A WAY SOCIAL MEDIA COULD BE USED TO AUGMENT COMMUNICATION IN A NATURAL DISASTER

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In a natural disaster environment, it is important for the affected population to establish and maintain communication with first responders. In the event of cyber infrastructure loss and power outages, the existing emergency services may be overwhelmed with calls to provide communication between the affected population, volunteers, first responders, and government. Because of the wide usage availability, and interoperability with almost every device that has internet service, social media is identified as a way that could augment communication in a natural disaster. Social media represents one means of providing information from and to the affected population and the first responders before, during, and after a natural disaster.

This paper examines some of the social media capabilities and cyber capabilities necessary for providing communications to the affected population, volunteers, first responders and the government in a natural disaster. Through case study analyses of different natural disasters, this paper describes the impact each disaster had on the affected population's ability to communicate, the status of the cyber infrastructure and some examples of successfully using social media during a natural disaster. The goal of the paper is to recognize gaps, and identify possible shortfalls of using social media during a natural disaster. The conclusion, with understanding the requirements and submitted recommendations, details a way to a more organized use of existing social media in order to support an affected population, and improve response and recovery capabilites of first responders.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

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This paper examines some of the social media capabilities and cyber capabilities necessary for providing communications to the affected population, volunteers, first responders and the government in a natural disaster. Through case study analyses of different natural disasters, this paper describes the impact each disaster had on the affected population's ability to communicate, the status of the cyber infrastructure and some examples of successfully using social media during a natural disaster. The goal of the paper is to recognize gaps, and identify possible shortfalls of using social media during a natural disaster. The conclusion, with understanding the requirements and submitted recommendations, details a way to a more organized use of existing social media in order to support an affected population, and improve response and recovery capabilites of first responders.

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CHAPTER 1

INTRODUCTION

> We don't have a choice on whether we do social media, the question is how well we do it.
>
> —Erik Qualman, *Twitter*

Since the first successful voice transmission over telephone in 1876, telecommunications have been recognized as an important factor of economic growth of every country. Telecommunications has found its purpose in every sphere of human life.

Emergency services that we know today are very similar to the first implemented telecommunication systems because both are operator assisted. If you wanted to call the police, ambulance, or firefighters you would call the operator first, then they would connect you manually to the emergency service. The mobile (cellular) communication network made a significant impact on the Public Switch Telephone Network (PSTN) telecommunication services or landlines. From that time, the number of mobile users has increased, while the number of fixed (land) line users has decreased. According to the latest research of Global System Mobile Association (GSMA) Intelligence,[1] there are more than five billion unique mobile subscribers in the world.

Mobile communications brought new services to customers including voice, data, and short message service (SMS), otherwise known as text messaging. Mobile communications have progressed through four generations of development (the fifth

[1] GSMA, "Number of Mobile Subscribers Worldwide Hits 5 Billion," GSM Association, June 13, 2017, accessed October 13, 2017, https://www.gsma.com/newsroom/press-release/number-mobile-subscribers-worldwide-hits-5-billion/.

generation is in the test phase) and has evolved into an essential tool for everyday life, which includes professional and personal applications. Today it is common for one person to use multiple mobile devices. This is important because each of these mobile devices can utilize or subscribe to social media services. Social media services are an important part of our everyday lives. Using them, we connect with our friends, receive information about our job, and share thoughts, opinions, and ideas. This wide spread usage of social media is an important factor, which must be also considered when facing different threats.

Social media represents a way to deliver early warning messages wherever and whenever necessary with the important ability to focus on the population in a particular area. Messages that are provided over social media can contain essential information including type of threat, time, location, area of impact, how long the event lasted (or will last), local conditions (roads, utilities, weather, etc.,) and more. It is important to provide several ways to reach the population and to update critical information in near real time. In comparison with the past, when people were waiting to a receive phone call over a landline, today's technological progress allows us to reach everyone everywhere. Unfortunately, emergency service systems have not followed all these changes and still are only voice oriented without the capability of transmitting data, images, or video. Social media represents one means of providing information from and to the affected population and the first responders before, during and after a natural disaster. Compared with other one-way communication systems like print media, radio, television, and loudspeakers that can provide information effectively, social media offers a feedback mechanism. This capability comes with some risks and challenges. For all the good social

media represents, there is an equal and opposite capacity for negative effects. In a world where cyber threats can endanger everyone's life, we must be sure that the human aspect of social networks is mitigated. Social media can be used to spread rumors, provide false information to first responders, propagate false news, and even create conditions through which malign actors can target citizens and first responders. Consequently, the responders to a disaster must consider means of managing content and flow of information in order to minimize the destructive potential of misinformation. Equally important, social media depends on the redundancy of telecommunication infrastructure, which is not always resistant to the destructive force of natural disasters.

Presidential Policy Directive 21 (PPD-21): Critical Infrastructure Security and Resilience identifies the Communications Sector as critical because it provides an "enabling function" across all critical infrastructure sectors[2] including energy, information technology, financial services, transportation systems, and the emergency services sector. This research explores how social media use in natural disasters evolved through time and how the public and first responders are adapting to the technological innovations. This study contributes to the understanding that technologies we generally use for fun in peacetime could help us to save our lives and the lives of beloved ones during natural disasters and other situations that disrupt our everyday life. Other important factors are how to provide credible information that is shared over social media and, if possible, to use parallel existing emergency services and social media.

[2] U.S. Department of Homeland Security, "Communications Sector," accessed October 23, 2017, https://www.dhs.gov/communications-sector.

Problem Statement

More and more people use social media to connect with other people in their region and all over the world in today's digital era. For many of them, social media is a tool to share data, plan and arrange future activities, and socialize with groups of people of similar interests and backgrounds. This has become an important part of our everyday lives. Free access and widespread usage of social media can be an important factor in reducing the effects of a natural disaster. No matter what kind of natural disaster affects a country or region, social media is being used and is a key factor that allows two-way communication between a population that is affected by natural disaster and a governmental or national element that is tasked for disaster relief. Effective use of social media during disasters is important in ensuring that the disaster relief elements provide fast and adequate support for the endangered population. In this collaborative effort against natural disasters, social media provides the affected population with important information because it allows better organization, coordination, and communication than the existing emergency 9-1-1 system. The first 9-1-1 system was designed around 20th century telephones that contained technology that was not capable of transmitting data, text, images, or video.[3] There was a great effort to upgrade this emergency system and switch it from analog to digital technology, to enable it to provide new features that a digital society demands. Future solutions for emergency services will incorporate

[3] Kristin Viswanathan, Theresa Wizemann, and Bruce M. Altevogt, *Preparedness and Response to a Rural Mass Casualty Incident,* Workshop Summary, Forum on Medical and Public Health Preparedness for Catastrophic Events, Board on Health Sciences Policy, Institute of Medicine of the National Academies (Washington, DC: The National Academies Press, 2011), 28.

capabilities of the Nationwide Public Safety Broadband Network (NPSBN) - FirstNet and Next Generation 9-1-1 network. More than half of the states accepted the NPSBN deployment plan created and designed by FirstNet and AT&T.[4] Even this modification of emergency services was not designed for or focused on bigger groups of people like the ones we have on social media networks. It does not allow communication between collaborative efforts of endangered populations and information sharing between them. It only allows communication with emergency centers. The object of this study is to determine the best possible use of social media as a tool for responding to natural disasters.

Research Question

The primary research question this thesis address is: How can social media best be used by the government, first responders, volunteers, and the affected population as a means of communication in response to a natural disaster? To answer this, the following research questions are considered:

1. How well did social networks work during natural disaster case studies?
2. What is critical cyber infrastructure?
3. What types of social media worked best during natural disasters?
4. How do first responders ensure information received is accurate and can they afford to wait to validate before acting?

[4] FirstNet. "Power of FirstNet: How Do I?"accessed November 16, 2017, https://www.firstnet.com/power-of-firstnet/how-do-i.

5. Why is social media used more during disasters than traditional "911" services?

Assumptions

For the purposes of this thesis, it is assumed that social media can benefit from emergency communication systems in disaster risk reduction as a reliable source of information that can support decision-making processes for rescue teams and disaster exposed populations.

Limitations and Delimitations

The primary limitation of this research is out dated literature. People respond to a natural disaster while it lasts and after that, they work on solving the consequences. Rarely are natural disasters studied from the perspective of how emergency services, commercial communications, and social media are used. Due to the lack of research, most of resources are articles, reports, and documentaries from the internet. Another limitation is that technological advances are not followed by adequate regulations for available services in the public sector. Innovations in the field of communications and the use of social media are endless. People are adapting fast to new changes and they always find new approaches for how to use available services. I limited my research to recent natural disasters because of the lack of reliable sources for material, and on available and known variants of social media use. For my research, I only used literature published before December 31, 2017, knowing that effects of some of the natural disasters studied in this research are still in progress.

Definitions

This is an initial list of important terms in social media. Most of the terms will be more broadly explained in the rest of the thesis, but it is important for readers to be familiar with them. Whenever it was possible, definitions were used from the social network page where they originated.

Hashtag: is a "word or abbreviation (designated in a tweet by the "#" sign) that can be searched on Twitter's websites"[5] or some other social media services e.g. Instagram. It is a way of marking messages that allows the reader to find topics with a specific theme or content and to "connect Tweets that talk about the same thing in one place."[6]

Devices: are "the computing technologies that enable users to access the platform."[7]

Density: presents "number of connections contained within network."[8]

Structural holes: opposite of density, "lack of connections."[9]

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[5] John H. Parmelee and Shannon L. Bichard, *Politics and the Twitter Revolution: How Tweets Influence the Relationship between Political Leaders and the Public* (Lanham, MD: Lexington Books, 2011), ProQuest Ebook Central.

[6] Twitter Help Center, "Getting Started," Twitter, accessed December 27, 2017, https://help.twitter.com/en/twitter-guide.

[7] Ravi Gupta and Hugh Brooks, *Using Social Media for Global Security*. (Somerset: Wiley, 2013), ProQuest Ebook Central, 25.

[8] Charles Kadushin, *Understanding Social Networks. Theories, Concepts, and Findings* (Carey, NC: Oxford University Press, 2012), 27.

[9] Ibid.

Groups: "Groups provide a space to communicate about shared interests with certain people. You can create a group for anything - your family reunion, your after-work sports team, your book club—and customize the group's privacy settings depending on who you want to be able to join and see the group."[10]

Platforms: are "the virtual spaces that allow users to come together, and create and share information."[11]

Facebook status: Facebook status is "short update from users' personal account and generally gives information without going into too much detail. When a status is updated, it posts on the user's personal wall, as well as in the news feeds of their friends. Statuses can be updated from a web browser, mobile site, or through text message."[12] On Facebook, it is called Facebook status, while on Twitter is called Tweet.

Tagging: "Tag is a keyword or term assigned to a piece of information. It could be used to aid classification, mark ownership, note boundaries, and indicate online identity. Tags may take the form of words, images, or other identifying marks."[13]

Instagram: "Instagram is a mobile application that allows users to share pictures and videos with followers."

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[10] Facebook Help Center, "Groups," Facebook, accessed February 5, 2018, https://www.facebook.com/help/1629740080681586/?helpref=hc_fnav.

[11] Ravi and Brooks, 24.

[12] Margaret Rouse, "Facebook status," WhatIs.com, accessed December 30, 2017, http://whatis.techtarget.com/definition/Facebook-status.

[13] Facebook, "Tag (metadata)," accessed December 30, 2017, https://www.facebook.com/pages/Tag-metadata/105553626145520.

Retweet: "A Retweet is a re-posting of a Tweet. Twitter's Retweet feature helps you and others quickly share that Tweet with all of your followers. You can retweet your own Tweets or Tweets from someone else."[14]

Like: A widely used Facebook like or thumbs up button is a feature that allows other users to "give positive feedback about content on the web people care about."[15] Beside like button, Facebook developed several other buttons that "has many types of emoji designs" and "Facebook provides animated emoji reactions to posts." [16] Some of the emoji designs are: Love, Haha, Wow, Sad, and Angry, but exact list of emoji is updating daily.

Twitter: "An information network made up of short messages (including photos, videos, and links) from all over the world."[17]

Tweet: is message on the Twitter and it "may contain photos, GIFs, videos, links, and text."[18] It is similar to Facebook "status."

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[14] Twitter Help Center, "Retweet FAQs," Twitter, accessed December 30, 2017, https://help.twitter.com/en/using-twitter/retweet-faqs.

[15] Facebook for Developers, "Like Button for the Web," Facebook, accessed June 5, 2018, https://developers.facebook.com/docs/plugins/like-button/.

[16] Emojipedia, "Facebook," accessed June 5, 2018, https://emojipedia.org/facebook/.

[17] Twitter Help Center, "Glossary," Twitter, accessed June 5, 2018, https://help.twitter.com/en/glossary.

[18] Twitter Help Center, "Getting Started."

CHAPTER 2

LITERATURE REVIEW

This chapter first searches the way to explain social media, natural disasters and emergency services as individual factors that exist in the human environment. Everywhere around the world, people are exposed to these factors on a daily basis. People are familiar with some of these factors, but some may occur unexpectedly and affect many people. In order to find a way for how social media could augment communication between people and first responders during natural disasters, and the correlation between this factors, this research considered their origin, possibilities, and limitations.

During research, it was difficult to distinguish which literature provided competent and reliable definitions of our factors. Currently, there is a variety of literature about social media. Social media is everywhere and everyone is using it to improve the quality of social life and to expand business. There is a great amount of literature that focused only on of the use of social media in advertisement or the use of social media in commercial purposes. A person could think that literature focusing on advertisement does not have anything similar with emergency services or natural disasters. This could be correct, but a commercial approach to social media may be helpful to understand how to target a certain population. For example, by knowing users and their habits, social media could distinguish them by age, gender, religious beliefs, occupation, and by the location of where they live. From an advertisement perspective, it is important to know what commercial is most suitable for what kind of population. If a new animal shop in some area is opened, one would like to attract the people that have animals and live in that

neighborhood. There are several ways this can be accomplished. A person can pay for a commercial over local television and radio. That is effective, but people usually do not stand in front of a television with pen and paper waiting to write down the number or address from a commercial. Another action one can take is to create flyers and post them in the neighborhood. It will cost additional money and time to cover the area. The best and most effective way is to pay for advertisement over social media. Social media targets everyone in the neighborhood according to their online activity. Everyone that recently searched online in their browser terms for animal food, veterinarian or pet shop will get a post. Furthermore, those people that shared a photo with their pet will receive this advertisement. This is an important feature because creating messages for a targeted population could be used in emergency situations. Social media could intentionally provide group emergency messages to populations in certain parts of town that are affected by the natural disaster. This example shows that every approach of social media usage is relevant and must be analyzed in order to find an adequate purpose in emergency communication. Researchers of disaster management continue to avoid implementing social media and social networks in the list of possible communication systems that provide first responders with information from the public in real time. Coppola in his research identifies those systems that allow the public to alert first responders and sort them to "public emergency reporting system ("9-1-1 system"), telephone-based public warning system ("reverse-9-1-1 system"), remote-activated emergency (weather) radios, sirens and public announcement (PA) systems, signs (electronic or conventional, stationary or moveable), internet-based warnings, disaster public information systems (to answer the flood of public inquiries during and in the aftermath of disasters that can flood

communications lines and distract response resources.)"[19] From his research, internet-based warnings are nothing but social media services, but called with different name. Avoiding mentioning social media, Coppola decides not to enter in-depth with communication systems. Internet based warnings could not exist without adequate platforms that enable web communication.

It provides aim and focus for the topics selected in this research. Analyses of a variety of literature was considered for this research and allowed the researcher to recognize possible gaps in understanding the problem and framing the thesis. Some of the events recognized as important and relevant for this research are still in progress (e.g. wildfires in California) and because of that, literature used to research this event is comprised mostly from news articles and internet sites. Other events happened in 2017, and because of the current events, there is the possibility that available literature has made some initial reactions and quick responses that do not display real conditions in the field. Consequences of some of the events are still subject to investigation. Because of the complexity of this subject and the correlation between social media, government and natural disasters, a broad literature study is used. The researcher first focused on literature that covers a specific area of research, then transitioned to literature that investigated a cohesion of researched elements. The literature study used information about social media, natural disasters, and emergency management. This type of literature explained a specific area in details and did not seek relations between other elements of research, but was important for the initial research.

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[19] Damon P. Coppola, *Introduction to International Disaster Management* (Amsterdam, Netherlands: Elsevier Science. 2006), ProQuest Ebook, 220.

The literature base for building this research included books including: “Public Response to Alerts and Warnings Using Social Media: Report of a Workshop on Current Knowledge and Research Gaps”; “Social Media in the Public Sector -Field Guide”; and, “Book Disasters, Collective Behavior, and Social Organization”. These books are important because they explain ties between factors that are the research topics. These books try to connect social media with government, social media with natural disaster, and behavior of people during natural disasters.

