UNIVERSITY OF OKLAHOMA

GRADUATE COLLEGE

THE FEDERAL EMERGENCY MANAGEMENT AGENCY:
A NEW ERA OF WEATHER DISASTER MANAGEMENT

A DISSERTATION

SUBMITTED TO THE GRADUATE FACULTY

in partial fulfillment of the requirements for the

Degree of

DOCTOR OF PHILOSOPHY

By

SOMER ALANE ERICKSON
Norman, Oklahoma
2019

THE FEDERAL EMERGENCY MANAGEMENT AGENCY:
A NEW ERA OF WEATHER DISASTER MANAGEMENT

A DISSERTATION APPROVED FOR THE
GRADUATE COLLEGE

BY

Dr. Kevin Kloesel, Chair

Dr. Harold Brooks

Dr. Justin Reedy

Dr. Mark Shafer

Dr. Lee Williams

DEDICATION

For Barking Flower

Whose spirit is unyielding, strength unwavering, compassion unending, and love eternal.

Everything I am is because of you.

Follow Your Dreams

Philippians 4:13

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

Weather directly accounts for nearly all Major Disaster Declarations nationwide and plays a critical role in FEMA decision making. However, the decision making process among FEMA, and emergency management in general, is not substantially embedded within existing literature. Despite the importance of weather information and continued increase in vulnerabilities due to climate change, population migration, etc., the decision making process in relation to weather events is not well understood. This study examines FEMA utilization and communication of weather information for maintaining situational awareness in support of decision making. The culmination of this work advances the profession and discipline of emergency management by providing a sound methodology and decision making process framework for FEMA, in relation to weather information. The utilization of which is applicable for FEMA beyond the scope of this study and can be extended analogously to be inclusive of all hazard types. The implications of this work are to enhance FEMA leadership weather decision making capabilities in support of more timely, relevant decisions and more effective, efficient operations to enhance their ability to mitigate, prepare for, respond to, and recover from disasters leading to saved lives and property.

The purpose of this research is to bridge the gap between meteorological needs and existing educational and informational structures, requirements, and impediments to enhance decision making, situational awareness, and communication within FEMA. The major overarching questions this research seeks to answer are: (1) How is weather information utilized and communicated within FEMA?, (2) What are the primary elements and influencers of FEMA

leadership decision making regarding weather?, and (3) How can FEMA best prepare for disaster operations for weather events? Utilizing an exploratory case study design, based on the Baumgart et al. (2008) model of local emergency management severe weather decision making (comprised of three systems: (1) environmental, (2) informational, and (3) perceptual and cognitive) in conjunction with the Endsley (1995) model of situation awareness (comprised of three levels: (1) perception, (2) comprehension, and (3) projection), data analysis of qualitative surveys and interviews yielded several findings.

First and foremost, (1) operational decision making at FEMA is heavily influenced by a multitude of factors including (a) organizational, (b) operational, (c) individual, (d) informational, (e) impact, and (f) hazard. Further complicating matters, FEMA utilizes a variety of information sources and communication mechanisms including media/social media, State/Tribe/Territory, private sector/apps, television/radio, internet/web, Emergency Support Functions/partners, National Weather Service, and other agencies, yet (2) a communication gap exists between FEMA and the public. Furthermore, (3) utilization of weather information across FEMA is substantive for the purposes of (a) situational awareness, (b) analysis and assessment, (c) communication, (d) planning, (e) disaster assistance, and (f) overall decision making. (4) Maintaining situational awareness of weather hazards is an essential and mission critical FEMA function requiring (a) environmental information (weather and non-weather information), (b) impact information, and (c) communication elements, through an information management process of (a) monitoring, (b) collecting, (c) interpreting, (d) analyzing, and (e) disseminating. However, (5) FEMA personnel lack weather experience, knowledge and training overall, posing significant challenges.

These findings resulted in (1) a proposed decision making conceptual framework, in conjunction with a (2) descriptive decision making model, and (3) identification of associated influencers. Extending this work beyond theoretical notions into praxis, (4) an adaptation of the CDC's Crisis and Emergency Risk Communication (CERC) model is proposed for FEMA utilization, and (5) operationalization of a FEMA weather training module for situational awareness was designed and implemented. Additional recommendations from these findings and results include: (1) development of weather driven FEMA decision/support policy for standardized coordination, (2) implementation of CERC principles within FEMA and emergency management for enhanced and continuous communication practices, (3) incorporation of evaluation into the Comprehensive Emergency Management (CEM) framework as a standalone element in accordance with CERC, and subsequent incorporation of evaluation findings consistently within FEMA for advancement of programs and procedures, (4) enhanced decision support and development of State and FEMA Region weather products, graphics, and overviews, etc. for improved situational awareness, and lastly, (5) inclusion of weather training requirements within FEMA qualifications for increased knowledge and awareness in support of more effective decision making and operations.

CHAPTER 1: INTRODUCTION

Provided the contemporary and interdisciplinary nature of emergency management, this chapter provides a brief overview of the academic context of the discipline (section 1.1), the statement of the problem (section 1.2), research objectives and questions (section 1.3), overview of the research (section 1.4), value of this study (section 1.5) as well as the overall design of this dissertation (section 1.6). Driven by the interdependence of weather/climate and disasters/emergency management, communication, utilization, and knowledge of weather/climate hazards and information is crucial for effective decision making. Conducting qualitative analysis of data collected through surveys and interviews of Federal Emergency Management Agency (FEMA) personnel, this study hopes to (1) advance the field of emergency management, (2) contribute to the foundational knowledge of the discipline, and (3) provide a path forward for future academic, educational, and operational endeavors.

1.1 EMERGENCY MANAGEMENT

Emergency management isn't easily defined, and the field contains a wide array of facets with numerous specialties. An emergency manager must work with a variety of personnel and can be categorized as a jack-of-all-trades as they must possess a multitude of skillsets and knowledge of different subject matter areas. Effective emergency managers must be a good leader, communicator, decision maker, and critical thinker as well as work well under pressure, be independent, and flexible among other qualities. During incidents they may be required to complete tasks that are above and/or below their pay grade and skill level as the situation warrants. Many of the skills emergency managers require can be difficult to obtain through training and formal education but can often be acquired through extensive experience and application. Nonetheless, training and education provides the necessary foundation, resources, and tools from which to build.

Historically, the education of emergency managers was generally an on-the-job experience. In the more recent decades, a much greater emphasis has been placed on the education and training of emergency managers specifically with regards to command structure. Operationally, training components for emergency managers is widely available, primarily through FEMA. Formally speaking, emergency management as an academic discipline, was substantially unchartered territory that gained significant attention after 9/11. Although there was a small increase in the number of undergraduate degree programs in the mid 1990's, since 9/11 and Hurricane Katrina, dozens of undergraduate degrees in emergency management, homeland security, etc. are now available. However, far fewer graduate degree programs, including only a handful of doctoral degrees, are in existence that have begun in the most recent decade. In fact, only a handful of emergency management degree programs existed at the higher education level until the mid-2000's. Despite the formation of such programs, education of emergency managers continues to rely largely on training hosted by state and Federal government agencies in addition to on-the-job experience. As formal education programs continue to grow, there remains a gap between the new and upcoming workers and those of today. It is also not apparent if the current degree programs will meet the needs of the future employed emergency manager.

By its very nature, the field of emergency management is interdisciplinary and less tangible than most disciplines. Many scholars and practitioners do not agree how to define what is included within the discipline. The depth of research and knowledge of the field as its own discipline is limited, with most studies having been conducted in the past decade. While there are conceptual and theoretical components that may be of value, overall the current state of the profession lends itself to experience and application. Despite utilization of themes from other disciplines, there are a myriad of gaps within the literature and associated challenges along the path to uncovering them.

Emergency management as a discipline requires an extensive knowledge base and skillset that incorporates many fields such as education, political science, psychology, sociology, geography, and communication to name a few. Incorporating all subject areas would be too broad of a scope for one study, for the purpose of this research, emphasis will be placed on the decision making process. This study will provide a review of weather information utilization, situational awareness, communication, development of a weather training component, and policy recommendations. Contributing to the theoretical body of knowledge and providing operational support for emergency management are the two primary goals for this study. The implications of this research are to advance the knowledge base of the field of emergency management and offer a beneficial contribution to practitioners and society alike. This study and area of research provides a unique opportunity to advance the pioneering effort of establishing emergency management as a genuine academic discipline and laying foundational knowledge for further review and study.

1.2 STATEMENT OF THE PROBLEM

Preparedness, response, recovery and mitigation are the primary functions of emergency management and FEMA. All of these functions rely tacitly on one main component, maintaining situational awareness. Maintaining effective situational awareness is the lifeblood of the agency as it is vital to conduct safe, effective, efficient, and timely planning, response, and recovery operations. Ineffective or insufficient situational awareness affects the outcomes of the decision makers, the impacts of which are late or delayed response operations, inadequate planning efforts, and misappropriated resources, among others. Understanding the role that enhanced communication and weather information and resource training has on FEMA as a whole and its implications on their partners is imperative for successful engagement of the 'whole community' concept.

Weather phenomena directly accounts for the majority of all Federally declared disasters nationwide. However, all disasters regardless of cause involve weather information or support in some capacity. Throughout all phases of the disaster life cycle (mitigation, preparedness, response, and recovery) weather information and data is a critical component to manage the threat and ensure safe response and recovery efforts. Therefore, maintaining situational awareness and monitoring of weather conditions along with utilizing weather information is an essential function of emergency management and FEMA decision making and operations.

Decision making regarding weather events is a primary function of an emergency manager not only surrounding an event, but throughout the disaster life cycle. In order to make more informed decisions, emergency managers must have the knowledge and skills to aid the decision making process. Emergency managers deal with all types of hazards and disasters including both natural and technological. However, most disasters fall into the natural hazard category. Even though this is the case, the lack of standardized natural hazard/meteorological training available to emergency managers nationwide is prevalent across available training programs, particularly with regards to rapid response events. Areas include:

- **Basic meteorology, weather phenomena, and terminology**
- **Weather information product availability and usage**
- **Radar/Satellite imagery and software packages**
- **Hazard and risk interpretation and analysis**
- **Scientific limitations and potential impacts**
- **General decision making strategy**

Currently, as it stands at this time, training regarding weather information and resource navigation has not permeated into the emergency management arena the way that other knowledge and skills have. Although there are some course options currently in existence they mainly address the needs of local authorities whose needs are more along the lines of rapid response and notification leaving a gap for Federal weather information users whose needs cover a longer time frame from months to years. Although they do provide some relevance, no existing weather training adequately serves the Federal users' needs nor has one been integrated as the standard weather training component.

Further complicating matters is the evolution of the weather enterprise (i.e. - government, private, academic, media, etc.) and competition within. As a result, the expansion of available information sources, that at times, provide inconsistent reports from one another along with the amount of available information and access, created an era of informational uncertainty. In turn, this poses a challenge for some users and possibly impedes the decision making process. Additionally, changes in National Weather Service (NWS) weather products and services over the past two decades (i.e. - storm based warnings, product simplification, etc.) further exemplifies the need for education and training. However, there is little understanding of how FEMA and partners are utilizing this new information and the perspective of weather information usage overall among emergency management is limited.

Dealing with uncertainty during decision making is one of the most pressing and prevalent issues facing emergency managers today, especially for rapid response events. The potential for impending disaster is greater than ever due to climate change, population growth, and migrations to larger and coastal cities. One goal for this work is to establish a standardized weather training program geared towards FEMA and their partners and their mission critical area of maintaining situational awareness. Decreasing or eliminating at least part of their potential uncertainty, the uncertainty due to a lack of meteorological understanding, is imperative for building effective emergency managers and further advancement of the profession and discipline as a whole. Making sure that emergency managers receive proper training in the area they most often deal with, weather, is crucial for making timely and effective decisions leading to saved lives and property. One way to better prepare communities is to have well trained emergency managers, planners, and decision makers as to enhance their ability to mitigate, prepare for, respond to, and recover from disaster.

1.3 RESEARCH OBJECTIVES AND QUESTIONS

The purpose of this study is to advance the body of knowledge and theoretical concepts applicable within emergency management and to operationalize certain components within the field by reviewing current practice. In support of this notion, there are two primary goals. The first goal of this research is to better understand the deficiencies of Federal emergency managers with regards to meteorological information and knowledge. In correlation, the second goal is to help bridge the gap between emergency management weather needs and the existing educational and informational structure. Ultimately, I hope to enhance decision making efficiency and communication for improved disaster operations.

In order to accomplish this, (1) I will determine the utilization of meteorological information and deficiencies within FEMA; (2) review the communication flow of meteorological information within FEMA and amongst their partners and propose a standardized framework; (3) assess meteorological decision making amongst FEMA Senior Leadership and frame the decision making process; (4) develop meteorological training requirements, design a training program and determine best practices for enhancement of situational awareness, decision making efficiency, and information communication; and lastly, (5) I will provide policy recommendations and procedural guidance in support of effective disaster response and recovery operations.

The major questions this research sought to answer were: (1) How is weather information utilized within FEMA?, (2) What are the primary elements and influencers of FEMA leadership decision making regarding weather?, and (3) How can FEMA best prepare for disaster operations for weather events? To address these questions, I investigated the following:

1. **What is the FEMA decision making process?**
    - **a.** What are the key elements FEMA requires for decision making?
    - **b.** What are their decisions/actions/thresholds?
    - **c.** What factors influence decision making?
    - **d.** What are the policy implications?
2. **What is the FEMA communication flow of weather information?**
    - **a.** From whom/where do they receive information?
    - **b.** To whom/where do they disseminate information?
    - **c.** What are the communication challenges?
    - **d.** How can communication be improved?
3. **How does weather influence FEMA decision making?**
    - **a.** How do they utilize weather information?
    - **b.** What are the critical pieces of information? Why are they critical?
    - **c.** What information resources/channels/mechanisms do they utilize?
    - **d.** What are the challenges associated with weather information?
4. **How does FEMA maintain situational awareness?**
    - **a.** What impacts are they most concerned about? Why those impacts

b. What is their situational awareness structure?

c. What are the barriers to maintaining situational awareness?

d. How can enhanced situational awareness be accomplished?

5. What is the status of weather knowledge and training at FEMA?

a. What is their weather experience/background?

b. What weather training have personnel received?

c. What weather training is available?

d. What weather training is needed?

To answer these questions, it is important to understand the meteorological knowledge level of emergency managers as well as emergency managers meteorological training needs. Knowledge level and training affect the decision making process, especially under uncertainty conditions. During hazardous weather outbreaks (i.e. - severe storms, winter weather, hurricanes, etc.) imprecise or ambiguous information can be prevalent. However, all events emergency managers face deal with weather information at some level, making it imperative that they have a good understanding of weather, impacts, and resources and navigation. It is also important to gain feedback on how to best provide training to meet the needs of emergency managers and to create meteorology training programs that will best aid or inform the decision making process.

1.4 RESEARCH OVERVIEW

Through completion of a survey questionnaire and consequent analysis of the data, gaining a better understanding of emergency managers' needs, will aid in bridging their knowledge gaps and identification of possible vulnerabilities within the meteorological information and training system. Finalization of this analysis will provide guidelines for development of a needed training curriculum that will serve to inform and enhance efficiency in decision making and preparedness and lead to more timely and effective responses. This study seeks to further the body of knowledge concerning emergency management through meteorological training standards as well as provide the initial steps for creation of a useful training program to reduce deficiencies, increase effectiveness, and provide better decision support for various levels of emergency management.

Through this assessment, a review was conducted of training elements, information collection, requirements, and utilization, resources, challenges, situational awareness, communication, and decision making. There is heavy emphasis on the foundational pieces, so as to further advance theoretical and conceptual knowledge within the field of emergency management, yet also among the differing disciplines/areas comprising this study. Emphasis was placed on the informational and training elements as they influence situational awareness, which in turn influences decision making. Inherent throughout this process, end-to-end communication is a vital component towards effective action taking and avoidance of a systematic breakdown. To avoid being remiss, mention of relevant communication components will also be noted throughout this work, with a more focused discussion in Chapter 6, regarding the advancement and utilization of a proposed adaptation of the Crisis and Emergency Risk Communication (CERC) framework.

1.5 VALUE OF THIS RESEARCH

This dissertation promulgates the extensive purview of situational awareness within FEMA and among its partners as well as the pivotal role that the FEMA Regional/National Watch Centers (RWC/NWC) play in maintaining situational awareness. The intent of this research is to identify the situational awareness, communication, and decision making structures and processes at FEMA, assess weather knowledge experience and utilization background of FEMA personnel, and establish the relationship with weather information usage to support development of enhanced weather information and resource training for FEMA personnel and partners. The results of this work will enhance the decision making capabilities of leadership and lead to more timely and appropriate preparedness, mitigation, response, and recovery efforts, in turn saving lives and property.

The ideas put forth in this dissertation contribute to the foundational knowledge base of emergency management by advancing various frameworks within several academic disciplines. This includes but is not limited to emergency management, communication, risk and crisis management and human factors via situational awareness. The end product of this work also has implications for public policy, which could result in operational impacts while also enhancing FEMA's and other emergency management partners' processes and procedures for more effective and efficient disaster support efforts. In finality, through conducting this research, I hope to advance the understanding of FEMA weather informational needs and put forth training requirements and communication strategies to facilitate the decision making process.

1.6 DISSERTATION OVERVIEW

Including this introduction (Chapter 1), this dissertation consists of eight chapters in total. Chapter 2 provides a background overview of relevant subject matter and a historical perspective of emergency management. Chapter 3 provides an extensive literature review of the various areas, notions, and ideas addressed in this study. The research design and methodology utilized in this study are provided in Chapter 4 along with a proposed conceptual framework. Chapter 5 discusses the overall data analysis and results, while Chapter 6 discusses the overall extended findings and conclusions. Operationalization and overview of the weather training component developed from these findings along with training evaluation is discussed in Chapter 7. Lastly, a summary and discussion of future work is provided in Chapter 8.

CHAPTER 2: BACKGROUND AND HISTORICAL CONTEXT

For additional context useful for gaining an understanding of the subject matter of this study, this chapter provides a brief overview of the history of emergency management (section 2.1), a description of the levels of emergency management (section 2.2), an overview of comprehensive emergency management (phases of emergency management) (section 2.3), an introduction to FEMA (section 2.4), highlights of disaster policy, legal authorities, and doctrine (section 2.5) as well as an overview of FEMA disaster declarations and assistance (section 2.6). Due to the specialized and not widely understood technical nature of FEMA and emergency management across disciplines, this chapter provides an overview and highlights of relevant content for perspective. It also serves as an abbreviated historical reference guide for emergency management and disaster response.

2.1 HISTORY OF EMERGENCY MANAGEMENT: STATE OF THE FIELD

The field of Emergency Management, as it is known today, has evolved tremendously over the past several decades, since its inception and beginnings within Civil Defense. Although stemming from the Civil Defense era, the roots of disaster support and management in the U.S. are tied to early governmental programs as far back as the early 1800's. "Congress would continue this pattern of providing assistance through special acts, passing some 128 such pieces of legislation between 1803 and 1950" (Canton, 2007). However, the idea of systemized disaster support began to be ignited particularly around the turn of the 20th century to include the efforts of the Red Cross (Butler, 2007). Since population distribution has differed from today's current status along with building standards, technology, agriculture, and economics, the primary hazards at that time were fires, floods, earthquakes, and droughts (Bumgarner, 2008; Canton, 2007).

Prior to the 1950's and even up until the creation of FEMA in 1979, Federal disaster support was ad hoc. With the cold war era in full swing by the 1950's, greater attention focused on the threat of nuclear war (Haddow, Bullock, & Coppola, 2017; Butler, 2007). As population growth, westward expansion and eventual migration to coastal cities and urban areas continued, earthquakes, hurricanes and tornadoes became more prominent and a new era of emergency management was born. Two pieces of legislation, the Federal Disaster Act of 1950 and the Civil Defense Act of 1950, drastically changed the field by establishing roles and guidelines for the different levels of government and "laid the foundation for modern emergency management" (Canton, 2007). As disaster assistance evolved, it became more haphazard and complex with over one hundred agencies involved (Bumgarner, 2008). Following suit, many pieces of amended disaster legislation were passed, which led to an outcry from the States and reform of disaster support from the Federal government, culminating in the creation of the Federal Emergency Management Agency (FEMA) in 1979 under President Jimmy Carter (National Governors' Association [NGA], 1979; Exec. Order No. 12,127, 1979). Tasked with coordinating the disaster functions at the Federal level, the implementation of FEMA streamlined Federal disaster functions under one entity. FEMA is not only responsible for managing a variety of natural and un-natural hazards and disasters at the Federal level, but also tasked with providing overarching guidance for State and local authorities.

Since the creation of FEMA, robust and expansive legislative amendments have been made along with a vast amount of reorganization and policy implementation. Although civil defense notions waned in the 1990's, after the September 11, 2001 (9/11) attacks, there was a resurgence of terrorism and civil defense related activities among the Federal sector, resulting in FEMA restructuring and creation of the Department of Homeland Security (DHS) (Homeland Security Act [HSA], 2002). When Hurricane Katrina struck in 2005, it forced the issue of creating a balance between different types of hazards including natural, technological and terrorism. Various major disasters since Katrina and associated policy changes have tested and refined disaster assistance. FEMA remains in a state of flux, and expansion of mission areas to include cyber threats and immigration challenges among others.

Within the past few decades, the field has been transitional resulting from greater emphasis placed on emergency management due to several large-scale catastrophes, population migration to urban and coastal areas and evolving impacts including climate change. The field of emergency management as well as FEMA's role and responsibilities continues to evolve with every disaster as new challenges arise, technological innovation emerge and political and public demands increase. Today, the field of emergency management covers all types of hazards and includes members from a wide array of disciplines. The position of emergency manager falls across all levels of government as well as the private and non-profit sectors. Given the multifaceted nature of the field it is more difficult to define the position, rather than the mission. Therefore, emergency management may best be defined as '*a group of people possessing a variety of skill sets,* *working toward the same goal to save lives and property before, during and after a disaster and to aid in the resiliency of our populace and communities'*.

Due to the professionalization of emergency management as a grassroots effort, evolving disaster doctrine, and the reorganization of FEMA, developed or identified theoretical and conceptual frameworks and underpinnings are lacking. To advance the field and fill this gap, there is an enhanced need to build an established body of knowledge through research and associated educational programs. Research contributes to overall understanding of the field and facilitates establishment of guiding principles with progression towards a standardized ideology. Educational program development adds to or enhances existing skill sets and meets the growing demands of the field, which ultimately refines disaster operations and helps to lessen or prevent future disasters.

