty concerning Twitter monitoring of any group, with over one in three (36%) indicating they did not know how often their organization check Twitter, and only 60% report checking Twitter multiple times per day. GOV respondents report continuing to check SM at similar frequencies of non-emergency times, with still about one-quarter (24%) checking Twitter multiple times each day. The ratio of NGO-C respondents who report checking SM multiple times day was the same as during non-emergency times, with 56% checking Twitter during Hurricane Harvey. NGO-Cs also reported a large amount of uncertainty, as 22% did not know how often their organization monitored SM.

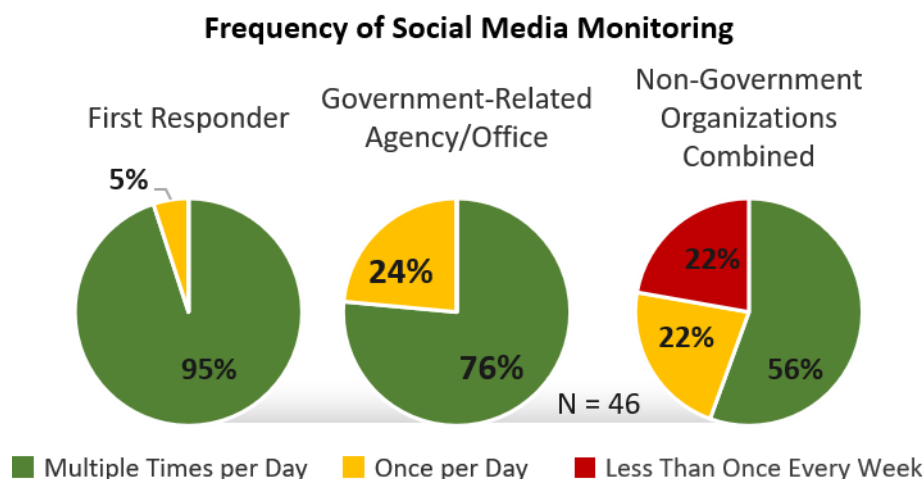


Figure 6.6. Frequency Respondents Monitored Twitter Accounts during Hurricane Harvey in 2017. Data Source: Survey Question 10. N=52.

6.4. Addressing Common Social Media Challenges

Research Question 3.2: How did survey respondents address commonly reported obstacles concerning the use of social media during disasters?

Enhancing risk and crisis communication with the incorporation of SM requires EMs to adopt bi-directional communication tactics on unofficial or new communication channels. Channels like WEA or 911 are official channels that are restrictive and dedicated to EM, making SM unofficial or alternative. For public information officers (PIOs), these changes have been described as transitioning from the role of a gatekeeper to a translator, who interacts with more of the public and more often (Hughes and Palen 2012). This evolution in the role of PIOs often presents burdensome new technical, social, and socio-technical challenges. These include challenges such as anonymity and unknown location of individuals posting on SM. Here, we explore how responders in the Texas and the Houston area report strategies and tactics to enhance risk and crisis communication.

6.4.1. Survey Respondents Likelihood of Employing Personnel Dedicated to Monitoring Social Media

The second research objective previously found that insufficient staffing is a commonly reported obstacle in studies exploring challenges of SM for risk and crisis communicators. Employing assigned SM personnel is encouraged by the NECP, including recommendations to implement communication-related roles and ensure operational planning incorporates new technologies (DHS 2014a).

Four in five (80%) survey respondents report employing assigned SM personnel. GOV respondents were most likely (94%) to utilize assigned SM personnel, followed by NGO-Cs (75%), then FRs (74%). Figure 6.7 illustrates these findings, which indicate the responses of FRs indicate greater uncertainty than the other groups, at 21% being unsure whether they have assigned SM personnel. This survey question asked whether respondents had personnel assigned to monitor Twitter specifically, potentially skewing the results of respondents who focus on SM with larger audiences such as Facebook as indicated in the results. However, a review of the

data found that respondents always monitoring Twitter also report *always* monitoring an additional three SM channels.

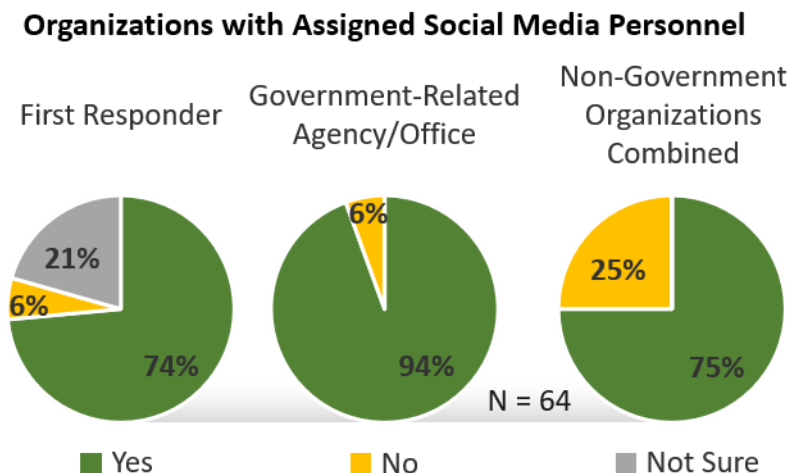


Figure 6.7. Organizations with Assigned Social Media Personnel. Data Source: Survey Question 8. N=64.

6.4.2. Prioritizing Rescue Requests

We also were interested in whether the respondents had developed or applied any type of decision criteria to prioritize the requests they received for help from the public. We asked survey respondents: “If there are multiple requests, how did you or your organization determine who would be rescued first? Please check all that apply.”

Respondents indicated their prioritization of seven response options regarding prioritization of rescue requests with the option of contributing an open-ended response. Two-thirds (66%) of survey respondents indicate one single method for determining how to prioritize multiple rescues, though responses were largely split among the top two response options. The most commonly reported method to determine how to prioritize multiple requests for help (Figure 6.9) was based on the health conditions of flood victims, followed closely by distance to the victims. While FR and GOV respondents placed greater priority on the health conditions of victims, one-fifth of NGO-C responses indicating distance being the most important factor (tied

with not having policy for prioritization) contributed significantly to the second and third top methods in Figure 6.8.

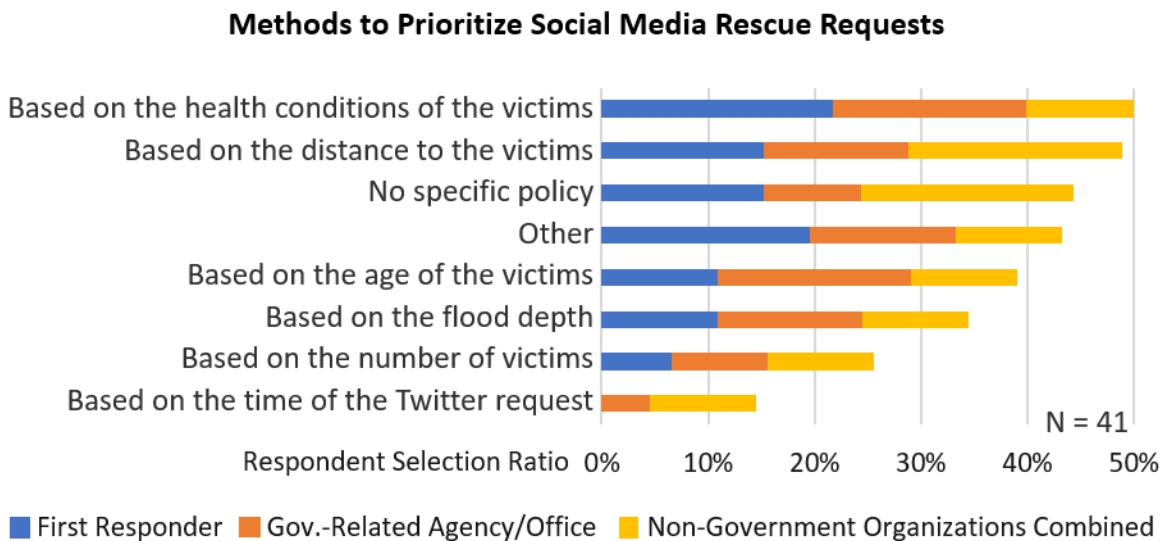


Figure 6.8. Reported Methods to Prioritize Social Media Rescue Requests. Data Source: Survey Question 17. N=41.

The most commonly offered *other* method of prioritizing rescue calls was based on the availability of resources in the areas of the call, which may be stretched thin during a disaster. While jurisdiction and geographic reach of public agencies and NGO-Cs may be a common deciding factor in typical response scenarios, operationalizing flood rescues presents a unique problem in which flood patterns may vary around the contours of local topography. During unprecedented events such as 2017 Hurricane Harvey, responders must consider the logistics of transportation required to cross areas of both inundation and dry land, possibly more than once, in which neither boats nor typical response vehicles can operate. In an ABC News interview on August 27, Houston Police Chief Art Acevedo discussed prioritizing calls based on flood depth, adding that some victims were calling for help with only an inch of water in their homes while other were stranded in attics (ABC News 2017). These findings suggest responders took more of an *ad hoc* approach to prioritize requests.

6.4.3. Information Sharing on Social Media

Another important topic concerns the extent to which these organizations shared information with other groups on SM. Interagency communication is critical for developing adequate situational awareness and achieving the common objective of emergency management, and supports the goals of the 2014 NECP, including the recommendation to “increase intra-State collaboration of communications, broadband, and information technology activities” (DHS 2014a).

Overall, 56% of survey respondents report not using Twitter to share information about flood victims with other potential rescuers on Twitter. This question received a limited number of responses, potentially because respondents overwhelmingly preferred to utilize Facebook over other social media platforms. Survey findings suggest FRs and GOVs were less likely to share information about flood victims on SM than NGO-Cs.

6.5. Recommendations for Improving Social Media for Disaster Response

Research Question 3.3: Which recommendations do responders suggest could improve the utility of social media in future emergencies?

Survey respondents answered questions about improving SM, specifically Twitter, to assist rescue and response efforts in future emergencies, reporting on useful tactics, features, and difficulties based on experience during Hurricane Harvey in 2017. Survey question 20 asked respondents: “Do you have suggestions on how to improve the use of Twitter for future emergencies? Please check all that apply.” Question 20 included three pre-determined recommendations and included the option for respondents to offer open-ended responses. The following question (21) asked respondents to rate the potential usefulness of a range of web-based tools, specifically asking: “Which tool(s) could help rescue operations? Please select a score on a scale of 1 to 5, with 1 meaning very useless and 5 being very useful?” The question

included four examples of web-based tools followed by the opportunity to contribute text responses. The following discussion highlights reported difficulties and suggestions for improving SM-assisted disaster response contributed by these questions.

6.5.1. Difficulties of Social Media and Suggested Improvements

We included an open-ended question designed to gather additional information from respondents concerning suggestions for how to improve social media use during large-scale emergencies. A dozen respondents shared their observations and advice based on first-hand experience with SM. These include seven first responders, two government-related agencies and organizations, and three non-government organizations. The following are selected responses concerning difficulties and potential improvements to SM use during these events.

We cannot currently convert Facebook / Twitter / etc messages into emergency calls. That is step one. Beyond that, there is little current functionality to categorize messages by type (information request, emergency needs, etc) and no live location attached.

–Local Level First Responder

Two first responders suggested flood victims should only use 911 dispatch or set emergency lines to request help. While one offered the “trolls on social media that simply interrupt,” (county level first responder), the second (local level first responder) suggested social media is useful for coordinating volunteers and rescue resources. For example, League City Police relied heavily on their Facebook network to leverage community resources and to coordinate volunteer rescue boats (Figure 6.9). Another local-level first responder expressed their barrier to the use of social media was technical based on their capabilities, which are limited by the antiquated legacy 911 systems.

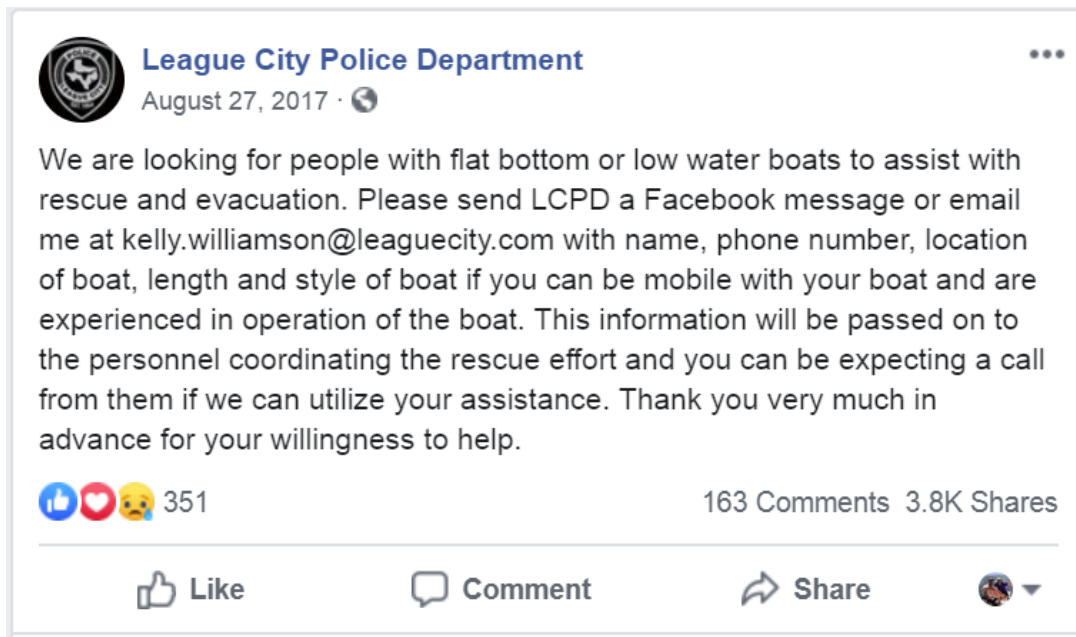


Figure 6.9: League City Police Department Facebook Post Coordinating Community Resources.