The book, “Public Response to Alerts and Warnings Using Social Media: Report of a Workshop on Current Knowledge and Research Gaps” is the product of a workshop on the role of social media in a disaster response. This book is important because it is the work of experts in the field of disaster response and social media from the IT staff over, nongovernmental organizations that deal with emergencies, to the first responders. Through an understanding of science, social behavior, and experience from the field, the authors described challenges that face disaster managers in their search to incorporate social media into regular practice. It analyses information from different perspectives, which is most important for this research. The book is focused on the use of social media for providing alerts and warnings to people before, during, and after natural disaster. From the perspective of this study, this could be just one options that social media must have in order to augment communication in natural disaster. The second part of the book gives insight into the current use of social media in emergencies. It described the way Los Angeles Fire Department (LAFD) uses a Tweeter account in order to communicate with the public.

Actually, they use two Tweeter accounts; first one "@LAFD"[20] is used solely for alerts, and second one "@LAFDtalk,"[21] is used for conversations with the public.[22] Case study of LAFD is in contrast with the main idea because those accounts provide much more than just alerts and warnings, which was the intent of researchers. From alerts and warnings, the authors "slide down" to emergency communication with public, which is our topic of research.

A second important book is "Disaster, Collective Behavior, and Social Organization." This book is important because it observes human behavior in different phases of disasters. The book is based on the work of E.L. Quarantelli, former director of Disaster Research Center, who achieved "significant theoretical and empirical contributions"[23] in the field of disasters, collective behavior and social organization. In the chaotic environment, like the impact of natural disasters on populations, Quarantelli would look for patterns. Quarantelli's Jominian's approach to disaster and human behavior in a structured, scientific manner helped him to study how behavior in chaotic

[20] Los Angeles Fire Department (@LAFD), Twitter accessed December 25, 2017, https://twitter.com/LAFD.

[21] Los Angeles Fire Department (@LAFD), "LAFD Talk," Twitter, accessed December 25, 2017, https://twitter.com/LAFDtalk.

[22] Computer Science and Telecommunications Board, Division on Engineering and Physical Sciences, and National Research Council, *Public Response to Alerts and Warnings Using Social Media: Report of a Workshop on Current Knowledge and Research Gaps* (Washington, DC: National Academies Press, 2013), ProQuest Ebook, 12.

[23] Russell R. Dynes and Kathleen J. Tierney, eds., *Disasters, Collective Behavior, and Social Organization* (Newark, DE: University of Delaware Press, 1994), 9.

situations becomes organized.[24] Although this book was published in 1995, the theories still have significant value and could be applied today. This is especially important because understanding of "public risk communication"[25] implications with traditional media have similar implications with use of social media in emergency communications. This is relevant because both traditional media and social media affect the behavior of the masses. Finally, the author recognized two trends that could apply to the use of social media in the future. In the first trend, the author emphasized, "Increased importance of electronically based interaction";[26] while in the second trend, he focused more on "the emergence of new social forms that will combine and make less meaningful some of our traditional distinctions, for example, between centralization and decentralization."[27]

A third book relevant for this research is "Social Media in the Public Sector; A guide to Participation, Collaboration and Transparency in the Networked World." This book provides a way government could use social media and its benefits. Lessons learned from practical application of social media in some public agencies "indicates that the government has an increasing need to create, distribute, and collect information outside

[24] Dynes and Tierney, 9.

[25] Colleen Fitzpatrick and Dennis S. Mileti, "Public Risk Communication," in *Disasters, Collective Behavior, and Social Organization,* Russell R. Dynes and Kathleen J. Tierney, eds. (Newark, DE: University of Delaware Press, 1994), 71.

[26] Dynes and Tierney, 325.

[27] Ibid.

of the traditional communication mission."[28] This body of knowledge considers relevant factors that need to be fulfilled in order to adopt social media in the public sector. Additionally, this book connects social media with government. Understanding of these relations is important because emergency services in every country are driven by the government agencies.

Definitions of Social Media

It is a shared belief that social media is a different name for Facebook, Twitter, and other various tools that individuals use in collaboration with other people on the web. This answer is true for the common user of these social media tools. However, for people that are deeply interested in this area, this is just a small piece of a puzzle named social media.

Because of the complexity of this term, there is no widely accepted definition of social media. From the literature study, three groups of researchers of social media prevailed: one group observed social media in comparison with traditional media, the second group defined social media from the perspective of technological advances, and a third group combined the previous two approaches in their research.

Large groups of social media researchers agree that social media phenomenon has changed the way of traditional media (press, radio, and TV broadcasting) published information. Mergel and Greeves argue, "The fundamental component of all social media— or the next generation of the interactive Internet— is a cultural shift, enabled by

[28] Ines Mergel and Bill Greeves, *Social Media in the Public Sector Field Guide: Designing and Implementing Strategies and Policies* (Somerset: John Wiley & Sons, Incorporated, 2012), ProQuest Ebook Central, 4.

social networking platforms that transform linear give-and-take communication into a collaborative discussion."[29] It is a new approach where "users have the ability to comment on what's being said"[30] instead just receiving a message. Mergel and Greeves suggest this change from traditional to social media approach explains the fact that "The writer becomes part of the story and becomes a reader as well,"[31] which was not typical of traditional media. On one side, we have "organizations and traditional broadcast media that had a stranglehold on the message"[32] and on the other side, a population that receive information, but cannot have an opportunity to provide feedback. As already mentioned, Jacka and Scott argue that "social media is the set of Web-based broadcast technologies that enable the democratization of content, giving people the ability to emerge from consumers of content to publishers."[33] This definition is very similar to one of the definitions invented by the group of enthusiasts gathered around famous digital analyst Brian Solis in 2007. Actually, in their search for a universal definition of social media, they came up with a shorter and a longer version. According to the longer version, "Social Media is the democratization of information, transforming people from content

[29] Mergel and Greeves, 4.

[30] Michael Cross, *Social Media Security: Leveraging Social Networking While Mitigating Risk* (Saint Louis, MO: Elsevier Science, 2014), ProQuest Ebook Central, 2.

[31] Mergel Greeves, 9.

[32] IIA Staff and Mike J. Jacka, *Auditing Social Media: A Governance and Risk Guide* (New York: John Wiley & Sons, Incorporated, 2011), ProQuest Ebook Central, 3.

[33] Ibid., 5.

readers into publishers. It is the shift from a broadcast mechanism, one-to-many, to a many-to-many model, rooted in conversations between authors, people, and peers."[34]

A similar approach is shared by the New York University journalism professor, Jay Rosen's blog post, "The People Formerly Known as the Audience"[35] in 2006. In the post, Rosen claims that power of information and power of influencing is not any more just a tool of big media system that owns printed media, radio, and TV broadcasting. With social media and internet, all that power is brought to common people, which are according to Rosen, "simply the public made realer, less fictional, more able, less predictable."[36] Even the fact that he does not use word democratization in his definition, it is obvious that social media evolved from the desire of people to have freedom of speech and freedom of information. The most important thing is that social media won the battle for its status, and according to Mergel and Greeves, "Traditional media now rely on social media accounts of events, as they occur, to provide updated information"[37].

Other groups of researchers of social media are more focused on technological innovations that provide the functioning of social media. Hill explains social media as

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[34] Brian Solis, "Defining Social Media: 2006-2010," January 7, 2010, accessed December 22, 2017, http://www.briansolis.com/2010/01/defining-social-media-the-saga-continues/.

[35] Jay Rosen, "The People Formerly Known as the Audience," *Huffington Post.* last updated May 25, 2011, accessed December 21, 2017, https://www.huffingtonpost.com/jay-rosen/the-people-formerly-known_1_b_24113.html.

[36] Ibid.

[37] Mergel and Greeves, 4.

"web-based technologies for communication and sharing over the Internet."[38] A shorter definition of Solis's group presents social media as, "Any tool or service that uses the internet to facilitate conversations."[39] It could be said that this definition is short and simple. But, we could say that it is less accurate because of the word "conversation" that usually refers to oral communication between two or more people. Appropriate words for this definition would be "online communication" as broader term that allows sharing voice, video, and data information between involved parties. Kaplan and Heinlein provide us another technical oriented definition of social media. From their perspective, social media is "a group of Internet-based applications that build on the ideological and technological foundations of Web 2.0, and that allow the creation and exchange of User Generated Content."[40] It could be suggested that User generated content was born when Rosen's "The People Formerly Known as the Audience"[41] met Web 2.0. Term Web 2.0 is recognized as the enabler of social media and provides "online interaction, including online social networks, joint content creation, and content sharing."[42]

Researchers from the third group of social media definitions tried to combine two previous approaches. Thesimplest definition of social media from the third category is

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[38] Craig A. Hill, Elizabeth Dean, and Joe Murphy, *Social Media, Sociality, and Survey Research* (Somerset: Wiley, 2013), ProQuest Ebook, 3.

[39] Solis, "Defining Social Media: 2006-2010."

[40] A. M. Kaplan and M. Haenlein, "Users of the World, Unite! The Challenges and Opportunities of Social Media," *Business Horizons* 53, no. 1 (2010): 61.

[41] Rosen.

[42] Mergel and Greeves, 4.

"Social Media = Social Networks + Publishing."[43] In this definition, social network refers to technology or enabler of social media, while publishing refers to content that need to be shared. The most complete definition that contains previous researches claims, "Social media is the collection of websites and web-based systems that allow for mass interaction, conversation, and sharing among members of a network. In this definition, social media has four defining characteristics: user-generated content, community, rapid distribution, and open, two-way dialogue."[44]

Everything mentioned above is focused on relations between subjects that provide information and subjects that read and comment on that information in online environments without time limits or at least, while provided information is available to everyone. It is interactive communication where shared content could be data, voice, and video information. For this research, these definitions are important to differentiate traditional media and social media and technological factors that are necessary to provide communication with adequate feedback.

Types of Social Media

Difficulties that researchers face in their efforts to define social media also applies when one tries to differentiate types of social media. This is reasonable because there are hundreds of social media applications in use in the world. According to Mergel and

[43] Visakan Veerasamy, "The Precise Difference Between Social Networks And Social Media," *Referral Candy* (blog), November 18, 2013, accessed December 25, 2017, https://www.referralcandy.com/blog/difference-between-social-networks-and-social-media/.

[44] Hill, Dean, and Murphy, 3.

Greeves, most of these applications have "similar features, such as profile pages for individual users and friending features for connecting with other members."[45]

Kaplan and Heinlein provide their perspective about classification of social media by "social presence/media richness and self-presentation/self-disclosure."[46] They organized social media into six categories:[47] collaborative projects, blogs, content communities, social networking sites, virtual game worlds, and virtual social worlds. But Adam Acar, in his book, argues that the way Kaplan and Heinen organized social media is "not enough to compare social media sites today, considering the fact that users can manipulate how much they want to disclose about themselves or create several accounts (one public, one private) on the same platform."[48] Instead of that categorization of social media, he suggests the one Brian Solis provided in his "Conversation prism,"[49] but with some additional suggestions. Mistakenly, he argues that Solis's "social media platforms and social applications can be classified into twenty-one different categories"[50] instead of 25, which can be found from the "Conversation prism."[51] Solis's approach is much

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[45] Mergel and Greeves, 37.

[46] Kaplan and Haenlein, 62.

[47] Ibid.

[48] Adam Acar, *Culture and Social Media: An Elementary Textbook* (Newcastle-upon-Tyne: Cambridge Scholars Publishing, 2014), ProQuest Ebook, 26.

[49] Brian Solis, "Conversation Prism 5.0," accessed December 26, 2017, https://conversationprism.com.

[50] Acar, 26.

[51] Solis, "Conversation Prism 5.0."

detailed, because he divided applications by their abilities. As a result, we have Facebook sorted in to social networks, messaging, livestreaming, and events area. It is a similar situation with other applications. For this research, Kaplan and Heinen's organization of social media is adequate, while Solis's perspective is too broad, but can be helpful for understanding what individual applications can provide. In further text, the researcher will explain some of these types of social media in order to provide clear picture of which application belongs to what type of social media.

Collaborative Projects

Collaborative projects enable the joint and simultaneous creation of content by many end-users and are, in this sense, probably the most democratic manifestation of UGC.[52] The best-known representative for this group are Wikis. These kinds of websites "are collaboratively written by their readers"[53] and all of them "share four common attributes"[54] which are:

1. Participatory,
2. Decentralized,
3. Linked,
4. Emergent.

[52] Kaplan and Haenlein, 62.

[53] Mark S. Choate, *Professional Wikis* (Hoboken, NJ: John Wiley & Sons, 2008), ProQuest Ebook Central, 1.

[54] Ibid., 4.

Participatory: it enables and allows everyone to take part in active collaboration on editing content. All editors are equal and without a distinct role, they can edit whatever they want.

Decentralized: It is not necessary for editors to be on one place, they could edit content from every part of the world if they have internet approach. Furthermore, there is no management hierarchy or content editing hierarchy in a decentralized approach.

Linked: In order to provide decentralization of editing, content need to be linked. According to Wikipedia their "articles provide links designed to guide the user to related pages with additional information."[55] Linking can be done by "old-fashioned hypertext links from one document to another document, or it can be a conceptual link made manifest by the sharing of a common tag."[56]

Emergent: Creation of content is emergent. All previous mentioned attributes above tend to provide existence of the new content. Because of that, as soon as content is written, it will be available to everyone without need to be printed or copyrighted.

Blogs and Microblogs

A weblog, or shorter blog, is a digital diary or "frequently updated online personal journal."[57] In the beginning term, "weblog" was used for the activity today we know as

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[55] https://en.wikipedia.org/wiki/Wikipedia:About Accessed December 26, 2017.

[56] Choate, 4.

[57] Colleen Cuddy, "The Weblog Handbook: Practical Advice on Creating and Maintaining Your Blog/We've Got Blog: How Weblogs Are Changing Our Culture." *Library Journal* 127, no. 13 (2002): 127-128, accessed December 21, 2017, https://lumen.cgsccarl.com/login?url=https://search-proquest-com.lumen.cgsccarl.com/docview/196869592?accountid=28992.

blogging. Because of its similarity with older and existing term, "web log" which is technical term that "refers to the computer files generated by web servers to log their activity"[58] researchers started using just the term, blog. There are a variety of purposes for blogging. It can be a diary that provides interesting things from a personal life, beliefs, feelings or practical advices about cooking, home repairing tips or something from the fashion world. One can write a blog about everything imaginable. In order to provide communication with readers and to see what the population thinks about his writing, an author could allow others to post their comments. There are two approaches. First, one can allow just posting feedback in private communication. In this case, only an individual will be able to see what the person thinks about a blog topic. In the other approach, a person "can act as a central communication platform where citizens discuss issues with each other - a platform in which an individual can participate."[59] Every comment on a person's blog is important because of several factors. As a writer, one will get important information about their topic. For example, did people like it or hate it, suggestions to improve or modify their work, and provide additional ideas that would not be considered during writing. The more communication and participation on a blog, that indicates more people read it. If you want to increase the number of people that visits your blog and retain the audience, you have to update your content occasionally, and to "respond in a timely, honest, and appropriate manner"[60] to all comments in order to

[58] Michael P. Sauers, *Blogging and RSS: A Librarians' Guide* (Medford, NJ: Information Today, Inc., 2010), ProQuest Ebook Central, 1.

[59] Mergel and Greeves, 52.

[60] Mergel and Greeves, 52.

"maintain the necessary level of trust and interaction with the audience."[61] However, on some occasions, comments can have a negative effect. Working in a big organization, competitor's competition could post negative comment on the blog. According to Sauers, "An organization that needs to retain control of its public image may not want to host uncensored reader commentary on its blog."[62] For better transparency of the blog, posts are organized in that manner; the newest post is always on the top of the web page, so the readers do not need to search through page for it.

When blogging is discussed as "an act of creating posts for a blog,"[63] we cannot forget to mention microblogging as another version of blogging. Microblogging is considered as "a form of blogging that allows users to write brief text updates."[64] However, in comparison to a blog where content can be several pages, microblog "content is typically much smaller, in both actual size and aggregate file size."[65] It could have up to 140 alphanumerical characters, photos or embedded video, and links to other websites. One of the most popular representatives of microblog services is Twitter. As an idea, Twitter originated from blogging and it "was created in 2006 by a team of

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[61] Ibid.

[62] Sauers, 2.

[63] Ibid., 1.

[64] Ines Mergel, *Social Media in the Public Sector: A Guide to Participation, Collaboration and Transparency in the Networked World* (Somerset: John Wiley & Sons, Incorporated, 2012), ProQuest Ebook Central, 18.

[65] Sauers, 259.

programmers who had worked in blogging and podcasting."[66] The mission of Twitter is to "give everyone the power to create and share ideas and information instantly, without barriers."[67] This democratization of ideas supports the definitions of social media addressed earlier in this chapter. All tweets are publicly visible and "contain status update information, sharing links and information, direct messages to other Tweeters."[68] With the "330 million active users in the third quarter of 2017," [69] Twitter represents a respectable social media.

Content Communities

Content communities are a type of social media that provides online sharing of various contents between registered members organized into communities. Communities "exist for a wide range of different media types, including text (e.g., BookCrossing, via which 750,000+ people from over 130 countries share books), photos (e.g., Flickr, Instagram), videos (e.g., YouTube), and PowerPoint presentations (e.g., Slideshare)."[70] Registration into some of these communities is not demanding. Usually, it is necessary to provide some basic information (e.g., e-mail address, nickname) without personal data.

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[66] Parmelee and Bichard, 10.