2.2 EMERGENCY MANAGEMENT LEVELS

There are three primary governmental levels of emergency management: local, State/Territory/Tribal and Federal. While they all must work together to accomplish their missions, they have vastly different roles. The overarching disaster assistance system is designed such that when an incident exceeds the capabilities one level can provide, the next higher level will support. As 'all disasters are local', local public safety officials are the first responders for all incidents. If an event is too large to manage with existing resources, they may utilize assistance from other jurisdictions and/or the State/Territory. If the State/Territory is unable to provide appropriate assistance, FEMA and any relevant partners at the Federal level will be called upon to assist. Tribal Nations are designated as sovereign nations, which allows them to also request assistance from FEMA similarly to a State or Territory, yet they also have the flexibility to receive assistance as a 'local' jurisdiction as well (Sandy Recovery Improvement Act [SRIA], 2013).

Characteristics and responsibilities of emergency managers vary greatly between local jurisdictions. These differences between roles and positions allow for variation among educational and professional backgrounds, experience, resource availability, support, authority and the department in which they reside. Many emergency management positions or duties are located within a local fire or police department. Their duties differ from office to office, state to state and region to region. Some of these positions are paid, yet many are not or are dual-hatted with another position, such as a Fire or Police Chief. The diversity of the emergency management spectrum has both advantages and disadvantages. One of the greatest advantages, is the sharing of one another's expertise and resources. Conversely, one of the biggest disadvantages is a lack of consistency amongst jurisdictional policies and protocols, which poses a challenge for the field as a whole, the discipline as well as disaster support operations. Emergency management at the local level, generally speaking, includes a fairly substantial amount of responsibilities. Some of which include ensuring the communities response capabilities, monitoring and/or managing mitigation projects, developing plans and exercises, conducting outreach, maintaining the warning systems and responding to disasters. They accomplish these tasks through collaboration and partnerships amongst the community, local governing body and through State and Federal assistance, support, and guidance.

At the State/Territory level, each governing body has some type of emergency management/public safety/homeland security office, department or division that is designated for supporting the local jurisdictions and serving as the liaison between the local municipalities and FEMA. Their role is to facilitate submission of disaster declaration requests to FEMA through the Governor, assist with the coordination of activities between multiple jurisdictions and manage State/Territory level programs (National Response Framework [NRF], 2013). The State/Territory serves as the conduit through which FEMA provides support and assistance. Otherwise, the process would escalate rapidly and overwhelm FEMA resources quickly. Additionally, although Tribal Nations can choose to submit independently for disaster assistance in line with the process of a State or Territory given their sovereign nation status, they design their own governance structure. Hence, the structures can vary from tribe to tribe. The size of a tribe and designation, resource availability, and assistance required determines the best suited avenue to pursue (SRIA, 2013).

FEMA and other Federal agencies do not generally serve as first responders. Rather, they support disaster response operations when State/Territory/Tribal and local resources have been exhausted. Their primary role is to deploy assets and provide resources, funds, and assistance as warranted according to current policy guidelines. They also provide training, conduct exercises, develop policy and doctrine, implement support programs, provide financial assistance through grants, and lead the nationwide emergency management effort. Overall, FEMA maintains policies and programs, supports initiatives and ongoing efforts before, during and after a disaster as well as administers assistance through a variety of mechanisms in collaboration with a vast number of partners.

Due to the interdisciplinary nature of disaster response, emergency managers must act as liaisons between various departments, agencies, organizations (non-profit and private) and the public. Differing responsibilities and priorities across the spectrum from local first responders to Federal authorities lead to differences within weather information usage and decision making. Unlike local emergency management officials, whose focus is on localized threats no matter size or extent, FEMA's area of responsibility is much greater. Covering up to multiple states at a time, FEMA involvement will be dependent on incident scale and impacts. Versatility among levels, jurisdictions, backgrounds, and responsibilities of emergency managers poses a challenge for obtaining a general understanding of the field, educational standardization, and theoretical development as there is no specified body of knowledge, function, structure, responsibility or authority.

The scope of emergency management is quite broad, involving a plethora of players across a wide spectrum of hazards, tasks, and outcomes. While all aspects and levels of emergency management are important and valuable, emphasis for this study will focus more specifically on FEMA and the Federal level. Gaining an understanding of FEMA weather information usage, influencing factors, and motivation of actions will guide changes to existing policies or allow for the formation of new ones. All of which supports operational guidance, determines the decision making and communication structure, and leads to advancement and development of appropriate educational/training requirements.

2.3 PHASES OF EMERGENCY MANAGEMENT

The four primary phases of emergency management are to prepare, respond, recover, and mitigate (NGA, 1979). Although there are other variations of these components, these four main phases are widely recognized as the '*Disaster Life Cycle'* (Neal, 1997). The life cycle, as indicated in Figure 2.1, is continuous with no clear beginning or end points and phases often overlap as concurrent activities are ongoing. Currently, the system is designed to begin and end with Mitigation, while preparedness activities are generally continuous throughout all phases of a disaster. Responding to a disaster and recovering from one, often coincides with one another. While response mode will eventually fully transition to recovery, the duration of response and recovery operations will depend on the severity of the event and the spatial coverage.

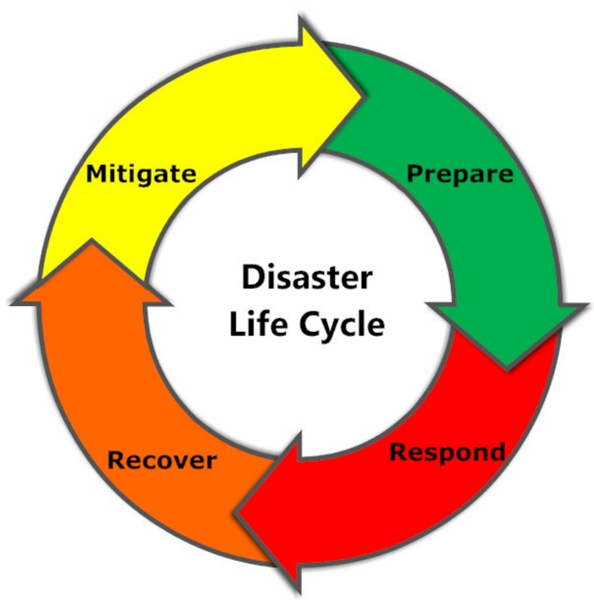

Figure 2.1: Comprehensive Emergency Management (CEM) also known as the disaster life cycle or phases of emergency management as adapted from National Governors Association (NGA) *Comprehensive Emergency Management A Governor's Guide* (1979) (NGA, 1979).

2.3.1 MITIGATION

Mitigation occurs "over the long term for the purpose of reducing or eliminating the risk of various hazards" (Bumgarner, 2008). This includes activities "to reduce the loss of life and property from natural and/or manmade disasters by avoiding or lessening the impact of a disaster" (NIMS, 2008). The goal of mitigation is to reduce vulnerability and build sustainable, resilient communities. A few examples of mitigation efforts include, floodplain mapping and buyouts, zoning and building code assessments, monitoring of dam and levee systems, and utilization of more resilient building materials are (Lindsay, 2012).

2.3.2 PREPAREDNESS

Preparedness and mitigation are often misconstrued. "Preparedness is distinct from mitigation because rather than focusing on eliminating or reducing risks, the general focus of preparedness is to enhance the capacity to respond to an incident" (Lindsay, 2012). Preparedness consists of activities "directed toward maintaining a state of readiness to respond to disasters and other large-scale emergencies" (Bumgarner 2008). Activities include performing outreach, planning, training, developing exercises, conducting after action reviews and subsequent lessons learned documents among other tasks (Haddow et al., 2017).

2.3.3 RESPONSE

The most urgent of all of the phases, "response activities are comprised of the immediate actions to save lives, protect property and the environment, and meet basic human needs" (Lindsay, 2012). "Response also includes the execution of emergency plans and actions to support short-term recovery" (NRF, 2008).

Response operations include, but are not limited to; information dissemination, public warning, mass care, and search and rescue, along with numerous other lifesaving missions (Haddow et al., 2017).

2.3.4 RECOVERY

Consisting of a multitude of elements, “recovery activities are intended to restore essential services and repair damages caused by the event” (Lindsay, 2012). These efforts will continue “long after a disaster strikes to restore an affected community to its pre-disaster condition or better” (Bumgarner 2008). A variety of measures ongoing throughout this phase strive to rebuild the affected areas via restoration of infrastructure, reconstitution of goods and services, and long-term housing missions (Haddow et al., 2017).

2.4 THE FEDERAL EMERGENCY MANAGEMENT AGENCY (FEMA)

FEMA was established in 1979 under the Carter Administration (Exec. Order No. 12,127, 1979). Born out of necessity, “the National Governor's Association (NGA) sought to decrease the many agencies with which state and local governments were forced work” (FEMA, 2010a). The purpose of which was to assist and provide support to people and governmental jurisdictions in the event of a disaster either technological or natural (NGA, 1979). FEMA combined various disaster related services into one entity and acted as a clearinghouse of sorts. Throughout the agency’s forty-year history, evolution has included continuous transformation and innovation. “These organizational changes have largely served as a response to the unique and increasing external challenges confronting the agency, and ultimately the nation” (Adamski, Kline, & Tyrrell, 2006). Changes in emergency management are often caused by disasters; as the essence of disasters has evolved over the years, so has FEMA. Over the past two decades, the agency and its responsibilities have changed greatly beginning with the events of 9/11. From inception, FEMA was a stand-alone agency. However, with the creation of the Department of Homeland Security (DHS) in 2003 following the events of 9/11, FEMA was reorganized underneath DHS where it resides today (HSA, 2002).

FEMA is tasked with coordinating the Federal disaster response for all disaster types and providing guidance for U.S. Federal, State, Territory, Tribal and local authorities. “FEMA’s mission is to support our citizens and first responders to ensure that as a nation we work together to build, sustain and improve our capability to prepare for, protect against, respond to, recover from and mitigate all hazards” (FEMA, 2010a). Composed of ten regions (Figure 2.2), in addition to headquarters (located in Washington, D.C.) and several training components around the country, FEMA Regions are organized into five divisions that reflect the phases of emergency management in addition to a Mission Support Division.

Each division serves a specific set of functions, maintains certain ‘core capabilities’ (DHS, 2015b) and is responsible for managing all relevant programs that support those functions and capabilities. While there are some deviations among FEMA Regions regarding specific structure, positions, etc., generally speaking, the mission of each division is the same and can be defined accordingly:

- **Mission Support Division:** Responsible for managing and maintaining continuity of critical business operations including administrative items, budgets, information technology, etc. (FEMA, 2010a).

- **Preparedness Division:** Responsible for the coordination and development of outreach, the exercise program, training, evaluation and improvement program, grant programs and technical assistance to prepare for all hazards (FEMA, 2010a).

- **Mitigation Division:** Responsible for the coordination, development and implementation of programs that reduce the impacts of hazards and loss of lives and property damage. Programs include Floodplain Management and Hazard Mitigation (FEMA, 2010a).

- **Response Division:** Responsible for maintaining situational awareness and analysis, as well as coordinating and implementing the Federal response to major disasters through planning, operations, logistics and communications (FEMA, 2010a).

- **Recovery Division:** Responsible for providing Federal assistance to individuals and households, as well as eligible public facilities in counties declared as major disaster areas. The two primary programs are Individual Assistance, and Public Assistance (FEMA, 2010a).

At FEMA Headquarters, the organization differs with Response and Recovery together under one umbrella, Mitigation under the Federal Insurance Mitigation Administration (FIMA), and Mission Support and Protection and National Preparedness as separate units (Figure 2.3). In addition to the emergency management functions, FEMA also manages FIMA, the U.S. Fire Administration and Urban Search and Rescue (USAR). Their roles are as follows:

- **Federal Insurance and Mitigation Agency (FIMA):** Manages the National Flood Insurance Program (NFIP) and other programs designed to reduce losses to property, facilities, businesses, and infrastructure from all hazards. (FEMA, 2012a).

- **U.S. Fire Administration (USFA):** Serves as a data collection repository highlighting current and emerging fire trends, causes, occurrence, demographics, and impacts. They also assess firefighter fatalities for reduction of casualties. (FEMA, 2012b).

- **Urban Search and Rescue (US&R):** Conduct search and rescue operations and stabilize trapped individuals for all types of hazards and disasters including local incidents. (FEMA, 2012c).

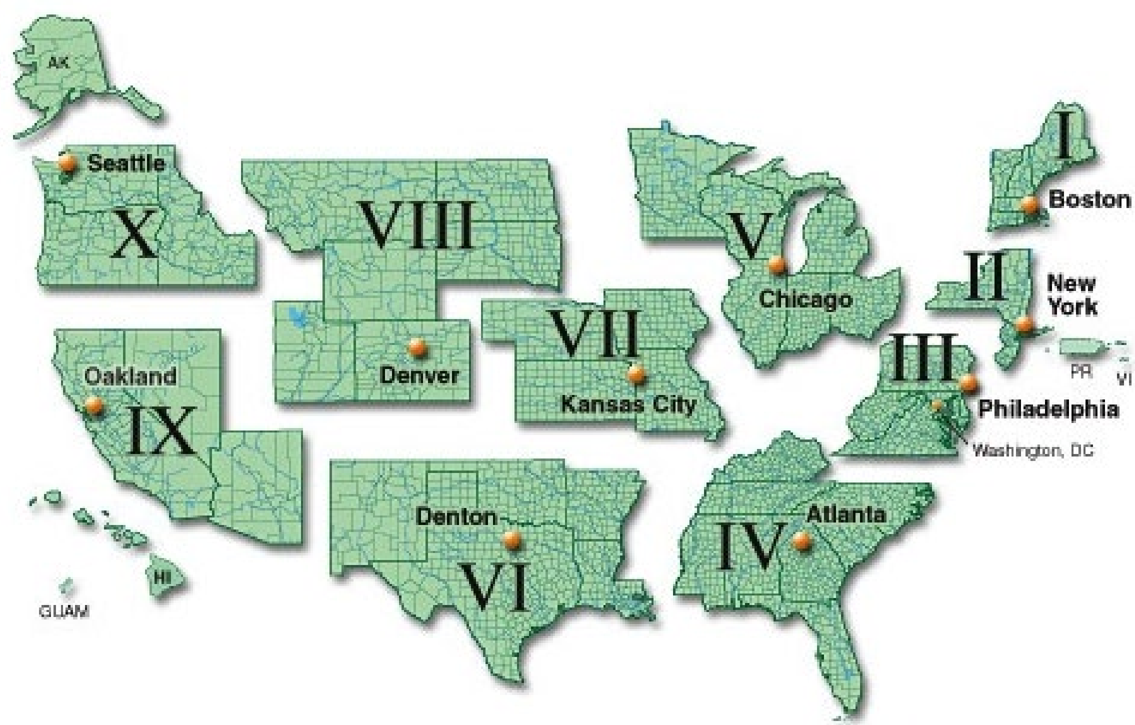

Figure 2.2: FEMA regional designations and associated areas of responsibility (FEMA, 2010b).

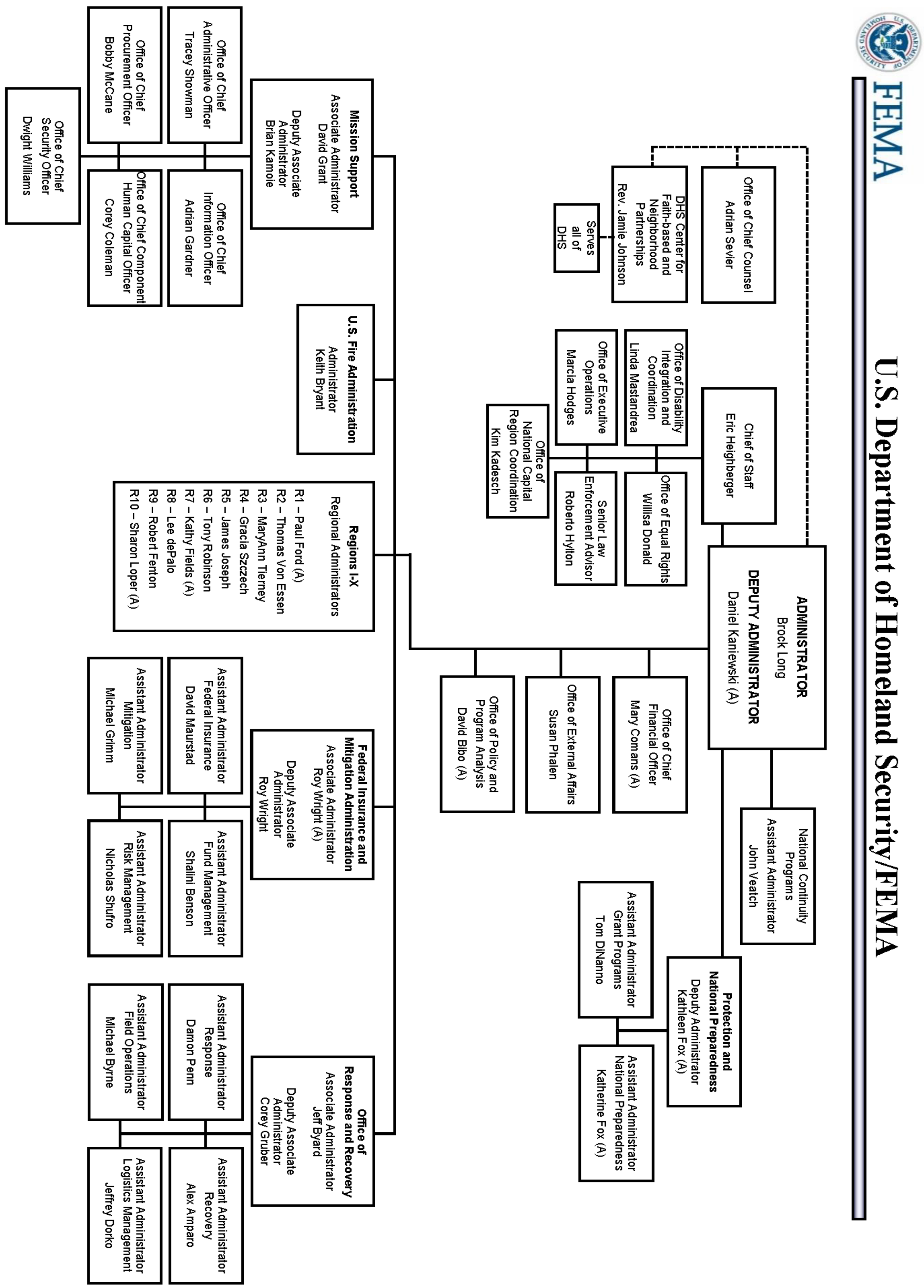

Figure 2.3: FEMA headquarters organizational structure as of 2017 (Source: (FEMA, 2017a).

Despite the multitude of permutations, the agency has been slow to develop. Largely this can be attributed to the changing of political parties associated with presidential administrations. In conjunction with these changes every four to eight years, different priorities and strategies are introduced. These changes include various iterations of funding support across FEMA and emergency management impacting the number and types of programs available, response capabilities, planning efforts, disaster assistance procedures, etc. Although politics and public policy are one of the primary factors contributing to changes in disaster response, they are not the only ones. Weather patterns, climate variability and climate change also contribute to the severity, location, and ultimately a potential declaration of a disaster. For reference, Table 2.1 provides an overview of the number of Federally declared disasters over the past thirty years (1988 to 2017), since the inception of the Robert T. Stafford Disaster Relief and emergency Assistance Act of 1988 (Stafford Act).

The highly political nature of the agency, the perceived unfairness of assistance provided along with the public's perception of the policies, processes, and procedures has garnered quite a bit of criticism over the years, even more so in the most recent two decades. While there are a variety of contributing factors, the major sources of consternation can be attributed to the publics' level of knowledge and understanding of emergency management policies and procedures and a breakdown of communication between the public and FEMA, State/Territory/Tribal, and local officials. As a result, the agency has been scrutinized by many and faced substantive oppositional backlash that has led to further refinement of disaster assistance and response operations.

YEAR	MAJOR	EMERGENCY	FIRE	TOTAL
1988	11	0	5	16
1989	31	0	1	32
1990	38	0	5	43
1991	43	0	2	45
1992	45	2	6	53
1993	32	19	7	58
1994	36	1	20	57
1995	32	2	4	38
1996	75	8	75	158
1997	44	0	3	47
1998	65	9	54	128
1999	50	20	40	110
2000	45	6	63	114
2001	45	11	44	100
2002	49	0	70	119
2003	56	19	48	123
2004	68	7	43	118
2005	48	68	39	155
2006	52	5	86	143
2007	63	13	60	136
2008	75	17	51	143
2009	59	7	49	115
2010	81	9	18	108
2011	99	29	114	242
2012	47	16	49	112
2013	62	5	28	95
2014	45	6	33	84
2015	44	2	34	80
2016	46	7	50	103
2017	59	16	62	137
AVERAGE	52	10	39	100

Table 2.1: 30 years of compiled yearly Federal disaster declarations from 1988 to 2017 nationwide (Data source: FEMA, 2018a).

2.5 DISASTER LEGAL AUTHORITY AND POLICY

Despite the frequent misconception that FEMA is a first responder, the initial Disaster Relief Act of 1950 "asserted the Federal role in emergency management as secondary to state and local government efforts" (Adamski et al. 2006). Since then, there have been various additions to the Federal legal authority designation of disasters including multiple follow up Disaster Relief Acts (DRA) in 1966, 1969, 1970, and 1974. Although FEMA was established in 1979, it wasn't until almost a decade later in 1988 that the Stafford Act was implemented, which authorized and outlined the modern-day programs and processes of Federal disaster and emergency assistance. Since inception of the Stafford Act (1988) additional amendments and modifications have been adopted as summarized in Table 2.2. Additionally, a plethora of guiding frameworks, policies, and doctrine outlining roles, structure and management of disasters have also been implemented as is discussed in the following sections.

2.5.1 NATIONAL RESPONSE FRAMEWORK (NRF)

In 1992, FEMA implemented the Federal Response Plan (FRP), revised to National Response Plan (NRP) in 2004, and the National Response Framework (NRF) in 2008. Along with NIMS, the NRF guides national response by integrating the capabilities and resources of the 'whole community'. They are "companion documents and are designed to improve the nation's incident management and response capabilities. While NIMS provides the template for the management of incidents regardless of size, scope or cause the NRF provides the structure and mechanisms for national level incident response policy" (FEMA, 2017b).