Other first responders embraced the utility of unofficial channels. A state-level first responder suggested that a “creeper bar”, a banner that continuously shares emergency contact options would have cut down on their requests for this information with 911 systems became inoperable. Another local level FR offered that the SM platform Nextdoor was very useful for rescue operations, to view and deploy resources as they became available, noting the use of SM required dedication at the station level where officers provided constant updates and communication in a north Houston community. Hurricane Harvey may have been the first major disaster that responders reported relying on the popular neighborhood networking app Nextdoor; a finding supported by Nextdoor associate Caitlin Lee, who found Houston-area agencies shared over 1,200 posts and 3,000 urgent alerts, which received 10,000 replies and 55,000 “likes” (Lee 2018). Another local level first responder provided features that would make social media most useful to their organization in order to optimize data collection and retention.

This could be an absolutely amazing tool if done right to allow one side for those requesting rescue and allowing them to add age, number health problems etc, and update

their status. Then a separate side for the rescuers to track all rescuers, see an exact location of requests, update their status and see/show completed rescues. It would also need to allow for downloading the data for updates and post event review.

-Local Level First Responder

One local government-related respondent reported social media was “extremely useful” in handling coordinating emergency government aid. A state level government-related respondent expressed difficulty getting local responders on board with social media, suggested social media was used to disseminate information, supplementing information offered through official channels.

Getting PD and Fire on board with social media is hard. We still relied heavily on 911 for direct calls. Social media was used for general information purposes only.

-State Level Government-related Agency or Office

While all three non-government accounts of social media use mentioned the use of Facebook, one county level NGO-C reported also coordinating recovery efforts through email and the web. A local NGO-C reported using Twitter and Instagram in addition to Facebook to share local updates on conditions and available resources. Lastly, another local level NGO-C reported using Facebook and email to direct requests for assistance to the proper authorities.

To my knowledge we mainly used Facebook during Harvey. This is where we received the most requests for assistance. We did receive some email requests for rescue. I remember one that someone from Houston called Austin radio station, they then turned to Salvation Army in Austin who then forwarded information to me in Houston. For those, I reached out to a friend in the Harris County Emergency Office, so she could pass along to Fire Department. The way we used Facebook was mainly in getting food and other immediate needs to flood survivors.

-Local Level Non-Government Organization

Survey respondents contributed an average of 1.7 suggestions to improve Twitter for future emergencies when provided three pre-selected suggestions, with a fourth option for text entry for respondents with “other” suggestions. Figure 6.10 illustrates findings expressed as a ratio of selection within respondent groups. Survey respondents cumulatively identified *educating users on how to use Twitter to contact dispatchers and volunteers* would be most

useful for future emergencies. User education is the most-selected option of first responders by ratio. The second most-reported suggestion was to *create special hashtags for emergency rescue*, which was the top-selected suggestion of government-related agencies and offices and NGO-Cs. Respondents proportionately reported *creating special accounts for users to contact when they need emergency rescue* least often, receiving the least support of government-related agencies and offices.

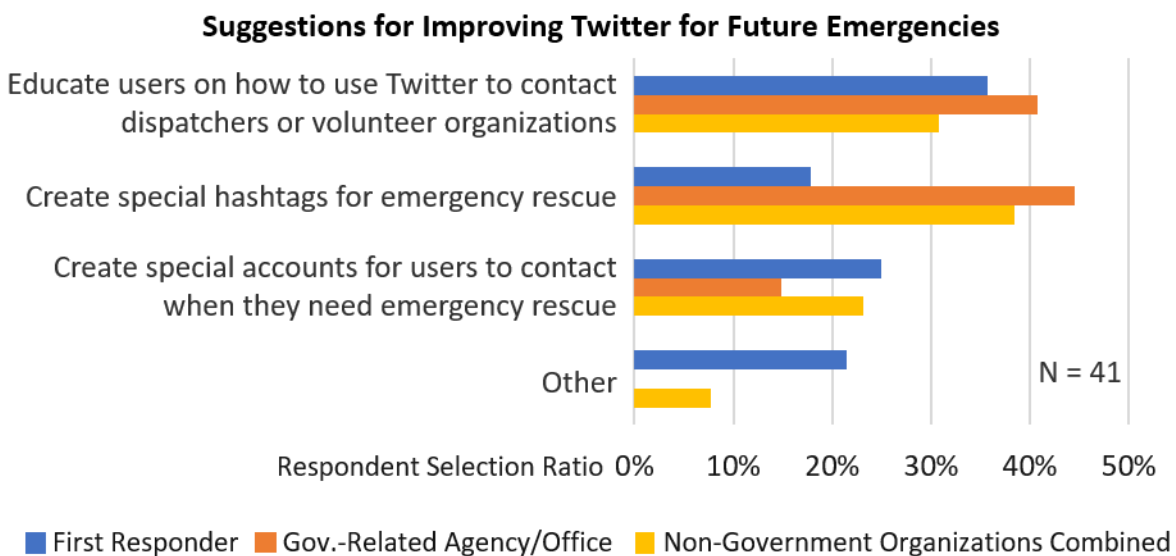


Figure 6.10. Suggestions for Improving Twitter for Future Emergencies. Data Source: Survey Question 20. N=41.

First responders mostly represented by local-level agencies contributed 80% of helpful qualitative responses. A state-level FR expressed frustration with Twitter, which all other responses related in some manner. Three of the five responses contained frustration with difficulty determining the status of a rescue. One NGO-C respondent added the process was time consuming, a finding consistent with a news story covering the issues surrounding the legacy 911 systems (Kelly 2017). Another NGO-C suggested the (Facebook) safety check feature would help address the issue for Twitter, a first responder added Facebook was more

beneficial for their agency overall because it contains more useful tools and a greater audience among the public.

Dont think Twitter will ever be especially useful in this situation. Its like talking in a crowded bar; you cant really hear anything because of all the noise.

-State Level First Responder

Determining the location of flood victims was the second most common frustration expressed in the text responses. Responders added that showing up to inaccurate addresses delayed response times. In the same sense, a local first responder suggested Twitter was only useful for sharing information with the public. Lastly, a county level first responder suggested making social media two sided (adding features and capabilities for responders) would help simplify the coordination of volunteers, adding that making the data downloadable would ease tracking the status and post-event review.

6.5.2. Potentially Useful Social Media Tools

Respondents contributed their opinions of the potential benefit of supplemental social media tools, with the option of text entry for “other” tools. The magnitude of usefulness was captured through a five-point Likert-type response matrix, illustrated in Figure 6.11, in which a score of one is least and five is most useful. While the lowest score “not at all useful” was never selected, “slightly useful” was only ever selected by 6% of respondents. Contrarily, 47% of respondents felt all three tools would be “extremely useful”, of which one in five provided additional attributes of useful tools through text response.

The most desired social media tool was *a map with real time requests for rescue*. First responders and government-related agencies and organizations favored this response option most, with first responders reporting the greatest usefulness of any respondent groups for any suggested tool. The second most useful tool reported by survey respondents was *a map with real-time flood depth*, the preferred tool of NGO-Cs, and least concern of first responders. A

platform to coordinate with other organizations was least selected overall, though preferred by first responders over other groups.

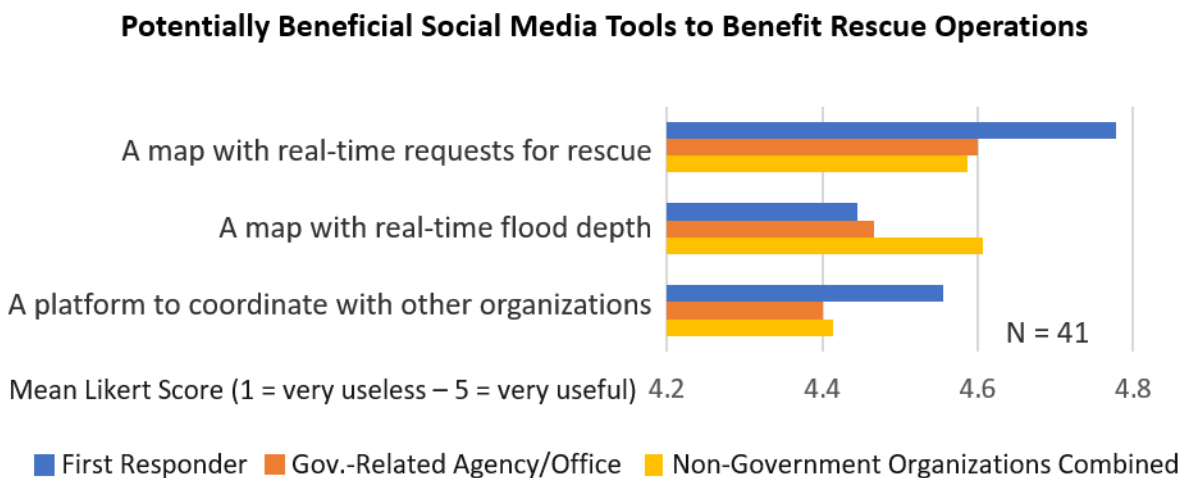


Figure 6.11. Potentially Beneficial Social Media Tools Data Source: Survey Question 21. N=41.

6.6. Summary of Findings

This case study contributed knowledge to the literature regarding the use of SM to assist rescue efforts during Hurricane Harvey in 2017. Original survey findings presented accounts of SM use by 64 first responders, government-related agencies and offices, and non-government organizations. We found at least 89% of survey respondents hold a social media account, a rate similar to that of Hurricane Isaac and Sandy study area survey respondents, through only three-quarters of Harvey survey respondents used social media to assist rescue efforts.

The Harvey survey respondents preferred SM communication channels that were consistent with those reported by organizations within the Hurricanes Isaac and Sandy study areas. All government-related agencies and offices and non-government organizations reported using Facebook during the Harvey response effort, with the second- most popular channels respectively for each respondent group being Twitter and websites. Nine in ten first responders

reported using Facebook and about six in ten use Twitter. Further investigation found first responders' use of social media was limited by their inability to convert requests from the public received through SM into dispatchable rescue missions, thereby relying solely on the overwhelmed and outdated 911 system. Survey findings also supported the notion that Hurricane Harvey was the first major disaster in which responders utilized the neighborhood SM platform Nextdoor to communicate with community networks suggested by Lee (2018).

First responders reported checking SM during Harvey with the greatest frequency, and non-government organizations reporting monitoring social media the least. The survey respondents reported receiving rescue requests on social media, with Facebook the most common platform and only about 3% of rescue requests received through Twitter. About 80% of respondents maintained assigned social media personnel to handle these requests. Government-related offices were most likely to employ social media personnel, with first responders least likely. This finding differed from the findings of the first survey, where NGO-Cs most commonly reported employing dedicated social media personnel.

While government-related respondents and first responders report prioritizing rescue requests based on the health of the victim, non-government organization most commonly reported prioritizing based on distance to the victim. Over half of the respondents reported not using Twitter to share information with other potential rescuers despite being the second most commonly used social media platform used during the Harvey response efforts.

Lastly, first responders commonly reported frustration with SM and indicated they were unable to convert social media requests to dispatchable missions to assist people in need. Government-related respondents noted that getting first responders to participate on SM was difficult. This finding suggests some government-related agencies and offices may be unfamiliar

with the technical barriers faced by first responders, who report an inability to incorporate SM communication into organizational communication strategies because wired 911 dispatch systems are incompatible with web-based communication protocol. Non-government respondents reported using Facebook, email, and the web to coordinate rescue missions, while others used Facebook, Twitter, and Instagram to share local updates. The most common suggestion for improving social media for disasters was to educate the users on how to contact dispatchers and volunteer organizations. The most valued potential web tool selected by respondents was a real-time map of rescue requests, which was requested by survey respondents in both surveys.

Several researchers have expressed the value of supporting listenable communication channels, or listenability of SM (Latonero and Shklovski 2011). Maintaining listenability and supporting bi-directional communication with community members may help to develop institutional trust in, which in turn has the potential to increase the effectiveness of crisis communications (Hughes and Chauhan 2015). First responders who contributed to flood rescues following the landfall of Harvey responders indicated they provided a high level of listenability in the wake of Hurricane Harvey, but also reported major challenges with how to handle the information found on SM. This finding was somewhat consistent with the first survey, in which survey respondents indicated interest and noted the value in using SM to pull information from the public, but did not report much experience doing so. The findings of the second survey suggest that responders could benefit much more from SM if dispatch centers could be upgraded to more adaptable web-based 911 systems.

Chapter 7. Conclusion

7.1. Summary of Findings and Research Implications

The overall aim of this dissertation was to provide new and useful insights about how social media (SM) has been used in recent large-scale hurricanes by key organizations that comprise the “whole community” of emergency management (EM). Research objectives I and II present original survey findings collected from 269 public agencies and organizations in the EM field in areas affected by 2012 Hurricanes Isaac and Sandy. Research objective III includes a case study exploring how SM was used to assist flood rescues in the Houston, Texas area during the response phase of Hurricane Harvey in 2017.

7.1.1. Research Objective I

The first research objective was to examine how members of the whole community of EM report using SM, including when they use SM relative to the four phases of EM (preparedness, response, recovery, and mitigation), how their SM preferences align with those of the public, and the barriers they may have encountered. We found that 90% of survey respondents report using SM in their EM work, a rate consistent with the findings of other researchers. The 10% of organizations in this survey that reported not using SM consisted mostly of NGOs, of which the majority stated that it is not their mission to participate in risk and crisis communication with the public through SM.