[67] Twitter, "About Twitter," accessed January 9, 2018, https://about.twitter.com/en_us/company.html.

[68] Hill, Dean, and Murphy, 8.

[69] J. Clement, "Number of monthly active Twitter users worldwide from 1st quarter 2010 to 1st quarter 2017," Statista, last updated July 29, 2017l accessed December 27, 2017, https://www.statista.com/statistics/282087/number-of-monthly-active-twitter-users.

[70] Kaplan and Haenlein, 63.

After becoming a member of a community, access to community content database is allowed, which grants the user the possibility to upload and download available content, according to community regulations. Some of the communities' practices are illegal to the extent because they provide sharing of copyright-protected materials." Officially, most of the communities have rules prohibiting such content, but in practice, content is rarely removed or members excommunicated unless the users receive a warning from an administrator or an order or legal authority. This is difficult, especially if they operate from some country that has not signed this kind of agreement. One example is shutting down the famous file sharing website "Megaupload" with 150 million registered users and arresting the owner, Kim Dotcom in 2012. "The allegations state that Megaupload facilitated millions of illegal downloads of films, music and other content, costing copyright holders a loss of over $500 million in lost revenue."[71]/[72] Even the fact that this "company is based in Hong Kong and the owner was living in New Zealand, some of the alleged pirated content was hosted on leased servers in Virginia, and that was enough for U.S. prosecutors to act."[73] While he is still resisting extradition to USA (arrested in 2012 in New Zealand), Kim Dotcom is looking for new ways to improve online piracy;

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[71] Nick Perry, "Popular file-sharing website Megaupload shut down," *USA Today,* last updated January 20, 2012, accessed December 27, 2017, https://usatoday30.usatoday.com/tech/news/story/2012-01-19/megaupload-feds-shutdown/52678528/1.

[72] Tom Eames, "Megaupload shut down by US officials," DigitalSpy, January 19, 2012, accessed December 27, 2017, http://www.digitalspy.com/tech/internet/news/a361102/megaupload-shut-down-by-us-officials/.

[73] Perry.

building new encrypted "file-sharing service, "K.im," which will allow uploaders to get paid for content through a bitcoin-based payment service – Bitcache,"[74] making it much harder for prosecutors to fight against online piracy.

Social Networking Sites

Social networking sites represent the most widely used social media services. One reason for this lies in fact that they connect people from all over the world, "allow for fast, bidirectional exchanges, oftentimes labeled real-time exchanges,"[75] "enable users to connect by creating personal information profiles, inviting friends and colleagues to have access to those profiles, and sending e-mails and instant messages between each other,"[76] enable users to have private chats, share images, data, video, and links. Social network sites is the user's digital ID and passport in online world. The most popular social network in the world is "Facebook." It was invented in 2004 by Mark Zuckerberg and his friends. In the beginning, Facebook was used as a tool for making friends and communication between college students. The name of the social network, Facebook "is derived from the 'face books' that appear on paper and used by American universities to help new students and staff quickly get to know one another."[77] As an innovative and

[74] Jamie Redman, "An Inside Look at Kim Dotcom's Upcoming Bitcache and K.im Platform," Bitcoin News, August 31, 2017, accessed December 27, 2017, https://news.bitcoin.com/an-inside-look-at-kim-dotcoms-upcoming-bitcache-and-k-im-platform/.

[75] Mergel, 14.

[76] Kaplan and Haenlein, 63.

[77] Visual Steps Studio, *Working with Facebook* (Chicago, IL: Visual Steps Publishing, 2014), ProQuest Ebook Central, 9.

emerging technology, Facebook started spreading from college to every house and cell phone, with the "reach of 2.07 billion monthly active users in the third quarter of 2017."[78] Facebook's mission statement is, "Give people the power to build community and bring the world closer together."[79] Facebook is currently the largest and most popular social network in the world. It allows many opportunities for its users. To use Facebook, the user needs to create personal profile that allows a person to be recognized in online world. If people do not know a person's existence in social network, there can be no engagement in communication. After creating a profile, a "friend" list is created (by accepting their friend requests or sending them requests for friendship) with whom the user wants to communicate. As owner of the profile, one can decide who can see posts, timeline, and communication on the Facebook. Facebook users can be organized in groups based on school, job, hobby, religious, or sympathy to some singer or actor as a fun group. Additionally, users can engage in variety of entertaining applications and social games that are provided on Facebook. If a user does not want to be friends with someone, there is the option to delete the friends list, but additionally "if one is receiving messages that seem like spam or create discomfort, messages can be blocked."[80] Most of the services that Facebook provides to users are mentioned in the definition of social

[78] J. Clement, "Number of monthly active Facebook users worldwide as of 2nd quarter 2016 (in millions)," Statista, last updated July 25, 2017, accessed December 28, 2017, https://www.statista.com/statistics/264810/number-of-monthly-active-facebook-users-worldwide/.

[79] Facebook, "About," accessed December 28, 2017, https://www.facebook.com/pg/facebook/about/?ref=page_internal.

[80] Facebook Help Center, "Messaging," Facebook, accessed December 30, 2017, https://www.facebook.com/help/1071984682876123/?helpref=hc_fnav.

networks above, but people and organizations everyday find some new perspective and ways for how to use them. Creation of a profile is free of charge.

Another very popular social network is LinkedIn. It is considered "the business version of Facebook."[81] In comparison to Facebook, which allows a presentation of personal categories, LinkedIn is person's career presentation. It communicates ones working skills, employment, duties, and job qualifications. Human Resource managers usually scout new employees over this network.

Virtual Game Worlds and Virtual Social Worlds

Kaplan and Heinen claim that "Virtual worlds are platforms that replicate a three dimensional environment in which users can appear in the form of personalized avatars and interact with each other as they would in real life."[82] If the virtual worlds are "interactive environments that support a broad range of social, entertainment, educational, and productive activities that are loosely based on activities in the physical world,"[83] and "users interact with each other as they would in real life,"[84] why do users not socialize in the real world or on social networks? One reason may be because it is easier to be in a virtual world and live behind some imaginable avatar that hides our imperfections. Origin of the word avatar is from Sanskrit and means "incarnation of a

[81] Hill, Dean, and Murphy, 9.

[82] Kaplan and Haenlein, 64.

[83] Ning Gu and Mary Lou Maher, *Designing Adaptive Virtual Worlds* (Boston: De Gruyter, 2014), ProQuest Ebook Central, 6.

[84] Kaplan and Haenlein, 64.

god."[85] Furthermore avatar "has been adopted universally in English to describe a player's representation in a virtual world, and increasingly, in online games."[86] Additionally the game is virtual; duties and rules for players are for real. Users need to "behave according to strict rules in the contex of a massively multiplayer online role-playing game (MMORPG). The most popular game in the virtual world of games is World of Warcraft.

Natural Disasters and Disaster Management

More and more people are affected by natural disasters every year. We are witnesses to the changes in nature that happen almost without warning. Sometimes technological advantages allow more time for people to prepare for natural disaster, but most of the time that warning comes too late. All damages to infrastructure could be repaired, all economy losses could be recovered, but unfortunately, loss of human life is irrecoverable.

There are a large number of definitions of natural disasters. The majority of these definitions describe natural disasters as natural phenomena. But in his book, "ABC of Conflict and Disasters" Redmond argues that natural disasters are "fundamentally human made" because "impact is governed by the prior vulnerability of the affected community"

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[85] Dictionary.com, "Avatar," accessed December 29, 2017, http://www.dictionary.com/browse/avatar.

[86] Celia Pearce, *Communities of Play: Emergent Cultures in Multiplayer Games and Virtual Worlds* (Boston, MA: MIT Press, 2009), ProQuest Ebook, 21.

while "the trigger for disaster can be natural phenomenon."[87] Other definitions generally agree that natural disasters are a change of normal social order caused by devastative elements of nature. To support the previously stated assertion, Kreps argues that, "Disasters are events, observable in time and space, in which societies or their larger subunits, incur physical damage and losses and disruption to their routine functioning."[88]

Professor Nelson from Tulane University distinguishes natural hazard and natural disaster. He argues that natural hazard is "a threat of a naturally occurring event will have a negative effect on humans" and that "negative effect is natural disaster."[89] According to this, one could say that natural disaster is an natural hazard with human casualties.

Natural disasters may be divided by its origin into: "geologic, atmospheric, and other disasters."[90] Geologic disasters are Earthquakes, Volcanic eruptions, Tsunami (tidal wave), landslides, and floods. Atmospheric disasters are Tropical storms, tornadoes, and droughts. Other natural disasters do not fall into the previous two categories, which include wildfires and contagious disease. More about effects of some of these natural disasters will be elaborated in chapter 4 through a case study analysis.

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[87] Anthony D. Redmond, Peter F. Mahoney, James M. Ryan, Cara Macnab, and Lord David Owen, eds., *ABC of Conflict and Disaster* (Hoboken, NJ: John Wiley & Sons, Incorporated, 2009), ProQuest Ebook Central, 4.

[88] G. A. Kreps, "Sociological Inquiry and Disaster Research." *Annual Review of Sociology* 10 (1984): 312.

[89] Professor Stephen A. Nelson, "Natural Hazards and Natural Disasters," EENS 3050, *Natural Disasters, Natural Disasters & Assessing Hazards and Risk*, 9 January 2017, Tulane University, accessed December 29, 2017, https://www.tulane.edu/~sanelson/Natural_Disasters/introduction.htm.

[90] Ibid.

Disaster Management

As Moltke the Elder stated, "One cannot be at all sure that any operational plan will survive the first encounter with the main body of the enemy" it could be said that there is no ultimate solution that could face every natural disaster in the world. Every natural disaster has its own signature although it "works" according same principles, but the effects are unpredictable. The role of disaster management is to prepare an adequate strategy in order to reduce the impact of natural disaster on infrastructure and save human lives.

According to Committee on Planning for Catastrophe Staff National Research Council (U.S.), the "goal of disaster management activities is to reduce, as much as possible, the degree to which a community's condition is worsened by a disaster relative to its pre-disaster condition."[91]

In literature, disaster management is mostly defined as "encompassing mitigation, preparedness, response, and recovery efforts undertaken to reduce the impact of disaster."[92] Disaster management does not start on the beginning of the disaster or does not end after a disaster is over; it is a continuous activity before, during and after natural disaster.

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[91] Tools, and Infrastructure Committee on Planning for Catastrophe: A Blueprint for Improving Geospatial Data, National Research Council, Board on Earth Sciences and Resources Staff, and Division on Earth and Life Studies Staff, *Successful Response Starts with a Map: Improving Geospatial Support for Disaster Management* (Washington, DC: National Academies Press, 2006), ProQuest Ebook Central, 48.

[92] Ramesh R. Rao, Jon Eisenberg, and Ted Schmitt, eds., *Improving Disaster Management: The Role of IT in Mitigation, Preparedness, Response, and Recovery* (Washington, DC: National Academies Press, 2007), ProQuest Ebook Central, 1.

Disaster mitigation is comprised of "actions taken to prevent or reduce risk to life, property, social, and economic activities, and natural resources from natural hazards."[93] When we talk about mitigation, we think about investment in preparation for natural disasters. The Multihazard Mitigation Council argues that investment in preparation saves money, or "for every dollar spend now, mitigation saves $4 later."[94] The goal of mitigation is to achieve a disaster resilient society, but it is not always so easy to implement mitigation programs. Sometimes mitigation programs are not correlated with future development of some area. Often times mitigation programs consider some land zone forbidden for building because of potential danger. For example, if a city decided to spread in a specific direction, it would be in conflict with the mitigation program. It is often difficult to persuade populations why some locations are more exposed to risk. The best example that describes why mitigation is difficult, is research about floodplain maps that are provided to residents of Topeka. Roders in his research "investigated the impact of risk education on perception by distributing floodplain maps to residents of Topeka followed by measuring their perceptions of risk related to residing in or near floodplains."[95] Results of the research illustrated that residents did not want to accept the

[93] U.S. National Committee for the Decade for Natural Disaster Reduction, Commission on Geosciences, Environment, and Resources, National Research Council, *A Safer Future: Reducing the Impacts of Natural Disaster* (Washington, DC: National Academy Press, 1991), 21.

[94] K. B. Penuel and Matt Statler, eds. *Encyclopedia of Disaster Relief*. 2 vols. (Thousand Oaks, CA: SAGE Publications, Inc., 2011), 424.

[95] Wolf Roder, "Attitudes and Knowledge on the Topeka Flood Plain," in Russell R. Dynes and Kathleen J. Tierney, eds., *Disasters, Collective Behavior, and Social Organization* (Newark, DE: University of Delaware Press, 1994), 71.

facts that their homes were in potential natural disaster area and, avoided relocation; therefore mitigation plans for creating safe zones failed. According to research, the biggest problem is that, "floodplain maps had no effect on public hazard awareness,"[96] which increase potential risk. However, it could be said that mitigation measures that include creation of forbidden areas for building in known flood zones should be adopted before all licenses are given to builders. Other barriers for adopting mitigation programs are "economic, social, and political; mitigation is often perceived as restrictive, costly, and incompatible with the community's economic development goals,"[97] which were previously discussed.

Disaster preparedness is another important factor of disaster management. It consists of preparation activities and measures what can be done when and after disasters occur. It is preparation and training that provides better response during natural disaster. Coppola defined disaster preparedness as an "actions taken in advance of a disaster to ensure adequate response to its impacts, and the relief and recovery from its consequences - is performed to eliminate the need for any last-minute actions."[98] Preparedness is mostly connected with specialized teams that first respond in case of natural disasters like firefighters, disaster management teams, police, medical emergency teams, and military. However, it is also important for every citizen to be aware of

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[96] Roder, 71.

[97] U.S. National Committee for the Decade for Natural Disaster Reduction, Commission on Geosciences, Environment, and Resources, National Research Council, *A Safer Future: Reducing the Impacts of Natural Disaster*, 21.

[98] Coppola, 209.

situations and how to respond in certain events, in a job, schools and home. According to McEntire and Myers "the goal of public education effort is to change people's apathy concerning disasters."[99] Generally, people are afraid of the things, which are not familiar, and that fear sometimes can save lives but sometimes could make situation worsen. Increasing knowledge of the population lets them understand the cause of their fear and that allows them to better prepare for hazardous situations. Preparedness is drilling and trained reaction on different hazardous effects, or "process of turning awareness of the natural hazards and risks faced by a community into actions that improve its capability to respond to and recover from disasters."[100] While Coppola's research was focused on five process of preparedness "planning, exercise, training, equipment, and statutory authority,"[101] other authors like McEntire and Myers recognized eight process of preparedness which are "establishing emergency management ordinances; assessing hazards, vulnerability and risks; creating an emergency operations plan; developing a warning system; identifying and acquiring resources and grants; instituting mutual aid agreements; training; exercising and educating the public."[102] This research recognize similarity with previous definitions of preparedness process and military operations

[99] David A. McEntire and Amy Myers, "Preparing Communities for Disasters: Issues and Processes for Government Readiness," *Disaster Prevention and Management* 13, no. 2 (2004): 140-152.

[100] U.S. National Committee for the Decade for Natural Disaster Reduction, Commission on Geosciences, Environment, and Resources, National Research Council, *A Safer Future: Reducing the Impacts of Natural Disaster*, 29.

[101] Coppola, 210.

[102] McEntire and Myers, 140-152.

process, which is used to help commander and staff "to drive the conceptual and detailed planning necessary to understand, visualize, and describe their operational environment; make and articulate decisions; and direct, lead, and assess military operations."[103] Preparedness needs military approach and could be run through four activities of operation process "plan, prepare, execute, and assess."[104] Planning is understanding, visualizing and describing of situation in preparedness phase. It is the way that helps government to better prepare for "most dangerous" natural disaster that could affect certain area. Preparation is the way that government is tasking disaster management and other institutions for acting before, during, and after natural disaster. Execution is the way that planned and prepared activities become operational and in function. Assess is ability that allow government to continually check status of preparedness systems in order to achieve the fastest reaction by first responders and to recognize possible gaps that need to overcomes.

Disaster response is the first responder's action on effects of natural disaster. The previous two phases has task to "reduce hazard vulnerability and increase resilience to disasters."[105] Task of disaster response is to activate capabilities that are planned in preparedness phase, but also "mobilization and distribution of resources to manage the

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[103] Headquarters, Department of the Army (HQDA), Army Doctrine Publication (ADP) 5, *The Operations Process* (Washington, DC: Government Printing Office, 2012), 1.

[104] Ibid.

[105] Coppola, 251.

immediate impact"[106] of natural disaster, in order to "minimize the loss of life, damage to property, and to the environment."[107/108] When natural disaster occurs, disaster response "begins with the deployment of resources such as personnel and equipment within community and concludes when the local community is able to begin focusing on the recovery process."[109] However, Copolla with good reason argues, "Response processes begin as soon as it becomes apparent that a hazard event is imminent,"[110] because warning and alerting systems inform population to take protective actions to incoming disaster. Usually, first responders that face with natural disaster are local emergency teams comprised of firefighters, police department, medic emergency teams and population that is affected with natural disaster, but it is ready and willing to voluntarily support rescue efforts. They are tasked "to secure the scene and maintain order, rescue and treat the injured, contain and suppress fire or hazardous conditions, and retrieve the dead."[111] Disaster response in many ways depends on the job that is done in mitigation and preparedness phase, but also depends of the scale of the natural disaster because the

[106] Penuel and Statler, 592.