YEAR	DISASTER LEGAL AUTHORITY MILESTONES
1950	**Disaster Relief Act of 1950** (Pub. L. No. 81-875 (1950)) Empowered the President to manage the Federal response to disasters without Congressional approval and with a minimal budget.
1966	**Disaster Relief Act of 1966** (Pub. L. No. 89-769 (1966)) Authorized a 50% Federal cost share for damage to public facilities.
1969	**Disaster Relief Act of 1969** (Pub. L. No. 91-79 (1969)) Directed the appointment of a Federal Coordinating Officer (FCO) to manager disasters and authorized temporary housing assistance.
1970	**Disaster Relief Act of 1970** (Pub. L. No. 91-606 (1970)) Included additional disaster support elements and authorized up to a 100% Federal cost share for damage to public facilities from disasters.
1974	**Disaster Relief Act of 1974** (Pub. L. No. 93-288 (1974)) Established the Presidential disaster declaration process, implemented the Individual Assistance program and authorized mitigation efforts.
1979	**FEMA Established** (Executive Order 12127, 44 Fed. Reg. (1979)) Established FEMA and transferred a variety of disaster related tasks from other Federal agencies.
1988	**Robert T. Stafford Disaster Relief and Emergency Assistance Act** (Pub. L. No. 100-707 (1988)) Authorized and outlined the programs and processes of Federal disaster and emergency assistance.
2000	**Disaster Mitigation Act of 2000 (**Pub L. No. 106-390 (2000) Required local Hazard Mitigation Plans and established pre-disaster mitigation programs.
2002	**Homeland Security Act of 2002** (HSA) (Pub. L. No. 107-296, (2002)) Implemented the Department of Homeland Security and transferred FEMA as one of the agencies within.
2003	**Homeland Security Presidential Directive-5** Directed the development of the National Incident Management System and the National Response Plan (Framework).
2006	**Post-Katrina Emergency Management Reform Act of 2006** (Pub. L. No. 109-295 (2006)) Amended HSA 2002/Stafford Act with new authorities for FEMA and mandated FEMA Administrator emergency management background.
2011	**Presidential Policy Directive-8** Directed development of the National Preparedness Goal and the National Preparedness System.
2013	**Sandy Recovery Improvement Act of 2013** (Pub. L 113-2 (2013)) Authorized new procedures for Public Assistance and allowed Tribal Nations to submit for disaster assistance aside from the State.

Table 2.2: Disaster legal authority milestones 1950 to present from the FEMA Disaster Operations Legal Reference (DOLR) (2017) (DHS, 2017a).

2.5.2 NATIONAL PLANNING FRAMEWORKS

In recent years, FEMA has expanded from one framework (the NRF) to five National Planning Frameworks (NPF) (Prevention, Protection, Mitigation, Response, and Recovery), in accordance with the National Preparedness Goal (NPG). The NPG is to ensure “a secure and resilient nation with the capabilities required across the whole community to prevent, protect against, mitigate, respond to, and recover from the threats and hazards that pose the greatest risk” (DHS, 2015b). The purpose of each framework is to define the roles and responsibilities of the ‘whole community’ within each mission critical area. For example, the NRF "provides a comprehensive, national, all-hazards approach to domestic incident response, while the National Disaster Recovery Framework (NDRF) provides a structure to manage and promote effective long-term recovery” (DHS, 2017a).

2.5.3 EMERGENCY SUPPORT FUNCTIONS (ESF)

Outlined in the NRF, there are 14 ESFs designated to support disaster relief (Table 2.3). They are not the only means of support, but they are the lead partners during disaster operations (DHS, 2016b). These functions, along with local, State/Tribal/Territory, and other partners, comprise the Regional Interagency Steering Committees (RISC). There is one RISC per FEMA Region, meeting quarterly at Region or within the area of responsibility. The purpose is to discuss new or evolving projects, and policies or initiatives that may affect disaster response. These meetings allow for partnership building before a disaster occurs and provides new and transitional personnel with the opportunity to learn their new role and the role of others in a non-disaster environment.

ESF #1 – Transportation (Department of Transportation)
Coordinates the support of management of transportation systems and infrastructure, the regulation of transportation, management of the Nation's airspace, and ensuring the safety and security of the national transportation system.
ESF #2 – Communications (DHS/Cybersecurity and Communications)
Coordinates government and industry efforts for the reestablishment and provision of critical communications infrastructure, facilitates the stabilization of systems and applications from malicious cyber activity, and coordinates communications support to response efforts.
ESF #3 – Public Works and Engineering (DOD/U.S. Army Corps of Engineers)
Coordinates the capabilities and resources to facilitate the delivery of services, technical assistance, engineering expertise, construction management, and other support to prepare for, respond to, and/or recover from a disaster or an incident.
ESF #4 – Firefighting (USDA/U.S. Forest Service & DHS/FEMA/U.S. Fire Administration)
Coordinates the support for the detection and suppression of fires.
ESF #5 – Information and Planning (DHS/FEMA)
Supports and facilitates multiagency planning and coordination for operations involving incidents requiring Federal coordination.
ESF #6 – Mass Care, Emergency Assistance, Temporary Housing, and Human Services (DHS/FEMA)
Coordinates the delivery of mass care and emergency assistance.
ESF #7 – Logistics (General Services Administration and DHS/FEMA)
Coordinates comprehensive incident resource planning, management, and sustainment capability to meet the needs of disaster survivors and responders.
ESF #8 – Public Health and Medical Services (Department of Health and Human Service)
Coordinates the mechanisms for assistance in response to an actual or potential public health and medical disaster or incident.
ESF #9 – Search and Rescue (DHS/FEMA)
Coordinates the rapid deployment of search and rescue resources to provide specialized lifesaving assistance.
ESF #10 – Oil and Hazardous Materials Response (Environmental Protection Agency)
Coordinates support in response to an actual or potential discharge and/or release of oil or hazardous materials.
ESF #11 – Agriculture and Natural Resources (Department of Agriculture)
Coordinates a variety of functions designed to protect the Nation's food supply, respond to plant and animal pest and disease outbreaks, and protect natural and cultural resources.
ESF #12 – Energy (Department of Energy)
Facilitates the reestablishment of damaged energy systems and components and provides technical expertise during an incident involving radiological/nuclear materials.
ESF #13 – Public Safety and Security Coordinator: Department of Justice/Bureau of Alcohol, Tobacco, Firearms, & Explosives
Coordinates the integration of public safety and security capabilities and resources to support the full range of incident management activities.
ESF #14 – Long Term Community Recovery*
*Superseded by the National Disaster Recovery Framework (NDRF) 2016
ESF #15 – External Affairs (DHS)
Coordinates the release of accurate, coordinated, timely, and accessible public information to affected audiences, including the government, media, NGOs, and the private sector. Works closely with state and local officials to ensure outreach to the whole community.

Table 2.3: Emergency Support Functions as outlined in the National Response Framework (DHS, 2016b).

2.5.4 NATIONAL INCIDENT MANAGEMENT SYSTEM (NIMS)

Implemented in 2004, "NIMS is a set of principles that provides a systematic, proactive approach to guiding government agencies at all levels, non-governmental organizations (NGO), and the private sector to work seamlessly to prevent, protect against, respond to, recover from, and mitigate the effects of incidents-regardless of cause, size, location, or complexity-in order to reduce the loss of life or property and harm to the environment" (DHS, 2011). Having evolved over many decades with its roots within the firefighting community, the overarching objectives of NIMS according to the NRF (DHS, 2016b) are:

- **Provide a systematic approach to incident management**
- **Be applicable to all incident types and sizes**
- **Provide guidance, structure for all hazards and disaster phases**
- **Provide resource management procedures for coordination**
  Provide communication/information management principles

2.5.5 FEMA WORKFORCE TRANSFORMATION

Aligned with priorities set forth by former FEMA Administrator W. Craig Fugate, in the FEMA Administrator's Intent Memorandum (2010), and impending financial concerns, FEMA implemented a workforce transformation initiative. Components intended to refine the workforce under the notion that "every employee is an emergency manager" (former Deputy FEMA Administrator Richard Serino, 2012). The goal of the initiative was to enhance personnel qualifications through training and experience so that all FEMA employees possess the required skills to perform various tasks during both Stafford Act (disaster) and non-Stafford Act (non-disaster) activities. In support of this concept, the FEMA Qualification System (FQS) was born which set forth the idea that employees would have two titles: one for Stafford Act activities (incident support (IS)) and one for non-Stafford Act activities (incident management (IM)). The system also provided new guidance and qualifications in the form of Position Task Books (PTB). Personnel achieve qualified (vs. trainee) status in their respective IS positions, through completion of the PTBs. Since the PTBs are based on experience and training it is necessary to establish consistent, standardized training programs and mechanisms to ensure that all personnel acquire the relevant skill sets.

2.6 FEMA DISASTER DECLARATIONS AND ASSISTANCE OVERVIEW

Based on policy, authorities, and statutes, FEMA utilizes pre-established economic and demographic thresholds, among others, for declaring a 'disaster'. Resulting from this process, there could be a hazardous event that is considered scientifically significant but not relevant to FEMA. For example, a flooding event that affects agricultural or recreational lands with little to no impact to people or infrastructure would likely not elicit a FEMA response. For the purpose of this study, as defined by FEMA, a disaster is "an event that results in large numbers of deaths and injuries; causes extensive damage or destruction of facilities that provide and sustain human needs; produces an overwhelming demand on state and local response resources and mechanisms; causes a severe long-term effect on general economic activity; and severely affects state, local, and private sector capabilities to begin and sustain response activities" (FEMA, 2014b). For the remainder of the document, this notion will be utilized when referencing 'disaster'.

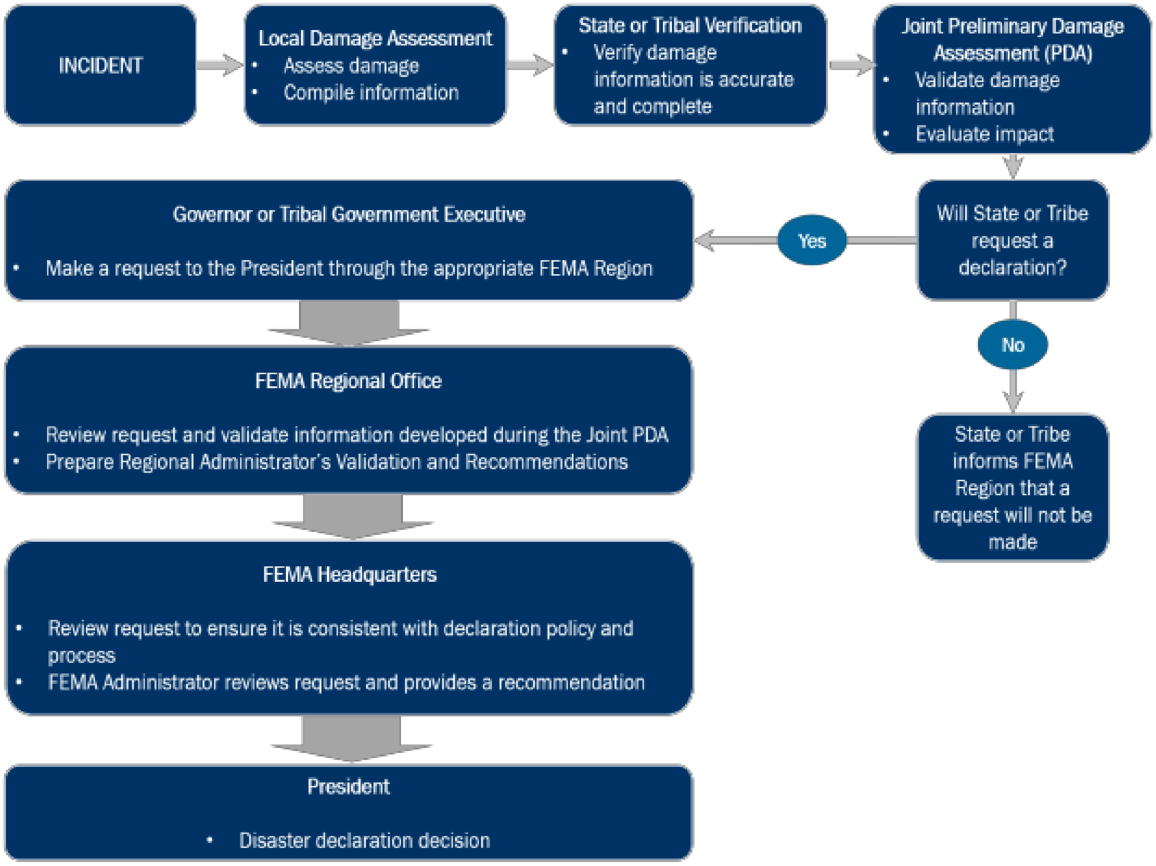

Figure 2.4: **FEMA Major Disaster Declaration (DR) request process. The process begins with the State/Territory/Tribe resulting in a final decision from the President. (DHS, 2017b)**

2.6.1 DISASTER DECLARATIONS

In order to receive Federal disaster assistance, State/Territory/Tribal governments must follow the process outlined in Figure 2.4. Upon incident occurrence, if initial damage surveys indicate that impacts will likely exceed State, Territory, and Tribal capabilities, the Governor, Territory or Tribal lead can request Preliminary Damage Assessments (PDA) from FEMA. Pending the outcome, they can then submit a request to FEMA for a declaration. Upon review of the event and PDAs, FEMA will then make a recommendation to the President for a final decision (FEMA, 2018b). However, the impending impacts of some events (i.e. – hurricanes) are evident. As such, a declaration can also be issued, at the request of the Governor, Territory or Tribal lead, before an incident if significant impacts are imminent.

If the impacts from a hazardous event have been determined to exceed the capability of state, territory, or tribal jurisdictions, FEMA can issue one or more of three primary types of disaster declarations: (1) Major Disaster Declarations, (2) Emergency Declarations, and (3) Fire Management Assistance Grants. "A Major Disaster (DR) could result from any natural or manmade event that the President determines warrants supplemental Federal aid. The event must be clearly more than state or local governments can handle alone. If declared, funding comes from the President's Disaster Relief Fund (DRF), managed by FEMA and the disaster aid programs of other participating Federal departments or agencies" (DHS, 2016b). "An Emergency Declaration (EM) is more limited in scope and without the long-term Federal recovery programs of a Major Disaster Declaration. Generally, Federal assistance and funding are provided to meet a specific emergency need or to help prevent a major disaster from occurring" (DHS, 2016b). Lastly, a Fire Management Assistance Grant (FMAG), while not issued from the President, "is available to local and Tribal governments, for the mitigation, management and control of fires on publicly or privately-owned forests or grasslands, which threaten such destruction as would constitute a major disaster" (FEMA, 2018c).

2.6.2 DISASTER ASSISTANCE

In addition to the declaration types, there are also differing types of assistance available. The type of assistance allowable under a declaration will be determined by the damage sustained and the assistance requested through the declaration request. The three disaster assistance types are: (1) Individual Assistance (IA), (2) Public Assistance (PA), and (3) Hazard Mitigation Assistance (HM). As is indicated by the title, IA is provided to individuals while PA and HM are provided to jurisdictions. HM provides funding to communities for projects that will "prevent or reduce long term risk to life and property" (DHS, 2015a). PA will assist with covering the cost of emergency work as well as damages sustained to infrastructure. There are seven designated allowable categories under PA as follows (DHS, 2018a):

- **Category A:** Debris Removal
- **Category B:** Emergency Protective Measures
- **Category C:** Roads and Bridges
- **Category D:** Water Control Facilities
- **Category E:** Buildings and Equipment
- **Category F:** Utilities
- **Category G:** Parks, Recreational and other Facilities

For some disasters, all types of assistance are made available if a DR is issued. While for others, only IA or PA is provided along with HM. HM is nearly always provided to assist communities with building or rebuilding more resilient. Additionally, as EM declarations are more focused and urgent, they primarily offer assistance for categories A and B under PA. If an EM declaration is issued, a DR can also be requested following the aftermath of an event upon assessment, when impacts are more widely known.

2.6.3 DISASTER SUPPORT

While FEMA is not considered a first-responder per say, they do provide disaster support through funds, resources, planning, etc. In order to administer assistance, they rely on several disaster support units within the agency. The first line of defense at FEMA is the National and Regional Watch Centers (N/RWC). The N/RWCs maintain 24/7 situational awareness to establish a Common Operating Picture (COP) and support response efforts by facilitating an orderly transition from steady-state operations through National/Regional Response Coordination Center (N/RRCC) activation (FEMA, 2014a).

The N/RRCC is the facility through which the Administrator/Regional Administrator (RA) directly controls and coordinates FEMA disaster operations and support until field operations are established and beyond as an incident warrants (DHS, 2013a). If necessary, an Incident Management Assistance Team (IMAT) will deploy to a disaster location or near a State Emergency Operations Center (EOC) (DHS, 2017b). Upon arrival, they will establish a Joint Field Office (JFO) which will provide disaster support to State, Territory, Tribal and/or local governments. Additionally, if IA was allowed in the received declaration, then Disaster Recovery Centers (DRC) will be established onsite in or near the disaster areas. These locations are where those impacted by the disaster can receive information about the various assistance programs available to them through FEMA, the U.S. Small Business Administration (SBA) and other non-profits. In addition, there will be personnel in the disaster area to provide disaster assistance information to survivors.

The N/RWC serves as a conduit for receiving and communicating mission critical information and analysis to Federal, State, Territory, and Tribal partners and at times local officials. Responsibilities include monitoring various sources of information to identify potential threats, determine emerging hazards, assess potential impacts, disseminate information through reports and daily readiness briefings to alert personnel of any potential threats, and notify personnel of significant event occurrence (FEMA, 2014a). Additionally, the N/RWC facilitates the implementation of N/RRCC activation and deployment orders in accordance with current FEMA policy and directives. Once established, operations will be carried out by predesignated personnel.

Unlike local emergency management officials, whom utilize weather information to make immediate, potentially life-saving and time critical decisions, FEMA generally utilizes weather information and data in more of a supporting role. For example, N/RWC personnel are constantly monitoring and assessing weather hazards and impacts in order to alert FEMA personnel and response partners of potentially impending threats that may lead to a disaster declaration. Once an incident occurs, scope, size, scale and impacts of the incident will determine what further action by N/RWC personnel is warranted if any, such as coordination of resources and personnel. Throughout this process and in the aftermath of an incident, various types of weather information and/or data are needed along varying timelines. It is particularly valuable in assisting with accurate interpretation and analysis for hazard and impact assessment as it is imperative for maintaining situational awareness, coordinating response efforts and supporting Senior Leadership decision making.

CHAPTER 3: LITERATURE REVIEW

To fully encompass the topic of emergency management wholly, it is necessary to discuss existing literature for a variety of subject areas for this study. As such, this chapter provides a brief literature review of emergency management as a discipline (section 3.1), hazards and disasters (section 3.2), hazard messaging and communication (section 3.3), risk and crisis communication and management (section 3.4), situation awareness (section 3.5), decision making (section 3.6), weather training (section 3.7), and ending with a summation of existing knowledge gaps (section 3.8). Examination of the aforementioned areas informed this study by identifying knowledge gaps and providing a starting point to guide and build from. The topics discussed in this chapter serve as the foundational components not only for this study, but also for future endeavors.

3.1 EMERGENCY MANAGEMENT

Emergency management can be defined in a multitude of ways and is often interchangeably referred to as disaster management, risk management, public safety, emergency response, etc. Simplistically, "emergency management is the discipline dealing with risk and risk avoidance" (Haddow et al., 2017) or "the expert systems that manage people and resources to deal with disasters" (Rubin, 2007). A more advanced definition of emergency management is "the managerial function charged with creating the framework within which communities reduce vulnerability to hazards and cope with disasters" (Blanchard et al., 2007). Operationally, emergency management is "the process by which the uncertainties that exist in potentially hazardous situations can be minimized and public safety maximized" (Drabek, 2004). Officially, FEMA defines emergency management as those who "coordinate and integrate all activities to build, sustain, and improve the capability to prepare for, protect against, respond to, recover from, or mitigate against threatened or actual natural disasters, acts of terrorism or other man-made disasters" (Post Katrina Emergency Management Reformation Act [PKEMRA], 2006). Among the group, "includes Federal, State, Territorial, Tribal, sub-state regional, and local governments, NGOs, private sector-organizations, critical infrastructure owners and operators, and all other organizations and individuals who assume an emergency management role" (FEMA, 2010c) More succinctly, emergency management is "an ongoing process to prevent, mitigate, prepare for, respond to, and recover from an incident that threatens life, property, operations, or the environment" (National Fire Protection Association [NFPA], 2007).

Cressman (1971) describes a very different state of the field, previous to "modern emergency management" (Perry & Nigg 1985). Providing a synthesis of public usage of weather information, he also extends beyond to include a brief discussion of social factors. He notes that "we are able to use sirens directly in only a few communities but are working with Civil Defense to extend this type of warning or to find a better and perhaps more modern or effective way" (Cressman 1971). Emergency management is a diverse and changing field that has been put at the forefront of many political discussions over the past few decades. A greater demand has materialized due to increasing disasters associated with climate change, population migration, and construction among others (Riebsame, Diaz, Moses, & Price, 1986). Once the small and lackluster profession of civil defense, the greatly evolved field of emergency management has emerged from meager beginnings. Transitioning from the era of civil defense to emergency management, the National Governors Association (NGA) initially put forth the idea of Comprehensive Emergency Management (CEM) as the organizing structure for the development and implementation of FEMA in 1979 (NGA, 1979). Composed of four phases: (1) preparedness, (2) response, (3) recovery, and (4) mitigation, CEM is an approach that includes all hazards and impacts throughout all phases and amongst all partners (Blanchard et al., 2007). While the first official notion of CEM may have been set forth in 1978, the idea of disaster phases and social influences dates back to 1932 (Carr, 1932). FEMA remains organized within respective divisional components according to this framework forty years later. Additionally, the phases of CEM, also frequently referred to as the disaster lifecycle, continue to serve as the overarching guide for emergency management disaster activities.