This research found that the primary role or rationale for SM use by these organizations is to supplement their established communications on official channels by disseminating or *pushing* information out to online audiences. Survey respondents reported optimistically about SM’s ability to extend the reach of their communications and its potential for increasing public engagement. They seemed less certain about the utility of SM to gather valuable or consistently

useful information from the public. Despite their eagerness to benefit from SM, the majority of respondents reported less ambition regarding gathering or *pulling* information from the public using SM. Specifically, most respondents agreed that SM has a limited ability to crowdsource information from community members or to identify individuals in need of assistance. The exception was news media organizations, who report being most comfortable with activities involving *pulling* information from the public through SM. As the Department of Homeland Security Social Media Working Group recommends, all parties involved with risk and crisis communication on SM could benefit from *pulling* information from SM. Therefore, it may be advantageous for news media organizations, who report more involvement with using SM to pull information from the public, to demonstrate their tactics to others in the EM field who are interested in maximizing the benefits of SM. Survey respondents also indicated SM could be used to enhance community disaster resilience by maintaining dialogue with the public during all phases of the EM cycle to engage citizens and build relationships in the community. Introducing exercises utilizing *pull* tactics could help EMs develop experience and knowledge with these advanced SM operations between disasters as an approach to maintain communications with community members.

Preferences for SM channels were similar across the four respondent groups, with Facebook being the top choice of all groups. Nearly all (97%) SM users indicated using Facebook to respond to the public at least *sometimes*, followed by 84% using Twitter and 52% using Instagram at least *sometimes*. Respondents were least likely to utilize Google+, Nextdoor, and Snapchat. Facebook is the preferred SM platform among the general population in the US and among the organizations involved in EM. However, the adoption rates of newer popular SM

platforms, such as Instagram, by respondents seem to lag behind the growing audiences, which quickly outpaced public subscription to Twitter in its second year.

The first research objective found respondents in each group report SM could be used to enhance disaster resilience by maintaining communication with the public on a regular basis through all phases of EM, which is a recommendation made in the National Emergency Communication Plan (NECP) for improving emergency communications. Researchers agree the quiet times between emergencies present the most opportunity for building relationship in the community to foster credibility and build trust in risk and crisis information providers. This may lead community members to follow the advice of public warning messages, thus reducing the amount of time spent *milling*, or looking for information in personal networks when individuals face an unfamiliar risk to public safety or health (Hughes and Chauhan 2015, Janoke, Liu, and Sheppard 2012, Wood et al. 2017). The quiet time between emergency events includes the mitigation phase in FEMA's four-phase model of emergency management, the phase of lowest reported use of SM by the survey respondents to communicate with the public. Other works suggest that building relationships with community members helps facilitate the development of social capital, which is an important factor contributing to resilience to disasters (Aldrich and Meyer 2015). Respondents also suggest that redundancy in number of communication channels supported by risk and crisis communicators could help to narrow the gap in bi-directional, citizen-government communication by reaching more individuals. However, adopting more SM communication channels or platforms may be problematic for organizations following the restrictive nature of National Incident Management System (NIMS) protocol.

The first survey found that respondents representing government and public safety offices report using SM more during the response and the preparedness phases, while those performing

secondary roles in risk and crisis communication, such as news media and non-governmental organizations, report more SM activity during the recovery phase. This suggests organizations performing primary and secondary roles in EM may play complementary roles in risk and crisis communications with the public across the phases of emergency management. It is noteworthy that the survey respondents from each of the groups reported the lowest use of SM to communicate with the public during the quiet times between emergencies, or the mitigation phase of emergency management. This finding suggests an opportunity for the groups that comprise the whole community of emergency management to increase their public communication efforts via SM during this quiet phase when the immediate demands of the crisis and its aftermath have passed.

7.1.2. Research Objective II

The second research objective sought to identify obstacles and challenges regarding the use of SM including the emergence of new challenges, and tactics and strategies applied to overcome common challenges. Findings were presented between two groups instead of four to examine the potential influence of the NIMS on the challenges faced by government (GOV) versus non-government (NGO) type respondents, since NGOs are not guided by NIMS. Also, we were interested in detecting new or emerging challenges that may not have been identified in earlier examinations of SM use among the EM field. The remainder of the second research objective explored strategies respondents employ to overcome some common challenges.

The survey respondents reported that the most significant challenges are the unknown accuracy of information on SM, followed by insufficient human resources to manage SM use within their organizations, and the challenges presented through anonymity of users on SM. This finding is the first known case in the literature indicating that concerns about information accuracy is a top concern among EMs. NGO respondents expressed higher levels of concern

about each of these issues than GOV respondents. Additional problems noted by the survey respondents included information and communication infrastructure failure and problems with internet connectivity, followed by the low level of user-friendliness of SM for emergency management, then language and cultural barriers.

Regarding the extent to which these EM organizations attempt to evaluate the effectiveness of their online communications, we found that NGOs express greater interest in observing various audience behaviors than government agencies. NGO respondents also reported greater involvement in SM campaign-evaluation tactics and strategies to increase audience size and level of interaction. These findings suggest NGOs may put forth greater effort to encourage growth of their online audiences in order to reach more people.

We identified several tactics and strategies reported by the respondents to overcome obstacles to more effective SM use in their EM work. NGOs and GOVs reported similar rates of policy adoption within their organizations since 2012 to better respond to public comments and concerns, assign dedicated SM personnel, develop target goals for their SM communications, implement around-the-clock SM monitoring, leverage additional support to meet high demand for communication during emergencies, and develop policies regarding following other SM users. In general, we found that efforts to evaluate the reach and impact of communication campaigns with the public are much more likely to be implemented by NGOs than government organizations. However, we found that NGOs report committing less attention to the verification of the accuracy of information before sharing it with the public on SM. Therefore, NGOs may be more susceptible to the inadvertent spreading of misinformation during and after a disaster.

The second research objective identified common challenges that are both internal and external to reporting public agencies and non-governmental organizations. As organizations

move toward the institutionalization of SM as described by Mergel and Bretschneider (2013), they develop policies and allocate resources to support their SM campaign objectives. Lessons learned from experience with SM help to make challenges of SM communication more predictable and more likely for EMs to overcome. Through this process of campaign development, the challenges that are internal to the organizations may be mitigated against. The survey findings indicate both GOVs and NGOs report greater concern toward external-type challenges, with NGOs reporting higher levels of concern toward these challenges than the governmental organizations. When asked in an open-ended question about any other challenges of social media communication, only 13% of responses described internal-type challenges. These findings suggest the social media campaigns of respondents' organizations have matured into the "institutionalization" phase of SM adoption, as both groups report less concern toward internal-type challenges such as insufficient human resources and SM competence.

7.1.3. Research Objective III

The third research objective was to examine the use of SM during the emergency response phase of Hurricane Harvey in 2017. The case study reports on original survey findings contributed by 64 respondents organized into three groups to better understand how they used SM. The groups are: first responders (FR), government-related agencies and offices (GOV), and non-government organizations (NGO) – including news media organizations due to limited responses from that group. –The case study explored topics including specific channels they used to communicate with the public, popular channels they received rescue requests through, organizational resources and SM policies, and recommendations for improving the functionality of SM for future disasters.

Harvey responders reported using the same top six web-based communication channels as the respondents in the first survey, with Facebook being the most popular. Respondents

reported receiving a wide range in number of requests for assistance from the public, with FRs receiving the most of the three groups. We were interested in the extent to which these organizations monitored their social media during the emergency and during non-emergency or routine times. We found that while the GOVs observed the greatest number of SM channels, FRs reported checking their SM most often during the emergency. These findings suggest FRs may possess the greatest “listenability”, but on a narrower spectrum of channels. Interestingly, nearly all rescue requests were channeled through Facebook rather than Twitter. This finding highlights the importance of maintaining flexibility in terms of supporting listenability on multiple channels. While previous studies found Twitter played an important role in the response and recovery phases of other recent disasters, our findings suggest Twitter was not used as extensively as other platforms such as Facebook and Nextdoor, which respondents reported using to maintain contact with the public and coordinate community resources.

Several FR survey respondents reported significant difficulty or inability to convert requests received on SM to dispatchable rescue missions. This and other challenges, including routing calls away from damaged Public Safety Answering Points, present technical barriers for legacy wired 911 systems still in use throughout much of the US. Legacy wired 911 systems are unable to support web-based communications. As a result, incorporating SM communications into the protocol of FRs would require agencies to upgrade PSAP dispatch technologies to a more adaptable system such as Next Generation 911, a web-based adaptable PSAP system already being used in parts of the US.

When asked how respondents prioritized calls for assistance, a division was apparent between respondents acting under the direction of NIMS (FR and GOV) and NGOs. The GOV and FR respondents who are responsive to the NIMS guidelines reported prioritizing requests

based on the health conditions of the victim, while NGOs most commonly reported prioritizing requests for assistance based on distance to the individual(s) in need. Prioritizing requests based on distance may indicate NGOs lacked resources such as high-water vehicles capable of traversing dynamic landscapes such as crossing between inundated and dry land to reach flood victims. Altogether, decision criteria used to prioritize requests for help among the survey respondent groups were varied, suggesting responders took more of an *ad hoc* approach to maximize their performance based on the available resources.

We were interested also in the amount of interagency communication conducted on SM. We asked respondents about sharing information about flood victims on Twitter based on the assumption that greater interagency communication helps to improve situational awareness. The findings suggest over half (56%) did not use Twitter to communicate with other agencies about flood victims. The low reported rate of information sharing may be attributed to two conditions. First, EMs maintain access to channels dedicated to emergency communication. Using unofficial channels to share potentially sensitive information is not recommended by NIMS protocol. Second, compared to other ITC including email and Facebook, few survey respondents reported using Twitter during Harvey.

Finally, we were interested in the recommendations to improve the utility of social media in future emergencies. Among the Hurricane Harvey survey respondents, several provided thoughtful feedback with suggestions to increase the effectiveness of SM during disasters. These included addressing the incompatibility of the legacy wired phone systems with web-based communications, a problem that limits the abilities of PSAPs to respond to requests for assistance. Other respondents provided insights on how they benefitted from SM, such as using Facebook to coordinate community resources (e.g. putting out a call for shallow-draw boats) to

contribute to rescue efforts. The neighborhood SM platform Nextdoor allowed responders to disseminate information rapidly at the neighborhood level to supplement official channels, and provided a responsive link for bi-directional communication between responders and citizens. Lastly, echoing a resonating theme throughout the study relating to the need for more bi-directionality in emergency communications, survey respondents suggested they could benefit more from SM during a disaster if Facebook was two-sided to provide additional functions for responders. For example, a *back-end*, or separate application for platforms like Facebook could be engineered to allow government-related agencies to collect and store information about the victims requesting assistance. Attaching a web form to Facebook's Safety Check feature would allow responders to compile and display rescue requests geographically, including information about the victims such as age and any health concerns or physical limitations. A map or visual display of the calls for assistance, relevant attributes of the callers, and the rescue status of each call would support more efficient and effective responses.

Several researchers have expressed the need and value of supporting listenable communication channels, or listenability of SM (Latonero and Shklovski 2011). Maintaining listenability and supporting bi-directional communication with community members may help to develop institutional trust, which in turn has the potential to increase the effectiveness of crisis communications (Hughes and Chauhan 2015). These findings offer additional insight about the challenges to bi-directional communication during large-scale crises. While, first responders who contributed to flood rescues following the landfall of Harvey indicated they provided a high level of listenability in the wake of the storm, they also reported major technical problems, such as how to handle the information gathered through or observed on SM. By contrast, survey respondents from the areas affected by Hurricanes Sandy and Isaac indicated interest and noted

the value in using SM to pull information from the public at greater rates, but did not report much experience actually doing it. The findings of the Hurricane Harvey respondents suggests emergency responders could benefit much more from SM if dispatch centers could be upgraded to more adaptable, web-based 911 systems.

7.2. Research Contributions and Limitations

The dissertation research contributed knowledge to the literature regarding the use of SM by public agencies and organizations filling primary or secondary roles in EM. While the intersection of SM and EM has been studied in recent years, this research aimed to generate new information about how members of the whole community of EM utilize SM for risk and crisis communication with respect to the four phases of the EM cycle. The findings were derived from two original survey instruments made available to respondents in 2018 in areas affected by Hurricanes Isaac and Sandy in 2012, and by Hurricane Harvey in 2017. The work identified important barriers to the use of SM in the EM field, new challenges, and examples of best practice techniques and lessons learned from recent disasters.

The work also provided a systematic technique to develop study populations using keyword-combination queries to sample relevant agencies and organizations in a defined area using Twitter Search. The combined study population contained nearly two thousand public agencies and organizations assumed to be involved in risk and crisis communication, along with SM network statistics, audience sizes, age of SM accounts, and additional baseline information to support additional or comparative analysis in the future.

While the sampling methodology included robust querying, it also introduced potential bias into the findings by only identifying public agencies and organizations publicly visible and active on SM. Authors of some related studies relied on snowball sampling (Su et al. 2012) and

arduous examinations of public records to guide web queries to compile a comprehensive dataset containing all fire and police agencies in the study area (Hughes et al., 2014). However, these methods were not appropriate for the nature of the study, which sought feedback from public agencies and organizations of the whole community of EM already active on SM. In fact, relying on systematic Twitter queries to identify potential survey respondents (as done here) for counties and states with FEMA disaster declarations following Hurricane Sandy allowed for the compilation of a sample population of police and fire accounts with “join dates” prior to August 2012 nearly twice as large as the sampling method developed by Hughes et al. (2014).