[107] Penuel and Statler, 592.

[108] Coppola, 251.

[109] Penuel and Statler, 592.

[110] Coppola, 251-252.

[111] George Haddow, Jane A. Bullock, and Damon P. Coppola, *Introduction to Emergency Management* (Amsterdam, Netherlands: Elsevier Science & Technology, 2007), ProQuest Ebook Central, 171.

large-scale natural disaster can fast overwhelm the disaster management capabilities[112]. In comparison with other four phases of emergency management "disaster response is the most intense" phase with shortest duration.[113]

Disaster recovery is the process that provides continuous efforts of all disaster management organizations to keep involved in "rebuilding, reconstruction, repairing and bringing back to functional, pre-disaster condition,"[114] and also creates conditions that prevent and reduce future risks. Those actions could last for several weeks, months, even years, depending on the anticipated scale of natural disaster, how mitigation and preparedness phase are exploited, and depending on governmental goals for the future. If one is to improve the safety of the area in future by establishing adequate hazard prevention, than more money and more time will be used. Generally, Penuel and Statler claims that recovery is done through three phases which are "overlapping initial response phase to prevent or mitigate additional life and safety hazards, conducting short-term patches for important social needs and long term reconstruction phase with rebuilding damaged infrastructure."[115]

Haddow states that "the mission of an effective disaster communications strategy is to provide timely and accurate information to the public in all four phases of

[112] Coppola, 251.

[113] Penuel and Statler, 592.

[114] Coppola, 299.

[115] Penuel and Statler, 556.

emergency management,"[116] but it is also important to recognize value of information that public could provide to first responders not just vice versa. Coordinated efforts of local, governmental, nongovernmental, and voluntary organizations are necessary through all four phases of disaster management. This coordination is of crucial importance during response and recovery phase because effects of the natural disaster degrade existing communication systems. Because of that "communication technologies, such as 800 megahertz radios, web based systems, warning systems such as sirens, and mass media alerts such as the emergency broadcasting system, have been the primary focus for improving communication."[117] Research focus on social media, web based system as modern approach of communication in disaster management between first responders and public, but also between different parties involved in disaster management.

Role of Social Media in Disaster Management

In order to successfully achieve the mission and goals through all four phases of disaster management, disaster managers must reduce uncertainty about events in natural disaster. A way to reduce uncertainty is to have real time information about natural disaster because "times of crisis require the dissemination of timely and accurate information."[118] This could be achieved by establishing communication system that

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[116] Haddow, Bullock, and Coppola, 134.

[117] Timothy L. Sellnow and Matthew W. Seeger, *Theorizing Crisis Communication* (Hoboken, NJ: John Wiley & Sons, Incorporated, 2013), ProQuest Ebook Central, 3.

[118] Penuel and Statler, 544.

allows government to rely also on "proactive community engagement" which considers sharing of information (not just receiving) and collaboration between all involved parties. Cohen argues that today's emergency communication systems "have been built on core technologies such as two-way radio for emergency responders, telephone line switches for 911 calls, and broadcasting for emergency alerts."[119] That existing communication systems in coordination with traditional media "communicate warnings to an endangered public to elicit public protective actions."[120] One-way communication is good in the response phase to point people to what measures to take in order to better prepare for incoming danger. However, when the existing emergency communication system is overwhelmed with calls and degraded by devastative effects of natural disaster, it is always good to have a backup solution. U.S. National Committee for the Decade for Natural Disaster Reduction states that "advances in warning and communication technology in the United States provide new opportunities for emergency responders,"[121] recognizing in research use of mobile and cellular phones in Loma Prietha earthquake response. Further, it is stated that the coordination of all elements involved in repairing

[119] Nicolás Cohen, ed., *Emergency Communications: Enhancing the Safety Network* (United Kingdom: Nova Science Publishers, Inc., 2010), ProQuest Ebook Central, 2.

[120] Collen Fitzpatric and Dennis S. Milety, "Public Risk Communication," in Russell R. Dynes and Kathleen J. Tierney, eds., *Disasters, Collective Behavior, and Social Organization* (Newark, DE: University of Delaware Press, 1994), 71.

[121] U.S. National Committee for the Decade for Natural Disaster Reduction, Commission on Geosciences, Environment, and Resources, National Research Council, *A Safer Future: Reducing the Impacts of Natural Disaster*, 29.

disaster consequences "depends on operable communications systems,"[122] with specific, emphasize on the possible use of "facsimile machines and cellular telephones."[123] In the other research Sellnow argues "that repositioning of the public as an active participant is enabled by new mobile technologies, especially cell phones and Internet-based tools."[124] If researchers from different research recognized the value of cellular phones as an important communication tool in natural disaster, one could say that using it we could overcome communication equipment interoperability problem first responders face all the time while working in the field. When everyone use cellular phones as a universal communication tool or enabler of online services, it is easy to stay connected through social media services.

Enablers of Social Media in Mitigation Phase

The mitigation phase role is to shape the environment in order to set up conditions that will decrease possibility of disaster, or in case that disaster happened, it will reduce its negative effects. For the public it is necessary to have safe, reliable, and resilient communication systems that will remain in function during and after natural disaster. The Presidential Policy Directive (PPD) on Critical Infrastructure Security and Resilience "recognized 16 critical infrastructure sectors whose assets, systems, and networks, whether physical or virtual, are considered so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national

[122] Ibid., 33.

[123] Ibid.

[124] Sellnow and Seeger, 128.

economic security, national public health or safety."[125] Communication sector includes five areas broadcast, cable, satellite, wireless, and wireline. For this key enabler of communication services, it is important to recognize three types of risk "physical risks, cyber risks, and human risks"[126] that could affect communications capabilities. Physical risks to communication critical infrastructure are natural disasters, especially "Category 4 or 5 hurricanes, major urban floods, major earthquakes, and solar super storms,"[127] and human hazard activities. Cyber risks include every malicious or unintentionally action that could cause failure of information technology systems, damage to data, programs or software. Although, human actions are parts of physical and cyber risks, they could also be involved in "the impact of humans on network confidentiality, integrity, and availability across multiple categories: access of communications personnel to a disaster area, security of personnel and equipment during response and recovery, employee security awareness, and internal and external threats."[128]

The mitigation measures that could face physical, cyber, and human risks could be divided into two categories "structural and nonstructural."[129] Coppola identified

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[125] U.S. Department of Homeland Security, "Critical Infrastructure Sectors," accessed January 16, 2018, https://www.dhs.gov/critical-infrastructure-sectors.

[126] U.S. Department of Homeland Security, *Communications Sector-Specific Plan: An Annex to the NIPP 2013*, 2015, accessed January 16, 2018, https://www.dhs.gov/sites/default/files/publications/nipp-ssp-communications-2015-508.pdf.

[127] Ibid.

[128] Ibid.

[129] Coppola, 178.

structural mitigation as "risk reduction by implementing structural and engineering changes of the physical environment, while nonstructural mitigation contains measures that reduce risk through modification of human behavior or natural processes."[130] Structural mitigation provides more resistant construction of objects where critical communication infrastructure is set up, relocation of communication cables or other communication equipment to area that is not going to be affected by disaster, and building public warning and alert system. Nonstructural mitigation could include "regulatory measures, community awareness and education programs, nonstructural physical modifications, environmental control, and behavioral modification."[131] This structural and nonstructural mitigation measure presents shaping of the environment and is an enabler of social media services. Besides providing financial funds and adequate communication infrastructure during the mitigation phase, disaster management must identify what social media is most appropriate for engagement with public during natural disaster. This social media could be used as carrier of warning and alert messages about incoming hazard and tool for two-way communication between first responders and public. In the mitigation phase, it defines regulations about the use of specific social media. This regulation include rules and policies that every user of social media should apply. Every disregarding and disrespect of this rules as a consequence could have ban and expel of user from social network. Building and integration of social network with existing emergency communication system is important mitigation measure that can be

[130] Ibid.

[131] Coppola, 185.

taken. All other mitigation measures correlated with critical communication infrastructure are in service of enabling this capability to public and disaster management.

Social Media in Preparedness Phase

If the mitigation phase role is to protect critical communication infrastructure and to enable the use of communication capabilities necessary for functioning social media, then the preparedness phase role is to establish communication services and to train disaster management employees and public how to collaborate in this online environment. Disaster preparedness educates how to behave, train how to react, and teach what to do before during and after disaster.

One of preventive measures that are important for establishing communication services of preparedness phase is signing "pre-event agreements between local jurisdiction and telecommunication companies for provision of emergency assistance and restoration of telecommunication services."[132] Contracts like this are important for both sides because they are profitable for telecommunication companies while local jurisdiction will get best alternative for providing telecommunication services for the public in case of emergency. This alternative is not so reliable like special communication equipment that disaster management use but it is much cheaper and it is like "first aid" or comes handy in situations when you do not have anything.

The preparedness phase, according to disaster sociologist Jeannette Sutton, a senior research scientist at the University of Colorado at Colorado Springs should be

[132] U.S. National Committee for the Decade for Natural Disaster Reduction, Commission on Geosciences, Environment, and Resources, National Research Council, *A Safer Future: Reducing the Impacts of Natural Disaster*, 33.

more about training people "how to use social media effectively, how to get information from the Web and how to put out useful information."[133] This is partially true because most of the people today know how to use social media and they use it every day. It is more important to teach people where to find relevant information and what kind of information is interested for first responders and disaster management. While first responders in preparedness phase need to train how to understand messages from public and how to communicate with public, disaster management role is to plan and announce which social media has reliable information from governmental sources. In the book Facing Hazards and Disasters: Understanding Human Dimensions, it is explained by Mileti and Fitzpatrik's analysis how government could increase public awareness about incoming hazard in preparedness phase. Research showed that "printed materials, such as the brochures residents received, were more effective in communicating risk than more ephemeral forms of communication such as television and radio" but also that "printed material - or any risk communication vehicle - is not sufficient to raise awareness and motivate action."[134] Conclusion is that information about incoming hazard must be delivered "through multiple channels, in different (but consistent) form, and must be

[133] Dina Fine Maron, "How Social Media Is Changing Disaster Response," *Scientific American*, June 7, 2013, accessed January 18, 2018, https://www.scientificamerican.com/article/how-social-media-is-changing-disaster-response/.

[134] U.S. National Research Council Staff, Division on Earth and Life Studies Staff, and National Academy of Sciences, *Facing Hazards and Disasters: Understanding Human Dimensions* (Washington, DC: National Academies Press, 2006), ProQuest Ebook Central, 114.

repeated."[135] Social media could provide information that traditional media deliver to public, and even public could print all guidance's and material that disaster management provide online. Also, in preparedness phase disaster management need to use traditional media and social media to advertise names and web addresses of social media people could use during disaster. This is important in providing right emergency evacuation route, based on information which direction disaster is going, tracking the path of disaster and which roads are maneuverable and less jammed of traffic, information about regular hurricane updates, data about public preparedness (which store have more water, food and other important supplies.) Proper decision making in preparedness phase and adequate training could mitigate effects of natural disaster in response phase.

Social Media in Disaster Response Phase

When disaster occurs, it is an important cooperative effort of disaster management, government, first responders and volunteers to restore order and provide adequate support for disaster affected population. Providing information to the public quickly on an incoming disaster is critical to reduce the first impact on the population and decrease human casualties. Unfortunately, soon after disaster is announced communication systems start to become overcrowded with calls and chasing for information. In the societies where disaster management trained with the population in a certain scenario in the preparedness phase, there is less uncertainty then in societies that did not provide enough resources to the preparedness phase. People "hear, understand,

[135] Ibid.

believes, personalizes, and decides and responds"[136] according to provided training. Lack of training and education cause big impacts to the communication system because, when people are not sure of the validity of the information, they are concerned about their beloved ones and they do not want to follow disaster management instructions. Traditional media in combination with existing warning and alerting system are important to keep public updated with current situation about natural disaster. But the one, which is in critical situations, must have two-way communication with emergency services, in order to call for help and provide disaster managers with situational awareness information. Those critical data contain information about location, situation and number of people that need help. While the traditional media and warning and alerting system are most common ways to provide information about incoming disaster, some emergency management organizations and public use social media as a way to keep updated with recent information. Need for obtaining information from social media came from relatively new human addiction, to be updated with latest news in every place and every moment. Technological innovation of cellular phone, tablet and PDA made people always available to other people but also bring them information much closer which allow them to respond faster and more efficient.

Communications between the public and first responders is important for both side because it allows the public to use responders' knowledge about disaster and event-specific information while the public provides responders with live information from the

[136] Fitzpatrick and Mileti, 71.

[136] Dynes and Tierney, 72.

field, navigate them through town to reach wounded and give other information first responders could not gain by use of technological innovations. Use of special equipment is dedicated to responders only and often they are unable to coordinate their efforts amongst themselves. People do not have special equipment to communicate with first responders so they need to use available assets. When phone lines are overwhelmed with calls for help and degraded by effects of natural disaster, the media that remains in use is the cell phone, tablet, PDA, or similar device that can connect to available Wi-Fi networks. That kind of equipment is available to everyone and does not need any special requirements to be compatible within a commercial network. As soon as a user has internet access, communication is possible. In that moment, it is vital that the preparedness phase provides all this, it is important that a user is familiar with disaster management links and trained to ask and provide information related to the situation. Even if the user is not familiar with disaster management efforts in the preparedness phase, basic knowledge of the use of social networks could help to reach other users and ask for help. First responders and disaster managers would then have the additional important ability to disseminate rumors from scammers and people that are afraid and overseeing the disaster. In that event, governmental organizations must be ready to act quickly because fake information could cause the downfall of rescue efforts and may result in rescue teams losing authority. In addition, social media in the rescue phase should provide information about emergency shelters for the ones whose homes are destroyed in the disaster and also provide information about missing people, and their location in order to reconnect with beloved ones. It is also important to provide relevant

information about places where someone could find supplies, water, food and medical attention.

Social Media in Recovery Phase

One would usually say that everything is over when disaster ends. That is not correct because when the disaster ends, disaster management starts to work to restore everything to a predisaster state. Buildings are ruined, stores and services are not working and most of the population is usually evacuated if the government was ready for the incoming disaster. However, if the disaster was a surprise such as an earthquake, then search and rescue efforts begin. There is also a way social media could be used in combination with traditional media in a recovery phase. The role of social media could be applied to the Penuel and Statler three phases of recovery, which were already mentioned in this research. Nevertheless, these phases could be divided in sub-phases that have short and long duration periods. In first phase, short term, social media could be used to warn people about additional life and safety hazards by providing maps of disaster affected areas, and estimates from the government about an incoming disaster. However, in long term it is important to search for missing and evacuated population over social media. The second phase would consider important social needs in order to avoid humanitarian catastrophes. In this short term phase, information would be provided about safe houses and collective rooms and shelters where people without homes could stay temporarily; while in long term, social media could be used to attract people to donate money, food, and clothing. In final phase of reconstruction with rebuilding damaged infrastructure, social media could interest more people in order to attract more donations.

Disadvantages of Social Media Usage

Since there is such a wide use of different kinds of social networks, one could ask why everyone doesn't use social media in disaster management. Social media as web-oriented services are built in environments that are available to everyone. That makes it vulnerable to different kinds of risks. While the government tries to use social media as a relatively cheap and efficient tool to help people, there are some groups that use social media for illegal purposes because it is difficult to discover and trace these kind of activities in the digital world.

Beside that there are also existing concerns about safety and security issues, quality and reliability of information, access issues, lack of informational knowledge, and some other factors that cannot fit in either of these groups.

Because social media is relatively new and widely spread over the internet, there is an existing concern about shared content, safety, and security of personal data. In the digital world, there is "trench war" for every subscriber. On one side, there are marketing experts who try to reach to every internet user for commercial purpose, while on the other side, there are various violent extremist organizations trying to use the same approach in order to attract more attention and sympathizers. While the purpose is different, the approach of both is very aggressive. Scott MacKillop is one of the authors with knowledge of neutral approaches regarding social media. He stated, "Social media has the potential to unite people across borders, races, and religions. It is a voice for the public in the new age."[137] But, understanding something as a good thing does not exclude

[137] Justin Healey, *Social Impacts of Digital Media* (Thirroul: The Spinney Pressm 2014), ProQuest Ebook Central, 21.

that thing from being bad. If social media could help and unite, there is also a way that social media could be used to worsen relations or even divide more people. Social media played a significant role in organizing the masses in Arab spring. Social media was used as a tool to organize populations, share information and turn the public against regimes in some of the countries. In addition, social media is used by VEO to advertise radical ideologies, promote wrong values to wide populations and to reach masses. It is difficult for any government to stop this activities in peacetime, while in emergencies, it is even harder.