Despite implementation of FEMA in 1979, it wasn't until the early to mid-2000's, following the events of 9/11 and Hurricane Katrina, that the field of emergency management came to the forefront. During this time, development and implementation of certifications and undergraduate degree programs in emergency management, homeland security and the like began. Master's degree and eventually Doctoral degree programs followed suit. Discussion of 'theory and emergency management' began to emerge (McEntire, 2004; Drabek, 2004) as development of degree programs has expanded. Research in these areas increased, resulting in greater emphasis and study on disaster response within the academic sector. FEMA has since taken an emergent lead to advance the field of emergency management through FEMA's Emergency Management Higher Education Project. Comprised of academics and practitioners, the convened working group proposed eight principles to guide development and advancement of the profession of emergency management. The monograph entitled 'Principles of Emergency Management Supplement', outlines important characteristics for emergency management professionals to embody including comprehensive, progressive, risk-driven, integrated, collaborative, coordinated, flexible and professional (Blanchard et al., 2007).

Academically, compared to other disciplines, fairly limited research has been conducted to better understand emergency management in general, inhibiting theoretical or conceptual framework and model development. Theory development and theoretical applications are greatly understudied due to the 'newness' so to speak of the discipline. Furthermore, much of the research that does exist focuses on lessons learned and policy with greater concentration at the local level. As a developing discipline, in conjunction with the multidisciplinary facets of emergency management, the field has struggled to establish a foundation within the academic sector. With no real theorems and models specific to emergency management and without an existing in-depth body of knowledge, some scholars argue for the application of relevant theories from other disciplines (Drabek, 2004), while others hope to work toward a 'theory of emergency management' (McEntire 2004). While one could make the argument either for or against a theory of emergency management, McEntire and Marshall (2003) identified ten challenges in attempting to do so:

1. **Defining 'disaster'**
2. **Defining 'emergency management'**

3. **Deciding what hazards to focus on**
4. **Giving preference towards 'hazards' vs. 'disasters'**
5. **Deciding what variables to explore**
6. **Deciding what partners to include**
7. **Determining what phases are given priority**
8. **Disciplines to include**
9. **Determining what paradigms will guide the field**
10. **Finding the proper balance for knowledge generation**

Despite continued academic efforts to advance the overall knowledge base, most emergency management ideas and concepts are not substantially embedded within peer reviewed, academic literature (Perry & Nigg 1985). This is true most notably for FEMA, the primary representation of Federal level emergency management. Rather, they are a culmination of ideas that have evolved over time based on operational needs. Operations continue to lead advancement of theoretical and conceptual developments within emergency management presently. Fundamentally, further solidification of foundational standards and comprehensively distinguishing the prevailing status of the field is required before substantive academic progress can be achieved.

3.2 HAZARDS AND DISASTERS

A natural hazard is defined "as extreme, low-probability meteorological or geological phenomena that have the potential to cause disasters when they strike human collectives" (Mileti, 1999). Examples include weather, earthquakes, tsunamis, volcanoes, etc. Technological hazards include human caused incidents such as hazardous materials, nuclear/radiological events, etc. (Lindsey et al, 2011). Over the years, the idea of 'hazards' has expanded to include oil spills, explosions, terrorist attacks, public health, chemical and bioterrorism, active shooter scenarios, civil unrest, and cyber threats. A broader definition of a 'hazard' "refers to a situation, event or substance that can become harmful for people, nature or human-made facilities" (Rohrman, 2008). "Hazards do not necessarily imply the presence of vulnerability. However, vulnerability always takes into account hazards" (McEntire 2004). In other words, "a hazard is a physical entity while risk is not; it is an inference about the implications of a hazard for people (or nature, or assets) exposed to it" (Rohrman, 2008). Simply, risk can be defined as the impact of hazards on populations and vulnerabilities (Drottz, 1991; Fischoff et al., 1984; Renn, 1992; Taylor-Gooby, 2002; Yates & Stone, 1992). Furthermore, disasters are the characterization of risk and include both natural and man-made (terrorist and technological) events (Quarantelli, 1998). FEMA's motto is to be 'flexible and adaptable', a bit of a play on words for the 'F' and 'A' in FEMA with regards to emergency management (the 'EM'). As the agency and nature of disasters is constantly changing, mindfulness, or the need "to constantly adapt our perceptual skills to account for the ever-changing world around us" is important to best maintain awareness (Combs, 2007).

George P. Cressman (1971) of the National Weather Service, speaking on behalf of meteorologist noted that "the public exposure to loss of life and property is increasing in spite of our best efforts in providing warning services" and that "this new aspect of increasing population, increased exposure of large number of people to environmental hazards, places a double burden on the profession." He also noted that "the magnitude of this problem is quite new" due to construction, population migration, evacuations, escape routes, flood plains, etc. (Cressman 1971). Riebsame et al. (1986) proposed a preliminary listing of a multitude of socioeconomic trends thought to contribute to disasters and resiliency as well as information demands (Table 3.1). These items provide a snapshot of the beginning of a new era in disasters and disaster management.

Social trend	Impact on vulnerability	Impact on information demand
Population growing older	↑	↑
Coastal zone growing more rapidly than rest of country	↑	↑
Population shift to West and South	?	?
Leisure time increasing, outdoor recreation increasing	↑	↑
Information-technology development	?	↑
Western water development	↑	↑
Development in agricultural technology	↓	↑
Rapid increase in agricultural flexibility	↓	↑
Loss of best farmland and crop genetic diversity	↑	↑
Need to go farther afield for resources (e.g., North Slope oil)	↑	↑
Increased energy efficiency (e.g., home insulation)	↓	?
Transportation switch from rail and barge to highway	↑	↑
Pollution-control requirements	↑	↑
Employment shifts from manufacturing to service	?	?
Increased liability litigation	↑	↑
More mobile homes	↑	↑

Table 3.1: Initially identified socioeconomic trends affecting sensitivity from atmospheric hazards (Riebsame et al., 1986, p. 1384).

During the early days of hazards and disasters research, it was predominantly studied within the fields of geography and sociology (e.g. Quarantelli, 1960; Barton, 1969; Dynes, 1970; Kreps, 1984). Although somewhat limited in volume, early studies conducted in “geography has enabled scholars to understand the characteristics of hazards, while sociology fostered an understanding of the social causes of and human behavior in disasters” (McEntire, 2004). While that tradition continues today, various other fields such as psychology, communication, public health, public administration, political science, etc. also conduct hazards and disasters research, re-affirming the interdisciplinary essence of emergency management, hazards, and disasters. The most relevant literature applicable for this study is more recent, yet a few prominent scholars paved the way by conducting instrumental disaster research since the 1960’s. For reference, these scholars include but are not limited to, Thomas Drabek, Russell Dynes, Charles Fritz, J. Eugene Haas, Gary Kreps, Dennis Mileti, Enrico Quarantelli, John Sorensen, and Gilbert White among others.

Historically, much of the weather research conducted was science and mathematics based, with limited knowledge of perception, communication, usage, response, etc. Over the past two decades, integration of social sciences and meteorology has grown exponentially (e.g. Demuth, 2011, 2012, 2016; Morss, 2005, 2007, 2008, 2015; Benight et al., 2004; Lazo, 2009, 2015; Baumgart et al., 2008). In part, this rapidly growing field is due to an increasing disaster footprint on an expanding population, particularly among coastal areas, and associated rising cost (IPCC, 2014). Prior to now, there has been fairly substantial progress toward assessing warning messages and public response to hazards in general

(Sorenson & Mileti, 1987; Mileti & Sorenson, 1987, 1990; Mileti, 1999). However, understanding of decision making and communication among emergency management and public safety officials is not as well understood, which this study will begin to address.

Early work from Quarantelli (1978, 1989) noted three problem areas within response: (1) "information flow problems in the communication processes within and between organizations, to and from organizations and citizens, (2) organizational decision problems resulting from losses of higher echelon personnel because of workload, conflict regarding authority over new disaster tasks, and confusion over jurisdictional responsibilities, and (3) problems in inter-organizational coordination that results from a lack of consensus about what constitutes coordination, strained relationships created by new disaster tasks and the magnitude of the disaster impacts." For this study, emphasis will focus on the first problem area for FEMA. Despite decades of change and technology, this issue is still relevant today. Communication of information is imperative for effective situational awareness and informed decision making, hence providing an elemental motivation for this study.

Provided the varying hazards, extent of hazards, and the diversity of exposed populations, interdisciplinary and cross-cultural research is necessary (e.g. - Weber and Hsee, 2000; Grothman and Reusswig, 2006; Taylor-Gooby and Zinn, 2006; Zinn, 2008). Knowledge gained through further research will aid practitioners with decision making and operations. However, "the utilization of such knowledge requires an open-minded interdisciplinary collaboration of researchers and public authorities which are responsible for emergency management" (Rohrmann, 2008). The likes of which I plan to perpetuate forward in future work and collaborations across a multitude of disciplines and into operations extending beyond completion of this study.

3.3 HAZARD MESSAGING AND COMMUNICATION

Although complex, at a primitive level, warning systems are designed to detect a threat, communicate it and enable response. The first step toward responding to a hazardous event requires identification of a threat and reception of information. Furthermore, the message must be specific, consistent, accurate, certain and clear while containing the nature, location, guidance, time and source of the hazard (Sorenson, 2000). Stemming from decades of work, Mileti (1999) states that the decision to take action from a hazard warning includes: (1) hearing the warning, (2) believing the warning is credible, (3) confirming the threat, (4) personalizing the warning, (5) determining if action is needed, (6) determining if action is feasible, and (7) determining what action to take. In addition, a variety of factors have been determined as influencing warning response. Mileti et al. (2006), categorized these factors as (1) socio-demographic, (2) personal, (3) source/channel, (4) information, and (5) threat. While mostly applied to instances regarding the public, these will also apply to emergency managers as well.

Behavioral studies have investigated the public's perception and response to natural hazards (e.g. – Drabek, 1986, 1999; Lindell and Perry, 1992; Mileti and Sorenson, 1990), which includes the notions of risk perception and approach. Risk perception pertains to one's interpretations based on experiences or beliefs (Slovic, 1987, 2000). "Human behavior in emergency management endeavors is influenced by risk perception, risk attitude, risk communication and risk management facets" (Rohrmann, 2008). Discussed in more detail below, Rohrmann (2008) posits that "risk communication is the indispensable link between risk perception and risk management." Not only does this relate to risk, but also to crisis which is "influenced by such factors as personal experience, framing, culture, and individual tolerance" (Seeger & Gouran, 2002). "Perceptions of risk and capability are also influenced by the manner in which experience is interpreted" (Paton & Flin, 1999).

"Risk perception is a key component in encouraging protective action in the context of natural hazards" (Sullivan-Wiley & Short Gianotti, 2017; Lindell & Perry, 1992; Wachinger, Renn, Begg, & Kuhlicke, 2013). A vast amount of research has been conducted on risk perception and influencing factors (e.g. – Fischoff, 1995; Lindell and Perry, 1992; Slovic et al., 1979; Slovic, 1987; Wachinger et al., 2013; Boholm, 1998). Sullivan-Wiley and Short Gianotti (2017) synthesize much of this work and the potential factors that influence risk perception, which are categorized among the following three areas: (1) hazard characteristics, (2) individual characteristics and (3) trust in communicating institutions.

Hazard characteristics include (a) likelihood, (b) impact potential, (c) understanding, and (d) knowledge (Slovic et al., 1979; Slovic, 1987; Boholm, 1998). Individual characteristics include various self-efficacy factors such as gender, age, education and personal experience (Sjoberg, 2000; Siegrist & Gutscher, 2006; Wachinger et al., 2013;). Personal experience includes (a) recency, (b) frequency, and (c) severity of a hazardous event (Lindell and Perry 2012). Mileti and O'Brien (1992), refer to this as "normalization bias", where an individual's experience may bias their perspective on future events. Furthermore, “many of the difficulties associated with hazard communication stem from the difficulties of choice under uncertainty” (Viscusi & Zeckhauser, 1996). Paton (2008) noted that trust is important for communication of decision making under uncertainty, “trust as determined by knowledge and expertise, openness and honesty, and concern and care” (Sullivane-Wiley & Short Gianotti, 2017; Kasperson, 1986; Peters et al., 1997; Renn & Levine, 1991). In emergency response there is an additional layer of complication, “even after a level of trust is established, security issues must still be considered” (Manoj & Baker, 2007).

“Because the atmosphere is a dynamical system that exhibits limited predictability, weather forecasts are unavoidably uncertain” (Morss et al., 2008). “Current key knowledge gaps include understanding how people interpret weather forecast uncertainty and how to communicate uncertainty more effectively in real-world (rather than theoretical or idealized) settings” (Morss et al., 2008), despite previous work from Murphy et al. (1980), Roulston et al. (2006), National Research Council (NRC) (2003, 2006), and Joslyn et al. (2007). Trust and communication with the NWS proved to be an important factor among the emergency managers studied in Morss and Ralph (2007). However, constant contact with NWS officials throughout an event is taxing to NWS personnel and they may be unable to satisfy all requests among many differing officials by the required time. These findings support the need for a widely available meteorological training program, where emergency managers could potentially further develop their skills and self-confidence. In turn, this would decrease unnecessary communications with the NWS, due to a greater understanding of meteorological phenomena, products, resources, and impacts.

Additionally, cultural (Sjoberg, 1996) and social (Sandman, 1987) factors may also play a role (Kasperson et al., 1988). For example, the Social Amplification of Risk framework (SAR) describes how social influence can affect risk perception (Pidgeon, 2003). Through communication of risks, perception can either be amplified or attenuated via direct or indirect experience (Kasperson et al., 1988). Within the information system, influencers include: (1) volume, (2) information disputes, (3) dramatization, and (4) symbolic connotations (i.e. – channels, language, etc.) (Kasperson et al., 1988), all of which compound decision making at FEMA. Beyond the information system, interpretation and response mechanisms include: (1) heuristics and values, (2) social group relationships, (3) signal value, and (4) stigmatization (Kasperson et al., 1988), which also contribute to FEMA decision making. The SAR framework showcases the social processes experienced by many personnel within the emergency management community. These processes can also be completed iteratively as the event and/or information changes. All of which leads us to the notion of communication overall.

Communication within emergency management is multifaceted across internal and external partners. Nilsen (1974) best characterized many of the communication challenges also applicable to and encountered at FEMA and emergency management in general, including (1) incomplete information, (2) biased information, (3) statistical units that are inadequately defined/incomplete, (4) vague or ambiguous terminology, (5) erroneously implied relationships, (6) false sense of urgency, and (7) emotionalized language. Manoj and Baker (2007) further identified three overarching types of communication challenges within emergency response: (1) technological, (2) sociological and (3) organizational. Furthermore, "relative to emergency management, communication with the public has one of three general objectives": (1) information exchange, (2) educational contacts, and (3) support building exchanges (Perry & Nigg, 1985). This holds true for FEMA, "the more attention that an emergency manager can give to providing information on hazards, risk, and protective measures in non-crisis situations, the more likely it is that such information communicated during an actual emergency will result in adaptive citizen action" (Perry & Nigg, 1985). Although FEMA and others have focused efforts on informing the public about the threat, FEMA and emergency managers have been remiss at providing disaster assistance information before an event occurs. This shortfall does not allow the public to prepare adequately, leading to frequently misunderstood and false expectations from the public regarding available disaster funds after event occurrence.

3.4 RISK AND CRISIS COMMUNICATION AND MANAGEMENT

The terms 'risk', 'crisis', 'emergency', 'disaster', etc. are often used interchangeably and not consistently defined among a variety of fields. Coombs (2007) best synthesized various crisis perspectives stating that "a crisis is the perception of an unpredictable event that threatens important expectancies of stakeholders and can seriously impact on organizations performance and generate negative outcomes." Others see "crisis as creating a basic need for information, communication, structure, actions and related processes to reconstitute a basic understanding or interpretation of the situation" (Seeger & Gouran, 2002;

Hermann, 1963; Weick, 1988). More simplistically, “a crisis is simply a negative event that commands a person’s attention” (Sweeny, 2008). Variations among ‘risk’ definitions also exist which include similarly plentiful aspects and factors. Reynolds and Seeger (2005) and Ulmer et al. (2007) provide further refinement.

While the definition of a ‘disaster’ is also somewhat debatable, a disaster can be equated to a ‘crisis’ as it follows the same type of phasing structure and activities (Shaluf, 2003). Lastly, ‘emergency’ is most often utilized within the medical and public health professions. Despite this discrepancy, the term ‘emergency management’ continues to be perpetuated today. Furthermore, emergency management contains aspects of both ‘risk’ and ‘crisis’. As a disaster incorporates elements of all of these areas for all types of hazards, ‘disaster management’ is a more appropriate term. Nonetheless, as ‘emergency management’ is more widely used for this purpose, I will keep within the tradition for this study, but offer it up as suggestion for future work and field advancement.

Signal detection theory (SDT) postulates that ‘risk’ can turn into ‘crises’ (Fink, 1986) and consists of a three-part process: (1) information sources, (2) information collection and (3) information evaluation (Swets, 1964). Within SDT, event occurrence can be portrayed via a 2x2 contingency table, of which a false alarm is one option (Murphy, 1980). The caveat of the false alarm issue is that ‘crying wolf’ too often can decrease response, leading a decision maker to find balance between information reception and response (Roulston & Smith, 2004). Stemming from this work and rooted in public relations, substantial work has been conducted within the fields of risk and crisis communication and management.

Many of these notions extend to support emergency management and associated areas, concepts and ideas.

Risk communication, as defined by the National Research Council (NRC, 1989), is “an interactive process of exchange of information and opinion among individuals, groups, and institutions.” For comparison, “crisis communication is what happens as an event is unfolding and in the immediate aftermath” (Manuel, 2014). “Traditionally, risk communication concentrates on persuading individuals to take action to limit risk, whereas crisis communication focuses on responding to immediate public need for information” (Veil et al., 2008). FEMA utilizes a ‘technology centered approach’ for risk communication, where “experts are called upon to make recommendations based on their sophisticated knowledge of the subject and situation. These recommendations are then translated into laws and regulations for managing the situation” (Coombs, 2007). However, this approach also contributes to difficulty in gaining and losing public trust, which is a frequent attitude exhibited toward FEMA. Sandman (1993, 2000) best characterizes the issue by defining ‘risk’ as inclusionary of ‘hazard’ (science) and ‘outrage’ (perception). Tied to ‘risk communication’, 'risk management’ encompasses “the activities of individuals or authorities to remove or mitigate the sources and/or impacts of hazardous events” (Rohrman, 2008), driven by cost and technical nature (i.e. “can the risk actually be eliminated or reduced?” (Coombs, 2007)).

A wide variety of management stages have been proposed (e.g. Fink, 1986; Sturges, 1994; Mitroff, 1994; Gonzalez-Herrero & Pratt 1995, 1996; Richardson, 1994; Birch 1994; Guth, 1995; Seeger et al., 2003). They all correlate within the elements of the Coombs (2007) general model. Synthesizing this work, Coombs

(2007) offers an adaptable three stage model consisting of (1) pre-crisis, (2) crisis event, and (3) post crisis. The 'pre-crisis' stage includes (1) signal detection, (2) prevention, and (3) crisis preparation, while the 'crisis event' stage includes (1) crisis recognition and (2) crisis containment. The final stage, 'post crisis', aims to "(a) make the organization better prepared for the next crisis, (b) make sure stakeholders are left with a positive impression of the organizations crisis management efforts, and (c) checks to make sure that the crisis is truly over" (Coombs, 2007). Furthermore, these also correlate within the four phases of the disaster life cycle/CEM.

Combining elements from both risk and crisis communication, "the Crisis and Emergency Risk Communication (CERC) model merges many existing activities into more comprehensive systems of communication" and "acknowledges that effective communication regarding crises and emergencies must begin long before an event erupts and continue after the immediate threat has subsided" (Reynolds & Seeger, 2005). Utilizing a five-stage framework, "the CERC model offers a comprehensive approach within which risk and warning messages and crisis communication activities can be connected into a more encompassing communication form" (Reynolds & Seeger, 2005). "One important value to this systematic approach is that it reduces uncertainty and allows crisis managers to look ahead and anticipate subsequent communication needs and problems" (Reynolds & Seeger, 2005).

CERC evolved from training efforts initiated at the Centers for Disease Control and Prevention (CDC) (Reynolds, 2002; Courtney et al., 2003). The CERC approach provides an overview of communication activities that should be ongoing before, during, and after an incident. In turn, this framework facilitates the decision making process and helps to guide public response and recovery activities. Consisting of five phases: (1) pre-crisis, (2) initial event, (3) maintenance, (4) resolution, and (5) evaluation, each phase is outlined accordingly in Table 3.2 (Reynolds 2002) as applied within the public health sector.

Pre-crisis	Initial	Maintenance	Resolution	Evaluation
■ Be prepared. ■ Foster alliances. ■ Develop consensus recommendations. ■ Test messages.	■ Acknowledge the event with empathy. ■ Explain and inform the public, in simplest forms, about the risk. ■ Establish agency and spokesperson credibility. ■ Provide emergency courses of action, including how and where to get more information. ■ Commit to stakeholders and the public to continue communication.	■ Help the public more accurately understand its own risks. ■ Provide background and encompassing information to those who need it. ■ Gain understanding and support for response and recovery plans. ■ Listen to stakeholder and audience feedback, and correct misinformation. ■ Explain emergency recommendations. ■ Empower risk/benefit decision-making.	■ Improve appropriate public response in future similar emergencies through education. ■ Honestly examine problems and mishaps, and then reinforce what worked in the recovery and response efforts. ■ Persuade the public to support public policy and resource allocation to the problem. ■ Promote the activities and capabilities of the agency, including reinforcing its corporate identity, both internally and externally.	■ Evaluate communication plan performance. ■ Document lessons learned. ■ Determine specific actions to improve crisis systems or the crisis plan.

Table 3.2: Crisis and Emergency Risk Communication (CERC) five phase framework as applied within the public health sector (Reynolds, 2002).

In addition, six primary underpinnings or assumptions of the CERC framework are: (1) Risks and crisis are equivocal and uncertain, (2) Two-way communication is important, (3) Communication processes change as risk evolves into crisis and beyond, (4) Risk and crisis communication are interrelated, (5) Communication promotes self-efficacy, and (6) Risk and crises and communication of, affects a diverse audience (Veil et al., 2008). Furthermore, there are six overarching principles associated with the CERC model to assist communication (Reynolds & Seeger, 2012):

1. **Be First:** Crises are time-sensitive. Communicating information quickly is almost always important. For members of the public, the first source of information often becomes the preferred source.

2. **Be Right:** Accuracy establishes credibility. Information can include what is known, what is not known, and what is being done to fill in the gaps.

3. **Be Credible:** Honesty and truthfulness should not be compromised during crises.

4. **Express Empathy:** Crises create harm, and the suffering should be acknowledged in words. Addressing what people are feeling, and the challenges they face, builds trust and rapport.