7.3. Future Research

Enhancing risk and crisis communication helps public information brokers narrow risk-related communication gaps. Communication gaps may include vital information about safety not reaching all residents and/or the needs of the public not being identified quickly by emergency managers. The findings presented in this dissertation indicate dissipating concern surrounding some of the earlier challenges to SM that were found to be of great concern as reported in recent studies. These results suggest that experience implementing SM and the guidance provided by the federal government in recent years have facilitated greater use and confidence in the utility and applicability of SM in emergency management. The concerns expressed by the survey respondents point to a new set of challenges, and the most significant among them is the growing issue of false or inaccurate information being spread during and after the crisis. Non-governmental organizations expressed greater concern over this problem than did the government-related organizations. Government agencies and offices tend to disseminate information from official sources to the public, and thus may have more confidence in the information they share. However, questions about the accuracy of the information gathered from

the public by both government and NGOs, may make maintaining the important capacity of “listenability” with the public during the four phases of an emergency more difficult.

Overall, these results show that SM is widely used by key groups that comprise the whole community of emergency management, and that they play complementary roles in risk and crisis communication. Future studies could build upon the baseline information developed here to identify changes in the objectives, methods and evaluation strategies used by these types of organizations concerning their use of social media for emergency management. Further, the specific technical recommendations offered by those groups that were active during the response phase of Hurricane Harvey offer useful insights into how SM could be made more responsive and interactive to enhance the efficiency of rescue efforts. Understanding the ways in which SM enhances emergency management activities throughout the preparation, response, recovery and mitigation phases, as well as the limitations of current platforms and technology provides researchers, practitioners and residents with useable knowledge to inform future investment and planning for more effective emergency management.

Appendix A. Obstacles Reported in the Literature

Study Citation	Condition Observed	Study Type	N	Respondent Profile	Findings (*=top-reported obstacle)
Latonero, M. and I. Shklovski (2011)	Interview Transcript Inference	Interview	1	Fire Department PIO	<ul style="list-style-type: none"> > Blurred lines between intentions and communications of private and public spheres > Building credibility with the community is labor intensive > Information validation can be difficult
Hughes, A. L. and L. Palen (2012)	Social Media Difficulties	Interview	25	All levels of Gov.-type EM	<ul style="list-style-type: none"> > Obtaining approval to share messages from leadership fearing novel approaches could backfire > Lacking time and resources > Lack of leadership backing social media initiatives > Insufficient funding > Lack of dedicated personnel* > Lack of established policies > Lack of knowledge > Personnel lack sufficient training
Su, Y. S., et al. (2013)	Barriers to Social Media Use	Survey	505	All Levels of EM, law enforcement, and fire PIOs	<ul style="list-style-type: none"> > Coordinating multi-actor networks > Information asymmetries created by uneven sharing > Inaccurate information sharing > Rumor control requires constant monitoring
Wukich, C. and I. Mergel (2015)	Communication Challenges	Network/Content Analysis	n/a	n/a	<p>Technical:</p> <ul style="list-style-type: none"> > Trustworthiness > Information overload <p>Organizational:</p> <ul style="list-style-type: none"> > System support* - Financial cost of technology and staff - Manpower to maintain records > Policies and procedure* - Account access and management - Guidelines for social media use - Data management - Privacy and security - Accessibility
Plotnick, L. and R. Hiltz Starr (2016)	Barriers to Social Media Use	Explatory Interview	200	County level emergency managers	<p>Internal:</p> <ul style="list-style-type: none"> > Insufficient staffing* > lack of formal policies > Institutional infrastructure prohibiting social media lack of training <p>External:</p> <ul style="list-style-type: none"> > Data verification > Security of information > Liability that might characterize information > Subjectivity that might characterize information
McCormick, S. (2016)	Social Media Challenges	Interview	19	Whole Community multi-level	

Appendix B. Survey Instrument 1: Hurricanes Isaac and Sandy Responders Survey Instrument

ICAR4.3_Survey1_RK

Start of Block: Screening Questions

Q0 Hello and welcome. We are ICAR, a multi-department research team at Louisiana State University.

Thank you for your interest in being part of our research study entitled “Understanding Social and Geographical Disparities in Disaster Resilience Through Social Media” and funded by the National Science Foundation. We are giving online surveys to agency and organization representatives in areas that were affected by Hurricanes Isaac and Sandy. We are surveying about 1,500 agencies and organizations directly active in or supporting functions of emergency management from the federal to local levels. This research seeks to understand how they use social media, specifically Twitter to communicate and gather information before, during, and after these hurricanes.

This survey will take approximately 15 minutes of your time. Your participation in this research is voluntary. You may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled. Your name, and responses will be kept confidential.

There are no direct benefits to you for participating in the survey, but the information gathered may help us further understand disaster resilience in your community and for other communities across the country. You do not face no more/greater than risks than you would come across in everyday life for participating nor are there any costs to participate.

If you have questions about the study, you can contact any of the principal researchers at the contact information listed below. This study has been approved by the LSU IRB. For questions concerning participant rights, please contact the LSU Human Subjects Protection Program at 225-578-8692 (irb@lsu.edu).

Thank you again for your time and participation in our study. By clicking below to continue the survey, you are indicating your consent to participate and allow us to collect your responses for research purposes.

Sincerely,
Nina Lam, nlam@lsu.edu
Michelle Meyer, mmeyer@lsu.edu
Margaret Reams, reams@lsu.edu
Ryan Kirby, rkirby3@lsu.edu

1.1 How would you describe the nature of the organization your Twitter account represents? Select One:

- ☐ Charitable Organization (1)
 - ☐ Government-Related Agency or Office (2)
 - ☐ First Responder (3)
 - ☐ For Profit Non-Government Organization (4)
 - ☐ News Media Organization (5)
 - ☐ Non Profit Non-Government Organization (7)
 - ☐ Other, Please Explain: (6) _____
-

1.2 How would you describe the geographic reach of your organization? Select One:

- ☐ Local Organization representing a city, municipality, or neighborhood (4)
 - ☐ County-wide (3)
 - ☐ State-wide (2)
 - ☐ Nationally within the United States (1)
-

1.3 Please provide the geographic area for which your organization is most associated.

For Example, Appropriate Responses Include:

The United States New Jersey Escambia County, FL Newport, RI

1.4 Does your organization use social media to inform the public of emergencies? Select One:

- ☐ Yes (1)
- ☐ No (2)

Skip To: 2.7 If Does your organization use social media to inform the public of public health crises or emergencies? = Yes

1.5 Why doesn't your organization use social media to inform the public of emergencies?

Select all that apply:

- ☐ Lack of Financial Resources (1)
- ☐ Lack of Human Resources (2)
- ☐ Lack of Policy or Protocol Regarding Social Media Use (3)
- ☐ Lack of Technology Resources (4)
- ☐ Lack of Training or Skills (5)
- ☐ Social Media has a Limited Ability to Reach our Target Audience (6)
- ☐ Uncertainty of the Accuracy of Information (7)
- ☐ Not Our Organization's Mission (9)
- ☐ Other, Please Explain: (8) _____

1.6 Do you plan to incorporate social media into your organization's communication strategy in the future?

- ☐ Yes (1)
- ☐ Maybe (2)
- ☐ No (3)

Skip To: End of Survey If Do you plan to incorporate social media into your organization's communication strategy in the fu... = Yes

Skip To: End of Survey If Do you plan to incorporate social media into your organization's communication strategy in the fu... = Maybe

Skip To: End of Survey If Do you plan to incorporate social media into your organization's communication strategy in the fu... = No

2.7 How does your organization respond to public questions and comments?

	Never (1)	Sometimes (2)	About half the time (3)	Most of the time (4)	Always (5)
Blog (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Email (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Google+ (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Facebook (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Instagram (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mobile Application (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nextdoor (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nixel (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Snapchat (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Text Message Alerts (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Twitter (11)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Website (12)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zello (13)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Traditional News Media (14)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2.8 Which types of messages does your organization share over social media platforms?

Select All that apply:

- ☐ Press Release (1)
- ☐ Local Updates, Alerts, or Warnings (2)
- ☐ Retrospective or After-action Reports (3)
- ☐ "Send Us Your Pictures" or "Let us Know" Type Messages (4)
- ☐ Call for Action (click a link to read more, etc.) (6)
- ☐ Retweets of Citizens' Messages (7)
- ☐ Interactive Community Engagement/Networking (replying to individual users, acting as a part of the community) (8)
- ☐ Responses to Media Organizations (9)
- ☐ Other (10) _____

2.9 Does your organization validate information before sharing it with the public?

Select one:

- ☐ Always (1)
- ☐ Most of the time (2)
- ☐ Sometimes (3)
- ☐ Never (4)

Skip To: 2.11 If Does your organization validate information before sharing it with the public? Select one: = Never

2.10 How does your organization validate information before sharing with the public?

Select all that Apply:

- ☐ Sharing information only from official sources (1)
- ☐ Sharing information only from Verified Accounts (Twitter) (2)
- ☐ First person accounts from persons on the ground (3)
- ☐ No policy regarding information sharing on social media (4)

2.11 How would you rate your organization's use of social media during the following phases of emergency management?

	Never (1)	Sometimes (2)	Most of the time (4)	Always (5)
Mitigation: Preventing future emergencies or minimizing their effects (For Example: conducting inspections of building safety) (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Preparedness: Preparing to handle an emergency (For example: stocking hurricane supplies) (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Response: Responding safely to an emergency (For example: Checking official news sources before returning to an affected area) (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Recovery: Recovering from an emergency (For example: rebuilding stronger after a disaster) (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

2.12 Does your organization have a plan to increase support for social media communications during a crisis? (For Example: Assigning additional staff members to meet high demand)

- ☐ Yes (1)
- ☐ No (2)
- ☐ Not Sure (3)

Skip To: End of Block If Does your organization have a plan to increase support for social media communications during a c... != Yes

Skip To: End of Block If Does your organization have a plan to increase support for social media communications during a c... = Not Sure

2.13 How does your organization increase capacity to monitor social media during crisis events?

Select all that apply:

- ☐ Ad Hoc Leveraging of Volunteers (1)
- ☐ Crisis Plan Diverting Support Within Organization (2)
- ☐ Crisis Plan Leveraging Third Party Organizations (3)
- ☐ Other, Please Explain: (4) _____

3.14 Please describe your agreement with communicating risk-related information through social media.

	Strongly Agree (1)	Agree (2)	Somewhat Agree (3)	Neither Agree nor Disagree (4)	Somewhat Disagree (5)	Disagree (6)	Strongly Disagree (7)
Serves as primary means of communication (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Supplements primary means of communication through other media outlets (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Collects information from the public through two-way communications (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Assists and informs official disaster response strategies (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Identifies individuals in need of assistance (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Will play a greater role in crisis and risk communication in the future (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3.15 Does your organization “follow” other users on social media? If so, how do you select who to follow?

Select all that Apply:

- ☐ ☒ This is not a focus of our social media campaign (1)
- ☐ Following users in the local area (2)
- ☐ Following reputable verified sources of crisis or risk information (3)
- ☐ We have other criteria for selecting who to follow, such as: (4)

3.16 Which audience behaviors does your organization seek to measure?

Select all that Apply:

- ☐ Awareness of organization (1)
- ☐ Online engagement with organization (2)
- ☐ Clicks and shares to organization’s website or mobile application (3)
- ☐ New advocates and fans of organization (4)
- ☐ Increasing organization’s online presence relative to competing organizations (5)
- ☐ ☒ None (7)

☐ Other, Please Explain: (6) _____

3.17 Which metrics do(es) your organization use to evaluate communication through social media?

Select all that Apply:

- ☐ Gather feedback from public (1)
- ☐ Monitor social media metrics with built-in features (2)
- ☐ Consultation with third party organizations (3)
- ☐ Use data collected from metrics to make efforts to expand reach of communications (4)
- ☐ Advertise or cross-reference social media profile elsewhere (5)
- ☐ ☒ We do not actively monitor communication success on social media accounts (6)
- ☐ Other, Please Explain: (7) _____

3.18 When reaching out to a disaster-affected community, how would you rank the extent of concern when confronted with the following common obstacles on social media?

	Not a concern (1)	Small concern (2)	Major concern (3)
Difficulty or complexity of social media (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Low subscription to social media by public in the local area (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Insufficient human resources to monitor social media (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Unknown accuracy of Information on Social Media (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Anonymity of users (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Insufficient technology resources (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Improper/Insufficient training (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Lacking procedure or protocol within agency/organization (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

3.19 Are there other obstacles that you encounter when reaching out to a disaster-affected community using social media?

- ☐ None/Not Sure (1)
- ☐ Please Explain: (2) _____

3.20 Because some people do not use social media, do you think the uneven social media use (disparity) may affect your emergency management to disasters?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Not Sure (3)

Skip To: 3.22 If Because some people do not use social media, do you think the uneven social media use (disparity)... = No

3.21 Do you have any thoughts on how to improve disaster resilience through social media?

3.22 How might social media benefit your organization in the future?

	Unlikely (1)	Maybe (2)	Likely (3)
Providing means reach more people than traditional media (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Increasing public engagement (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Tool for improving situational awareness and crowdsourcing information (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Source of news and information (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other, Please Explain: (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Carry Forward Selected Choices from "How does your organization respond to public questions and comments?"



4.23 Did your organization use these specific communication platforms during Hurricanes Isaac or Sandy in 2012?

	Yes (1)	No (2)	Not Sure (3)
Blog (x1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Email (x2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Google+ (x3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Facebook (x4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Instagram (x5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Mobile Application (x6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nextdoor (x7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nixel (x8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Snapchat (x9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Text Message Alerts (x10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Twitter (x11)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Website (x12)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zello (x13)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Traditional News Media (x14)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

4.24 Which year did your organization begin Tweeting about disaster or emergency events?

▼ 2006 (1) ... We do not use Twitter (13)

Skip To: End of Survey If Which year did your organization begin Tweeting about disaster or emergency events? = We do not use Twitter

Skip To: End of Survey If Which year did your organization begin Tweeting about disaster or emergency events? = 2013

Skip To: End of Survey If Which year did your organization begin Tweeting about disaster or emergency events? = 2014

Skip To: End of Survey If Which year did your organization begin Tweeting about disaster or emergency events? = 2015

Skip To: End of Survey If Which year did your organization begin Tweeting about disaster or emergency events? = 2016

Skip To: End of Survey If Which year did your organization begin Tweeting about disaster or emergency events? = 2017

4.25 Did your organization use Twitter during Hurricane Isaac in August 2012?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Not Sure (3)

4.26 Did your organization use Twitter during Hurricane Sandy in October 2012?

- ☐ Yes (1)
 - ☐ No (2)
 - ☐ Not Sure (3)
-

4.27 Which policies (if any) does your organization practice in respect to crisis or risk-related communication on Social Media since Hurricanes Isaac and Sandy in 2012?