Information shared over social media must be trustworthy and reliable because dissemination of inaccurate and false information can cause panic and mass hysteria. Fitzpatric and Mileti agree that public response depends on activities accomplished in the planning (preparedness) phase. They say the public must be able to "hear warnings, understand what is said, believing what is heard, personalizing what is believed as may be appropriate, deciding what to do, and then engaging in response behavior."[138] This research was done for warning and alerting systems but it can also be used for understanding messages over social media. It is easy to control the flow of information when everyone is playing according to already set rules. But if the first responders are unable to communicate with the public or the information they provide is different than what is happening in the field, then the public starts to search for additional information, communicate over different social media and spread rumors, panic and loose trust in governmental agencies. According to Allport and Postman "rumor intensity is a function

[138] Fitzpatrick and Mileti, 82.

of importance of the topic multiplied by the ambiguity of available information."[139] Regarding social media, availability and speed of information is very important. If the system is not prepared for fast responses, then all the information whether valid or wrong has the same strength. Disaster sociologist Jeannette Sutton explains that, "false information can easily go viral."[140] In this article as an example, Mrs. Sutton uses the Boston Marathon incident where she found that information provided over social media was not relevant and difficult to search. On the other hand, we have fresh examples about false missile alerts in Hawaii that cause panic and disruption across the country. False information was broadcasted on radio and TV, and an emergency alert was delivered to all mobile subscribers over social media. According to latest information, the mistake was made by a technician during regular emergency system checking, but it was interesting that the technician didn't know to turn off the emergency system or to send an additional message that was a false alarm. In a similar case in Alaska, alarms were delivered for a Tsunami warning, but this was also false. "Rumor Control, run by FEMA, attempts to nip misinformation" but in general there is a significant problem "who has responsibility to police social media information or how - or even - if that would work."[141] Lack of control, insufficient knowledge about technology, wrong or missing

[139] Ralph Turner, "Rumor as Intensified Information Seeking: Earthquake Rumors in China and United States," in Russell R. Dynes and Kathleen J. Tierney, eds., *Disasters, Collective Behavior, and Social Organization* (Newark, DE: University of Delaware Press, 1994), 244.

[140] Maron.

[141] Ibid.

procedures, and lack of training are common problems that government agencies face through all disaster management phases.

In the recovery phase, the public organizes and collects funds to help the one that needs help. The big amount of money attracts scammers who create false social media accounts to collect money from people that are willing to help. People open accounts and pretend that they lost family in a disaster or that their house is devastated and they ask money from the public. People are usually more generous in that time and rarely check if it is fraud or a real need so often money ends up in the wrong hands. If the government has control over those accounts, fraud like this would be avoided.

CHAPTER 3

RESEARCH METHODOLOGY

The primary purpose of this research is to analyze how social media can be used by the government, first responders, and the people as a means of communication in a response to a natural disaster. The research examines structure of social media and ways the social media services are used in everyday life, and lessons learned when using social media in different natural disasters. This research supposes that an analysis of the previous use of social media in natural disasters could help us to better understand how disaster management should establish and use social media as a way to augment existing communication systems. Communication systems are the mutual thing that exists in all disaster management phases, and using social media should improve the state of readiness for first responders and may be a rescue tool for people that need help. Because of its complexity this research needed to be studied through qualitative and case study methodology approaches. The purpose of this chapter is to outline the method used to answer the primary research question:

How can social media be used by the government, first responders, and the people as a means of communication in response to a natural disaster?

The literature review showed that to research this study, quantitative data could be used but it does not lead in the right direction and does not help to answer the primary question. This research is interested in the number of social media messages sent during natural disasters, but that number does not show what that communication is about and who the participants include. If the quantitative approach provides information regarding two million messages related to a certain natural disaster, it can include all messages all

over the world that have key words correlated with a specific natural disaster. This research is dedicated to social media messages between first responders and the public that is affected by a natural disaster that could be better explained by qualitative methodology. The other reason for using a qualitative approach is explained by John W. Cresswell in the book *Research Design: Qualitative, Quantitative and Mixed Approaches* where the author emphasizes that qualitative approach provides us information on how and why something happened which is more correlated with this research. Author also compared qualitative and quantitative research in terms of "philosophical assumptions that researchers bring to the study, the types of research strategies used in the research (e.g., quantitative experiments or qualitative case studies), and the specific methods employed in conducting these strategies (e.g., collecting data quantitatively on instruments versus collecting qualitative data through observing a setting)."[142] This research tended to explore and understand social problems from case study perspective, because it provided an adequate method to reach into the depth of problem analyzing events from the past and predict similar events and approaches in future. Similar to Cresswell's research, Dr. Yin explains, "case studies are the preferred method when (a) "how" or "why" questions are being posed, (b) the investigator has little control over events, and (c) the focus is on a contemporary phenomenon within a real-life context."[143] Using case studies as an explanation of how something has been done in the past allows

[142] John W. Cresswell, *Research Design: Qualitative, Quantitative and Mixed Method Approaches* (Thousand Oaks, CA: Sage Publications, Inc., 2014), 32.

[143] Robert K. Yin, *Case Study Research, Design and Methodology* (Thousand Oaks, CA: Sage Publications, Inc., 2009), 2.

the reader to decide the possible outcome and how to avoid failure in the future. Better understanding of different disasters and the surroundings in each of disaster, provides insight in the current state of readiness and could serve as comparison model. The main idea with case studies is to increase the number of known facts in order to provide better decision support. Similar to Cynefin framework, it is important to keep information between simple, complicated and complex in order to have a good basis for avoiding problems. Disaster is something that causes chaos, but case studies are the factor that allows understanding of disaster behavior. It is important for first responders to have known inputs that could help them to better control the situation. Unfortunately, many of disasters were barely investigated or research came too long after the actual event. In that situation, case study could not contribute to creating a bigger picture of the certain type of disaster. In a multiple case study approach, it is important to analyze different events or different disasters in order to become familiar with existing variables. The four case studies for the purposes of this thesis were selected based on their relevance to the broader topic. If this research used only one type of disaster in case study, the research topic would not be relevant for everyone because some of the mentioned disasters could happen only in certain regions.

CHAPTER 4

ANALYSIS

The purpose of this chapter is to understand, visualize and describe gaps and problems that occur during natural disasters and approaches that government could take to augment communication between affected populations, first responders, volunteers, and government. This approach is necessary because natural disaster effects to cyber infrastructure and people are too complex for just a simple observation.

According to Army Doctrine Publication ADP-5, understanding the environment is to establish "the set of circumstances that surround a particular event or situation."[144] For the research purpose, it is important to provide understanding of the conditions that natural disasters cause on the cyber capabilities then on the effects on people and infrastructure.

Visualization of natural disaster includes case studies about Hurricanes Irma, Harvey and Maria, earthquakes in Mexico and Nepal, flooding in Sri Lanka and wildfires in California. The reason the research includes various different natural disasters is to show how critical cyber infrastructure is vulnerable to different threats and what people can expect from every disaster. It is important to understand that no two disasters are the same. The effects one earthquake had in the past does not mean that another will have the same effect. Lessons learned from these disasters could point to what are critical cyber infrastructure vulnerabilities that were recognized during each disaster and what required cyber capability is necessary to support parties involved in disaster response.

[144] HQDA, ADP-5, 2.

After the phases of understanding and visualization, the phase of description discusses governments' need to provide a set of rules and regulations for future engagement during natural disaster.

Natural disasters, in contrast to man-made disasters cannot be avoided but with good preparation, effects of disaster can be mitigated. Every disaster "that threatens a community will affect it in a unique way,"[145] but often that one disaster that has less effect on one population may trigger other disasters that cause a more devastating effect. Those effects could be "primary, secondary, and tertiary."[146] This research used different disasters in different parts of the world to compare how public and disaster management uses available capabilities of social networks in developing and developed countries affected by various types of natural hazards. It is especially important to understand that sometimes natural disaster may surprise even the most powerful nation in the world, the United States of America, as during Hurricane Katrina. This is the reason why it is important to understand and apply lessons learned from previous experiences in order to avoid similar, costly mistakes.

[145] Coppola, 38.

[146] Nelson.

Table 1. Cyber Implications of Natural Disaster Effects to People and Infrastructure		
PEOPLE	INFRASTRUCTURE	CYBER IMPLICATIONS
Number of affected population	Damage to critical infrastructure (underground cables, cell towers, data centers, telecommunication buildings and equipment)	Communication failure and degradation cyber capabilities
Number of deaths	Impact on transportation infrastructure (bridges, roads, railways, airports)	Inability to contact emergency services and first responders
Number of injured, dislocated, and evacuated population	Power grid failure	Inability to share situational awareness
Impact to basic human needs (food, water, shelter, electricity, medical help)	Destruction of buildings	Lack of wider support
Impact to social life (education, information, local bossiness, property loss, separation from family)	Damages to hospitals, police stations, firefighters.	Lack of coordination

Source: Created by author.

Table 1 shows the effects that natural disaster may cause to people and infrastructure and the cyber implications of those effects. Both direct and indirect impacts of natural disaster may be lethal to a population. The direct impact of natural disaster on a population causes death and injury, while the indirect impact is the destruction of buildings, transportation and cyber infrastructure. The more infrastructure destroyed, the more people are affected. If the hospitals are destroyed people do not have a place to bring wounded and the number of deaths will increase. Collapse of constructions and architecture could cause more deaths but also disrupt societal functions and destroy elements of communication systems. When buildings are destroyed, families lose their

homes, schools, and jobs, and in addition, other important institutions such as police and medical care could be affected. Destruction of transportation infrastructure could cut off evacuation routes and prevent disaster management helping the population. If the roads are destroyed, evacuation is impossible; but, if cyber infrastructure is destroyed there is no possibility to call for help. From the cyber perspective, this is also very important because most of the time the fiber optic backbone network follows big roads. Longer periods without power could affect almost every segment of human life, however, most of the time vital institutions have backup generators to provide electricity until power is restored.

Natural disasters are like human beings, they look alike and they are similar, but their nature and character is different. Even when they belong to the same type of disaster (two hurricanes or two earthquakes), every disaster is different and so is the way that disaster affects people and infrastructure. This leads to cyber implications that degrade disaster management team abilities to react. High numbers of the affected population may result in large rescue efforts and that is very challenging for everyone because rescue efforts have to be massive in order to adequately face the effects of disaster. The effects the natural disaster has on people and infrastructure affects everyone's ability to communicate and share information. The highest impact is when cyber infrastructure is destroyed and communication cannot be established or is significantly degraded. This leads to failure of communication, lack of situational awareness and insufficient coordination.

People as an important element that is affected by natural disaster could be divided into four categories as the affected population, volunteers, first responders or

government. However, there are more divisions and subdivisions of these four categories but this research will focus on this four.

Affected populations are the group of people directly influenced by the natural disaster and depends on support provided by first responders, volunteers and government. In order to receive help, logistics, and medical support, it is necessary to communicate and share information over every available cyber capability. When contact is established with first responders, both sides exchange information. This information is useful because the affected population receives information that someone will come to save them while first responders get information that will increase their situational awareness. In Table 2 are some of the required capabilities of an affected population and cyber capabilities necessary to provide it.

Table 2. Required Capability of Affected Population			
REQUIRED CAPABILITY	Request immediate assistance/evacuation due to life threatening situation during natural disaster	Articulate life support needs during natural disaster (water, food, medicine, medical assistance, clothes, shelter,)	Communicate and interact with local affected population
REQUIRED CYBER CAPABILITY	Using of available cyber capability (landline, cellphone, internet)	Using of available cyber capability (landline, cell phone, WI-FI, social media) establish contact with first responders	Using of available cyber capability (social media) establish contact with other affected population in area
TASK	Provide First responders individual or group status (name/s, conditions, life/death status, missing personnel, wounded, injured)	Provide first responders individual or group status (name/s, conditions, life/death status, missing personnel, wounded, injured,) but also food, water, medical and fuel shortfalls.	Support disaster management effort and provide volunteer support for other affected population if necessary
PURPOSE	Create list of affected population and location where each individual is displaced in order to have population tracking	Create list of logistic and medical shortfalls in each area in order to have resource tracking and allocation	Provide additional volunteer capability in order to help other affected population

Source: Created by author.

Volunteers are groups of people who are willing to help the disaster-affected population without expecting financial or any other benefit for their work or services. Volunteers are led by humanitarian principles. Anyone could be a volunteer but it is

always good to have well trained and skilled personnel who are self-sustained in providing support. In disasters, it is good to have volunteers with some cyber skills that could establish unity of effort across the disaster affected area, communicate with the public about natural disaster in order to provide situation awareness and collect funds and donations that will be distributed to the affected population (see table 3).

Table 3. Required Capability of Volunteers

REQUIRED CAPABILITY	Establish Unity of Effort across the disaster impacted area	Communicate the public about natural disaster	Actively participate in Emergency operations center.
REQUIRED CYBER CAPABILITY	Using of available cyber capability (landline, cell phone, WI-FI, social media) establish contact with affected population and first responders	Using of available cyber capability (mass media, social media) establish contact with non-affected population and NGO	Using of available cyber capability (landline, cell phone, WI-FI, social media) establish contact with government
TASK	On the ground assessment of affected population needs	Provide situation awareness for non-affected population and NGO	Support local government disaster rescue effort
PURPOSE	Provide immediate localized support and determining future requirements	Better engagement with the public and increased volunteer support in order to provide affected population with recognizes shortfalls	Provide volunteer resources to work for government interests

Source: Created by author.

In Homeland Security Presidential Directive (HSPD-8) first responders are defined as a "individuals who in the early stages of an incident are responsible for the protection and preservation of life, property, evidence, and the environment, including emergency response providers" but also "emergency management, public health, clinical care, public works, and other skilled support personnel (such as equipment operators) that provide immediate support services."[147] First responders (Table 4.) play a significant role during natural disasters because the speed of first responders' reaction is critical for saving more people. In order to know the situation they are dealing with, first responders must have information about the threat. Sometimes when first responders are in the field, they realize the briefing they received does not depict the real situation. However, they still need know how to provide adequate help to the affected population. First responders collect information from different sources but also it is of vital interest to achieve contact with affected population. This communication between first responder and affected population is based on trust and respectability because human lives depend on it.

[147] U.S. President, Presidential Policy Directive/PPD-8, Subject: National Preparedness, U.S. Department of Homeland Security, accessed January 19, 2018, https://www.dhs.gov/presidential-policy-directive-8-national-preparedness.

Table 4. Required Capability of First Responders			
REQUIRED CAPABILITY	Provide immediate assistance to affected population	Coordinate activities with other first responders	Provide information sharing
REQUIRED CYBER CAPABILITY	Using of available cyber capability (landline, cell phone, WI-FI, social media) establish contact with first responders	Using of available cyber capability (landline, cell phone, WI-FI, social media, satellite phone, HF radio, HAM radio and) establish contact with first responders	Using of available cyber capability (landline, cell phone, WI-FI, social media, HF radio, mass media) establish contact with affected population, non-affected population, other first responders, volunteers and government
TASK	Protect human lives	Eliminate duplication of activities	Increase situational awareness
PURPOSE	Evacuate affected population	Effectively use of available resources	Increase situational awareness and identify gaps

Source: Created by author.

The role of the government is to provide funds, coordinate all government entities to work toward same goal, and to provide a wide set of regulations that could define everyone's role in the natural disaster. This procedural and policy framework could include the regulation of telecommunication market in the way that governmental entities during natural disaster could ask operators in the region to subordinate parts of their network capacities to work for government purposes during the emergency. It is important to define priority of communication in the entire network so the affected

population in the affected region with minimum capabilities can maintain necessary communication. The role of the government is shown in table 5.

Table 5. Required Capability of Government			
REQUIRED CAPABILITY	Declare state of emergency	Activate the Emergency Operations Center	Provide information to the public through mass media announcements
REQUIRED CYBER CAPABILITY	Using of available cyber capability (landline, cell phone, WI-FI, social media, HF radio, mass media) establish contact with affected population, unaffected population, other first responders, volunteers.	Using of available cyber capability (landline, cell phone, WI-FI, social media, HF radio, mass media) establish contact with affected population, un-affected population, other first responders, volunteers.	Using of available cyber capability (landline, cell phone, WI-FI, social media, HF radio, mass media) establish contact with affected population, un-affected population, other first responders, volunteers
TASK	Activate all available resources to fight natural disaster	Better use of available resources	Increase situational awareness.
PURPOSE	Achieve unity of effort	Delegate responsibility	Provide situational awareness to public through mass media announcements

Source: Created by author.

All disasters have the same characteristics: loss of human lives, power outages, destruction and loss of cyber capabilities. All these characteristics are interconnected but in order to achieve the required capabilities for the above mentioned categories and to

prevent more casualties, it is crucial to have good planned and developed cyber capability. In order to provide cyber capability to the affected population, volunteers, first responders and the government, it is important to identify what critical cyber infrastructure, technology and telecommunication market regulation is necessary.

There are many different approaches to distinguish types of cyber infrastructure. According to one approach, it could be divided into landline network, cellular network, radio network, satellite network, and data/ip network. All these networks provide various cyber capabilities to end users. The most basic services are video, voice and data signal. Some networks have better capabilities than others but there is no ideal one. Depending on the situation, sometimes voice communication is more preferable but sometimes there is a need to share data or video in order to explain a situation that cannot be explained by words. Social media is a multi-capability approach because it consolidates video, voice, and data in one communication and it could be sent through any cyber infrastructure network.