5. **Promote Action:** Giving people meaningful things to do calms anxiety, helps restore order, and promotes a restored sense of control.

6. **Show Respect:** Respectful communication is particularly important when people feel vulnerable. Respectful communication promotes cooperation and rapport.

Stemming from its origins, the majority of CERC applications have been concentrated in the public health sector (Reynolds, 2005; Veil et al., 2008; Manuel, 2014). However, meteorology, like public health, exhibits both 'risk' and 'crisis' elements through all five of the designated phases, making this model applicable for weather hazards as well. FEMA engages with a variety of partners and publics, including the CDC, during hazards and disaster events. The similarities among missions and roles make this paradigm a good fit within the field of emergency management. In addition, the principles within this framework are “theory driven, research driven, and practice driven” (Veil et al., 2008) lending itself to the advancement of the operational field of emergency management.

3.5 SITUATION AWARENESS

“Communication also plays a critical role in acquiring situation awareness” (Son et al., 2007). “Most simply put, SA is knowing what is going on around you” (Endsley & Garland, 2000). Endsley (1988) defines situation awareness as “the perception of elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.” Another definition is that “situation awareness requires decision makers to quickly detect, integrate, and interpret information gathered from the environment” (Zhang et al., 2002).

Depicted in Figure 3.1, Endsley (1995) stipulates that situation awareness is one of the major components in the decision making process and consist of three levels: (1) perception, (2) comprehension, and (3) projection. Additionally, opportunities for uncertainty arise among each level (Endsley & Bolte, 2003). “SA is largely affected by a person’s goals and expectations which will influence how attention is directed, how information is perceived, and how it is interpreted” (Endsley, 1995). Although deemed critical for informed decision making, “high situation awareness does not always lead to better decisions. Other factors such as strategy, experience, training, personality, organizational and technical constraints also effect the decision making process" (Son et al., 2007).

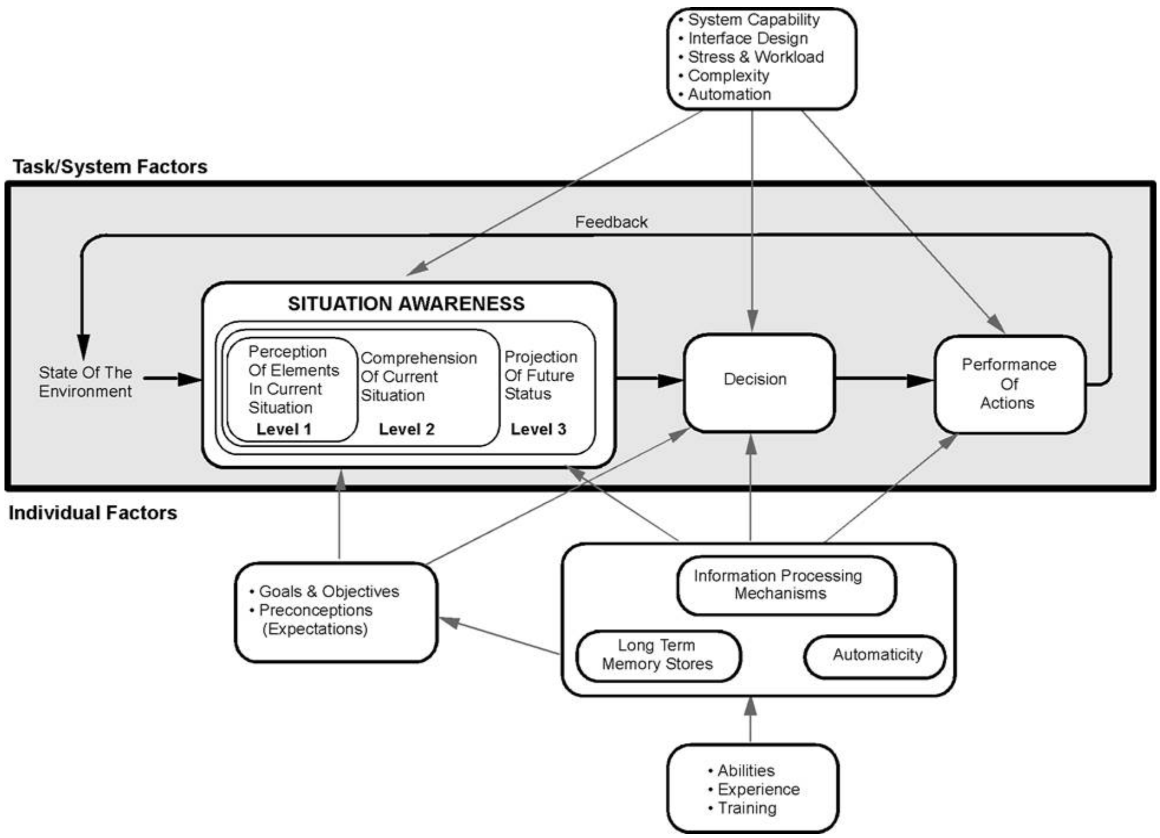

Figure 3.1: Endsley (1995) Model of Situation Awareness in decision making. Black arrows depict flow between phases, while gray arrows indicate influences (Endsley, 1995).

Endsley and Robertson (2000) determined a variety of causes for possible situational awareness errors in aviation: workload, communications, improper procedures, time pressure, equipment, weather, unfamiliarity, fatigue, night conditions, and emotion, among others. For level 1, perception, errors were caused by information (1) not available, (2) difficult to detect, (3) not observed, (4) misperception, as well as (5) memory error. For level 2, comprehension, errors were caused by (1) lack of/incomplete mental model, (2) incorrect mental model,

(3) over-reliance on defaults values in the mental model. Lastly, for level 3, projection, errors were caused by (1) lack of/incomplete mental model, (2) over-projection of current trends, or (3) other. “A mental model is the underlying knowledge that is the basis for SA” (Endsley and Garland 2000a), essentially the situation model represents the current state of the mental model (Mogford, 1997).

Endsley and Robertson (2000) also stated that there is a need for more research on situation awareness in other areas to advance understanding of developing and maintaining situation awareness in order to improve it. Situation awareness is generally built up over time, and training is one way that can help to expedite this process. “Effective improvement of situation awareness through training approaches will most likely be achieved by improving the skills and knowledge bases that are critical” (Endsley & Robertson, 2000).

Situational awareness requires continuous monitoring of relevant sources of information regarding actual and developing incidents. For an effective national response, jurisdictions must continuously refine their ability to assess the situation as an incident unfolds and rapidly provide accurate and accessible information to decision makers. It is essential that all response partners develop a common operating picture (COP) and synchronize their response operations and resources. When it comes to decision making regarding weather information at FEMA, there are three levels of inputs that complicate matters further, in turn, making for a very complex situation which provides ample opportunity for communication breakdowns in addition to user inputs. It can be thought of as the telephone game where what was initially intended did not turn up in the end. Given that the weather data and information have three or more layers to go through, the initial message can easily be ‘lost in translation’ so to speak. An additional complicating factor is that FEMA Watchstanders generally work in pairs and therefore each person may have their own inputs that the two may need to reconcile.

Furthermore, “there is a significant lack of information about the scale of a disaster in the immediate aftermath; this is followed by large amounts of imprecise information” (Manoj & Baker, 2007). Hence, management and processing of information (Weick, 1993; Seeger et al., 2003) and the extension of, knowledge management (Wang & Belardo, 2005), are important components throughout the situation awareness and decision making cycles. Generally speaking, “situation awareness describes the point at which the crisis team feels it has enough information and knowledge to make a decision” (Coombs, 2007; Kolfschten & Appleman, 2006). Complicating matters is the decision makers need for expert knowledge, possible additional threats, managing casualties, and environmental concerns, etc. (Gouran, 1982). FEMA implores an information management system that operates to monitor, collect, analyze, interpret and disseminate information to establish the COP.

Zhang et al. (2002) describes a knowledge management framework which connects the situation awareness and decision making processes within disaster relief and humanitarian aid. This includes acquisition, filtering, indexing, linking, sharing, categorization, creation, and maintenance. One of the biggest challenges is processing the information to knowledge, which includes (1) serial reproduction errors, (2) the MUM effect, (3) message overload, (4) information acquisition bias, and (5) decision making errors (Coombs 2007). “The production of knowledge, along with the imputing of meaning, requires trained, experienced receivers”

(Harrald & Jefferson, 2007). Figure 3.2 postulates how data is transformed into action through a process of understanding, meaning, interpretation, and comprehension influenced by experience, training, and judgement.

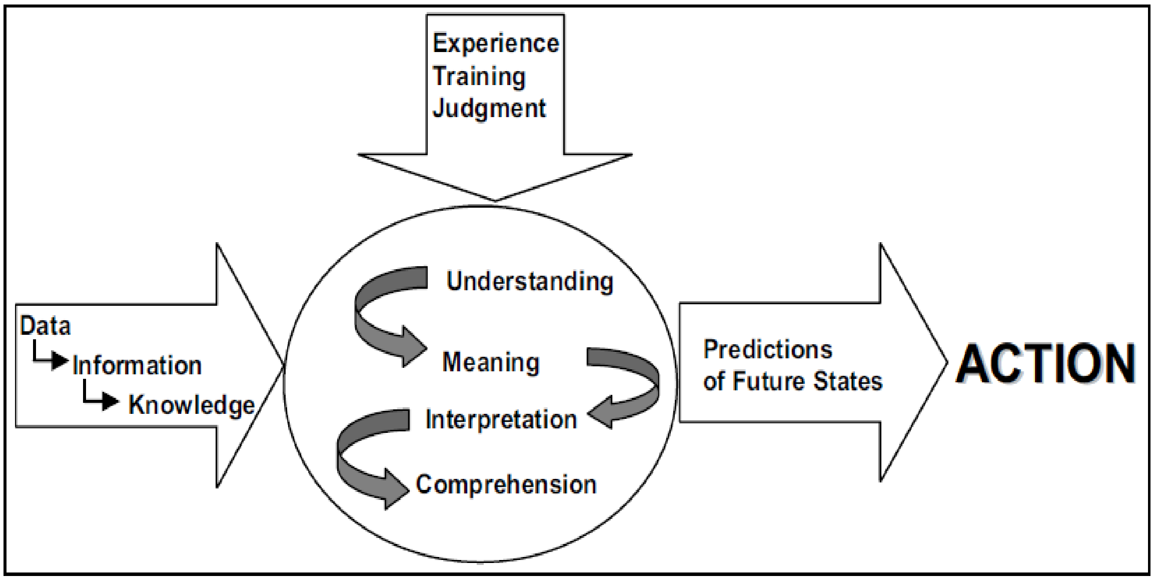

Figure 3.2: Proposed model of the transformation of data into action through a process of understanding, meaning, interpretation, and comprehension, influenced by experience, training, and judgement (Harrald & Jefferson, 2007).

Furthermore, there are two general types of knowledge, tacit and explicit (Tsoukas, 1996; Seppanen et al., 2013). Explicit knowledge is accessible through consciousness and more readily communicated, while tacit knowledge is more applied and not easily communicated (Evans, 2008; Nonaka & von Krogh, 2009; Seppanen et al., 2013). Within knowledge management, “it is necessary to manage both tacit and explicit knowledge” (French & Turoff, 2007). For FEMA and much of emergency management, many aspects are tacitly possessed, posing a challenge for disaster response and the need for further academic study.

3.6 DECISION MAKING

Yates (2003) defined a decision as "a commitment to a course of action that is intended to yield results that are satisfying for specified individuals." Decision making, or the process by which one reaches a decision, has been studied extensively in psychology, sociology, and communication among a variety of other disciplines. Until the 1980's, most decision making research focused on 'normative models', which "seek to improve the decision making abilities of people through a systematic approach to evaluating and selecting the best of several alternatives" and assume 'ideal conditions' (Clemen, 1991). One such example includes, expected utility theory, which deals with decision- making under uncertainty (Rabin, 2013). "It is generally assumed that people will follow the rules if they have sufficient information and time to dwell on the consequences of different paths" (Tarrant, 2006; Krimsky & Golding, 1992). Furthermore, descriptive models seek to understand and explain current decision making, while prescriptive models seek to improve decision making (Bell et al., 1988).

Naturalistic Decision Making (NDM), or how people make decisions in real-world settings (Lincoln & Guba, 1985), gained momentum in the 1980's. Scholars wanted to assess "how people make tough decisions under difficult conditions such as limited time, uncertainty, high stakes, vague goals, and unstable conditions" (Klein, 2008). NDM research has provided guidance for decision making training and associated research methods have been adapted into other fields such as situation awareness. NDM emphasizes experience in decision making, such as in the Recognition-Primed Decision Model (RPDM) (Klein, 1989) and has been "used to improve performance through revisions of military doctrine, training that is focused on decision making, and the development of information technologies to support decision making and cognitive functions" (Klein, 2008). "Crisis response and crisis management are examples of naturalistic decision making situations that are characterized by time, pressure, risk and uncertainty, multiple and changing goals, and multiple organizations" (Schraagen & van de Ven, 2008).

Furthermore, Simon (1957) described three types of decisions: (1) rational, (2) non-rational, and (3) irrational, as well as two types of processes (1) analytic and (2) intuitive. As both intuitive and analytic aspects are involved in the decision making process, after decades of work, Simon (1987) proposed the bounded rationality theory which "explains how people make decisions when bounded by the law, societal norm and cultural circumstances" (Hoekstra & Montz, 2017). All of these factors play a role in the decision making process of emergency managers and ultimately impact the decisions made, which may vary from person to person, place to place, and level to level. Decision making regarding weather events is a frequent occurrence for an emergency manager and a substantial amount of time is spent on it, not only surrounding an event, but throughout the disaster life cycle of mitigation, preparedness, response, and recovery. In order to make more informed decisions, emergency managers must have the knowledge and skills to aid in the decision making process.

3.6.1 UNCERTAINTY AND DECISION MAKING

Signal detection theory (SDT) postulates that uncertainty is present for nearly all decision making (Swets, 2014). "Uncertainty is the difference between the amount of information required to perform a task and the amount of information already possessed by decision making entities" (Cass McCaughrin et al., 2003). These situations can be described as ambiguous or unpredictable and include scenarios where one is unsure of the state of knowledge or when information is unavailable or incomplete (Brashers, 2001; Babrow et al., 2000; Babrow et al., 1998). Therefore, uncertainty promotes and can be managed through information seeking (Bradac, 2001; Brashers, 2001). Statistically, information theory postulates that uncertainty is related to the number of alternative choices and the chance that each will occur (Cass McCaughrin et al., 2003; Argote 1982). However, the amount of uncertainty can influence identification of courses of action and decision making (Dutton & Webster, 1988; Milliken, 1987).

According to Schmitt and Klein (1999), there are four sources of decision uncertainty: (1) missing information, (2) unreliable information, (3) ambiguous or conflicting information, and (4) complex information. Similarly, Lipshitz and Strauss (1997) addressed issues, sources, types, and tactics to manage uncertainty. They stipulate three fundamental issues of uncertainty as (1) outcomes, (2) situation, and (3) alternatives along with three fundamental sources of uncertainty (1) incomplete information, (2) inadequate understanding, and (3) undifferentiated alternatives (conflict). Furthermore, they define three types of incomplete information as (a) partial lack of information, (b) complete lack of information, and (c) unreliable information. Proposed tactics include collecting additional information, delaying action, soliciting advice, following SOP', norms, etc., and assumption-based reasoning. The three types of inadequate information as defined by Lipshitz and Strauss (1997) are (a) equivocal information, (b) novelty of situations, and (c) fast-changing or unstable situations. Tactics proposed include preempting, improving readiness, avoiding irreversible action, and weighing pros and cons. Lastly, the two types of conflicted alternatives they proposed are (a) equally attractive or unattractive outcomes and (b) incompatible role requirements. Ignoring uncertainty, relying on 'intuition', and taking a gamble are potential management tactics. Additionally, Sorensen and Mileti (1987) also categorized sources of uncertainty within warning systems into four types: (1) interpretation, (2) communication, (3) perceived impacts of decisions, and (4) exogenous influences with additional items further categorized within each type. Their findings concluded that these uncertainties affect warning system decision making and recommended planning as a resolve yet failed to discuss training mechanisms.

Disaster response is multi-faceted and decision makers must process large quantities of information and manage a multitude of factors urgently (Kowalski-Trakofler & Vaught, 2003). This includes but is not limited to (1) resource acquisition and deployment, (2) delegation, (3) communication and information management, (4) decision making, (5) inter-agency coordination, and (6) media and community liaison (Paton et al., 1998). Uncertainty further complicates matters as decision making is based on information that is ambiguous, incomplete or erroneous (Vaught et al., 2000). Stress is also of concern defined as "a process by which certain work demands evoke an appraisal process in which perceived demands exceed resources and result in undesirable physiological, emotional, cognitive and social changes" (Salas et al., 1996).

“Emergency Decision makers under stress not only have the effect of their own stress and its resulting consequences”, but that of others as well (Kowalski-Trakofler & Vaught, 2003). However, little is known about stress among emergency managers (Flin, 1996). Paton and Flin (1999) discuss three stressors relevant to the emergency management perspective: (1) environmental (i.e. - complex, dynamic), (2) organizational (i.e. - communication, bureaucracy), and (3) operational (i.e. - decision making, responsibility, management). They also discuss three primary influencers including (1) personalities, (2) personal factors (i.e. – fitness, fatigue), and (3) psychological factors (i.e. – danger). Planning for an event along with communication and coordination may reduce the risk for stress yet training assist with management and reaction (Paton & Flin, 1999). As such, both experience and training are important for reducing stress during an event (Vaught et al., 1997).

3.6.2 HAZARD RESPONSE DECISION MAKING

The lack of peer reviewed, academic literature specific to FEMA and decision making was evident through the literature review process. Although limited, emergency management decision making research provides some background context relevant for this study. However, a larger, more expansive body of knowledge exist for warning response and the public that could also be utilized. Two of the more relevant decision making models applicable for emergency management are the (1) Tobin and Montz (1997) hazard response model and the (2) Protective Action Decision Model (PADM) (Lindell & Perry, 2012). Tobin and Montz (1997) incorporates situational and cognitive factors in their preliminary hazard response model regarding the public, as did Mileti and Sorenson (1990). Psychological and attitudinal elements comprise the cognitive system, while physical and socio-economic elements comprise the situational system. Although relevant, this model is not specific to emergency managers and not robust enough to capture all relevant components.

One of the more widely utilized decision models within hazards and disasters research, to include risk communication, long-term hazard adjustments, and evacuation modelling is the PADM (Lindell & Perry, 2012). This model includes a more robust proposition of influential factors (i.e. – social cues, warning messages, situational impediments, etc.) (Figure 3.3). "The PADM identifies a series of information processing stages relevant to household adoption of protective actions" (Lindell & Perry, 2012). The model consists of environmental and social cues and messaging, psychological processes, and situational facilitators and impediments along with a feedback loop.

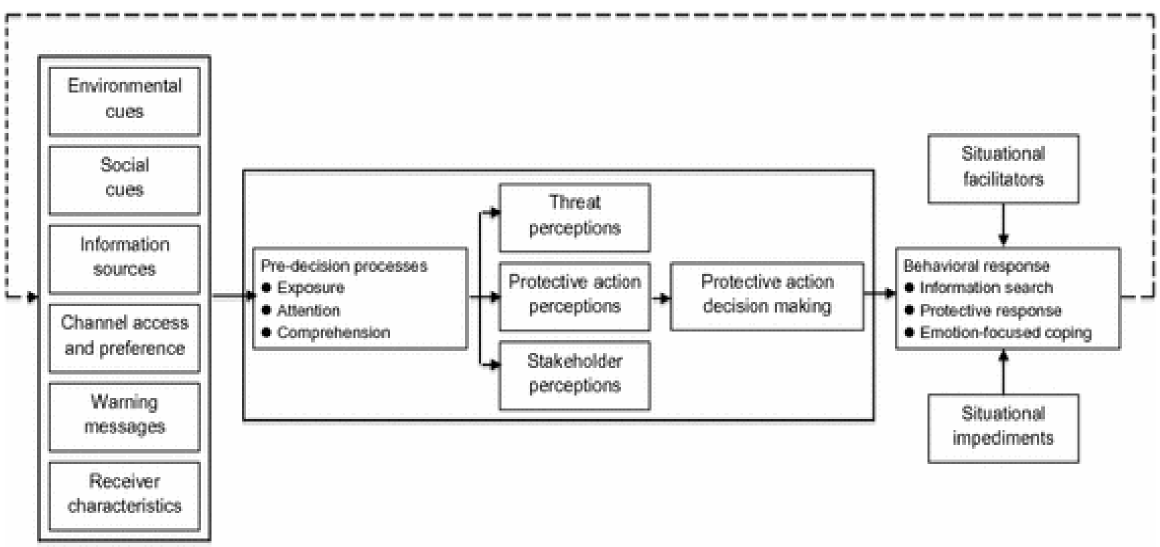

Figure 3.3: Information flow within the Protective Action Decision Model (PADM) along with influencing factors (Lindell & Perry, 2012).

The decision stages within PADM are (1) risk identification, (2) risk assessment, (3) protective action search, (4) protective action assessment, and (5) protective action implementation. PADM information seeking activities include (1) information needs assessment, (2) communication action assessment, and (3) communication action implementation. “The dominant tendency is for such information to prompt protective action decision making, but information seeking occurs when there is uncertainty at a given stage in the protective action decision making process” (Lindell & Perry, 2012). “Greater ambiguity is likely to cause warning recipients to spend more time in seeking and processing information rather than preparing for and implementing protective action” (Lindell & Perry, 2012). A big advantage of PADM is being able to detect erroneous perceptions and correct them, while a limitation is that PADM predicts some of the variables should form causal chains, but that is not always the case.

3.6.3 EMERGENCY MANAGEMENT AND WEATHER DECISION MAKING

Meteorologists frequently criticize emergency management decision making because of a lack of understanding of decisional factors. One highly debated example at the local level includes tornado warning issuance and outdoor warning siren policies. Understanding the emergency management decision making process, requires an understanding of the weather information utilized. Due to the critical role of weather information with regards to disasters, emergency managers are continuously monitoring forecasts. However, weather information is not the only deciding factor (Stewart et al., 2004, 1984; Stewart, 1997; Katz &

Murphy, 1997). Rather, the emergency management decision making process, in congruence with forecaster decision making, depends on a variety of factors.