Select all that Apply:

- ☐ We have developed target goals and a plan for communicating on social media (1)
 - ☐ We strive for rapid respond to public comments and concerns (2)
 - ☐ We have a staff or team member dedicated to monitoring our social media accounts (3)
 - ☐ Social media accounts are monitored 24 hours a day, 7 days a week (4)
 - ☐ Other, Please Explain: (5) _____
-

4.28 Has your organization changed social media policies since 2012?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Not Sure (3)

End of Block: Tweeting During Hurricanes Isaac and Sandy of 2012

Appendix C. Survey Instrument 2: Hurricane Harvey Responders Survey Instrument

Online Survey of New Twitter Use – Part 2: Disaster Responders

Start of Block: Default Question Block

Q0 Hello and welcome. We are a multi-department research team at Louisiana State University.

Thank you for your interest in being part of our research study entitled “The Changing Roles of Social Media in Disaster Resilience: The Case of Hurricane Harvey” and funded by the National Science Foundation. During Hurricane Harvey many residents in Houston area sought help through social media when the 911 system failed. We are surveying about 300 flood victims on their experience and opinions in using Twitter or other social media for rescue during Hurricane Harvey. Your input is very important, and we greatly appreciate your time in helping us understand this issue. This survey will take approximately 15 minutes of your time. Your participation in this research is voluntary. You may choose not to participate or to withdraw from the study at any time. Your name and responses will be kept confidential.

There are no direct benefits to you for participating in the survey, but the information gathered may help us further understand disaster resilience in your community and for other communities across the country. You do not face no more/greater than risks than you would come across in everyday life for participating nor are there any costs to participate.

If you have questions about our study, you can contact any of the principal researchers at the contact information listed below. This study has been approved by the LSU Institutional Review Board (IRB). For questions concerning participant rights, please contact the LSU Human Subjects Protection Program at 225-578-8692 (irb@lsu.edu).

Thank you again for your time and participation in our study. By clicking below to continue the survey, you are indicating your consent to participate and allow us to collect your responses for research purposes.

Sincerely,

Nina Lam, PhD. nlam@lsu.edu

Michelle Meyer, PhD. mmeyer@lsu.edu

Margaret Reams, PhD. reams@lsu.edu

Lei Zou, PhD. lzou4@lsu.edu

Q1 Which category best describes your role as a rescuer?

- ☐ Charitable Organization (1)
- ☐ Government-Related Agency or Office (2)
- ☐ First Responder (3)
- ☐ For Profit Non-Government Organization (4)
- ☐ Other, please specify: (5) _____

Q24 What is the geographic reach of your organization?

- ☐ Local (1)
- ☐ County (2)
- ☐ State (3)
- ☐ National (4)

Q2 Could you provide the name of your organization?

- ☐ Answer: (1) _____
- ☐ Not applicable (2)

Q3 Were you or your organization directly involved in emergency rescue efforts during Hurricane Harvey?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Don't know (3)

Q4 Did you or your organization use the web to assist in rescue operations during Hurricane Harvey?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Don't know (3)

Q5 Did you or your organization use social media to assist in rescue operations during Hurricane Harvey?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Don't have a social media account (3)
- ☐ Don't know (4)

Q6 Which social media platforms did your organization use during Hurricane Harvey?

	Never (1)	Sometimes (2)	About half the time (3)	Most of the time (4)	Always (5)
Blog (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Email (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Google+ (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Facebook (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Instagram (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nextdoor (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nixel (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Snapchat (8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Text Message Alerts (9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Twitter (10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Website (11)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zello (12)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other: (13)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Skip To: Q8 If Which social media platforms did your organization use during Hurricane Harvey? != Blog

Q7 Does your organization plan to create a Twitter account in the future?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Don't know (3)

Q8 Does your organization have someone assigned to report and monitor on Twitter?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Don't know (3)

Q9 How often does he or she monitor the Twitter activity?

- ☐ Multiple times a day (1)
- ☐ Once a day (2)
- ☐ Once every week (3)
- ☐ Less than once every week (4)
- ☐ Don't know (5)

Carry Forward Selected Choices from "How often does he or she monitor the Twitter activity?"



Q10 How often did your organization use Twitter during Hurricane Harvey?

- ☐ Multiple times a day (1)
- ☐ Once a day (2)
- ☐ Once every week (3)
- ☐ Less than once every week (4)
- ☐ Don't know (5)

Q11 How did you or your organization receive requests for rescue?

- ☐ Blog (1)
- ☐ Email (2)
- ☐ Google+ (3)
- ☐ Facebook (4)
- ☐ Instagram (5)
- ☐ Nextdoor (6)
- ☐ Nixel (7)
- ☐ Snapchat (8)
- ☐ Twitter (9)
- ☐ Website (10)
- ☐ Zello (11)
- ☐ Other: (12) _____

Q12 How many requests for rescue did you or your organization received from channels other than Twitter?

- ☐ Please estimate the number: (1) _____
- ☐ Don't know (2)

Q13 How many requests for rescue did you or your organization received from Twitter?

- ☐ Please estimate the number: (1) _____
- ☐ Don't know (2)

Carry Forward All Choices - Displayed & Hidden from "How did you or your organization receive requests for rescue? "



Q14 Did you or your organization **respond** to the rescue requests? Please check all that apply:

	Yes (1)	No (2)	Don't know (3)
Blog (x1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Email (x2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Google+ (x3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Facebook (x4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Instagram (x5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nextdoor (x6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Nixel (x7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Snapchat (x8)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Twitter (x9)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Website (x10)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Zello (x11)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Other: (x12)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q15 How many households did you or your organization rescue from the flood?

- ☐ Please estimate the number: (1) _____
- ☐ Don't know (2)

Q16 If you or your organization received requests for rescue on Twitter, how did you determine the location of flood victims? Please check all that apply.

- ☐ Based on the tweet content (1)
- ☐ Based on the geo-tagged address attached to the tweet (2)
- ☐ Contacted the twitter user to determine the user's location (3)
- ☐ Other, please specify: (4) _____

Q17 If there are multiple requests, how did you or your organization determine who would be rescued first? Please check all that apply.

- ☐ Based on the time of the Twitter request (1)
- ☐ Based on the flood depth (2)
- ☐ Based on the distance to the victims (3)
- ☐ Based on the health conditions of the victims (4)
- ☐ Based on the number of the victims (5)
- ☐ Based on the age of the victims (6)
- ☐ No specific policy (7)
- ☐ Other, please specify: (8) _____

Q18 Did you or your organization use Twitter to share information about flood victims with other potential rescuers on Twitter?

- ☐ Yes (1)
- ☐ No (2)
- ☐ Don't know (3)

Q19 Did you find Twitter or social media helpful in the rescue operation during Hurricane Harvey?
Please select a score on a scale of 1 to 5, with 1 being not helpful and 5 being very helpful?

	Extremely helpful (1)	Very helpful (2)	Moderately helpful (3)	Slightly helpful (4)	Not at all helpful (5)
Twitter was... (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q20 Do you have suggestions on how to improve the use of Twitter for future emergencies? Please check all that apply.

- ☐ Create special hashtags for emergency rescue (1)
- ☐ Create special accounts for users to contact when they need emergency rescue (2)
- ☐ Educate users on how to use Twitter to contact dispatchers or volunteer organizations (3)
- ☐ Other, please specify: (4) _____

Page Break

Q21 Which tool(s) could help rescue operations? Please select a score on a scale of 1 to 5, with 1 meaning very useless and 5 being very useful?

	Extremely useful (1)	Very useful (2)	Moderately useful (3)	Slightly useful (4)	Not at all useful (5)
A map with real-time requests for rescue (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A map with real-time flood depth (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
A platform to coordinate with other organizations (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Others, please specify: (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Q22 Do you have any additional comments or suggestions to improve the response and rescue operations using social media?

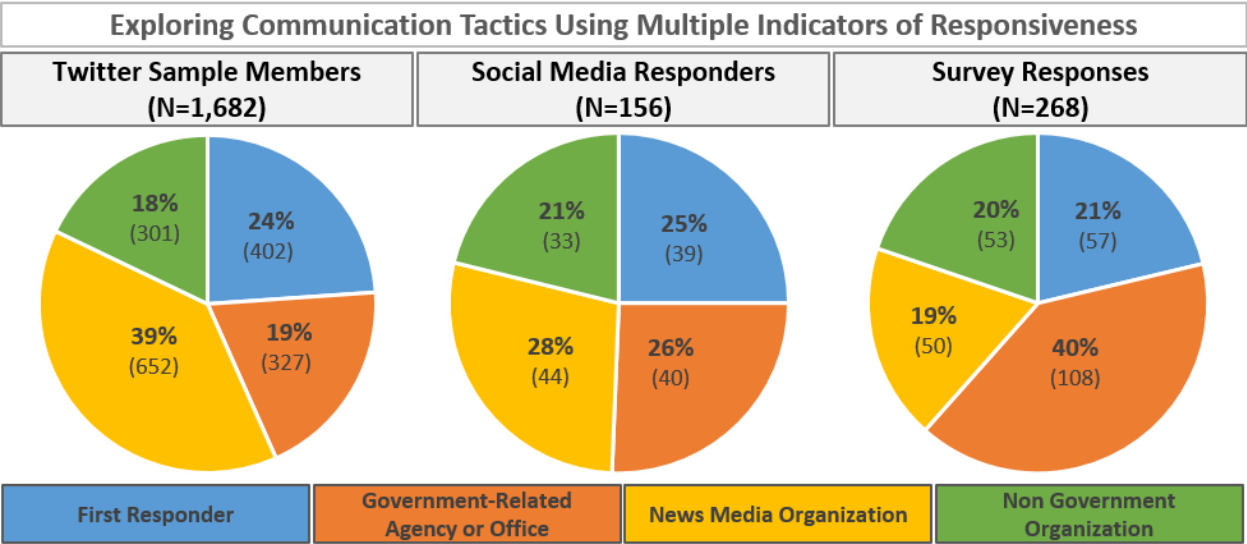
End of Block: Default Question Block

Appendix D. Improving Disaster Resilience with Social Media Text Responses

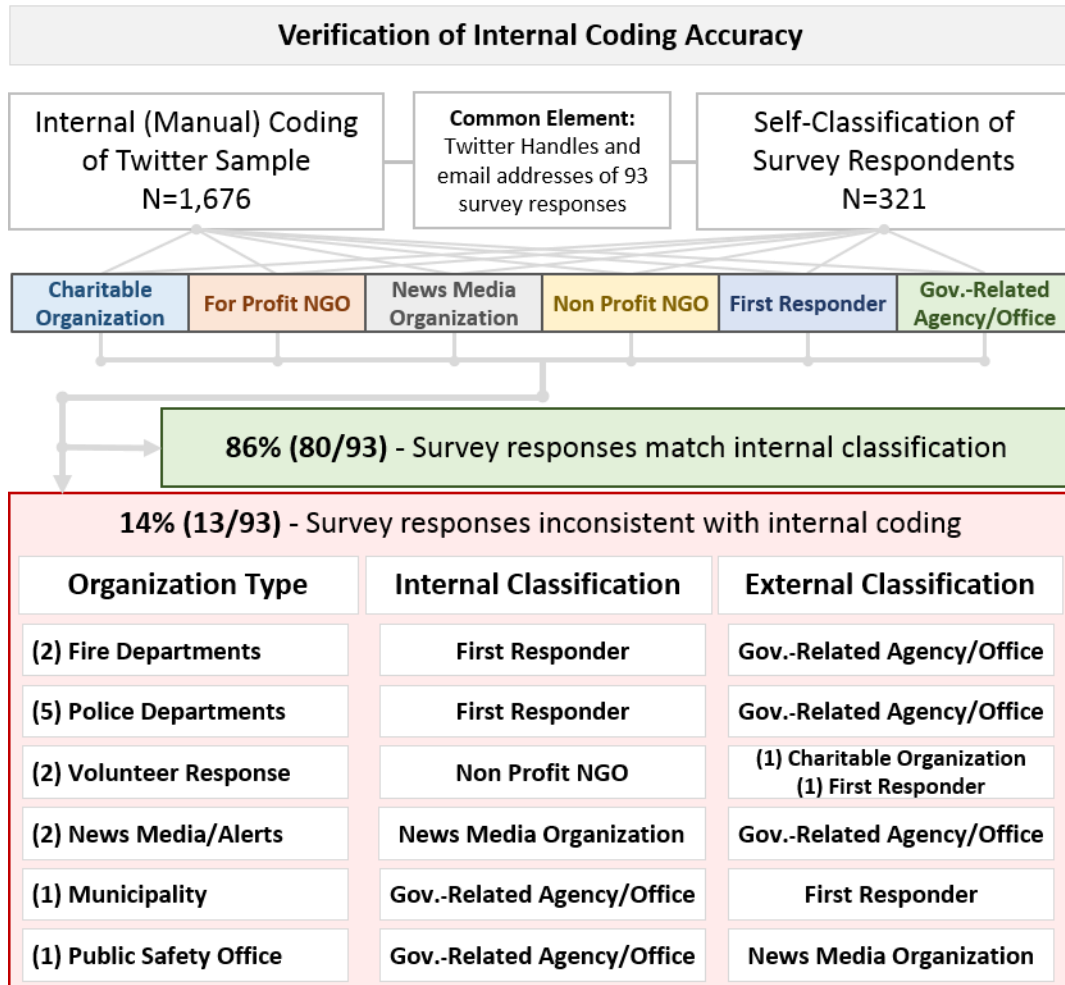
Theme	Original Text Responses
First Responder	
1	"Make social media more credible and available to more people"
1	"Must have a constant message and must put out information on a regular basis."
2	"Better awareness"
3	"a dedicated platform"
3	"Sending links to Facebook/social media posts directly to other forms of communication (email, text, etc)"
5	"Communications/Public Information officer training"
6	"Gain cooperation from social media companies to adjust their algorithms to ensure we are reaching people"
7	"Make it alerts that come up first and find a way to streamline the local outlets"
8	"I believe the most successful PIO's use social media as a tool but not as a stand alone"
	Government-Related Agencies and Offices
	"Better interaction and engagement with audiences during non emergency times (make it more interesting where folks would be apt to pay attention when an emergency isn't pending.)"
1	"sharing preparedness activities and messages"
1	"We worked to stream all our EOC briefings to FB live at the same time each day while fully activated during Hurricane Irma and saw as many as 200,000 view in a county with a pop. of 300,000."
2	"Ad boosts to reach people who do not follow your page"
2	"ongoing promotion throughout the year"
2	"We continue to promote use of our Facebook, NIXLE, and to some extent, Twitter. We hope more free hotspots and smart phone apps will increase saturation, but we are not confident that we are reaching all residents who require emergency messages"
3	"Yes, if Facebook would change its algorithms so that official government sites got preferred placement in the feed of their followers instead of us having to compete with big businesses with big budgets, that would help immensely."
4	"Be factual and correct all the time"
4	"Rumor control at all times"
4	"We will need personnel dedicated full time to social media"
5	"Better cross platform linked communications."
5	"Technology as a force multiplier"
5	"Utilize all communication resources to make sure people are aware of how to access info via social media."
6	"alerts thru SM"
6	"We need to be mindful to use traditional medi, community outreach equally with social media use"
9	"Currently working on this by analyzing past disaster events (recent ones)"