In peacetime, cyber infrastructure is vulnerable to failure of some of the network elements of the cyber system, or physical destruction of some part of the network that may be caused by people. In a disaster, cyber infrastructure is vulnerable to direct physical destruction, destruction of supporting infrastructure, over-usage, or congestion of the network. Some cyber technology is infrastructure dependent while others are infrastructure independent. That means that some cyber capability is more resilient to destruction, but that does not mean that it could provide all wanted services. Infrastructure dependent cyber technology is vulnerable to natural disaster destruction, and the specific hardware damage depends on the type of natural disaster. During an

earthquake, every component could be affected; however, during hurricanes only wind-exposed towers and antennas are destroyed but underground cyber infrastructure remains intact. Today everything is about resilience of cyber infrastructure as an enabler of cyber capabilities. This resilience lies in flexibility and innovative usage of existing technologies, adapting old technologies to modern times and acquiring some new technologies. One of the ways is to combine old technologies with new and integrating various media (traditional media and social media) is a good way to upgrade each media shortcomings and to increase "operation reach," distance or duration where disaster management message could reach the public. Beside this, it is important to provide alternative routes for delivering information through different types of cyber infrastructure by using fiber optics, line of sight communications or satellite communications. Power outages affect cyber capability and these could happen on either side of the distributor or receiver of information. Even though cyber capability is resilient to power outages, in the fiber optics era, it is more difficult to provide communication to the end user during power outages. For comparison, power outages rarely affected users of old PSTN because a copper wire central battery in telecommunication exchange provides sufficient voltage for a telephone. It was necessary to provide a power alternative for telecommunication exchange and if there were no physical damage to copper wire, the user would have a functioning landline. This is a situation where the user has a basic telephone in his home, while wireless phones need additional source of power. Fiber optics is more dependable on power than old PSTN, but provides a wider range of capabilities. An additional problem that can occur in the cyber infrastructure domain is network congestion due to over usage. Every system is projected to have more

usage than the average number of calls per user. However, during a disaster we have increased usage and equipment that is not projected to this number of calls overload. A high number of calls causes network congestion and may result in some users not receiving timely communication. Radio communications requires an additional set of equipment, or at least some parts of the equipment. Amateur radio, also known as HAM radio, belongs to the group of radio services for non-commercial purposes that could work with multiple frequency bands. It can send messages further than other equipment but the problem beside lack of equipment is the need for licensing and testing. During flooding in Serbia in 2014, people that had HAM radio would stream all communications over the internet so that everyone without HAM radio station could hear who needed help and the location of first responders. Communication and requests for help were established through email or through social media. Satellite communications is representative of infrastructure independent communication, which means that destruction of cyber infrastructure would not affect satellite communication. Recognized short falls of satellite communications are the lack of equipment, the high price of services, and that indoor communication is hard to establish. Data/IP networks provide internet services to users and it could be wire or wireless communication. From the perspective of the affected population, it is important to have unlimited access to internet in order to use social media, web pages, mails and VoIP services. Internet access is achieved through the use of Wi-Fi technology in hot-spot locations. Hot spots could be public or private depending on where they are created and for what purpose. Public hotspots could be set up in airports, train stations, internet cafes, or hotels, while private hotspots are mostly established in people's homes.

Cellular networks or mobile networks are made of cells that are interconnected between themselves by wire communication or wireless communication and they provide a wireless signal for the mobile devices. Cellular networks are very important in a natural disaster because they allow users to stay interconnected with friends and relatives but also with first responders, volunteers and the government.

Regulation of the telecommunication market is very important for every country because the development of cyber capabilities depends on liberalization of the market while a monopoly or a natural monopoly, which is another name for government control of leading companies, hinders development. As a leading authority, a government needs to coordinate international and domestic organizations that were involved in the disaster response and recovery phase. According to the results of the disaster analysis, one of the government concerns is to improve the survivability of critical infrastructure in order to achieve a more resilient system in case of natural disaster.

In the case study, first to be explained will be the condition and effect each natural disaster causes to cyber capabilities. After Table 6, a narrative follows that compares various factors in different disasters and different countries in order to recognize and find the gaps that prevent providing cyber capabilities to affected population, volunteers, first responders and government.

Table 6. Effects to Cyber Infrastructure in a Disaster		
CYBER INFRASTRUCTURE IMPLICATIONS	Cyber infrastructure destruction	High/medium/low impact
	Power outages	High/medium/low impact
	Network congestion	High/medium/low impact
	Impact to emergency services	High/medium/low impact
	Landline capability	High/medium/low impact
	Cellular capability	High/medium/low impact
	Radio capability	High/medium/low impact
	Satellite capability	High/medium/low impact
	Data/IP capability	High/medium/low impact
CYBER LIMITS	Identified gaps and limitations	
LEGEND:		
High impact	Medium impact	Low impact	None

Source: Created by author.

Hurricanes Irma, Harvey and Maria (People, Infrastructure, Cyber Capabilities)

As representatives of atmospheric hazards, hurricanes are strong tropical storms that are characterized by wind "speeds of over 60 miles an hour and ability to unleash more than 2.4 trillion gallons of rain a day."[148] Hurricanes bring destruction in many different ways and that mostly depends on a hurricane's strength that is represent by categories. The Saffir-Simpson Hurricane Wind Scale categorizes hurricanes in "scale from 1 to 5 based on a hurricane's sustained wind speed and estimates potential property

[148] National Geographic, "Hurricanes," accessed February 6, 2018, https://www.nationalgeographic.com/environment/natural-disasters/hurricanes/.

damage."[149] The hurricanes reaching category 3 and higher are considered dangerous and can cause loss of life and material damage. The hurricanes with categories 4 and 5 cause catastrophic damages. More than 45 percent of casualties during hurricanes result from storm surges, which are "produced by water being pushed toward the shore by the force of the winds moving cyclonically around the storm."[150] On the site The Weather Channel, the National Hurricane Center analysis of hurricanes was reported, in which "storm surge, rainfall flooding, high surf, and deaths just offshore (within 50 nautical miles of the coast) comprise 88 percent of all deaths in the U.S. from hurricanes."[151]

Several U.S. states, Puerto Rico, and the U.S. Virgin Islands were affected by the devastative force of three major hurricanes Harvey, Irma, and Maria, respectively, in late August and September 2017. This is first time in known history that the U.S. was affected by three category four hurricanes. The National Oceanic and Atmospheric Administration with the National Hurricane Center updated the list of the costliest tropical cyclones to strike the United Stated mainland: Katrina (2005) is the costliest storm on record, "it is followed by Harvey (2017), Maria (2017), Sandy (2012) and Hurricane Irma (2017)

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[149] National Hurricane Center and Central Pacific Hurricane Center, "Saffir-Simpson Hurricane Wind Scale," National Oceanic and Atmospheric Administration, accessed February 11, 2018, https://www.nhc.noaa.gov/aboutsshws.php.

[150] National Hurricane Center and Central Pacific Hurricane Center, "Storm Surge Overview," National Oceanic and Atmospheric Administration, accessed February 14, 2018, https://www.nhc.noaa.gov/surge.

[151] Jonathan Erdman, "88% of U.S. Deaths From Hurricanes, Tropical Storms Are From Water, Not Wind," The Weather Channel, accessed February 13, 2018, https://weather.com/safety/hurricane/news/hurricanes-tropical-storms-us-deaths-surge-flooding.

ranks fifth."[152] These hurricanes caused billions of dollars in damage in infrastructure, loss of economy and human lives casualties, but the good thing that came out from all of this is the way how first responders, governmental organizations and public were actively involved in sharing the knowledge and information of natural disaster over social media. For the most powerful nation in the world, the United States of America, hurricanes are believed to have been the costliest disaster in monetary terms, despite a strong governmental effort to increase mitigation and preparedness measures in vulnerable regions. However, good preparation and setting up of the mitigation measures in one year does not mean that it will have benefit next year because of different factors and climate changes. Frumkin warns that the "sea level has risen approximately 8 inches over the last 100 years,"[153] and that is considered as a factor that brings uncertainty into disaster management fights with natural hazards especially because same research estimates that the "sea level is likely to rise between 10 and 38 inches by 2100."[154] In combination with hurricanes, this will increase the power of surges, worsen costal erosion, and bring more flooding to low-lying areas. Other problems recognized by the National Hurricane Center that do not help disaster management teams with their mitigation plans are "increased population density in Gulf coastal counties, in Atlantic coastal counties, and in Hawaii,

[152] National Hurricane Center, "Costliest U.S. tropical cyclones tables updated," National Oceanic and Atmospheric Administration, January 26, 2018, accessed February 6, 2018, https://www.nhc.noaa.gov/news/UpdatedCostliest.pdf.

[153] Howard Frumkin, ed., *Environmental Health: From Global to Local* (Hoboken, NJ: John Wiley & Sons, Incorporated, 2016), ProQuest Ebook Central, 403.

[154] Ibid., 404.

and fact that much of the United States' densely populated Atlantic and Gulf Coast coastlines lie less than 10 feet above mean sea level."[155]

Hurricane Harvey formed in the Gulf of Mexico as a tropical storm that rapidly turned into a category four hurricane on August 17, 2017 and made landfall in southeastern Texas, "bringing record flooding and destruction to the region."[156] After Texas, Hurricane Harvey returned to the Gulf of Mexico, where it lost strength and degraded to a tropical storm and then made landfall a second time in Louisiana. With all the winds and the rains that brought to the land, Harvey caused enormous flooding and with total estimated damage of $125 billion ended as the second most expensive hurricane in history of United States, just after hurricane Katrina. Harvey caused at least 108 confirmed deaths.

[155] National Hurricane Center and Central Pacific Hurricane Center, "Storm Surge Overview."

[156] Defense Visual Information Distribution Service, "Hurricane Harvey," Department of Defense, accessed February 4, 2018, https://www.dvidshub.net/feature/HurricaneHarvey.

Table 7. Effects to Cyber Infrastructure in Hurricane Harvey		
CYBER INFRASTRUCTURE IMPLICATIONS	Cyber infrastructure destruction	Low impact
	Power outages	Medium impact
	Network congestion	High impact
	Impact to emergency services	High impact
	Landline capability	Low impact
	Cellular capability	Low impact
	Radio capability	Low impact
	Satellite capability	Low impact
	Data/IP capability	Low impact
CYBER LIMITS	First responders encouraging use of emergency services, Long time waiting for emergency services, calls for emergency services were disconnected or dropped, rumors and misinformation, scams.	

LEGEND:			
High impact	Medium impact	Low impact	None

Source: Created by author.

The other two hurricanes named Irma and Maria were not as strong as Harvey, but they still were in the list of the top ten most expensive disasters that hit United States. Hurricane Irma formed in the Atlantic Ocean and affected the Caribbean Sea, caused severe damage in St. Thomas and St. John in the U.S. Virgin Islands including Puerto Rico and the U.S. Virgin Islands, before affecting the mainland United States,[157] on Sunday, September 10. According to the US Bureau of Labor Statistics "initially rated as a Category 5 hurricane, Irma dropped to a Category 4 passing through the Florida Keys,

[157] Defense Visual Information Distribution Service, "Hurricane Irma," Department of Defense, accessed February 4, 2018, https://www.dvidshub.net/feature/HurricaneIrma.

and was then downgraded to a Category 2 hurricane when it hit mainland Florida."[158] Estimated damage caused by Hurricane Irma is $91.61 billion.

Table 8. Effects to Cyber Infrastructure in Hurricane Irma		
CYBER INFRASTRUCTURE IMPLICATIONS	Cyber infrastructure destruction	Low impact
	Power outages	Medium impact
	Network congestion	Medium impact
	Impact to emergency services	Medium impact
	Landline capability	Low impact
	Cellular capability	Low impact
	Radio capability	Low impact
	Satellite capability	Low impact
	Data/IP capability	Low impact
CYBER LIMITS	Congestion of emergency services, public safety compromised during amateur use of social media, rumor, lack of prioritization of objectives	
LEGEND:		
High impact	Medium impact	Low impact / None

Source: Created by author.

Last but not the least hurricane that affected US was Hurricane Maria. Hurricane Maria formed in the Atlantic Ocean on September 16 and affected islands in the

[158] Bureau of Labor Statistics, "Effects of Hurricanes Harvey, Irma, and Maria on BLS Data Collection and Reporting," United States Department of Labor, accessed February 5, 2018, https://www.bls.gov/bls/hurricanes-harvey-irma-maria.htm.

Caribbean Sea, including Puerto Rico and the U.S. Virgin Islands.[159] It is the most devastating storm to ever hit Puerto Rico and the Dominican Republic.

People of Puerto Rico were active on social media in the beginning of the hurricane, but when the storm wiped out telecommunication towers and power lines, cyber capability was not available to the public. Years of bad planning and low investment into cyber infrastructure and power grid came to the surface. Weak power infrastructure without underground cables to increase resilience collapsed during the first contact with the hurricane. The same situation happened with the cyber infrastructure. Total devastation of the cyber infrastructure and power grid cut off Puerto Rico from the mainland.

[159] Defense Visual Information Distribution Service, "Hurricane Maria," Department of Defense, accessed February 4, 2018, https://www.dvidshub.net/feature/HurricaneMaria.

Table 9. Effects to Cyber Infrastructure in Hurricane Maria		
CYBER INFRASTRUCTURE IMPLICATIONS	Cyber infrastructure destruction	High impact
	Power outages	High impact
	Network congestion	None because of total cyber infrastructure failure
	Impact to emergency services	High impact
	Landline capability	High impact
	Cellular capability	High impact
	Radio capability	Medium impact
	Satellite capability	Medium impact
	Data/IP capability	High impact
CYBER LIMITS	Weak cyber infrastructure, no underground power cables, small number of satellite and radio terminals, social media was used while cyber infrastructure was intact for updating population about disaster.	

LEGEND:			
High impact	Medium impact	Low impact	None

Source: Created by author.

If one compares how people react during hurricanes in different parts of the world, it is important to understand all factors that are relevant to the development of cyber infrastructure, power grid, quality of buildings, and transportation infrastructure. It is also important to understand that different parts of the country will suffer differently during a disaster. In comparison, when the affected area is an island, as Puerto Rico, people cannot run away deeper in mainland like they could when disaster strikes a continent. In addition, emergency help during and after a disaster on an island is difficult because of limited transport capabilities and the speed of delivering supplies.

Wherever you live on mainland or an island, it is important to follow instructions of disaster management and evacuate on time. Avoiding to obey instructions could have

negative implications in many ways. Disaster management announces what areas are ready to evacuate, and the ones that do not follow the plan can cause traffic jams on the streets. In addition, people that decide to stay in home, risk not just his/her life but also risks first responders' lives when they come on a rescue mission. This research analyzed human behavior and the use of social media during three hurricanes in different regions.

In the first moments when a government finds out that a disaster is imminent, it is important to quickly analyze the situation and announce the previously prepared emergency plans. This announcement could be made through a warning and alerting system or with traditional media and social media. It is also important to have estimates about what area will be impacted with disaster and what are the possible consequences. Translated to military terminology, governments have to understand the "most likely" and "most dangerous" course of action of a natural disaster. This estimate will include impacted area, affected population, damage to infrastructure, but also will predict what negative impact it will have on the whole country. Best examples of this includes the rise of fuel prices in the United Stated due to 10 refineries flooding in the Houston and Corpus Christi region caused by hurricanes. According to the web site of Port of Corpus Christi "Hurricane Harvey has significantly impacted the entire Texas gulf coast with the petroleum refining centers of Corpus Christi, Houston, Port Arthur, Beaumont, and Lake Charles Louisiana either completely shut down or significantly scaled back operations."[160] This has effected prices of fuel in the entire country.

[160] Port of Corpus Christi, "Post Hurricane Harvey Recovery Update Corps Christi Ship Channel Re-Opens After Record Six Day Closure, August 31, 2017, accessed February 4, 2018, http://portofcc.com/post-hurricane-harvey-recovery-update-corpus-christi-ship-channel-re-opens-after-record-six-day-closure/.

There are various examples of the use of social media during hurricanes. The public used social media to ask or to offer a help, search for friends and relatives, to look for gasoline, food, or even shelter in town, and to communicate the situation in real time in order to support first responders rescue efforts. Disaster management and government were using social media to provide relevant information about disaster, and to give guidance for further steps. In the beginning, officials were encouraging people to use standard emergency services "911," but when it became overwhelmed with calls, government turned to social media.

During hurricanes, numerous volunteer groups were formed over social media to support endangered population by connecting first responders with the ones that need help. Some of the groups were using familiar social media services over "Facebook," and "Twitter," while other groups were using new not so well known services. Fox published the "Nextdoor application, a private social network, to provide users with the latest news from their neighborhood during hurricane rescue efforts."[161] In the article, the author explains the benefit of this application during a disaster. To criticize this someone could say that the one that desperately needs help is not going to use an application that is not familiar to use and certainly is not going to download and install an unknown application during a life-threatening situation. Translated to military terminology, if you have two guns and the enemy is charging at you, which one you are going to use? Some new gun you saw for the first time or your gun that you clean and dismantle every day? People

[161] Fox Business, "This social media app helps neighbors during hurricanes," Fox News Network, LLC, September 26, 2017, accessed February 15, 2018, http://www.foxbusiness.com/features/this-social-media-app-helps-neighbors-during-hurricanes.

always choose familiar things. People generally first try to call "911" emergency service, but if the line is down, another solution may be a social media application that is most familiar. Volunteer groups organized as centralized locations were collecting information and providing already checked data to first responders. It is significantly important for first responders to have precise information in real time because they risk their lives and give outstanding effort to reach those that need help in the most critical areas. Sending first responders on wrong locations cause loss of morale, exhaustion, and unnecessary waste of resources. Of course, government agencies work with volunteer groups rather than single individuals, because it is easier to verify their credentials. In addition, volunteer groups filter messages they receive over social media in order to check for irrelevant, false, and fake information that does not have any value to first responders.