A preliminary framework of the weather forecast decision making process, proposed by Lusk et al. (1990), includes two systems (1) environment and (2) cognitive (borrowed from social judgement theory (Hammond et al., 1975; Brehemer & Joyce, 1988)). Stewart and Lusk (1994) extended this framework to three systems consisting of the (1) environment, (2) information, and (3) cognitive. Consistent with several models discussed in this review section, "the hierarchical nature of the model implies that error at any phase can be passed on to later phases" (Lusk et al., 1990). Although utilized in reference to forecasters, "the data from numerous sources must be perceived and assimilated by the forecaster" and then assessed, which also holds true for emergency management (Lusk et al., 1990). Effective decision making in this context is influenced by a variety of factors: (1) environmental predictability, (2) fidelity of the information system, (3) match between environment and forecaster (or in this this study emergency manager), (4) reliability of information acquisition, (5) the reliability of information processing, (6) conditional bias, and (7) unconditional bias (Stewart et al., 1994). Relevant in the context of emergency management, gaining a "detailed understanding of user needs and decision processes" has implications for guiding forecast improvements and assessing forecast value as well as supports weather policy decisions (Stewart et al., 2004).

Focusing on local emergency management decision making, Baumgart et al. (2008) conducted a review of weather information sources and decisions. Adapted from Lusk et al. (1990), Stewart and Lusk (1994), and Stewart et al. (2004), they proposed a decision making conceptual framework consisting of three systems: (1) environmental, (2) informational and (3) perceptual and cognitive (Figure 3.4) and developed a descriptive decision making model through four phases of severe weather (pre-storm, watch, warning, and event). The 'environmental system' contains information on the hazard and associated factors (i.e. - time, location), while the 'information system' consists of the collection and presentation processes. The perceptual and cognitive system is comprised of influencing factors, the decision process and the actual decisions. The 'perceptual and cognitive' system identified training and experience as two primary factors influencing emergency manager perception, assessment and ultimately decisions.

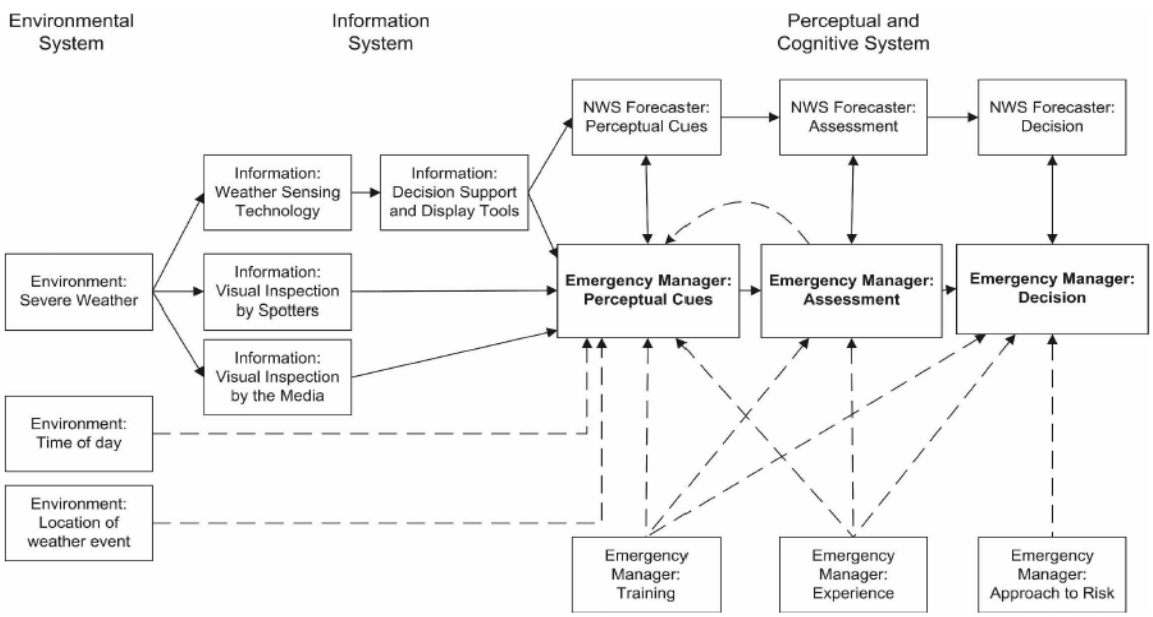

Figure 3.4: Conceptual framework of local emergency management severe weather decision making as proposed by Baumgart et al. (2008). Solid arrows depict inputs from one system to another, while dashed arrows indicate influences (Baumgart et al., 2008).

The initial model they developed provides a fundamental description of decision points during a severe weather event, yet it is incomplete in terms of inputs, cues, sources of information, and excludes prior knowledge and experience. The primary shortfall of this model is that the decision points assume detection of a hazard and begin shortly before event occurrence. Initial decisions must be made prior to the detection of a hazard for appropriate decision making and adequate response. The model does not account for longer term, risk-based decisions made well in advance of event occurrence in terms of planning, preparedness, mitigation, response, and training. Additionally, a small sample size (N=11) of semi-trained Oklahoma local emergency managers posed a challenge for generalizability, it provides a solid foundation to build upon. Furthermore, while the hazard chosen for the study was severe weather, the model and framework are adaptable for other weather phenomena and hazards.

Attempting to further quantify information sources and usage beyond the Baumgart et al. (2008) study, League et al. (2010) also utilized local Oklahoma emergency managers for a case study review of tornado warning communication. Specifically, in relation to radar technology and tornado warnings through (1) acquiring, (2) interpreting, (3) verifying, and (4) communicating information. Analysis yielded results pertaining to weather information sources and usage frequency both daily and during severe weather, yet it was unclear why they utilize certain products over others. The study also eluded to the influence of uncertainty, expressing a need for additional research on "how uncertainty affects the decisions they need to make" (League et al. 2010). Additionally, radar interpretation ability based on training was also assessed. Although helpful for local emergency managers, radar understanding is less of a concern for FEMA due to differing responsibilities. Lastly, there were multiple discussions of training overall as an important component for communication and decision making.

Another study from Morss and Ralph (2007), focused on emergency manager decision points and weather forecasts through the four phases of emergency management. Conducted during a field experiment, the exploratory case study investigated how local emergency managers utilize meteorological information during the decision making process. Emphasis was placed on the need for weather information not only before and during the event, but after for demobilization and recovery missions. Noted from this study, "emergency managers gather information from multiple sources, often seeking corroborating evidence as they assess the situation and decide on possible actions. Depending on the decision making stage, weather forecasts can play different roles" (Morss & Ralph, 2007). Additionally, participants indicated receiving "clear, concise, easily understandable weather forecast information" was important and that "decision making is influenced by forecaster confidence and trust in forecasters" (Morss & Ralph, 2007). While the study offered some insight, given the limited participation and research environment utilized in this experiment, it would be difficult to quantify and generalize any findings beyond the scope of the study.

Furthermore, Hoekstra and Montz (2017) determined that "the source and type of weather information greatly influenced emergency manager decision making" in relation to hurricanes. They also found "differences in EM experiences, knowledge, and culture led to differences in both the nature and timing of decisions and subsequent actions" (Hoekstra & Montz, 2017). Ultimately, three primary decision influencers were identified in the study: (1) municipality characteristics, (2) emergency manager characteristics, and (3) weather/storm characteristics. The first component may pose an additional concern for FEMA as they do not reside in or near the communities they serve. Additionally, "over the duration of weather watches and warnings, decision makers continuously change how they perceive an event as more information is received and processed. This process may even begin long before a watch is issued" (Hoekstra & Montz, 2017).

In finality, policy pertaining to usage and management of weather information by emergency managers is also not well understood, particularly with regards to decision making. Similarly, to Baumgart et al. (2008) and League et al. (2010), Donner (2008) conducted interviews with 39 Oklahoma emergency management officials. Data analysis identified three reasoning modes guiding decision making in relation to long-term weather policy including the (1) unique traits that distinguish each weather type, (2) differing application of mitigation strategies among weather hazards, and (3) implications of emergency manager decision making. As such the overall process is "the embodiment of environmental, technological, and social influences in the form of emergency management policy" (Donner, 2008).

In summary, "when it comes to the field of emergency management, the aim should be to develop new theory or adapt old theory to produce manageable policy" (Sylves, 2004). As discussed, the review of existing literature relevant to the decision making process of emergency management officials regarding weather is limited in scope, breadth, and predominantly ungeneralizable. Variations among emergency management roles and functions, small study population sample sizes, and difficulty accessing specific individuals (i.e. – FEMA, elected officials, etc.) has hindered research in this area. Despite the obstacles, the aforementioned literature provides some insight into weather related decision making and serves as a guide for this study. Extending beyond this work, proposed policy recommendations will further advance the field.

3.7 WEATHER TRAINING AND EMERGENCY MANAGEMENT

"The question of how to train emergency planners and managers has received increasing attention in recent years" (Alexander, 2003). Furthermore, Woodbury (2005) states that in addition to basic prevention mechanisms and human factors, emergency management officials "need to know the science behind the threats, not just the potential, operational consequences" for effective mitigation and preparation. The author states the importance of not only understanding this information but how to apply it to all types of events and for planning purposes. Woodbury (2005) also describes the need for more advanced training over the current main learning venues of presentations and after action reviews.

A common theme among the previously discussed literature is the need for development of new and/or continued support for existing weather training (Murphy et al., 2005). In both the situation awareness model (Endsley, 1995) and the Baumgart et al. (2008) model, comprehension and training is an integral part of the decision making process. In the Baumgart et al. (2008) study, the authors noted that additional training and tools could provide assistance with addressing perception and assessment issues. Both training and experience are contributing components to the perceptual and cognitive system of the framework, yet there is no discussion of the influence they may have on the environmental and information systems. Additionally, many of the local Oklahoma emergency managers who had weather training reported "having the ability to accurately interpret that information", but also noted that "continued training is an important component in the interpretation of weather information" (League 2010). One of the noted specific training needs for local emergency mangers was radar velocity and reflectivity interpretation, as OK-FIRST trained participants made better decisions regarding radar than non-OK-FIRST trained participants.

Currently, only a few entities provide meteorological training. Most notably, the in resident OK-FIRST training program run through the Oklahoma Mesonet in Oklahoma (Morris et al. 2001), as well as the UCAR COMET "Anticipating Hazardous Weather and Community Risk" module available online (FEMA, 2019a). However, both course options are more advanced and technical than is required for Federal level staff. Geared towards Oklahoma emergency management personnel and not a nationwide program, OK-FIRST is designed to aid decision makers concerning weather information, emphasizing the online decision support toolkit (Morris et al., 2001). It has been shown that the OK-FIRST program is a useful tool for emergency managers and for decision making (Morris et al., 2001; James et al., 2000). Therefore, it seems logical that implementation of such a training program would be useful nationwide with modifications according to geography, types of weather hazards, etc. However, there is not a national model nor a consistent way to deliver such a training program across the country for a multitude of audiences.

In addition to these discussed training offerings, a few academic opportunities are offered within or outside of a degree program as well. However, weather training is not an official degree requirement for the majority of emergency management degree programs (FEMA, 2019c), nor is it generally readily available. While some meteorological or natural hazard training is available, it is quite limited in quantity, fairly technical in nature and limited or topical in both content and scope. More extensive comparison of participants who have received no formal training against those who have (i.e. - OK-FIRST) would be of value.

3.8 KNOWLEDGE GAPS

Warning systems, hazard messaging, and response have been greatly studied with regards to the public. In contrast, emergency management is a relatively new field of study that is constantly changing and is not a well-studied group as a whole. It is difficult to define as there are varying levels with differing roles. Limited literature and knowledge exist for emergency management, particularly with regards to FEMA. Weather and emergency management is further limited in scope. However, as disasters continue to evolve, the knowledge base and field of emergency management continues to grow. As a varied field that is multi-faceted, with little academic supporting literature, the discipline requires an interdisciplinary approach. For these reasons, this study contributes to the overall lacking knowledge base by focusing on the weather decision making process at FEMA through a variety of lenses.

Through an extensive review of the literature, several areas were identified that provide value in this context including three primary areas (1) decision making, (2) situation awareness, and (3) communication. Decision making research in reference to emergency management is limited. Emergency management in relation to weather decision making literature is further limited. Over the past decade, interest it this area has grown, yet efforts have primarily been directed toward local emergency management officials. Nevertheless, Baumgart et al. (2008) provides a decision making framework in the context of severe weather and local emergency managers that can be adapted for this study in relation to FEMA and all-weather hazards with modifications in conjunction with the Endsley (1995) model of situation awareness.

When an incident occurs, responders assess the situation, identify and prioritize requirements, and activate available resources and capabilities to save lives, protect property and the environment, and meet basic human needs (FEMA, 2019b). Rooted within FEMA's NRF (DHS, 2016b), there are four main priorities regarding situational awareness: (1) providing the right information at the right time, (2) improving and integrating national reporting, (3) linking operations centers and tapping subject matter experts, and (4) standardizing reporting. However, the processes of how FEMA maintains situation awareness, makes weather related decisions and communicates is not well understood. More primitively, it is not understood what and how FEMA utilizes weather information or what decisions they are making/actions they are taking and when. Decision making is a highly complex process that requires various inputs and can be influenced by a variety of additional factors. Barriers to decision making result from a variety of mechanisms as the process is hierarchical with errors carried along the process or from influencers. Emergency management decisions often occur under uncertainty, stress, and non-ideal conditions which further complicate the process. Hence, the need for further study of emergency management behavior, practices, influences, perception, knowledge, training, and standards is apparent.

Despite acknowledgement of the role of training in existing literature, limited knowledge exists regarding emergency managers' meteorological training needs or gaps within the emergency management degree programs. There is no understanding of the implications of such programs or how weather training influences emergency management decision making, particularly at the Federal and State levels. How and why emergency managers utilize the weather products that they do is largely unknown. It may be due to any number of factors including level of understanding, training, or the product meets their needs. With all of the new technology and the addition of new communication channels such as social media, the need for preferred informational outlets and training is greater than ever. Enhanced training would provide the needed background required by emergency management officials to make more informed decisions.

To address this gap, I operationalized a weather training component for FEMA personnel based on insight gained from data collection and analysis of FEMA roles and responsibilities, informational needs and utilization, and challenges. Reflection of the conceptual framework I propose in Chapter 4 provided guidance for further investigation of training needs and curriculum development relevant to this study. It is my intent to work towards inclusion of meteorological elements as part of the core curriculum not only at FEMA, but also for emergency managers at all levels as the field continues to grow in size, scope and rigor. Additionally, identification of FEMA and emergency management required weather information can be used to further guide and enhance the decision support services offered by the weather enterprise.

CHAPTER 4: METHODOLOGY

Guiding the research structure and solidifying the research foundation this chapter provides insight into my perspective and worldview (section 4.1), my proposed conceptual framework guiding this study (section 4.2), the research design (section 4.3), data collection methods (section 4.4), data analysis techniques (section 4.5), and ending with a discussion of research challenges, limitations and assumptions (section 4.6). FEMA serves as the case study for this research to better understand the role, inclusion and influence of weather information on decision making. Deriving from existing literature, concepts addressed in this study include weather needs and usage, communication, situational awareness, and decision making. For this study, I will explore the FEMA decision making process through assessment of utilization, communication, challenges, and role/influence of weather information, knowledge, and interpretation. I will also operationalize a training component to support this process. I utilized two primary models/frameworks in accordance with associated relevant notions, concepts and elements to guide my study including the (1) Baumgart et al. (2008) framework of local emergency management severe weather decision making and the (2) Endsley (1995) situation awareness model.

4.1 PERSPECTIVE AND WORLDVIEW

Upon completion of my undergraduate degree in atmospheric science and mathematics and during the early stages of my master's degree in meteorology, I developed an interest in disaster response and emergency management. At which time I began volunteering through non-profit agencies that support disaster response and relief efforts and assisting local emergency management officials. Very early in my career transition from meteorology to emergency management, the lack of weather knowledge, training and available support became very apparent. My continued work within the field, revealed how prevalent weather associated shortfalls surrounding disasters and the field of emergency management were, despite all disasters (directly or indirectly), requiring utilization of weather information throughout all phases. My experience working across differing levels (local, State, Tribal, Federal, non-profit, etc.) of emergency management drove my desire to study the community and transition disciplines.

My interpretation of the world is based on me identifying as an educated, Caucasian cisgender female, who is frequently younger than many colleagues encountered in my role. My formal educational training lies within meteorology, communication and geography with a non-military background. I have served as a professional within the meteorological and emergency management communities, with fifteen years of experience. I am passionate about the role of weather in emergency management and remain actively engaged in this context. Currently, I occupy a liaison position within FEMA serving both internal and external partners across varying levels.

My personal worldview lies within the philosophies of constructivism and pragmatism. Extensive debate exists regarding these two paradigms (Hickman, Neubert, & Reich, 2009), with one school of thought dedicated to 'Pragmatist Constructivism' (Garrison, 1998). Pragmatism emphasizes practical application in assessing truth or meaning and makes use of both qualitative and quantitative methods, focusing on the research problem and utilizing any and all appropriate approaches to best study a topic (Hickman et al., 2009; Creswell, 1998; Hay, 2010; Patton, 2002). Specifically, in this context, 'pragmatic utilitarianism' and 'evaluation', which allows practitioners to answer concrete questions "in straightforward ways through qualitative inquiry and then judge the answers pragmatically by their utility, relevance and applicability" (Patton, 2002). Alternatively, Constructivism makes use of qualitative research methods as the belief is that people generate knowledge and develop meanings based on their experiences (Hickman et al., 2009; Creswell, 1998; Hay, 2010; Patton, 2002). My unique perspective situated between these two philosophies correlates with my inherent nature of finding value and gaining perspective through self-reflection of my own experiences and engagement with others on their experiences (constructivism), yet my inclination towards utility, systematic inquiry, and evaluation (pragmatism utilitarianism) (Patton, 2002). Philosophically speaking, I am a constructivist at heart, but my mind gravitates towards pragmatic notions as they provide me with more concrete, real-world resolutions. Essentially, I would consider myself a constructivist in a pragmatic world. As such, the constructivist paradigm predominantly guides this research with more pragmatic utilitarianism concepts extending this research beyond theoretical and conceptual notions into praxis.

4.2 CONCEPTUAL FRAMEWORK

Utilizing local emergency managers from Oklahoma as the study participants, Baumgart et al. (2008) proposed both a conceptual framework and descriptive decision making model for a severe weather event. Consisting of three systems (1) environment, (2) information, and (3) perceptual and cognitive, the descriptive decision making model consisted of four primary phases: (1) Prestorm, (2) Severe Weather Watch, (3) Severe Weather Warning, and (4) Severe Weather Event. These phases are appropriate to the decisions and actions required of an emergency manager during a severe weather event at the local level given the nature of the roles and responsibilities and being part of the first responder teams, whereas a wider view of the topic would best serve the Federal level involvement overall. Within each phase, usage of meteorological information sources were identified along with any decisions and/or actions that must be taken.

Review of the Baumgart et al. (2008) framework indicates that while aspects of severe weather information usage and sources were analyzed to build the model, several items were not addressed. The most significantly notable item not discussed was an overview of potential outside influencing factors (i.e. – politics) and how those may or may not impact decision making. Additionally, although somewhat inherent or implied, this model is void of a discussion and analysis of communication processes and the relevancy throughout the model. However, decision making depends on a variety of communication elements.

With a sample size of eleven local emergency management participants from Oklahoma, likely having received some meteorological training, and focusing on severe weather, the study is difficult to generalize. Regardless, the framework is adaptable to other weather phenomena, timeframes, decisions, and groups, as well as provides a glimpse into weather decisions and serves a good foundation to build from. Amongst the literature, the Baumgart et al. (2008) decision making framework (Figure 3.4) was determined to be the most relevant for this study. Due to the completeness and adaptability of this framework, it is well posed as the overarching guidance for my study. Building from this framework, in conjunction with related concepts and personal experience and in combination with the Endsley (1995) model of situation awareness (Figure 3.1), which consists of (1) perception, (2) comprehension, and (3) projection, I developed a conceptual framework (Figure 4.1) to aid with visualization of the overall FEMA decision making process.

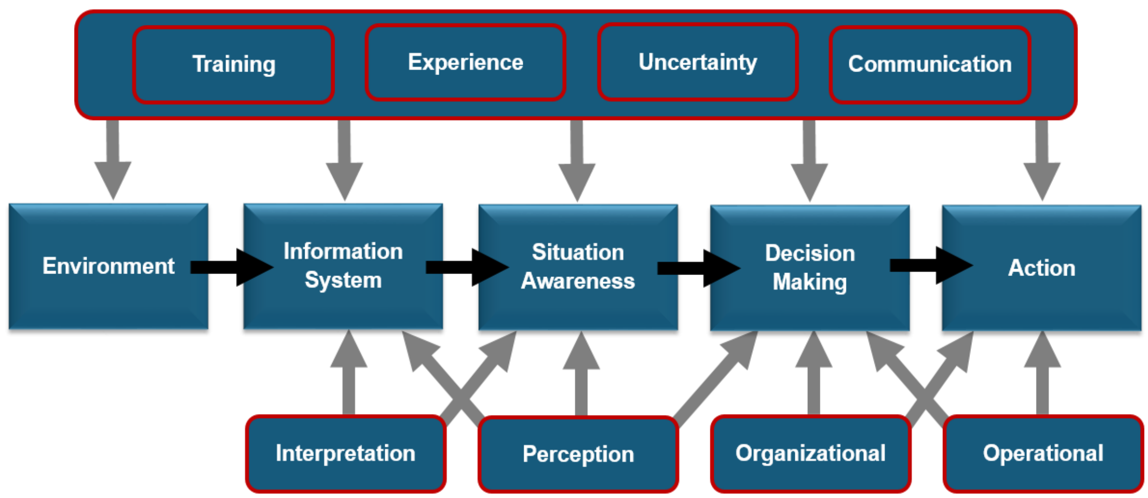

Figure 4.1: Proposed conceptual framework of FEMA Decision Making based on literature and experience. Black arrows indicate information flow, while gray arrows indicate influences. Created by Somer A. Erickson.

Currently, there is no existing literature for FEMA decision making. For this study, the conceptual framework focused on FEMA decision making surrounding weather threats. As this study is a first attempt to address FEMA decision making and weather, rather than viewing the framework from the perspective of a local emergency manager, I will be analyzing this framework from the Federal level perspective. At the Federal level, the decision making process is much more expansive. FEMA covers a broad spectrum of responsibilities and serves as the guiding force for national, state, local and tribal level emergency management policies and procedures. While the Baumgart et al. (2008) decision stages could be studied at the Federal level, the decision and actions that FEMA would be actively involved with are generally longer term. Therefore, a broader perspective will be reviewed in this study as it is more relevant for Federal response efforts. I will instead make use of the four phases within the disaster lifecycle/CEM lens (mitigate, prepare, respond, and recover) as it directly relates to how FEMA is organized. Doing so will provide an overall view of the decision making process of Federal level emergency management through each phase, and more easily allow for more specific topics within to be addressed in future studies.