Theme	Original Text Responses
News Media Organizations	
1	"More posting "
1	"We step up our use to social media to increase interaction with our audience."
2	"Encourage all students to set up an account as part of their college communications?"
2	"I think it's difficult to make sure that everyone is using social media. There are segments of the population who refuse to use social media, limiting the ability to reach the entire population in a disaster situation."
3	"Boost the signal of verified information from response teams and pre-disaster planning"
3	"Facebook should have a "fast lane" for disasters and emergency info."
4	"Immediately send press releases. Notify website what sites we need to monitor"
5	"Have a broader base of social media accounts"
1	"I believe we have to continue to use social media in all phases of EM. Unfortunately there is too little training for "old School" EMs and not enough experience in some of the newer professionals."
1	"Make social media more "social" -- resilience through online community-building, avoiding pitfall of social media "echo chambers" that might not do much beyond garnering RTs and Likes"
Non-Government Organizations	
1	"I believe we have to continue to use social media in all phases of EM. Unfortunately there is too little training for "old School" EMs and not enough experience in some of the newer professionals."
1	"Make social media more "social" -- resilience through online community-building, avoiding pitfall of social media "echo chambers" that might not do much beyond garnering RTs and Likes"
2	"Our member base is 60+ yrs old so this is a challenge"
2	"Suggest the community to opt in to the social media (for this purpose) when registering to vote or renewing vehicle registration."
3	"Future clarification of the Facebook Safety Check"
3	"Have disaster updates rank higher on social media platforms algorithms. Given your geographic location when a state of emergency has been issued."
4	"Success in predicting events gets people's attention"
4	"verify sources!"

Appendix E. Exploring Communication Tactics Using Multiple Indicators of Responsiveness



Appendix F. Testing Respondent Self-Classification Accuracy



Appendix G. Detailed Sampling Methodology

The Hurricane Isaac sampling area is defined as the 123 US counties and four respective States which received federal assistance following Hurricane Isaac in August 2012. Sampling in Isaac area resulted in the compilation of 380 Twitter accounts at the state and local levels.

Similarly, the Sandy sampling area is defined as the 93 US Counties, seven respective States, and the District of Columbia, which received federal funding after the landfall of Hurricane Sandy in October 2012. Sampling for Hurricane Sandy contributed 1,255 Twitter accounts to the sample.

Table AH1 illustrates the study area and study population overview.

Table AH1: Study Area Overview

State/County	State Counties	Included Counties	County Land Area (mi ²)	State Land Area (mi ²)	2010 State Population	2010 State Pop. Density
Alabama	67	8	8,030	50,646	4,779,736	94/mi ²
Florida	67	12	11,329	53,631	18,801,310	350/mi ²
Louisiana	64	55 ¹	35,685	43,206	4,533,372	104/mi ²
Mississippi	82	48	29,273	46,924	2,967,297	63/mi ²
Isaac Counties	280	123	84,317	249,451		
Connecticut	8	7	4,108	4,843	3,574,097	737/mi ²
Delaware	3	3	1,949	1,949	897,934	460/mi ²
District of Columbia	1	1	61	61	601,723	9,864/mi ²
Maryland	23	24 ²	9,709	9,709	5,773,552	594/mi ²
New Jersey	21	21	7,355	7,355	8,791,894	1,195/mi ²
New York	57	15 ³	5,884	47,125	19,378,102	411/mi ²
Pennsylvania	67	18	10,584	44,743	12,702,379	283/mi ²
Rhode Island	5	4	624	1,034	1,052,567	1,017/mi ²
Sandy Counties	185	93	40,273	157,092		

Data Source: United States Census, 2010.

¹53 parishes plus the City of New Orleans counted as a metropolitan county-level geographic unit

²23 counties and one Independent City

³14 counties plus New York City counted as a single county-level geographic unit

Sampling Methodology

Twitter accounts were identified through a series of queries into the Twitter search bar. Excel spreadsheets exported from FEMA shapefiles helped to preserve geographic ties for later spatial analysis. The Twitter sample was developed From February until December of 2017

through a several phases of data collection aimed at achieving geographic saturation, methodological refinement, and quality control. The objective geographic saturation was to collect at least one relevant account for each county and state in the study area. National, state, and county level queries identified members of the *whole community* in the study area. Searches were also performed for one major metropolitan area per study area, including New Orleans, New York City and Houston.

The first round of sampling included the pairing of the names and abbreviations of geographic areas with five keywords. For example, state level queries included “(state) emergency”, “(state) disaster”, “(state) news”, “(state) police”, and “(state) fire”, then “(state abbreviation) emergency”, “(state abbreviation) disaster”, “(state abbreviation) news”, “(state abbreviation) police”, and “(state abbreviation) fire”. This method returned local government and non-governmental organizations and individuals participating in disaster communication such as local government leaders, fire chiefs, and non-governmental individuals delivering emergency alerts. Twitter accounts were included in the database if the met three requirements:

Twitter accounts representing individuals were preferred against, although individuals representing official positions in emergency management such as state and local government leaders and high-ranking members of law enforcement and emergency response services were included. News reporters communicating on behalf of news or press agencies were not included in the database. Fashion, political, and business news outlets were excluded due to the subject of news being reported.

The first round of sampling concluded in March of 2017 with the development of a database containing 728 relevant Twitter accounts meeting the sampling criteria including the collection contact information obtained from Twitter profiles and a simple binary classification

relating accounts to government or non-government organizations, which is useful for the polarization of survey data in the event of low response rates. Governmental emergency management agencies and first responders fill a primary role in emergency management while non-government organizations are considered to fill supporting roles.

The initial sample achieved 81% geographic saturation for the counties of the Sandy study area and 23% for the Isaac study area. Additional literature review focusing on emergency management in the US, social media, and the intersection of the topics and senior guidance informed the development of a secondary method of Twitter sampling seeking geographic saturation. Compelling evidence for the importance of chambers of commerce in the times following a crisis (Wukich & Steinberg, 2013) indicated that a voice of the *whole community* of emergency management would not be heard without sampling for chambers. This realization provoked the realization that other important organization may not have been identified in the broad-method initially employed. A second attempt to sample specific organizations was necessary to target certain actors, referred to herein as *direct* searches.

The names (or acronyms) of organizations with a known role in emergency management were queried into the Twitter search bar, then again paired with the names and abbreviations of states and counties as in the first round of sampling. *Direct* searches occurred for thirteen criteria including:

- American Red Cross (ARC) – Queried as “Red Cross”
- Chambers of Commerce – Queried as “Chamber”
- Community Emergency Response Teams (CERT)
- Department of Homeland Security (DHS) – Queried as “Homeland Security”
- Emergency Management Agency (EMA)
- Emergency Operations Center (EOC)
- Federal Emergency Management Agency (FEMA)
- National Weather Service (NWS)
- Office of Emergency Management (OEM)
- Principle Information Officer (PIO)

- Salvation Army (SA)
- Special Emergency Response Team (SERT)
- United Way (UW)
- Volunteer Organizations Active in Disasters (VOAD)

The second phase of sampling expanded the amount of useful information included for each entry. Newly acquired and existing entries were coded with a field titled *Class* during sampling based on roles or responsibilities for emergency management and/or supporting organizations. This step aided in the standardization of the study sample, providing response options for the survey instrument. Classification categories include:

- Charitable Organizations (CHRTY)
- Government-Related Agency or Office (GOV)
- First Responder (1R)
- For-Profit Non-Government (FP)
- News Media Organization (NP)
- Non-Profit Non-Government Organization (NGO)

Next, a coding field was added indicating geographic reach or jurisdiction. The field *Range* sorts organizations into three levels of organization including national, state, and county. Organizations were also coded with a field titled *Tag* (Table AH2) to increase the precision of classification. The additional levels of coding were necessary to reflect the separation of roles and responsibilities. For example, first responders are responsible for rapid deployment for the protection of human health. We expect first responders will communicate during similar stages of the four-phase emergency management model, though the literature shows types of first responders (fire and police) published differing content on differing social media platforms during Hurricane Sandy (Hughes et al. 2014). The high-detailed taxonomy provided by the pairing of coding fields *Range* and *Tag* allows the classification of roles and responsibilities defined the DHS National Response Framework, NIMS, and NECP.

Table AH2: Tags Applied to Twitter Accounts

Tag Code	Tag Description
Government or Official Related Tags	
GOV	Government offices or agencies
EM	Emergency management organizations
DR	Disaster response organizations
Police	Police departments
Fire	Fire departments
EMS	Emergency medical services
Alerts	Official alerts and news
Non-Government Tags	
NG EM	Non-government emergency management
NG DR	Non-government disaster response
NG Alerts	Unofficial alerts or news
NP	News organization or press
ARC	American Red Cross

Although some organizations and agencies maintain policies restricting staff from following and/or replying to individuals on social media (Beneito-Montagut et al. 2013), the literature demonstrates the effect of network structure for enhancing situational awareness, inter-agency communication, and message reach (Wukich and Khemka 2017, DHS 2012b, Wukich and Steinberg 2013, Sutton et al. 2012, Wukich and Mergel 2015). Network statistics collected from Twitter accounts including tweets published, followers, following, likes, list, and moments. These attributes provide an indication of audience size, engagement, and capacity for bi-directional communication. Table AH3 lists and defines all fields collected and developed to classify and study social media use of the study population.

Table AH3: Population Sampling Data Collection Fields

Field Name	Field Description	Completion
STATE	State corresponding to Twitter account	yes
CoNAME	County corresponding to Twitter account	yes
Name	Name of organization	yes
Subname	Sub-name or acronym if applicable	yes
Class	Government or non-government classification	yes
TAG	Specific tag of primary purpose of organization or Twitter account	yes
SL	Search level employed to identify agency	yes
Range Class	Level of organization	yes
Range	Range or specific location of organization	yes
Contact	Contact name	no
Contact Title	Contact's affiliation with organization	no
Phone	Local phone number	no
Email Address	Email address of contact	no
Physical Address	Physical address of organization	no
Website	Website found on Twitter page	yes
Twitter	Twitter handle and hyperlink to Twitter page	yes
T_Age	Joined Date, Twitter account start month and year	yes
Official	Binary coding: 0 = unofficial, 1 = official twitter account	yes
Facebook	Facebook link if found on Twitter page	no
Tweets	Total number of Tweets published at time of sampling	yes
Following	Total number of accounts following at time of sampling	yes
Followers	Total number of followers at time of sampling	yes
Likes	Total number of likes at time of sampling	yes
Lists	Total number of lists developed by user at time of sampling	yes
Moments	Total number of moments published at time of sampling	yes
Responsive 24/7	An Indication of 24/7 monitoring	no
Notes	Notes about Twitter account	no

The method of classifying Twitter grew in complexity as the sampling continued. Figure AH1 maps organizational taxonomy, illustrating group membership per classification levels, *Binary*, *Class*, and *Tag*.

Sampling and coding concluded in December 2017. The additional efforts of *direct* searches resulted in identification of 947 relevant Twitter accounts, achieving 96% and 54% geographic saturation in the Sandy and Isaac study areas respectively, or an overall increase in geographic saturation of 24%. The inability to retrieve relevant Twitter account using the

sampling method was greatest in Mississippi, where 59% or 28 of the 49 counties in the study area not represented in the study population. Complete (100%) geographic saturation was achieved in the Isaac study area for Florida, and in Connecticut, Delaware, the District of Columbia, New Jersey, New York, and Rhode Island in the Sandy study area.