POTUS Donald Trump signed an emergency declaration for states affected by hurricanes and on September 5, for Puerto Rico. This declaration "authorizes FEMA to coordinate all disaster relief efforts which have the purpose of alleviating the hardship and suffering caused by the emergency on the local population, and to provide appropriate assistance for required emergency measures."[162] After information about hurricanes start appearing over social media, FEMA opened "Rumor Control"[163] page where everyone can check information in order to fight misinformation. This lack of

[162] Federal Emergency Management Agency, "President Donald J. Trump Signs Emergency Declaration for Puerto Rico," U.S. Department of Homeland Security, September 5, 2017, accessed February 15, 2018, https://www.fema.gov/news-release/2017/09/05/president-donald-j-trump-signs-emergency-declaration-puerto-rico.

[163] Federal Emergency Management Agency, "Harvey Rumor Control," U.S. Department of Homeland Security, September 8, 2017, accessed December 30, 2017, https://www.fema.gov/disaster/4332/updates/rumor-control.

verification of user of social media is identified as a crucial problem, because officials are unable to disseminate real or fake message over social media and to focus on solving the problem. Beside activity on social media, FEMA employees were working very hard to coordinate disaster management activities between all parties, to restore power and communication services in affected areas, and to deal with rescue and relief activities in the field. For FEMA, it was also important to provide updated information over different social media to inform public about measures taken to overcome the disaster and to be in contact with the population in the endangered area. This was accomplished by the official FEMA account on Facebook (https://www.facebook.com/FEMA/) and Twitter (https://twitter.com/fema).

Soon after the hurricane warning was announced, Facebook activated its Safety Check feature, which allowed users to add already offered information. This information informs friends and family that the person is in a safe place and not in a dangerous situation. This option of Facebook is a good innovation because users can announce their status and that has benefit for everyone. Families do not worry and disaster management is aware they do not need to go on a search and rescue mission for that person.

These hurricanes caused enormous damages to infrastructure and people but if it is possible to say that there is any benefit of the disaster, it is that both people and government in one moment start using the same social media services and coordinate mutual rescue efforts. This use of social media in an emergency means that higher usage will increase knowledge, which implies that new ways of using of social media in opposing disaster threat will be developed.

Hurricanes Harvey, Irma and Maria caused different consequences to cyber infrastructure. While during Hurricane Harvey, first responders were referring people to 911 emergency services instead of social media channels; during Hurricane Irma first responders were using both, emergency services and social media. This approach allowed for better communication and coordination between first responders and affected population, but also real time communication and information sharing increased situational awareness. This crowd-sourced approach allowed everyone on social media to become a dispatcher of urgent information, which has good and bad sides. A good side is that within a large number of people, there are always some that possess some specific skills or have some rare equipment (rubber boat, amateur radio, satellite phone) that could be used to support first responders rescue effort. On the other side, there is part of any population that wants to gain some benefit from the whole situation. They spread misinformation, trying to trick people with insurance frauds, adding fake news in order to force people to evacuate to loot their home, etc.

The Earthquakes in Mexico and Nepal (People, Infrastructure, Cyber Capabilities)

There is one significant difference between earthquakes and other natural disasters. Coppola recognized that "while hazards such as wildfires, droughts, and cyclones may have a significant lead-time that can be measured in hours, days, or even weeks, hazards like earthquakes can strike with almost no advance notice."[164] It means

[164] Coppola.

that in the case of earthquakes disaster management could not warn people about an incoming disaster, which are more predictable and traceable.

On 25 April 2015, a powerful 7.8 magnitude earthquake hit Nepal, "devastated Kathmandu, created avalanches on Mount Everest, killed more than 9000 people and left hundreds of thousands of impoverished Nepalese people homeless."[165] It was the largest disaster to occur in Nepal in over 80 years. After the earthquake and subsequent aftershocks, extensive damage to infrastructure was reported throughout whole country. Thousands of buildings were completely destroyed including power plants, schools, hospitals, government buildings, telecommunication infrastructure and even 13% of total transportation networks were destroyed. The last two are very important because without telecommunication infrastructure, nobody can send calls for help but without transportation networks any medic, rescue or disaster management team cannot come closer unless they are using helicopters. Nevertheless, even with the help from the air, a rescue approach is limited because of transport capability and distances they need to overcome to transport food and supplies in one direction and wounded to safe places in the other direction. Damages to power infrastructure caused outages in power supply to the whole country. Effects that earthquakes cause on telecommunication infrastructure are unpredictable. Sometimes complete underground telecommunication infrastructure is

[165] Greg Rodgers, "2015 Nepal Earthquake," TripSavvy, last updated May 16, 2017, accessed February 5, 2018, https://www.tripsavvy.com/nepal-earthquake-1458517?utm_term=earthquake+in+nepal&utm_content=p1-main-3-title&utm_medium=sem&utm_source=gemini_s&utm_campaign=adid-f2c7d954-ad91-4162-aad6-faa69d0f1ce0-0-ab_tse_ocode-38137&ad=semD&an=gemini_s&am=exact&q=earthquake+in+nepal&o=38137&qsrc=999&l=sem&askid=f2c7d954-ad91-4162-aad6-faa69d0f1ce0-0-ab_tse.

destroyed while wireless infrastructure and base stations are intact and sometimes the situation is just the opposite. In the case of Nepal, earthquake telecommunication infrastructure was significantly damaged, and both fiber optic infrastructure and microwave links were damaged in a number of areas. This affected first responder's ability to share, exchange, gather information and maintain communication with their command center but also with other parts of the population. Telecommunication operators did outstanding work to support the population after disaster. First repairing teams on the ground were created a mobile base station due to the large number of destroyed buildings. Unfortunately, instead of temporarily engaging mobile teams, the number of mobile teams increased over time because people were afraid that cell towers would affect stability of already damaged buildings. In order to prevent whole buildings from falling down, residents demanded telecommunication operators to remove base stations immediately from their rooftops. Lack of base stations affected the quality of telecommunication services. People faced frequent congestion of the network and low quality of telecommunication services. The mobile communication operators provided free SMS, data and voice services for six days after the disaster,[166] while other mobile operator provided sim cards to rescue teams and news reporters. Due to the problem in mobile network functioning, operators suggested everyone use short messages because they are not as demanding as data and voice services. However, most people continued to use social media and voice communications and this lead to frequent congestions in the

[166] GSMA, *Disaster Response: Nepal Earthquake Response and Recovery Overview*, GSM Association, October 2015, accessed February 28, 2018, https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/12/GSMA_Disaster-Response_Nepal_Workshop.pdf.

network. Skype and Viber enabled all calls to landlines and mobiles to Nepal and from Nepal free of charge. The social media usage after the earthquake can be divided into three groups, government, big corporations, and volunteers. Similar to the situation in Puerto Rico, the Nepal disaster revealed government limitations in operating with the aftermath of such a big disaster. In the beginning, it was difficult for the government to coordinate rescue operations with limited information from the scene; but soon after the military arrived, the situation started to look much better. The government should take credit because their active participation on social media helped to stop rumors about new incoming aftershocks that were disturbing the population. Big corporations also participated in the rescue effort from the start. After the earthquake hit Nepal, Facebook activated the online option Safety Check that allowed people to notify their friends that they were at a safe location and they were not hurt in the disaster. After the rescue phase, and in the recovery phase, Facebook set up fundraising campaigns in order to collect money to rebuild destroyed buildings and help the population to recover faster. Google Corporation had a similar plan. Google launched a person finder tool to help people locate visitors and residents in the rescue phase, and during the recovery phase, Google enabled users to donate money for Nepal's recovery. One of the bright spots of the Nepal earthquake was volunteers. Organized volunteers, first in small groups and later in bigger groups, started to work as soon as the disaster happened. Small rescue teams were on the ground helping survivors to rescue their beloved ones. Other groups decided they could serve better if they sent information about the catastrophe to the world because the survivors relied on communications to ask for rescue teams, deliver missing supplies and check availability of shelters.

Table 10. Effects to Cyber Infrastructure in Earthquake in Nepal		
CYBER INFRASTRUCTURE IMPLICATIONS	Cyber infrastructure destruction	High impact
	Power outages	Medium impact
	Network congestion	High impact
	Impact to emergency services	High impact
	Landline capability	High impact
	Cellular capability	High impact
	Radio capability	Low impact
	Satellite capability	Low impact
	Data/IP capability	High impact
CYBER LIMITS	Weak cyber infrastructure without international redundancy, free services offered by mobile operators increased congestion of the network, lack of prioritization of services.	
LEGEND:		
High impact	Medium impact	Low impact	None

Source: Created by author.

On the 32nd anniversary of the 1985 earthquake in Mexico, on 19 September 2017, another earthquake with an estimated magnitude 7.1 hit south of the city of Puebla, Mexico.[167] This earthquake was not as destructive as the one in 1985, but still almost 400 people were killed, more than 6000 injured, and large numbers of buildings collapsed. An interesting fact is that the earthquake that hit Mexico happened while Hurricane Maria, mentioned in the text above, was heading toward Puerto Rico. Failure of disaster management to deal with a corrupted construction system that led to construction violations in the mitigation phase led to the collapse of large numbers of buildings. Cyber

[167] Nicole Chavez, Steve Almasy, Ray Sanchez, and Darran Simon, "Central Mexico earthquake kills more than 200, topples buildings," *CNN*, September 19, 2017, accessed June 5, 2018, https://www.cnn.com/2017/09/19/americas/mexico-earthquake/index.html.

infrastructure in urban areas, like the one in Mexico City, were not so affected by the destruction. After the earthquake, the initial wave of users overwhelmed communication networks, but the situation with the network soon returned to normal. Similar to Nepal, telecommunication operators in Mexico supported rescue efforts by temporarily providing free data and calls to all users. The lack of preparation of the government disaster management teams and their poor equipment slowed down rescue missions. Armed only with shovels and good will, first responders were not so efficient, but people did not want to wait for their families to be rescued. In Mexico, volunteers used social media to organize and direct relief efforts, they communicated with the public about missing persons, they directed efforts to communities that had no supplies, and supplied a workforce, when it was necessary. In one case, entrapped people were rescued when social media was used to assist in finding and providing tools necessary to penetrate massive concrete blocks. But there were other people that did not want to support rescue efforts because of various reasons. A majority of the fake information came as a result of chaos, inability to verify received information, best intentions, and misunderstood information. It is symptomatic that in every disaster there exists a group of people that propagate rumors in order to increase panic. In this case, the level of misinformation was so high that the government had to become involved and threatened severe punishments for those that provides false information during and after the disaster. The government suggested the public listen to information over traditional media and to check for the latest news on official government websites over social media. Moreover, the government found out that official social media capabilities were not developed enough to cover the whole country so volunteer groups were used to support mutual efforts and

to integrate with governmental teams. This coordination was good for both sides, government and volunteers. Through coordination, the government got enough skilled people to provide accurate information in real time over social media, while volunteers got legitimacy and credibility because they represented the government.

Table 11. Effects to Cyber Infrastructure in Earthquake in Mexico

CYBER INFRASTRUCTURE IMPLICATIONS	Cyber infrastructure destruction	Low impact
	Power outages	Low impact
	Network congestion	Medium impact
	Impact to emergency services	Low impact
	Landline capability	Medium impact
	Cellular capability	Medium impact
	Radio capability	Low impact
	Satellite capability	Low impact
	Data/IP capability	Low impact
CYBER LIMITS	Temporary congestion of the network, government unprepared for disaster, lack of organization of social media.	
LEGEND:		
High impact	Medium impact	Low impact / None

Source: Created by author.

In comparison with earthquake in Nepal, the earthquake in Mexico provided insight into cyber resilience of urban areas. While people in Nepal dealt with the inability to communicate with first responders, first responders effectively communicated with the affected population in Mexico because cyber infrastructure was much more interconnected and resilient to disaster influence.

Flooding in Sri Lanka (People, Infrastructure, Cyber Capabilities)

The monsoon rains that hit Sri Lanka on May 28, 2017, caused catastrophic flooding and landslides that forced more than 500,000 people to evacuate to safe areas. In the Aranayake region, several villages were buried under landslides. Rescue teams that were also in danger because of additional landslides, searched for survivors with primitive tools and bare hands because the wet and muddy terrain and damaged roads, blocked the arrival of heavy machines. Additional problems for the evacuated population were flood-related diseases, such as malaria and dengue, diarrhea, and dysentery. In circumstances like this everyone wondered what the government was doing to help. However, even the fact that the government of Sri Lanka established a Disaster Management Center in 2005, their ability to deal with such a disaster was insignificant. In the country, where according to Tissera, "the most frequent natural hazards are droughts, floods, landslides, cyclones,"[168] it is unprofessional that a disaster management center "does not have an active social media account on Facebook and Twitter."[169] This is recognized as a big problem because instead of using social media to interact with the population, government agencies decided to inform the population about the current situation over traditional media. This old-fashioned approach did not support disaster relief at the level people expected. First, this approach was slow because even though the

[168] Margaret Arnold, Robert S. Chen, Uwe Deichmann, Maxx Dilley, and Arthur L. Lerner-Lam, eds., *Natural Disaster Hotspots Case Studies* (Washington, DC: World Bank Publications, 2006), ProQuest Ebook Central, 109.

[169] Amantha Perera, "With social media, 'we could have saved more lives'," *Reuters*, May 25, 2016, accessed March 6, 2018, https://www.reuters.com/article/us-sri-lanka-landslide-socialmedia/with-social-media-we-could-have-saved-more-lives-idUSKCN0YG156.

government organized press conferences to inform the public, and press releases to the media were prepared and edited, information was outdated. Secondly, for the majority of the population, traditional media was not a good source of information because most of the population had power outages and the only reliable communications equipment was the mobile phone.

And last, but not least, is that this form of communication with the public does not allow two-way communication, like when using social media. Two-way communication is crucial in conditions like this because all involved parties, people, government, first responders and volunteers must have updated information and that could be achieved only through allowing communication in real time. Therefore, social media encourages and helps maintain communication with a disaster affected population without the need for any equipment beside the one the population uses in everyday life. As the disaster management center could not lead or coordinate disaster relief efforts, more than 10,000 military personnel were deployed to save and protect the civilian population. However, even with the capacity for conducting search and rescue missions, it is problem for the military to determine where to find people when they are in an endangered area. The inability to coordinate rescue operations between parties caused multiple problems. The military took survivors to safe areas and evacuation centers but, without good coordination, some of the centers were overwhelmed and congested while other were almost empty. Families were taken to different centers and a lack of interconnected databases or social media where people could check their status led to problems when families tried to locate each other. It was a missed opportunity to interconnect all camps into one network especially because Sri Lankan Telekom provided the affected

population in flood victim camps with essential telephone calls free of charge. Integration of the lists of the affected population into a database would decrease congestion in the cyber network.

Similar between the flooding in Sri Lanka and the Nepal earthquake disaster was the fast, self-organized response of volunteers and lack of government activity in a critical disaster. These events showed that the initiative of volunteers was better than poorly organized government rescue efforts, because volunteers acted fast, had initiative and were organized. However, even though the majority of the volunteers did their job with good intentions, there were some whose purpose was not humanitarian help, and that is the reason to be cautious when working in with them. The bad side of volunteering is that volunteers do not accept responsibility, they may act in the manner they want, and sometimes they have hidden intentions to steal precious things from damaged houses or to gain some other benefits from disaster. Because of isolated cases, people generally avoid donating money to funds collected by volunteering organizations.

Lessons learned from the Sri Lanka flooding disaster experience is it is possible to use volunteers to organize disaster relief efforts over social media in order to support first responder teams. This scenario could include creating a social media account with the name of the disaster, collecting the data from the field and updating the situation, coordinating between public and first responder teams, maintaining an online request for all types of donations (food, cloths, money) and distributing supplies to families in need. The government must establish a link or to provide a liaison officer to control volunteer organizations and to make sure that all funds are going in the right direction. This liaison officer could help volunteers to better communicate with first responders in order to

provide them with the most important information because an overage of information needs too much time to understand and that leads to slow reactions. On the other hand, volunteers must know basic negotiation techniques in order to calm callers and to get a better picture of the situation. All of this will coordinate disaster management activities and kept bureaucracy at a minimum, but it is necessary to have a good plan in the preparedness phase of disaster management.