In addition to using different phases, a primary deviation in this study is that the utilized weather information sources within FEMA are unknown. It is also important to note that while the source of the information is important, the actual information they are looking for is also unknown. One confounding factor is that those personnel who are locating and supplying the information are often different personnel than the decision makers. Therefore, the decision makers mostly receive weather information from someone between the actual source and themselves. Complicating matters further is that the decision makers are also likely receiving some information from additional outside sources and at times directly from the source in addition to the internal designated personnel. Assessing this model within FEMA, this work will further assist with development of training geared toward FEMA leadership and other high-level decision makers as well as other relevant decision support tools.

Previous literature along with the components within the proposed conceptual framework served as a guide for study areas, training development, instrument development, data collection and analysis. Although discussed at times in reference to the study, provided the expansive nature of the framework and expertise, I did not directly address psychological (i.e. – perception, cognition), or sociological (i.e. – values, culture) aspects. Starting with the environment and ending with action, the framework identifies five components which includes three underlying processes. Four identified overarching influencing factors include (1) training, (2) experience, (3) uncertainty and (4) communication. Additionally, interpretation along with organizational, perceptual, and operational factors influence various components throughout the process from threat to action.

Beginning with the environment component, which consists of hazard, geographic and demographic elements, the framework outlines three primary processes of: (1) information management, (2) situation awareness, and (3) decision making, before arriving at the action component. In relation to identification and awareness within the environment component, training, experience, uncertainty and communication serve as influencers as well as among the three processes identified. The information system identifies a process of collecting and presenting information and consists of human (i.e. – a reporter or personnel) and technological sources (i.e. – radar) through a variety of mechanisms (i.e. – internet, television, partners, etc.). This information is then processed into knowledge obtaining situational awareness through perception, comprehension and projection leading to the decision making process and action.

Stemming from this framework, I reviewed multiple facets of the FEMA decision making process in reference to the phases of the disaster life cycle (Figure 2.1). There is no widely known or explicit knowledge available in the literature regarding FEMA weather usage and decision making. In order to develop a comprehensive overview of FEMA decision making and provide a strong foundational platform for future research in this area, there was a vast amount of considerations. For this study, I (1) assessed utilization of weather information, (2) developed a descriptive decision making model, (3) reviewed and proposed a working model for the overall communication process, (4) operationalized training for maintaining situational awareness, and (5) identified elements, processes, factors and/or influences pertaining to each component. Serving as a starting point, testing and verifying this framework will expand the usability and applicability of this model toward understanding emergency management decision making across all levels for all (natural) hazards.

Furthermore, when it comes to weather related disasters, elements of risk and crisis communication are evident. Climate change supports the notion of changing events potentially impacting greater and/or different portions of the population. Given that meteorological hazards deal with portions of both risk and crisis communication, for this research I will also discuss and propose an adaptation of the Crisis and Emergency Risk Communication (CERC) model in the context of emergency management, FEMA and the disaster life cycle/CEM.

4.3 RESEARCH DESIGN AND OVERVIEW

The research topics addressed in this work are primarily exploratory and descriptive in nature warranting a qualitative research design (Hay, 2010; Creswell, 1998). Following suit of the most relevant literature for weather decision making and emergency managers, a case study approach was employed for this research. "Disaster researchers have adopted experiential case study approaches for decades" (Veil et al., 2008). The case study was chosen as it provides an in-depth analysis of a phenomena for a specific group or element and "may be used to understand and solve practical problems" toward advancement of knowledge (Hay, 2010). A case study is a research methodology that is frequently employed within both quantitative and qualitative research and among a variety of disciplines. Typically, case studies offer detail-oriented analysis and insight for future work while generalizability of results and researcher bias pose challenges (Hay, 2010; Creswell, 1998; Yin, 2009; Stake, 1995). Resulting insights from this work have implications for policy, procedure and future research (Merriam & Tisdell, 2016). This approach was chosen to determine not only the 'what', but also to assess the 'how' and 'why' (Yin, 2009) of weather information utilization within FEMA.

Federal emergency management officials were the focus of this research as existing literature and theory does not adequately describe or acknowledge their roles and responsibilities, as they differ from local jurisdictions and the general public. The result of which is a gap within the body of knowledge pertaining to the decision making process at the highest level, particularly regarding weather information. Through my observations, I determined weather information to be a significant requirement for the FEMA mission. However, informational needs, usage and utility regarding weather hazards was unknown. Focusing on FEMA, the purpose of this study was to gain an understanding of the overall role of weather information, assess influencing factors on decision making and operationalize a weather training component.

Initially, I planned to study weather usage across the three primary levels of emergency management (local, state and Federal) for this study. However, gaining access to FEMA personnel and an understanding of the agency's overall design proved to be a challenge. Seeking access to this group, I served as an intern within one of the regional components which modified the plan I had originally intended. During my tenure I acquired an insurmountable amount of valuable insight about the agency, governing policies, roles and responsibilities, and overall structure and composition. I was able to observe firsthand weather information and data usage as well as establish trust and credibility among FEMA personnel, partners and senior level emergency management leadership. This unique opportunity (participant-observer role) allowed me to engage with FEMA in a manner that is difficult to accomplish externally. In turn, this allowed me the ability to study weather utilization, related communication and associated decision making within their environment and in a way that might not exist otherwise (Kearns, 2010). Provided with a new platform, I shifted the focus of my research to the FEMA perspective. While this research concept and work began before I joined FEMA, it was largely conducted and finalized during my FEMA tenure.

FEMA is a seemingly elusive and mysterious entity, comprised of a closed, tight knit group of personnel, attributable mostly to the high level and stressful nature of the work along with the highly visible and political aspects associated with the mission. FEMA is frequently scrutinized by the publics at large and often feels threatened by 'outsiders', inhibiting personnel accessibility. Tasked with high level responsibilities among a myriad of mission specific areas, working under urgent and limited time constraints, and consisting of high-ranking officials, further limits availability and awareness of FEMA structure. For researchers, knowing who to contact and identifying paths for obtaining access to FEMA personnel is challenging when seeking out desired research participants and conducting studies. Having access and an internal perspective of the agency and field, along with having gained trust and credibility amongst the community greatly assisted with identification of relevant personnel and data collection.

Within FEMA, I have been provided with the needed access and appropriate background knowledge to assist with identification of those tasked with weather related decision making. My acquired perspective provided context with which to conduct weather-related decision making research, as well as an observational perspective of the decision making process at times. Other than through observation, I have rarely been directly involved in the leadership decision making process beyond providing relevant weather data and forecasts, nor is it in my purview to do so. Through my experience, I have acquired knowledge of weather utilization relevant to certain areas but lack a widespread perspective of weather utilization agency wide. My unique position and perspective served to enhance and inform this work as relevant (Kearns, 2010), yet this work served to enhance my perspective.

Numerous studies have been conducted on the human/public side of disasters, as discussed in Chapter 3. While they may offer some insight, they do not directly support the notion of emergency management response decision making at high levels. Some social research focusing on emergency managers and weather decision making at the local level has been conducted, but there is little dedicated to the topic at the Federal and State/Territory/Tribal levels. As the roles between local, State/Territory/Tribal and Federal emergency management officials differ, existing literature from the local perspective cannot be completely generalized to the Federal level. Theoretically, this study attempts to build toward bridging this gap through developing an understanding of 'how', 'why' and 'what' weather information is utilized and communicated across FEMA for situational awareness and in support of decision making. Operationally, results from this analysis assisted with development of relevant weather training and describe FEMA weather needs and requirements for weather enterprise inclusion.

Despite the number of emergency management educational programs that have developed in the recent decade or so, theory and academic applications remain low in volume. While many can make the case for a theory of emergency management or applying theories from other disciplines (Drabek, 2004) within emergency management, the body of knowledge to support emergency management is lacking, particularly with regards to Federal and State/Territory/Tribal emergency management. Either way, the goal is to continue to build out the discipline as the field continues to grow. This research contributes to the limited academic knowledge of weather applications within emergency management, provides substantial breadth and depth of weather information usage within FEMA, and lays a foundation and path forward for continued and future work in this field.

4.4 DATA COLLECTION

I utilized multiple methods for this study in order to thoroughly address the previously identified research areas, while also assessing the value placed on weather information within the context of decision making. Data collection consisted of two primary methods: (1) surveys and (2) interviews. Observations from the researcher also played a crucial role throughout the research process by informing various aspects of this research including design, instrumentation, analysis, and interpretation (Hays 2010). Along with review of relevant policy and doctrine, observations were used to guide development of an open-ended survey instrument, which was conducted to gain an overall perspective of the status of weather information needs and usage and identify areas to address in a follow-up semi-structured interview. There were many moving parts in this study and the path forward was not always evident. Without this observational insight, development, direction, and completion of this study would have been arbitrary and impervious, restraining the utility of this groundwork.

Purposive sampling strategies were utilized for administration of the survey instrument, while snowball sampling was utilized for the interviews. A purposive sampling strategy was initially adopted for administration of the survey instrument. Commonly utilized within qualitative research methods, purposive sampling allows the researcher to select participants based on various characteristics (Bradshaw & Stratford, 2010; Patton, 2002). The survey instrument was designed to address the overall needs of those who utilize weather information and data most significantly within FEMA. Initially, the survey was voluntarily administered to a pre-identified group of FEMA personnel, as designated by each FEMA Region and Headquarters, who occupy the position of Watch Officer or Watch Analyst. The positions of Watch Analyst/Officer were chosen initially as they are responsible for maintaining 24/7 situational awareness to support FEMA and State/Territory/Tribal decision making as well as serve as the initial response for any FEMA requested disaster assistance. As most disasters are directly weather related, monitoring weather is a major function of their daily responsibilities (FEMA, 2018a).

A survey instrument was utilized for this group, as participants are located nationwide, work varying shift schedules, and were able to be completed at their convenience. I was able to collect a greater amount of data across a more varied group of personnel in a shorter amount of time at low cost, in turn providing a more expansive perspective and ensuring a more robust analysis and results. Conversely, questions were less flexible with no opportunity to ask a follow up for clarification or explanation and there was no interaction or verbal cues. Questions were primarily open ended, with one hazard ranking question and three multiple choice questions addressing education, experience, and how they formulated any existing weather knowledge. Formation of the survey instrument was guided by in situ observations of emergency management officials and the conceptual framework and addressed multiple facets of the situational awareness-communication-decision paradigm and the relationship with decisions and the decision making process.

The survey instrument was tested amongst a few relevant personnel associated with FEMA Region VII in Kansas City, Missouri. This location was chosen as I was an intern at this office at the time of survey development and had established a rapport. The initial test instrument was disseminated via a third-party email account through FEMA regional personnel. The survey was optional and anonymous, allowing for electronic completion with the participants having the option to respond back to the email account through an anonymous link or a secure drop box location within the common administration area. Upon collection the surveys were provided to me for preliminary assessment and revision as relevant.

The final survey focused on the following areas: (1) roles and responsibilities, (2) weather experience, (3) weather information utilization, (4) weather information requirements, (5) sources of weather information, (6) challenges working with weather information, (7) non-weather information requirements, (8) weather topics of interest, (9) weather items unable to be located, (10) weather concepts that are difficult to understand, (11) needed skills, and (12) weather training. Based upon review and analysis of the initial survey data collected, a weather training course was designed. Consequently, surveys were voluntarily administered to those who registered for additional weather course offerings. The tested and revised survey instrument was administered via email through the training or course manager and returned accordingly. Although registration was only open to FEMA Watchstanders initially, after the piloted weather training course all FEMA personnel were allowed to enroll.

There were sections specific to each of the five weather types (fire, severe, tropical, water, winter) as well as in general. General questions were asked first followed by the specific weather type sections. Generally speaking, the overarching purpose was to determine overall utilization of information, elicit feedback indicative of roles and responsibilities, and support activities, operations, actions, etc., all of which contribute to or result in decisions. Extending beyond utilization a determination of weather information requirements and needs was also elicited. It was important to determine what weather information and data is required for training content development and support evolution of the decision making framework. Related to information requirements and needs was the assessment of information resources and communication of information. This was important from the standpoint of resource access, utility, and navigation along with information and communication flow. Furthermore, as a big part of FEMA's mission is dedicated to response and recovery, input regarding impacts and other non-weather aspects were also solicited. Lastly, issues participants have encountered when working with weather information and data was evaluated. Items they are unable to locate and terms or concepts they don't understand were assessed, in addition to overall challenges, analysis of which revealed a myriad of problem areas. Demographic information was also collected separately to show the overall 'perspective' of the participants as a whole but was not utilized in the analysis. Additionally, sections more specifically designed to elicit training needs and elements were added in subsequent revisions of the instrument (i.e. – topics of interest, needed skillsets, format, etc.).

Those who registered for the course were provided the survey either before the course offering following the protocol above or the day of. Those who did not receive the survey until the day of, were provided a paper copy of the survey if desired, time for completion, and an available drop box. The survey continued to be administered to course registries as those who desired or were required to take the course have a role in situational awareness or utilizing weather information in some capacity. However, many students continued to be Watch Analysts/Officers, as the position has a fairly high turnover rate due to the requirement that personnel work rotating shifts that includes nights, weekends, and holidays. In combination with the lack of existing weather training for FEMA personnel, despite the identified need, there is a continued demand for additional course offerings and a constant flow of new students participating. These participants provide unique perspectives and continue to add value to the overall understanding of weather information utilization.

Following analysis of the survey data, I constructed an interview guide to gain additional insight into the decision making process and the role of weather information and influences (Jacob & Furgerson, 2012). The interviews were conducted with various high-ranking FEMA officials. Through my work with FEMA I identified contacts within leadership who were willing to assist with the study and pass along to additional relevant parties. I targeted personnel from specific regions including FEMA Regions III, IV, V, VI, VII and VIII as they are the regions that deal with the greatest variety of the most frequent occurrence of weather threats. On the contrary to the surveys, which allowed me to specifically target the greatest users of weather information, for administration of the interview a snowball sampling strategy was implemented (Bradshaw & Stratford, 2010) to reach the most relevant decision makers. The downside of this process was that recruitment took longer and was more time consuming. To start the process, I reached out to a few pre-identified members of FEMA Leadership via a recruitment email. The email requested willing participants for the interviews and that they pass along the email containing study information to relevant personnel. Based on my previous interactions with members of FEMA leadership, I chose the interview method, as senior leadership is more inclined to participate in an interview versus a survey, focus group, etc. due to availability, time constraints, etc. Interviews are also flexible, yet allow for more in-depth descriptive, exploratory analysis (Steinar, 1996), which aligns with the purpose and objectives of this research study. On the contrary, challenges included the amount of time to conduct the interviews as well as transcribe and analyze the data.

The number of FEMA leadership is a much smaller pool compared to the rest of the agency and some are also political appointees. For identity protection to avoid any potential political criticism or repercussions I took extra precautions by conducting interviews via phone from a secure room to minimize exposure and anonymous correspondence. Typically, each interview lasted approximately one hour and allowed time for the participant to ask any questions or convey any concerns they may have. They were also provided with contact information for myself as the Principle Investigator (PI) and the Internal Review Board (IRB) should they have any additional follow-up questions or concerns at a later time.

After being advised of and receiving verbal acceptance of the consent form, to ease participants into the interview process, I began with an overview of myself and my work followed by encouragement for them to do the same (Jacob & Furgerson, 2012). Interviews then followed a semi-structured format to allow for flexibility yet ensure a response for all elements (Steinar, 1996). Utilizing the pre-approved interview guide participants where asked a series of broad, overarching questions or provided a scenario seeking narrative responses, followed by more specific questions as appropriate. Ambiguity among the overarching questions was intentional as to not bias their response and allow them to discuss what they felt was most pertinent (Steinar, 1996). Interview questions and data collection focused on weather events in relation to situational awareness, communication, and the decision making process. Primary areas addressed in the instrument included (1) the communication flow and (2) role of weather information along with (3) weather support, and (4) factors that influence decision making. Analysis of the interview data along with elements of the survey analysis contributed to advancement of the proposed conceptual framework (Figure 4.1). Additionally, extension of the decision making model to Federal emergency management has implications for consistent, standardized decision support, refined response operations, and training, among other uses.

Additionally, continuing to assess and refine the weather training, following the conclusion of each course offering, standardized evaluations were voluntarily administered through the training or course manager. Compilation of the data and analysis yielded results that served as the foundational platform for revision guidance. Based on these findings, a few defined areas emerged, which I employed to implement relevant training component revisions accordingly. In reference to the piloted training, pertinent identified areas encompassed (1) course content and materials, (2) presentations and instructors, (3) activities and exercise, and (4) format as well as a few overall (5) logistical items. The evaluation process was repeated for all other course offerings, analysis of which has resulted in further refinement and revision of relevant course related components. This evaluation process was not a full program evaluation, but rather a preliminary assessment of the newly developed training for purposes of enhancement. A full training program evaluation is desired, but rather is reserved for future work along with analysis of the effects the training has on decision making.

Due to the lack of existing knowledge and literature on emergency managers' meteorological informational needs, I assessed meteorological information usage along with needs and inadequacies among FEMA personnel. The intent of this study was to provide foundational knowledge to guide future research through identification of FEMA decision making influencing factors and a greater understanding of how to better prepare emergency managers to make more informed decisions. Data analysis yielded guidance that informed development of weather training that perpetuates a baseline understanding of meteorological information, products, and concepts. Due to the inherent uncertainty and technical nature of meteorological information, understanding basic concepts, impacts, terminology, and product availability supports interpretation and utilization. The developed educational program facilitates decision support, guides communication, and contributes to the overall curricular framework

4.5 DATA ANALYSIS

For collection of the survey data, participants had the option to return surveys electronically or via paper. Upon receiving the survey data, I digitized any written data and compiled as appropriate combining with the existing electronic data. Interview data was recorded and transcribed if consent was received, otherwise notes were taken. Once all data was compiled I reviewed the dataset several times for familiarity and to gain the general ideas portrayed overall. Each time I reflected on the meanings implied and any emerging themes. During the first few passes I digested information with no real attempt at analysis. After several thought only review sessions, I began to make notes along the way regarding any general thoughts, themes, ideas or questions. After letting the data formulate in my mind I began to separate the data section by section. As the narratives often contained more than one idea or theme, it took a while to sort through all of the data and separate the combined narratives appropriately.

Initially, I separated data by common themes or ideas, some of which were able to be categorized according to the pre-identified categories determined through observation and the framework, but not all. Next, I began to assign codes to the data based on the overall theme of each data statement or element. Once all codes were assigned for a data section I grouped the data according to the codes. Analysis of the data contained within each code was then re-assessed and organized in-vivo. To preserve the meaning or intent of a respondent's feedback, I maintained their language, words, and phrases to the fullest extent including the codes themselves and category name. I coded and recoded the data for several iterations until reaching a consistent set of results. Throughout this process I would often go back and re-read the data and reflect. Eventually, some codes where grouped together with other similar codes. I categorized the more easily characterized data first setting aside any items that didn't fit into a predesignated category. After all initial data was categorized I went back to the more difficult items and coded and categorized them as appropriate. Ultimately, a handful of themes emerged for each section addressed. Upon completion of the data analysis, I compared the analysis with the original data for further confirmation that the themes identified were viable, consistent, and made sense.

Objectivity and bias can be a difficult balance for all researchers to achieve as many factors influence one's perspective. Each person views the world through a different lens based on their experiences and attributions. While some measures can be adapted to reduce the influence, one may contribute during study development, data collection, interpretation, and analysis, it cannot completely be eradicated. My reflexivity or acknowledgement and recognition of this bias speaks to the validity of the study (Mansvelt & Berg, 2010). Several other strategies were also employed in this study, with respect to validity, based on the eight strategies discussed in Creswell (2014). Before proceeding with the data collection, I had two research colleagues separately review my initial research design and methodology along with survey and interview questions. I also utilized and triangulated different data sources and was able to verify findings from the survey data through interviews. After completion of data analysis, I utilized member checking of my identified themes through a few participants to ensure accuracy. Additionally, a robust description was utilized in the analysis and results to ensure conveyance of multiple perspectives. While my fifteen years of experience within emergency management and FEMA could present bias, it also provides a more detailed and thorough understanding relevant for this study. Furthermore, I also took into consideration measures of reliability. In this context, transcriptions and compiled data were reviewed for errors and I often assessed and revisited the data in comparison with the analysis, even recoding portions of the data to assess consistency of findings (Yin, 2009; Saldana, 2016).

Through this analysis I assessed FEMA weather training and information needs, identified the communication and situation awareness structures, and described the decision making process. Analysis provided an extensive and in-depth overview of weather information utilization, sources, flow, and requirements as well as identified numerous challenges. Review of the results led to the establishment of the communication process and mechanisms in conjunction with a depiction of the situation awareness maintenance process. I also determined decisions, actions, critical decisional elements and potential influencers. Utilizing qualitative research methods provided a robust understanding of the role of weather information within FEMA and a comprehensive understanding of incorporation and impact of weather information throughout the decision making process and across all phases of the disaster life cycle. Findings provide a foundational knowledge base to build from, contribute to the advancement of emergency management decision making understanding, and serve as a starting point for possible theoretical development, helping to solidify its validity as a discipline within academia.

4.6 CHALLENGES, LIMITATIONS AND ASSUMPTIONS

Challenges and limitations in conducting this research study were difficult to navigate, and complicated and extended the research process. The primary challenge was an artifact of the interdisciplinary and pioneering nature of this research. This topic of study required extensive background research and knowledge across a variety of areas and disciplines. In relation, the 'newness' of the area of study allows for a broad spectrum of paths with multifaceted ideas, further enhancing the difficulty of narrowing down the topic. Additionally, given the qualitative nature of the data collected, analysis was tedious and time consuming requiring multiple rounds of coding for each defined area. Furthermore, since this work extended beyond to also serve operational components, once the analysis was complete, I developed weather training elements to meet the needs assessed in this research for FEMA personnel and partners. These components were quite time consuming, requiring multiple, iterative rounds of assessment and revision.