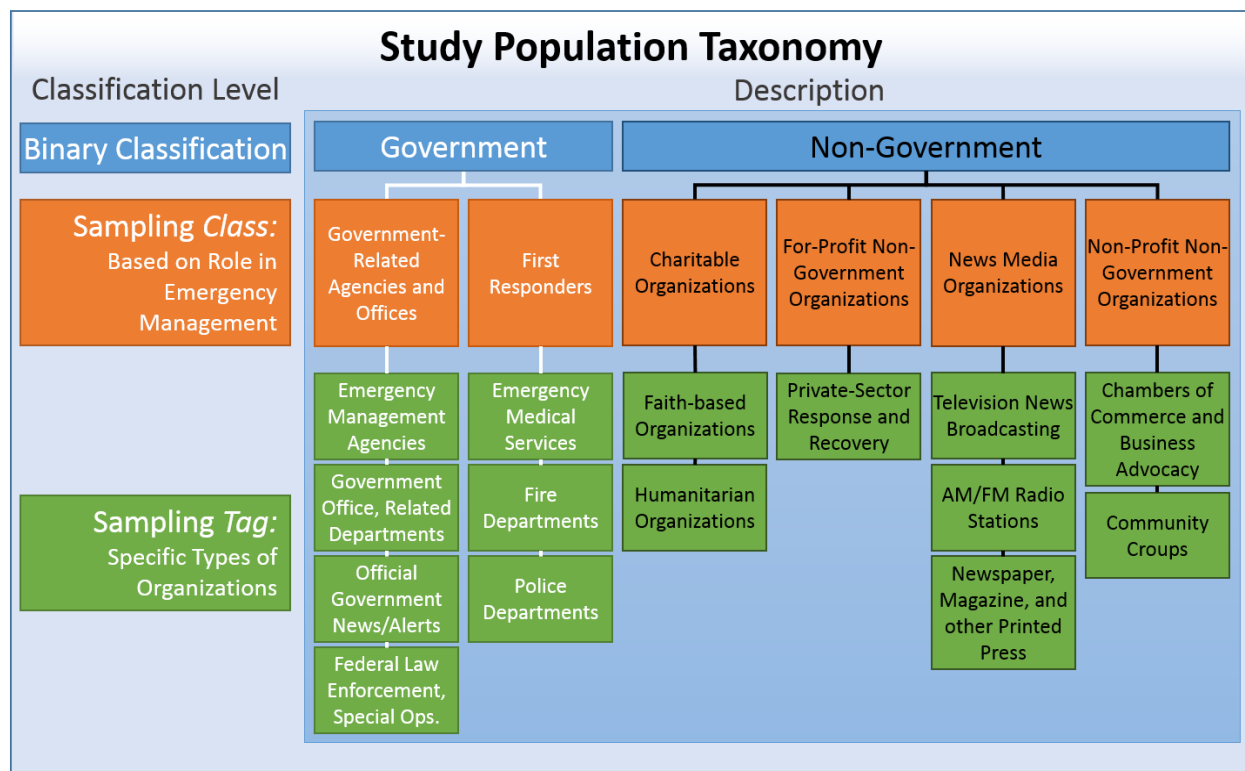


Figure AH1: Study Population Taxonomy

Appendix H. Coded Qualitative Responses Regarding “Other” Obstacles

Group	Obstacle
No Reported Obstacles	
GOV	“Our disaster use of social media is very limited so we have not experienced too many obstacles.”
GOV	“Typically, we do not use Social Media to disseminate official instructions until after the county emergency management agency has put something out. We then &Share> ; their post when time permits.”
GOV	“Fortunately we have not experienced a large scale disaster”
Infrastructure failure/Connectivity issues	
GOV	“Access to phones, computers etc during power outages”
GOV	“Loss of power to communities who do not have Wx radios”
GOV	“Access to social media due to power and communications outages in the public.”
GOV	“Depending on the disaster, loss of electricity and internet connectivity can make less effective”
GOV	“Lack of power/connectivity”
GOV	“Inoperable communications”
GOV	“Availability of internet access during disaster”
GOV	“Once power goes out WiFi is lost so the use of face to face or paper communication is necessary.”
GOV	“Connectivity/Power Outages”
NGO	“connectivity issues / lack of internet service”
NGO	“Availability of reliable data service across the county”
NGO	“Cell towers may be down.”
NGO	“Hurricanes being the most prevalent crisis we deal with, social media will only reach those who have access to powered up devices and intact data/service capabilities”
NGO	“In certain situations, people have a hard time accessing social media during an emergency, and that is our primary method for reaching the communities we cover. Without power or internet (and with spotty cell reception or issues with the availability of data minutes on a cell plan), some people are not able to access our Facebook page and cannot get the relevant information from our Facebook page.”
Scamming/phishing	
GOV	“robo calls”
GOV	“People who divert attention from the emergency message by blowing up an issue they disagree with”
Rumor control/information accuracy	
GOV	“countering rumors and incorrect information”
GOV	“citizens overreacting to rumors”
GOV	“Length of time lapsed from initial sm posting to when the sm posting was analyzed. Is the data still relevant?”
NGO	“Lots of fake information gets spread on social media diverting resources to people who need help.”
NGO	“Finding users that can actually convey messaging as intended from IMT”
Reaching elderly and low income residents	
GOV	“Eldery or low income that may not have access to technology and power outages”

Group	Obstacle
Language and cultural barriers	
GOV	"Language and cultural barriers"
GOV	"We do think about language barriers and being inclusive."
GOV	"Depending on the community there may be a language barrier. NJ is a melting pot. We have on occasion needed to reach out in a language specific to that community."
GOV	"Different Languages"
NGO	"Our biggest obstacle is that people don't understand that 1. United Way is not a front line agency. We provide funding and support for these programs, but we do not actively provide these services. 2. People also don't understand that we don't hand out cash or goods to individuals, rather community organizations that are equipped to distribute the funds/goods where they're most needed. This misunderstanding of what we do in a crisis/disaster can cause ripples on social media from citizens upset that they're not able to get immediate help directly from us."
Insufficient human resources	
NGO	"Language, Cultural and Religious Competency"
GOV	"staffing"
User friendliness & limited utility of social media for emergency managers/volunteers	
GOV	"Being a volunteer department, getting the information out and keeping up with updates is difficult occasionally when the people running social media are at their actual jobs."
GOV	"Some social media platforms are easier to use and monitor. Most of our residents follow on Facebook."
GOV	"Not being able to see the comments on some of our shares due to the sharer's privacy settings is an issue because the public seems to think we can see them and should respond. Also, followup posts sometimes don't have the same reach as the original post so we have begun UPDATING the original post to keep the latest info out. This does not work for Twitter."
NGO	"Tags from Facebook not translating over to Twitter or vice-versa"
NGO	"Mostly that, besides facebook safety check (the data from which they do not currently share with orgs), that can show actual needs. We have internal platforms but nothing that can do what facebook's platform can and will be able to do. the fear being that without open access to that data, we will not be able to do our jobs effectively and the role of providing aid will be left to your friends network instead of a network of aid orgs."
NGO	"I find I am often in the way! Although they want me to promote and get the word out...getting the word proves difficult"
NGO	"With regards to Facebook Pages Emergency Service and Volunteer Pages should not have page views limited. Facebook should not limit page views of official / volunteer pages."
Intra-agency coordination	
NGO	"Organic Reach is limited on social media platforms. At the mercy of the company's algorithm to spread information without spending ad dollars."
Practicing courtesy and respect for victims	
GOV	"We need to coordinate better with other departments social media sites during emergencies. Speak with one single voice"
NGO	"We have to be mindful that the impacted families have been through a lot. We aren't disaster tourist."

Appendix I. Institutional Review Board Documents

ACTION ON EXEMPTION APPROVAL REQUEST



Institutional Review Board
Dr. Dennis Landin, Chair
130 David Boyd Hall
Baton Rouge, LA 70803
P: 225.578.8692
F: 225.578.5983
irb@lsu.edu
lsu.edu/research

TO: Nina Lam
Environmental Sciences

FROM: Dennis Landin
Chair, Institutional Review Board

DATE: November 13, 2017

RE: IRB# E9947

TITLE: The Changing Roles of Social Media in Disaster Resilience: The Case of Hurricane Harvey

New Protocol/Modification/Continuation: Modification

Brief Modification Description: Revised surveys

Review date: 11/13/2017

Approved X **Disapproved** _____

Approval Date: 11/13/2017

Approval Expiration Date: 6/15/2019

Re-review frequency: (three years unless otherwise stated)

LSU Proposal Number (if applicable):

Protocol Matches Scope of Work in Grant proposal: (if applicable)

By: Dennis Landin, Chairman 

PRINCIPAL INVESTIGATOR: PLEASE READ THE FOLLOWING –
Continuing approval is CONDITIONAL on:

1. Adherence to the approved protocol, familiarity with, and adherence to the ethical standards of the Belmont Report, and LSU's Assurance of Compliance with DHHS regulations for the protection of human subjects*
2. Prior approval of a change in protocol, including revision of the consent documents or an increase in the number of subjects over that approved.
3. Obtaining renewed approval (or submittal of a termination report), prior to the approval expiration date, upon request by the IRB office (irrespective of when the project actually begins); notification of project termination.
4. Retention of documentation of informed consent and study records for at least 3 years after the study ends.
5. Continuing attention to the physical and psychological well-being and informed consent of the individual participants including notification of new information that might affect consent.
6. A prompt report to the IRB of any adverse event affecting a participant potentially arising from the study.
7. Notification of the IRB of a serious compliance failure.
8. **SPECIAL NOTE: Make sure you use bcc when emailing more than one recipient. Approvals will automatically be closed by the IRB on the expiration date unless the PI requests a continuation.**

**All investigators and support staff have access to copies of the Belmont Report, LSU's Assurance with DHHS, DHHS (45 CFR 46) and FDA regulations governing use of human subjects, and other relevant documents in print in this office or on our World Wide Web site at <http://www.lsu.edu/irb>*

References

- Adger, W. Neil. 2010. "Social capital, collective action, and adaptation to climate change." In *Der klimawandel*, 327-345. Springer.
- Adger, W. Neil. 2000. "Social and ecological resilience: are they related?" *Progress in Human Geography* 24 (3):347-364. doi: 10.1191/030913200701540465.
- Aldrich, Daniel P, and Michelle A Meyer. 2014. "Social capital and community resilience." *American Behavioral Scientist*:0002764214550299.
- Aldrich, Daniel P, and Michelle A Meyer. 2015. "Social capital and community resilience." *American Behavioral Scientist* 59 (2):254-269.
- Anderies, John M, and Marco A Janssen. 2013. "Robustness of Social-Ecological Systems: Implications for Public Policy." *Policy Studies Journal* 41 (3):513-536.
- AP. 2017. Harvey victims are using social media when 911 fails. *NY Post*.
- ARC. 2012. Social Media in Disasters and Emergencies.
- ATT News Team. 2017. Hurricane Harvey: Response & Live Updates. *Your Inside Connection*. Accessed Feb. 24, 2019.
- Austin, Lucinda, Brooke Fisher Liu, and Yan Jin. 2012. "How audiences seek out crisis information: Exploring the social-mediated crisis communication model." *Journal of Applied Communication Research* 40 (2):188-207.
- Beneito-Montagut, Roser, Susan Anson, Duncan Shaw, and Christopher Brewster. 2013. "Governmental social media use for emergency communication." proceedings of the 10th international conference on information systems for crisis response and management, Baden-Baden, Germany.
- Blake, Eric S., Todd B. Kimberlain, Robert J. Berg, John P. Cangialosi, and John L. III Beven. 2013. Tropical Cyclone Report Hurricane Sandy (AL182012). edited by National Hurricane Center.
- Brady, Matt. 2017. Obstacles to Promoting Emergency Preparedness & Community Awareness. *PA Times*.
- CARRI. 2013. Definitions of Community Resilience: An Analysis.
- CDC. 2014. Crisis + Emergency Risk Communication.
- Census, US. 2017. Annual Estimates of the Resident Population for the United States, Regions, States, and Puerto Rico: April 1, 2010 to July 1, 2016 (NST-EST2016-01).

Center, Pew Research. 2018. Social Media Fact Sheet. *Internet & Technology*. Accessed March 5, 2018.

Comfort, Louise K. 2005. "Risk, security, and disaster management." *Annu. Rev. Polit. Sci.* 8:335-356.

Cooper Jr, Guy Paul, Violet Yeager, Frederick M Burkle Jr, and Italo Subbarao. 2015. "Twitter as a potential disaster risk reduction tool. Part I: introduction, terminology, research and operational applications." *PLoS currents* 7.

Covello, Vincent T. 1992. "Risk communication: An emerging area of health communication research." *Annals of the International Communication Association* 15 (1):359-373.

Davis, Jenn D. 2012. "The 5 Easy Steps To Measure Your Social Media Campaigns." *Kissmetrics Blog*. <https://blog.kissmetrics.com/social-media-measurement/>.

DHS, US. 2004. The 9-11 Commission Report. edited by Homeland Security.

DHS, US. 2006a. The Federal Response to Hurricane Katrina: Lessons Learned. edited by Homeland Security.

DHS, US. 2006b. The Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina. edited by Homeland Security.

DHS, US. 2008. National Emergency Communications Plan. edited by Homeland Security.

DHS, US. 2012. "Social Media Use during Disasters." In *A Review of the Knowledge Base and Gaps*, ed National Consortium for the Study of Terrorism and Responses to Terrorism. College Park, MD: United States Department of Homeland Security. https://www.start.umd.edu/sites/default/files/files/publications/START_SocialMediaUseduringDisasters_LitReview.pdf (accessed 5 Feb. 2017).

DHS, US. 2013. "Lessons Learned: Social Media and Hurricane Sandy." In *Virtual Social Media Working Group and DHS First Responders Group*, ed United States Department of Homeland Security Science and Technology: United States Department of Homeland Security. <https://www.dhs.gov/sites/default/files/publications/Lessons%20Learned%20Social%20Media%20and%20Hurricane%20Sandy.pdf> (accessed 5 Feb. 2017).

DHS, US. 2014. 2014 National Emergency Communications Plan. edited by Homeland Security: DoD.