Table 12. Effects to Cyber Infrastructure in Floodings in Sri Lanka

CYBER INFRASTRUCTURE IMPLICATIONS	Cyber infrastructure destruction	Medium impact
	Power outages	Medium impact
	Network congestion	Medium impact
	Impact to emergency services	High impact
	Landline capability	Medium impact
	Cellular capability	Medium impact
	Radio capability	Low impact
	Satellite capability	Low impact
	Data/IP capability	Medium impact
CYBER LIMITS	Congestion of the network, flooding of cyber infrastructure, disaster management center ineffective, disorganized	
LEGEND:		
High impact	Medium impact	Low impact	None

Source: Created by author.

Wildfires in California (People, Infrastructure, Cyber Capabilities)

Wildfires are a common phenomenon that occurs during hot summer periods in areas with dry vegetation. Most of the time these fires are "caused by overheating of the

dry vegetation"[170] but also because of careless behaviors of the human population. In contrast to other mentioned disasters, during wildfires disaster management there is a fight to save the population and to stop the wildfire from spreading, while during other disasters first responders just seek a way to help the endangered population. That is the reason the wildfires are a specific disaster that deserves special attention. Wildfires cause environmental damage and changes in the ecosystem; and also represent a big problem and threat to infrastructures, transportation networks and human lives.

Because of the location and weather conditions, the California area is heavily affected by devastating wildfires that are supported by winds that makes them even more difficult to stop. California has a long history of wildfires and one cannot say that the mitigation measures of disaster management are organized and conducted in California on the highest level. Instead, mitigation measures failed to prevent or restrict spreading of the population in this area. More buildings mean more chances for wildfires and, of course, that leads to more endangered populations and more overall damage. In addition, traffic infrastructure is not developed in some rural areas, and there is less developed communication infrastructure, which is necessary for providing communication and internet services to the population in the area. In the past, local authorities had the right to coordinate disaster management efforts and to maintain leadership in the area because they have a "distinct advantage of being the most familiar with the affected area, including its people, geography, infrastructure, and important issues."[171] Unfortunately,

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[170] Matthew Varghese, *Disaster Recovery* (Course Technology, 2002), ProQuest Ebook Central, 37.

[171] Coppola, 279.

they were not prepared enough for large-scale disaster response and coordination between different local, state, non-governmental and governmental organizations.

In order to better organize the flow of information and coordination between various organizations that are focused toward the same goal, the Incident Command System was developed. FEMA defines the Incident Command System as "a management system designed to enable effective and efficient domestic incident management by integrating a combination of facilities, equipment, personnel, procedures, and communications operating within a common organizational structure."[172] Because of problems with wildfires, the first Incident Command System was developed in 1970 in California. A main advantage of this system is the ability to manage activities in five areas "command, operations, planning, logistics, intelligence & investigations, finance and administration."[173] Systems like this were recognized as a national model for command structures during disasters and is now used by all disaster management agencies. But regardless of all the functions within this system, in order to integrate all resources and capabilities under one incident commander, there is still no interoperability with social media and there is a lack of communication with the local population. Just as in the case of the use of traditional media, this was one-way communication.

The California Department of Forestry and Fire Protection or Cal Fire was a pioneer in using social media for emergency purposes. First, it was used to provide the

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[172] Federal Emergency Management Agency, "Incident Command System Resources," U.S. Department of Homeland Security, accessed April 1, 2018, https://www.fema.gov/incident-command-system-resources.

[173] Ibid.

newest information to the public about wildfires in the state and at the same time to remind people about fire prevention. In order to follow the trends and maximize the amount of the population being reached through social media, this department opened accounts on different social networks such as Facebook, Twitter, Instagram and Snapchat. To help people to be more familiar with the situation, network admin would use the naming convention that is known locally. Every fire location gets the name assigned by the closest landmark. After an operator gives that name to the wildfire, the population from the region is aware of the location of the disaster and where to safely evacuate. People used these social network accounts to upload information live from the scene, and in contrast to other disasters where the communication system was not so developed, people updated so much information that the server was overloaded.

Understanding the importance of providing information in real time, it was decided that every major wildfire will have an information officer on site dedicated to uploading information to social media. The Department of Forestry and Fire Protection also realized that the local population had more trust in small local media than in large broadcasting systems. This led to better cooperation and information sharing between local media and social networks. Small media is easy to maneuver through areas because they are familiar with the region and they do not need to send information to a central station for authorization and they can always go live. During the latest wildfires, the population was better prepared and organized than in the past. Lessons learned from the past include a better preparedness program helped people to better communicate amongst themselves and with first responders. The public used all available sources to communicate other people and first responders. The practical use of all of measures from

the preparedness phase preserved more human lives, but mitigation measures failed to prevent material damage.

Table 13. Effects to Cyber Infrastructure in Wildfires in California		
CYBER INFRASTRUCTURE IMPLICATIONS	Cyber infrastructure destruction	Medium impact
	Power outages	Medium impact
	Network congestion	Medium impact
	Impact to emergency services	High impact
	Landline capability	Medium impact
	Cellular capability	Medium impact
	Radio capability	Low impact
	Satellite capability	Low impact
	Data/IP capability	Medium impact
CYBER LIMITS	Destruction of cyber infrastructure, large quantity of information on server (video recordings)	
LEGEND:		
High impact	Medium impact	Low impact / None

Source: Created by author.

Case study analysis could help to better visualize and describe all factors and their ties related to cyber capability importance. From the perspective of cyber infrastructure, lessons learned from Hurricane Maria showed that it is difficult to provide cyber capability to an area where natural disaster led to a total destruction of power and cyber infrastructure. If tower cells are destroyed, and roads and highways are damaged, there is a great chance that the fiber optics backbone is also damaged, because a majority of fiber optics cables in the backbone network that connects regions is built next to the roads. However, there is always a way to provide cyber capabilities to the ones who need them most, but the question is what is the cost people are willing to pay to provide everyone

with satellite communications that are most resilient to natural disaster effects. Higher numbers of affected population increase cyber capability needs while increased numbers of dislocated and evacuated people challenges everyone included in the rescue effort.

The larger the size of the disaster, the more cooperation and interoperability is needed. Situational awareness about incoming disasters from a cyber capability perspective is important because critical information and warnings can be shared with the affected population as soon as the government has that information. Developed cyber capabilities provide information in real time that gives people an advantage in order to better face the first wave of disaster. Critical information that could be provided to people includes the type of disaster, route and predicted effect. People also want to have information about their relatives that are in the affected region. Case studies about California wildfires, and also Hurricanes Harvey and Irma have shown that in areas where the cyber infrastructure is highly developed, it is easy to provide resilient and uninterrupted cyber capabilities to all users. Congestion in the emergency services network happened when a large population do not have a valid source of information about the situation and when operators cannot handle and deal with the increased number of calls.

In the situations when first responders encouraged people to use already overwhelmed emergency services as the only solution, people lost trust in their ability to provide them help. Long waiting in ques to call emergency services is frustrating and it reduces the caller's ability to continue using available cyber capability, especially if the caller is using a mobile phone in a power outage area. Lack of training of the first

responders that receive calls could also be one of the factors that affects an overwhelmed emergency service network.

In almost every analyzed case study, it is recognized that a high rate of rumor, and misinformation that causes panic over the social media. This also has negative impact on cyber capability because instead of using resources to help the affected population, more people are used to deter false information.

Better planning of the cyber infrastructure is necessary for increasing resilience and providing more alternatives necessary to enable cyber capability to users during a natural disaster. Puerto Rico, Nepal and Sri Lanka are examples that show how poor planning of alternatives and low investments into cyber infrastructure caused the collapse of the entire network. Liberalization of the communications market brings new operators that want to expand business and enlarge the profit, while in a monopoly market, the state is the owner of the entire cyber infrastructure, and usually development of cyber capabilities is very slow. Not developing cyber capabilities in rural areas that are not so profitable, government or operators put the population that lives there at risk because limited capabilities will decrease their ability to call for help during a natural disaster.

Also from case studies, it is noticed that the disaster management center is not always well organized and ready to face a disaster. Disaster management must be ready and able to project capabilities in an affected region and to answer the requirements of the affected population. Good understanding of natural disasters and effects that disaster cause should be a good recommendation on what disaster management's role is in the disaster rescue phase.

Analysis of types of cyber capabilities shows that satellite and radio capabilities are most resilient to a natural disaster, however that doesn't mean that this is available to everybody. Satellite capabilities are very expensive and use of it for data transmission in order to access social media is not affordable for some affected populations. This could be useful for first responders in areas heavily affected by natural disaster and rural regions where the use of other cyber capabilities is impossible. Similar to satellite capabilities, radio capabilities and amateur radio HAM is also very resilient to natural disaster. This is a cheaper solution in comparison with satellite capabilities but requires additional certification where the user of amateur radio has to be licensed and tested. All other analyzed cyber capabilities are more or less exposed to influence of natural disaster, but their usage does not need any additional equipment or training.

Use of mobile phones, laptops and tablets on wireless network is the highest level of interoperability one system could have. This is most important for establishing communication among the affected population, first responders, volunteers, and, government because any piece of equipment even of different manufacturer can be used, as long as it is interoperable and available on social media.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Throughout history, the disaster management warning and alerting system always followed the newest technological trends and latest innovations to communicate with the public. Continuous changes in the social media environment and the wide availability of cyber capabilities have a great influence on the way disaster management may improve future communication to prepare a population for an incoming disaster, to guide them through the disaster, and to provide them with important information during and after the disaster.

The old school alerting approach comprised of sound systems of different tonality to announce different threats was later combined with traditional media (news, TV, radio). This approach was characterized with one-way communication, which provides information to others without the possibility of feedback. However, nowadays in the digital era, people are capable and more willing to share information and to cooperate with first responders and volunteers, which could lead to better cooperation and situational awareness. One of the reasons for that is because of technological improvements and the fast pace of life, people spend more time on social media, communicating in virtual and online environments, where they feel safe and comfortable. Social media is for some people a way of life and one could spend the whole day chatting instead of socializing with friends offline. This relatively new phenomenon allows better use of online resources and lets people communicate in the environment they like the most and where they are experts.

Final goal for disaster management lies in two-way communication over social media integrated with traditional media (radio and TV) in order to provide adequate support or to be integrated into emergency services. In order to provide this cyber capability to an affected population, first responders, volunteers, and government, it is important to well plan the cyber infrastructure to provide a resilient network and operative disaster management center where all cyber capabilities will be integrated. Effective coordination amongst all participants is critical for achieving unity of effort in a natural disaster, delegate responsibility, establish base for information sharing in order to increase situational awareness and to define policies and agreements of social media during a natural disaster. The purpose of this research is to ask how social media can best be used by the government, first responders, volunteers and the affected population as a means of communication in response to a natural disaster. To answer this, the following secondary research questions are considered:

1. How well did social networks work during natural disaster case studies?
2. What is critical cyber infrastructure?
3. What types of social media worked best during natural disasters?
4. How do first responders ensure information received is accurate, and can they afford to wait to validate before acting?
5. Why is social media used more during disasters than traditional “911” services?

In the background of all analyzed case studies, this research discovered smaller or bigger footprints of social media. Depending on development and resilience of cyber infrastructure, social media had higher or lower usage. One could say that the existence of

social media in the case study of Hurricane Maria in Puerto Rico is insignificant because cyber infrastructure was destroyed and social media networks were cut off. This is just partially true, because the affected population could not use social media during disaster but as soon as cyber infrastructure was recovered social media was available to everyone again. The affected population used social media before the disaster to receive important information about course, strength, and projected effect of natural disaster but also critical information on how to survive the incoming disaster. However, during the natural disaster, volunteers and first responders were active on social media providing valuable information to everyone and social media was also used for collecting funds and planning actions when the disaster ended. From analyzed case studies, there is a recognized lack of coordination, command and control in the social media network. In the situation when everyone is a dispatcher, like in social media, no one has real responsibility for actions. Generally, social media is characterized more by spontaneous than by organized action of affected population, volunteers, first responders, and government, but the results and effects of social media have huge potential that need to be more arranged in a systematic way.

This research intentionally analyzed various different natural disasters in order to understand how critical cyber infrastructure is vulnerable to different threats and what people can expect from every disaster. Analyzing elements of national power Diplomacy, Information, Military and Economy (DIME), critical cyber infrastructure is crucial component of information element of power. This strategic capability consists of networks, technology, equipment, and regulations that are important for every country and whose destruction would have great impact on safety, security, economy, politics. Critical cyber infrastructure is vulnerable to devastative effects of natural disaster and it

is hard to predict which part of the network or capability cyber infrastructure will be more affected by natural disaster. In order to enable cyber requirements and communication between affected populations, volunteers, first responders and government during natural disaster it is important to build resilient and robust cyber infrastructure that could work in every condition. Critical cyber infrastructure is an enabler of social media usage and real time communication depends on integration of all networks and well planned alternatives.

Each social media provides different capabilities and services to users. Generally during natural disaster people do not change habits and they stay loyal to their favorable social media. There is some other research that emphasizes the use of some new social media during natural disaster but lessons learned from case studies show that people do not change "from automatic to manual" during a drive or they just want to use things they know how to use it. Most widely used social media networks during natural disasters were "Facebook" and "Twitter" because the highest number of people have accounts with them. In addition, they provide unique capabilities that are available during natural disaster. However, there are also some other applications that support affected population decision-making. These applications could provide logistics information about availability of water, food, and fuel. Integration of capabilities of different social media in one place during natural disaster could provide better situational awareness and interconnection affected population, first responders, volunteers, and government.

During a natural disaster, the affected population uses emergency services or social media to contact first responders and call for help. First responders have a limited number of personnel and it is difficult to manage all calls for help at the same time. Personnel in a

disaster management center need to prioritize tasks in order to allocate resources. Time is a critical factor because human lives depend on a timely reaction. In order to prioritize tasks, personnel need to be well trained for crisis communication and to differentiate if it is real or a fake threat. Besides that, technological improvement and identification of users over emergency services provides an accurate address of the caller. It is different with the user of social media because it is difficult to identify the real location except to trust the caller. Identification through IP address is not as precise as identification through emergency services, but if a fake calls occur in the network disaster management, this could block this person and to disable its capability to misuse resources. Research discovered that people do not have tendency so much to disrupt work of first responders providing them with the fake calls as much as providing fake information in the social media. This has even a higher impact to first responders because fake information spreads fear through the network and more people ask for urgent help. Rumor control is necessary to stop fake information and to provide correct information over social media.

In the first moments of a natural disaster, people generally first use traditional emergency services “911” than other available resources. However, the capabilities of emergency services are limited and are not meant for a large number of calls. Personnel there are not trained to deal and process that number of requests, so these services quickly become overwhelmed and congested. Social media takes time to organize but after establishing a disaster account everyone shifts from emergency services to social media. Social media has more capabilities than just to serve as a support to emergency services. It allows interaction and provides real time information for more users. It is widely used during natural disaster because nowadays people are more familiar with this type of services and it is easy for everyone to send a video, photo, or to post a status on own account. On the other hand,

some devices (tablets, laptops) do not have the capability to call emergency services but people use it to access to social media networks. People feel safe and confident using social media and most importantly, people do not need additional training because everyone uses social media in everyday life.

Recommendations

Social media has high capabilities to be used just as a support to emergency services. In order to add to its involvement, it is important to integrate emergency services and social media into one system that could be controlled and monitored from the disaster operation center.

To provide situational awareness to an affected population, the government could also consider integration of social media and traditional media (TV and radio). The one that cannot use social media but has a radio device, could listen to everything as a radio journalist reads from social media.

Government needs to define who has responsibility for each task in a disaster operation center in order to improve efficiency, coordination, reduce cost and increase speed of action. In addition, the government's role is to establish the legal framework for sharing of the information over social media within affected and non-affected populations, volunteers, first responders and government.

Other roles of the government is to initiate development of critical cyber infrastructure. Only resilient and robust cyber infrastructure could face devastative forces of a natural disaster. Cyber infrastructure that have more alternatives and uses various cyber networks could support more people during disaster.

In order to better prepare operators in a disaster management center for handling the increased number of callers, it is important to have a crisis communication course. Better knowledge of crisis communication could reduce queuing in lines and give disaster the management center the ability to prioritize tasks in order to better allocate resources. Crisis communication should also establish rumor control that could deter rumors and false information in social media network.

Recommendation for Future Study

In this research, social media has been analyzed as an integrated service with various capabilities. However, it would be beneficial to find what capabilities affected population, volunteers, first responders, and government use the most and then find if it is possible to integrate these capabilities into one social media or to integrate it to the emergency system. This is important because if social media networks with the highest number of users do not want to provide information or integrate capabilities during natural disaster, disaster management could provide the population with the new social media solution in case of emergency.

Summary

This research recognizes social media as an important tool that could provide an affected population with the ability to establish and maintain communication with first responders during life threatening situations in a natural disaster. Benefits of social media are availability, and interoperability with almost every device that has internet service. Social media cannot be used as the only communication channel in natural disaster

because sometimes when an entire network is destroyed, first responders must have special equipment to communicate each other.

Goal of disaster management is to integrate traditional media and social media in disaster management centers to support emergency services. Even traditional media is old and provides only one-way communication and there are many examples where people were saved from disaster listening only to instructions on a battery operated radio. In order to provide this cyber capability to an affected population, first responders, volunteers, and government, it is important to plan a cyber infrastructure that could provide a resilient network and an operative disaster management center where all cyber capabilities will be integrated into one unique system.

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