DHS, US. 2018. Social Media Working Group for Emergency Services and Disaster Management. edited by DHS Science and Technology Directorate.

- Dwyer, Colin. 2017. 'The Goal Is Rescue': The Massive Response To Harvey, By The Numbers. *National Public Radio: The Two-Way*. Accessed 2/9/19.
- Ehrlich, Allison. 2017. Harvey timeline: See how the storm developed and marched across Texas and Louisiana. *Caller Times*.
- FCC. 2017a. Communications Status Report for Areas Impacted by Hurricane Harvey August 26, 2017.
- FCC. 2017b. Communications Status Report for Areas Impacted by Tropical Storm Harvey August 27, 2017.
- FCC. 2017c. Communications Status Report for Areas Impacted by Tropical Storm Harvey August 28, 2017.
- FCC. 2017d. Communications Status Report for Areas Impacted by Tropical Storm Harvey August 29, 2017.
- FCC. 2017e. Communications Status Report for Areas Impacted by Tropical Storm Harvey August 30, 2017.
- FCC. 2017f. Communications Status Report for Areas Impacted by Tropical Storm Harvey August 31, 2017.
- FEMA. 2006a. "Chapter 1: Introduction to Crisis, Disaster, and Risk Management Concepts."
- FEMA. 2006b. Principles of Emergency Management: Independent Study. edited by US Federal Emergency Management Agency. Washington D.C.
- FEMA. 2017a. FEMA Post-Harvey Modeled Damage Assessment. edited by Hien Le.
- FEMA. 2017b. Historic Disaster Response to Hurricane Harvey in Texas. In *HQ-17-133*, edited by Homeland Security.
- FEMA. 2017c. National Preparedness Goal. edited by Federal Emergency Management Agency.
- FEMA, US. 2017d. FEMA GIS Data Feeds. edited by FEMA GIS.
- FEMA, US. 2017e. Whole Community. edited by Homeland Security.
- Flizikowski, Adam, Witold Holubowicz, Anna Stachowicz, Laura Hokkanen, Taina A Kurki, Niina Päivinen, and Thomas Delavallade. 2014. "Social media in crisis management-The iSAR+ project survey." ISCRAM.
- Fugate, Craig. 2009. Administrator Craig Fugate, Federal Emergency Management Agency, before the United States House Transportation and Infrastructure Committee,

Subcommittee on Economic Development, Public Buildings, and Emergency Management, "Post-Katrina: What it Takes to Cut the Bureaucracy and Assure a More Rapid Response After a Catastrophic Disaster."

Fugate, Craig. 2011a. Administrator Craig Fugate, Federal Emergency Management Agency, before the United States House Transportation and Infrastructure Committee, Subcommittee on Economic Development, Public Buildings, and Emergency Management, "Improving the Nation's Response to Catastrophic Disasters: How to Minimize Costs and Streamline our Emergency Management Programs".

Fugate, Craig. 2011b. "Understanding the power of social media as a communication tool in the aftermath of disasters." *Senate Committee on Homeland Security and Governmental Affairs, Subcommittee on Disaster Recovery and Intergovernmental Affairs*.

Goodman, Robert M, Marjorie A Speers, Kenneth McLeroy, Stephen Fawcett, Michelle Kegler, Edith Parker, Steven Rathgeb Smith, Terrie D Sterling, and Nina Wallerstein. 1998. "Identifying and defining the dimensions of community capacity to provide a basis for measurement." *health education & Behavior* 25 (3):258-278.

Häuberer, Julia. 2011. *Social capital theory*: Springer.

Hayden, Michael E. 2017. Hurricane Harvey: Hundreds of rescues, thousands of 911 calls swamp Houston area. *ABC News*.

Holling, Crawford S. 1973. "Resilience and stability of ecological systems." *Annual Review of Ecology and Systematics*:1-23.

Holling, Crawford S. 2001. "Understanding the complexity of economic, ecological, and social systems." *Ecosystems* 4 (5):390-405.

Hughes, Amanda L, and Leysia Palen. 2012. "The evolving role of the public information officer: An examination of social media in emergency management." *Journal of Homeland Security and Emergency Management* 9 (1):1-20.

Hughes, Amanda L, Lise AA St Denis, Leysia Palen, and Kenneth M Anderson. 2014. "Online public communications by police & fire services during the 2012 Hurricane Sandy." Proceedings of the 32nd annual ACM conference on Human factors in computing systems.

Hughes, Amanda Lee, and Apoorva Chauhan. 2015. "Online Media as a Means to Affect Public Trust in Emergency Responders." the 12th International Conference on Information Systems for Crisis Response and Management, Kristiansand, Norway.

Hughes, Amanda Lee, and Leysia Palen. 2009. "Twitter Adoption and Use in Mass Convergence and Emergency Events." *International Journal of Emergency Management* 6 (3-4):248-260.

- Hunn, David, Matt Dempsey, Mihir Xavier, Mark Milligan, and Jordan Rubio. 2018. Harvey's floods. *Houston Chronicle*.
- Latonero, Mark, and Irina Shklovski. 2011. "Emergency Management, Twitter, and Social Media Evangelism." *International Journal of Information Systems for Crisis Response and Management* 3 (4):67-68.
- Lindell, Michael K, and Ronald W Perry. 2012. "The protective action decision model: theoretical modifications and additional evidence." *Risk Analysis: An International Journal* 32 (4):616-632.
- Luna, S., and M. Pennock. 2015. "Social media in emergency management advances, challenges and future directions." 2015 Annual IEEE Systems Conference (SysCon) Proceedings, 13-16 April 2015.
- McCormick, Sabrina. 2016. "New tools for emergency managers: an assessment of obstacles to use and implementation." *Disasters* 40 (2):207-225.
- Mergel, Ines. 2014. "Social Media Practices in Local Emergency Management: Results from Central New York."
- Mergel, Ines, and Stuart I Bretschneider. 2013. "A three-stage adoption process for social media use in government." *Public Administration Review* 73 (3):390-400.
- Mitchell, Amy, Elisa Shearer, and Kristina Lu. 2017. How Americans Encounter, Recall and Act Upon Digital News. *Journalism & Media*.
- Moravec, Eva R. 2017. Texas officials: Hurricane Harvey death toll at 82, 'mass casualties have absolutely not happened'. *Washington Post*.
- NASA. 2017. Harvey. Accessed Feb. 23, 2019.
- National Commission on Terrorist Attacks (9-11 Commission). 2004. *The 9-11 Commission Report*. Edited by Alice Falk. <https://9-11commission.gov/report/911Report.pdf>. Accessed 13 May 2019.
- NOAA. 2018. Hurricane Costs. edited by Office for Coastal Management National Oceanic and Atmospheric Administration.
- Norris, F. H., S. P. Stevens, B. Pfefferbaum, K. F. Wyche, and R. L. Pfefferbaum. 2008a. "Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness." *Am J Community Psychol* 41 (1-2):127-50. doi: 10.1007/s10464-007-9156-6.

- Norris, Fran H, Susan P Stevens, Betty Pfefferbaum, Karen F Wyche, and Rose L Pfefferbaum. 2008b. "Community resilience as a metaphor, theory, set of capacities, and strategy for disaster readiness." *American journal of community psychology* 41 (1-2):127-150.
- NWS. 2017. Hurricane Isaac - August 28, 2012. edited by National Weather Service National Oceanic and Atmospheric Administration. Mobile: weather.gov.
- NWS. 2018. Major Hurricane Harvey. edited by National Weather Service National Oceanic and Atmospheric Administration. Corpus Christi: NOAA.
- NWS, US. Hurricane Sandy. edited by National Weather Service National Oceanic and Atmospheric Administration. NYC: weather.gov.
- Owen, C., Bosomworth, K., B. Brooks, L. Fogarty, and G. Conway. 2017. Politics, Policies and Paradigms.
- Plotnick, Linda, and Roxanne S. Hiltz. 2016. Barriers to Use of Social Media by Emergency Managers. In *Journal of Homeland Security and Emergency Management*.
- Plotnick, Linda, and Roxanne Hiltz Starr. 2016. Barriers to Use of Social Media by Emergency Managers. In *Journal of Homeland Security and Emergency Management*.
- Procopio, Claire H, and Steven T Procopio. 2007. "Do you know what it means to miss New Orleans? Internet communication, geographic community, and social capital in crisis." *Journal of Applied Communication Research* 35 (1):67-87.
- Putnam, Robert. 2001. "Social capital: Measurement and consequences." *Canadian Journal of Policy Research* 2 (1):41-51.
- Reams, Margaret A., Nina. S. N. Lam, and Ariele Baker. 2012. "Measuring Capacity for Resilience among Coastal Counties of the U. S. Northern Gulf of Mexico Region." *American Journal of Climate Change* 01 (04):194-204. doi: 10.4236/ajcc.2012.14016.
- Revere, Debra, Rebecca Calhoun, Janet Baseman, and Mark Oberle. 2015. "Exploring bi-directional and SMS messaging for communications between Public Health Agencies and their stakeholders: a qualitative study." *BMC public health* 15 (1):1.
- Ripberger, Joseph T, Hank C Jenkins-Smith, Carol L Silva, Deven E Carlson, and Matthew Henderson. 2014. "Social Media and Severe Weather: Do Tweets Provide a Valid Indicator of Public Attention to Severe Weather Risk Communication?" *Weather, Climate, and Society* 6 (4):520-530.
- Scalf, Carli. 2017. HOW SOCIAL MEDIA TURNED HURRICANE HARVEY INTO A VIRAL STORM. *Study Break*.

- Schleifstein, Mark. 2017. Harvey's 2-day rain in Houston is 3 times floodwater pumped from New Orleans after Katrina. *Nola.com*. Accessed Feb. 23, 2019.
- Shearer, Elisa. 2018. Social media outpaces print newspapers in the US as a news source. *Fact Tank*.
- Shearer, Elisa, and Jeffry Gottfried. 2017. News Use Across Social Media Platforms 2017. *Journalism & Media*.
- Sheppard, Ben, Melissa Janoke, and Brooke Liu. 2012. Understanding Risk Communication Theory: A Guide for Emergency Managers and Communicators. In *Report to Human Factors/Behavioral Sciences Division, Science and Technology Directorate*, edited by US Department of Homeland Security.
- Sherrieb, Kathleen, Fran H Norris, and Sandro Galea. 2010. "Measuring capacities for community resilience." *Social indicators research* 99 (2):227-247.
- SLP (U.S. House of Representatives Select Bipartisan Committee), 2006. *The Final Report of the Select Bipartisan Committee to Investigate the Preparation for and Response to Hurricane Katrina*. Washington, D.C.:U.S. Government Printing Office.
https://www.npr.org/documents/2006/feb/katrina/house_report/katrina_report_full.pdf. Accessed 13 May 2019.
- Smith, Aaron, and Monica Anderson. 2018. Social Media Use in 2018. *Internet & Technology*. Accessed June 25, 2018.
- Su, Yee San, Clarence III Wardell, Zoë Thorkildsen, and Monica Giovachino. 2013. "Social Media in the Emergency Management Field 2012 Survey Results."
- Sutton, Jeannette N, Emma S Spiro, Britta Johnson, Sean M Fitzhugh, Mathew Greczek, and Carter T Butts. 2012. "Connected communications: network structures of official communications in a technological disaster." Proceedings of the 9th International ISCRAM Conference.
- USGS. n.d. Inundation Maps and Flood Details.
- Verizon. 2017. Verizon is ready as Hurricane Harvey threatens Texas.
- Wolfe, Lahle. 2018. Twitter User Statistics Through 2017. *the balance careers*.
- Wood, Michele M., Dennis S. Mileti, Hamilton Bean, Brooke F. Liu, Jeannette Sutton, and Stephanie Madden. 2017. "Milling and Public Warnings." *Environment and Behavior* 0 (0):0013916517709561. doi: 10.1177/0013916517709561.

- Wukich, Clayton, and Ashish Khemka. 2017. "Social media adoption, message content, and reach: an examination of Red Cross and Red Crescent national societies." *International journal of emergency management* 13 (2):89-116.
- Wukich, Clayton, and Ines Mergel. 2015. "Closing the Citizen-Government communication gap: Content, audience, and network analysis of government tweets." *Journal of Homeland Security and Emergency Management* 12 (3):707-735.
- Wukich, Clayton, and Alan Steinberg. 2013. "Nonprofit and public sector participation in self-organizing information networks: Twitter hashtag and trending topic use during disasters." *Risk, Hazards & Crisis in Public Policy* 4 (2):83-109.

Vita

Ryan Kirby was born in the State of Florida, where he developed a passion for nature and coastal environments. The spark of interest in environmental sciences was ignited at Gulf Breeze High School, where Ryan graduated in 2007. Ryan taught sailing for the University of West Florida, worked for the Florida Department of Environmental Protection, and interned in the City of Pensacola's Geographic Information Systems office while pursuing a Bachelor of Science majoring in Environmental Sciences at the University of West Florida. After the Deepwater Horizon Oil Spill, Ryan was forced to close his business maintaining several luxury yachts in the Pensacola area. He took the opportunity to seek higher education closer to the spill at Louisiana State University in Baton Rouge. His Master's degree was funded through a research assistantship, where he worked primarily with colleagues in the Netherlands, studying the spatial distribution of social vulnerability on the Southwestern Delta in the Netherlands. Ryan pursued a Doctorate in Environmental Sciences at Louisiana State University, during which time he continued to work as a research assistant in the Department of Environmental Sciences. Ryan produced research for local organizations including with the Louisiana Environmental Action Network and the Center for Planning Excellence on topics including EPA Superfund research, environmental justice, collaborative problem solving, and planning for the effects of climate change and coastal erosion in Louisiana. Ryan's doctoral research aimed to address disparities in emergency communications by examining how public agencies and non-governmental organizations engage their audiences in risk and crisis communication.