The mission of the agency and disaster work led to urgent, unforeseen scenarios that when combined with deployments to the field, heavy workloads, and transitional leadership posed a challenge for data collection. Availability of senior leadership for conducting interviews as study participants was an issue and limited the sample size (N = 8) and participant pool. It may have influenced the type of personnel responding consequently limiting the scope of participant's positions and hence feedback. Different components had to be interviewed about different pieces in order to form a complete picture as a result of the design of the agency. This proved to be both challenging and time consuming. Ultimately, it was decided that the decision portion of the study would be addressed through leadership with the informational and training portions relegated to those responsible for providing and assessing weather information. Due to response operations, interviews with FEMA leadership were delayed and difficult to obtain.

While it was advantageous to conduct this research from within the agency with access to internal personnel, my observations as a participant in the research process also potentially limited the perspective as discussed above. Additionally, coding the data and utilizing in-vivo codes allowed me to gain a greater understanding of their perspectives and meanings inductively (Saldana, 2016). While insights gained in this study may be applicable in other areas, one limitation of utilizing the proposed methodology is that findings will not be fully generalizable beyond FEMA. Although the work completed for this study does not entirely address all aspects or breadth of this topic, regardless, an in-depth analysis of the data for this initial exploratory, descriptive study yielded substantial insight and value to the field/discipline.

Associated with these factors, there are also a few assumptions to note. First, as was discussed previously, ideally, I performed this research as objectively and unbiased as possible. While attempts to limit personal bias within this research were taken, the paths through which I have experienced the world have implications on the formulation of my belief system. Therefore, I possess potential favoritism towards the notion that weather information and training plays a significant role in emergency management decision making. Subsequently, I assumed that available, timely, understandable weather information along with associated knowledge and understanding of, is imperative for effective and efficient disaster support operations. In relation, I assumed that the conceptual framework I developed for this study to describe Federal emergency management decision making is relevant and that working toward theoretical development within emergency management is a feasible and worthwhile endeavor. Lastly, I assumed that developing weather training and proposing an adapted communication model will be useful for Federal level emergency management.

CHAPTER 5: ANALYSIS AND RESULTS

Utilizing both surveys and interviews for data collection and subsequent qualitative data coding, this chapter provides data analysis and results of the pilot survey I conducted with FEMA personnel (section 5.1) as well as overall all survey respondents from within FEMA and interviews from FEMA leadership (section 5.2). Interest in varying weather phenomena along with roles and responsibilities were identified in the pilot survey. These results guided further data collection with topics focusing primarily on weather information utilization, information resources and requirements, and challenges of weather. Demographic information was also collected as a whole but was not utilized in the analysis due to anonymity concerns.

5.1 FEMA PILOT SURVEY ANALYSIS

An initial survey was administered in 2013 to a group of FEMA personnel who occupied the position of Watchstander. Residing within the FEMA National or Regional Watch Centers (N/RWC), personnel are responsible for maintaining 24/7/365 situational awareness and are the primary conduit for weather information flow across the agency. Watch Personnel are tasked with monitoring and identifying potential threats of any kind and assessing any possible impacts. Comprised of personnel from all ten FEMA regions as well as HQ, survey respondents (N=23) were also designated as possible participants of the yet to be developed weather training course. The intent of the survey was to gain insight into their roles and responsibilities, information and resource utilization, and challenges. Utilizing the results of the initial survey data analysis, a pilot weather training course was developed and administered. Voluntary evaluations administered to participants upon conclusion of the pilot course and completion of an associated After Action Review (AAR), facilitated course revisions accordingly. Subsequently, a revised version of the survey instrument along with evaluations continued to be voluntarily administered to participants registered in additional offerings of the "Weather and Climate for Situational Awareness" course through 2017. Survey responses continued to be analyzed and feedback gleaned from the evaluations was synthesized accordingly and relevant revisions implemented. Although the initial survey and pilot course was directed toward FEMA Watchstanders, follow up surveys included additional roles as the course attracted personnel from a multitude of positions across the agency such as planning, mitigation, external affairs, preparedness, operations, etc.

Ten courses were offered over the five-year period from 2013 to 2017, with 174 participants total and 123 survey respondents, 23 of which were from the initial survey and pilot course. Initially developed as an 'in-resident course', over time I revised the format to accommodate mobile course offerings, decrease maintenance costs, greater utilize technology, and facilitate usage of locally available SMEs as instructors. Class sizes ranged from ten to twenty-five on average and included participants from across the country. Surveys were administered via email or paper copy, through the appropriate training or course manager, and submitted either electronically or onsite. Survey completion was optional, but participants were provided time to complete surveys at the start of each course. Allotted time contributed to a high response rate of ~71%. Despite some surveys being returned incomplete, I included all responses in the analysis due to the qualitative nature.

My research consisted of multiple iterative layers as follows: administer initial survey, conduct survey analysis, develop product, administer initial evaluation, conduct evaluation analysis, revise product, administer revised survey, conduct survey analysis, administer evaluations, conduct evaluation analysis, revise product, develop other products, etc. The data analysis I performed consisted of several parts related to this process. For this section, I will discuss a brief overview of the initial survey analysis I conducted. Since I also included the initial survey responses with the others collected, I will defer further details to the full survey analysis in section 5.2 and evaluations will be discussed in Chapter 7.

5.1.1 DEMOGRAPHICS

Comparison among groups of participants by demographics was not intended for this study but will be considered in future work. Regardless, a few optional demographic questions were included as part of the survey to show the general consistency of the group and assess weather usage experience and training background. Initial survey participants identified predominantly as male at 70%, with 26% identifying as female, and another 4% choosing not to respond. The majority of participants (61%) indicated they resided in the 30's and 40's for age ranges, with 17% distributed equally above and below (Table 5.1). Of the initial participants, 22% chose not to respond for both age and race. However, just over half of the participants, at 52%, indicated they identified mostly with the white/Caucasian race, with an additional 26% divided between black/African American, Asian, Hispanic, and Native American/Pacific Islander (Table 5.2). For education, the majority (78%) of participants had achieved a bachelor's or master's degree (44% and 35% respectively) and no one indicated having achieved anything beyond a master's degree (Table 5.3). Of the remaining, 17% indicated having less than a bachelor's degree with no response from 4%.

AGE RANGE	TOTAL
Under 20	0%
20 to 29	9%
30 to 39	35%
40 to 49	26%
50 to 59	9%
Over 60	0%
No Response	22%

Table 5.1: Pilot survey participants age range distribution based on results from the data analysis.

RACE	TOTAL
African American/Black	13%
Asian	4%
Caucasian/White	52%
Hispanic	4%
Native Hawaiian/Pacific Islander	4%
Other	0%
No Response	22%

Table 5.2: Pilot survey participants race distribution based on results from the data analysis.

EDUCATION	TOTAL
High School/GED	13%
Associates Degree/Technical School	4%
Bachelor's Degree	44%
Master's Degree	35%
Doctorate	0%
Other	0%
No Response	4%

Table 5.3: Pilot survey participants educational background based on results from the data analysis.

WEATHER EXPERIENCE	TOTAL (N=23)
Less than 1 year	9%
1 to 5 years	26%
6 to 10 years	9%
11 to 15 years	13%
16 to 20 years	4%
21 to 25 years	13%
More than 25 years	17%
No Response	9%

Table 5.4: Pilot survey participants weather information usage experience based on results from the data analysis.

WEATHER TRAINING	TOTAL
Colleagues/On the job training	52%
Self-taught/Trial and error	44%
None	9%
Formal weather training	0%
Other: SkyWarn Spotter Training	4%
No Response	13%

Table 5.5: Pilot survey participants weather training sources based on results from the data analysis.

Experience utilizing weather information was distributed according to Table 5.4 (no response from 9%), with the lack of formal weather training evident in Table 5.5. Over half (57%) of respondents indicated having up to fifteen years of weather usage experience, with an additional 34% having more than fifteen years. More equally divided, 44% had less than ten years with 48% having more than ten years. Approximately one third of respondents (35%) indicated having five years or less experience. Despite the variance among experience levels, none of the participants indicated having received any formal weather training. Not surprisingly, 22% of the participants did indicate they had received some exposure to understanding weather elements within the military. Participants listed informal venues such as on the job training/from colleagues (52%) and/or trial and error/self-taught (44%) as their primary source for weather knowledge. Additionally, while 13% choose not to respond, 9% indicated they had no weather training exposure informal or otherwise and 4% listed the NWS SkyWarn Spotter training.

5.1.2 WEATHER PHENOMENA

In the initial survey, respondents listed the hazards of concern for their respective region. Analysis of the data yielded a variety of threats that I classified within the five primary weather types as I have defined below:

1. **Water Weather:** flooding, ice jams, flash flooding, coastal flooding
2. **Winter Weather:** winter storm, snow, ice, freezing rain, sleet, blizzard
3. **Severe Weather:** tornadoes, severe storms, wind
4. **Fire Weather:** fires, drought, dust storms
5. **Tropical Weather:** tropical storms, hurricanes, typhoons

For ease, I made a minor deviation in defining the five general weather type categories, utilizing water weather rather than hydrology. Aside from this change, the data provided some insight into participants concerns, although limited in scope given the homogenous group of participants and regional bias. Case in point, water weather hazards had the most frequent mentions, with tropical weather hazards mentioned the least; an artifact of tropical weather occurring primarily in coastal areas and not all hazards occurring or having the same frequency of occurrence in all regions. Winter weather hazards followed water weather hazards with the second greatest number of mentions, followed closely by severe weather hazards. Fire weather hazards fell just above tropical weather hazards. Although fire weather is more prevalent in certain locals, it can occur essentially anywhere in the U.S. in comparison with tropical weather. Future survey iterations asked respondents to rank the five primary types with no significant results.

Additionally, there were a few questions on the utilization of climate and seasonal forecasts. Of the 23 respondents, 70% indicated they did not use such forecasts, 13% indicated they did, and an additional 17% indicated they did sometimes. Respondents that did utilize longer term seasonal forecasts noted usage for long term planning and situational awareness. Respondents who indicated utilizing such forecasts sometimes stated doing so for spring flooding, with one participant clarifying they used it "*only if it's significant or has certainty*." Individuals who did not utilize such forecasts felt there was value for situational awareness and planning, or as some indicated, they did not know how it would be helpful. Overall, regarding climate and seasonal forecasts, there was not a good understanding of what was available, from where, or how it could be applied.

In the initial survey, participants identified weather related threats in their regions, which provided a frequency of weather-related threats of concern. I determined overall resource usage, information requirements and challenges. I also assessed informational needs, challenges, and impacts for each weather type. However, impacts were found to be mostly redundant across all phenomena. For the final survey, I categorized the hazards underneath the five primary weather types I defined and had them rank the priority of each type. I determined overall information requirements and challenges and assessed hazard specific resource usage, information needs, and challenges. Impact questions were moved to the overall section as they were determined to be redundant across all weather types. Lastly, I removed the climate/seasonal outlook questions as the majority of initial survey respondents did not use them and I added a few training related questions.

5.1.3 ROLES AND RESPONSIBILITIES

Analysis of the initial survey data resulted in three primary categories emerging under the umbrella of maintaining situational awareness: (1) monitoring, (2) conducting briefings, and (3) developing reports. Further review of the data determined this was in an effort to support leadership decision making, assist various partners, and respond to or support disasters as appropriate. Although primarily tasked with maintaining situational awareness for FEMA Leadership, FEMA Watchstanders also identified various other minor functions along with a secondary important function. Beyond providing situational awareness, they also assist in the maintenance and activation of the National/Regional Response Coordination Center (NRCC/RRCC) as guided by leadership, along with the associated task of notifying relevant personnel. Initially, upon incident occurrence, they serve as the first line of defense supporting response operations. Performance of these primary functions is essential to the agency's overall ability to respond in a timely manner.

5.1.4 INFORMATION AND RESOURCES

Due to the roles and responsibilities of Watchstanders, monitoring, collecting, and communicating an extensive amount of weather information is required to support leadership with mission critical tasks. Preliminarily, review of the survey data indicated that personnel most frequently monitor NWS 'alerts' (i.e. – watches, warnings, advisories, etc.) and utilize NWS forecasts, discussions, and outlooks. Most notably, there was repeated mention of the need for FEMA Region specific information, including graphical depictions, which is currently largely unavailable and *"information pertinent to 'my' Region."* Participants also mentioned requiring current conditions and an all hazards overview in relation to a variety of weather phenomena (i.e. – hurricanes, storms, fires, etc.) or *"anything that makes my job easier."* A few additional respondents also sought out informational weather briefings, GIS friendly data, and weather trends. Lastly, although not weather related, information on earthquakes and tsunamis was also listed, discussion of which is reserved for Chapter 7.

For weather events, most indicated the need for timing/timeframe, intensity/severity, location, and impact information. Although impacts were noted as important required information, and specifically addressed in the survey, there was difficulty discerning specific impacts. Many respondents listed hazards rather than impacts. The same confusion has been observed among meteorologists as well. Regardless, overall findings related impacts to people, property damage or any threats that may require *"possible FEMA involvement" (i.e. - "lifesaving, life sustaining activities and resources")*. A few other areas noted were operations, agriculture, power outages, evacuations, and shelters.

The two primary channels determined to be utilized to receive weather information was through the internet and television. Primarily, most indicated the use of NWS/NOAA websites and resources to include the NCEP centers, local offices, regions, RFC's and the JTWC/PTWC. Examples include, NWSChat weather.gov, NOAAWatch.gov, and the Enhanced Data Display (EDD). However, respondents also indicated utilization of National and local television, along with a host of additional open source (i.e. – google, yahoo, etc.) and social media outlets (i.e. – twitter, Facebook, etc.). The least utilized sources indicated were private weather entities, although some respondents did indicate occasional usage of such products. A caveat of FEMA being a government agency utilizing government information, yet this is also a result of inaccessibility to most private weather sector products and systems as they often require a fee.

5.1.5 CHALLENGES

Along with understanding FEMA Watchstander roles and responsibilities and information requirements, a determination of challenges or difficulties they experience was also assessed. Across all of the topics addressed, challenges elicited the most substantial amount of data and associated findings. Extensive review and coding of the data revealed a numerous amount, including, but not limited to, *"determining the potential severity of 'severe' weather"* and *"how 'severe' weather impacts the community/lives of those experiencing it."* Preliminarily, I categorized key words and phrases from the responses and listed them below according to the most (first listed) and least (last listed) frequently mentioned as follows:

- **Website Navigation:** so/too many websites/tools, organization, complexity, obscurity, manipulation, confusing, frustrating
- **Information:** most important, latest/most current/up to date, timing, accuracy, contradiction, focused specifics/details, so/too much available
- **Analysis:** impacts/real impacts, applications, consolidation, relevancy

- **Resources:** most accurate, best available/most useful, availability/new tools, timeliness/knowing when graphics update
- **Terminology:** laymen's terms, weather centric, lingo, uppercase
- **Understanding:** interpretation, graphics, data, reading models, too many watches and warnings
- **Communication:** conveying outcome/results, contact information, photos properly depict/best graphics
- **Technical:** flash player, website issues, slow to load graphics

Beyond the categorized challenges, analysis also determined items respondents are unable to locate, areas they do not understand, and inconsistency concerns. Confirmed tornado reports, historical data, local data, NWS forecasts, snowfall totals, and projections were listed as items they are unable to locate. Additionally, I identified three primary areas they have difficulty understanding. 'El Niño', 'La Niña', 'ENSO' and associated terms were the most significantly noted as something heard, but not understood. Space weather was also listed, which is related to the implementation of it being briefed during the morning 'FEMA Daily Operations Briefing'. The third concept identified as something they have difficulty understanding concerned terms or visuals associated with radar (i.e. – reflectivity, imagery, etc.). Less frequently mentioned items included a variety of terms associated with specific phenomena (i.e. – nor'easter, supercell, alberta clipper, pineapple express, etc.). Furthermore, nearly half of the initial survey participants had experiences with inconsistency, the majority of which primarily described issues between NWS offices (i.e. – National vs. regional vs. local). Other inconsistencies included between products or updates (i.e. – format, content, etc.) and among forecasters (i.e. – language, style, etc.). Methods indicated to reconcile these discrepancies included discussion with NWS or source, comparing with other sources or perspectives, or locating additional information. Lastly, as alluded to within various portions of the data, it is noteworthy to mention that combining weather information and data from a multitude of sources is quite tedious for the FEMA regions. As noted by one individual, *"I must read forecasts and create a combined forecast to cover a larger area. I need FEMA Region overviews."*

5.2 FEMA OVERALL DATA ANALYSIS

5.2.1 DEMOGRAPHICS

Demographic information was not recorded for the interview data, due to easier identifiability. However, all in total, there were 123 survey respondents among the 174 course registrations (including the 23 participants from the pilot survey). Of the participants, 61% identified as male and 33% as female with 6% not responding. Regarding race, 54% identified mostly as white/Caucasian followed by 15% black/African American and 8% Hispanic (Table 5.6). An additional 5% identified as Native Hawaiian/Pacific Islander, Asian or other with 18% choosing not to respond. Most participants ages ranged among the 30's (37%) and 40's (25%) with only 9% younger (20's) and 22% older (50's - 14% and 60's - 8%) (Table 5.7). No one identified themselves as below twenty or above seventy with 7% choosing not to respond. In comparison to the pilot survey, age was dominated by the 30's and 40's, and gender was predominately male albeit to a lesser extent.

RACE	TOTAL
African American/Black	15%
Asian	2%
Caucasian/White	54%
Hispanic	8%
Native Hawaiian/Pacific Islander	2%
Other	1%
No Response	18%

Table 5.6: Total survey participants race distribution based on results from the data analysis.

AGE RANGE	TOTAL
20 to 29	9%
30 to 39	37%
40 to 49	25%
50 to 59	14%
60 to 69	8%
No Response	7%

Table 5.7: Total survey participants age range distribution based on results from the data analysis.

Educationally, nearly half of the participants (~46%) had acquired a bachelor's degree with 37% having also acquired a master's degree (total = 83%) (Table 5.8). About 12% indicated they had achieved less than a bachelor's degree with only 1% indicating they had achieved a doctoral degree. The remaining 4% chose not to respond. Additionally, a plurality (29%) of participants fell between one and five years of experience working with weather information, of the defined ranges (Table 5.9). Overall, 40% had five years or less of weather experience. The lowest percentage of participants (3%) resided in the sixteen to twenty-year range of experience, of the defined ranges. The twenty-one to twenty-five-year range wasn't far behind, encompassing ~7% of participants. Overall, survey participants as a whole favored less experience than was initially assessed in the pilot survey.

EDUCATION	TOTAL
High School/GED	4%
Associates Degree/Technical School	8%
Bachelor's Degree	46%
Master's Degree	37%
Doctorate	1%
Other	0%
No Response	4%

Table 5.8: Total survey participants educational background based on results from the data analysis.

WEATHER EXPERIENCE	TOTAL
Less than 1 year	11%
1 to 5 years	29%
6 to 10 years	15%
9 to 15 years	16%
16 to 20 years	3%
21 to 25 years	7%
More than 25 years	15%
No Response	3%

Table 5.9: Total survey participants weather information usage experience based on results from the data analysis.

Initially assessed from the pilot survey, a lack of formal weather training among participants is evident (Table 5.10), with only 4% having received formal weather training. The majority (53%) learned on the job through other colleagues with an additional 29% self-taught through trial and error. Found to be consistent with the initial survey, most respondents learned via on the job training/from colleagues and/or trial and error/self-taught as their primary source for weather knowledge. While 6% chose not to respond, 5% indicated they had no weather training exposure, informal or otherwise. Further supporting the need for development of educational weather components, only 4% had received any kind of weather-related training via the NWS SkyWarn program, one of the military branches and/or a state emergency management conference.

WEATHER TRAINING	TOTAL
Colleagues/On the job training	53%
Self-taught/Trial and error	29%
Formal weather training	4%
None	5%
No Response	6%
Other: SkyWarn Spotter Training (2), Military (2), State EM Conference	4%

Table 5.10: Total survey participants weather training sources based on results of the data analysis.

5.2.2 UTILIZATION: ROLES AND RESPONSIBILITIES

To determine utilization of weather information, I assessed respondents' roles and responsibilities. The position each respondent held was not overtly noted in the survey, yet the respondents' role in the agency determined weather information and data utilization. This includes FEMA Watchstanders, planners, GIS personnel, safety officers, field personnel, operations, mitigation, and external affairs, among others. A vast amount of feedback was provided for this section, second to challenges. Pervasive usage of weather information and data throughout the agency and at the Federal level became quite evident. As a multitude of inputs were assessed for this section, coding the data took several iterations. Arduous review and analysis of the data eventually revealed six primary categories of FEMA weather information utilization quantified as:

- **Situation Awareness:** monitoring, reporting, briefings, life safety/ operations, future trends

- **Analysis and Assessment:** interpretation, GIS mapping/modelling, risk assessment, threat assessment, impact assessment, damage assessment
- **Communication:** infrastructure, visuals, dissemination, messaging/outreach
- **Planning:** crisis, deliberate, hazard mitigation, continuity of operations, exercises/scenarios
- **Disaster Assistance:** preliminary damage assessments, event summaries for declaration requests, disaster assistance and grant determinations
- **Decision Making:** posture/activation, resource allocation, support/mission assignments, field applications

Situation Awareness

Within each of the six categories, data analysis determined several additional subcategories. Each subcategory describes the activities attributed to each specific category. Situational awareness was identified as being one of the fundamental and most frequently mentioned codes. All participants indicated that they were either directly involved in maintaining awareness or the recipient of the awareness products. As one participant stated, *"it's helpful to understand what's going on with the weather from a holistic standpoint."* Varying levels and ranges of personnel included situation awareness in their input as follows:

- **Monitoring:** potential or ongoing threats
- **Reporting:** daily reports, event reports, situation reports

- **Briefings:** States, ESFs/partners, Leadership, Command and General Staff, pre-deployment, daily operations brief
- **Life safety/operations:** field personnel/impacts
- **Future trends:** climate, patterns, seasonal outlooks

The majority of respondents for this section indicated that they utilized weather products for situational awareness through monitoring, developing reports, and briefings. One respondent best summarized these activities stating that *"we are constantly monitoring NWS sites for potential weather hazards to our region. We then create situational awareness reports to alert the necessary departments of possible involvement and response to a weather incident. We also provide a morning brief every day, which includes national and regional outlooks of 72-hour forecasts."* Another respondent extended this notion by stating that *"we monitor any weather event that may lead to a significant loss of life, destruction of private property, or damage to infrastructure."*

Participants also indicated that weather information was utilized for situational awareness for *"life safety"* missions and *"impact on operations*." A number of positional roles within the field from 'safety officers' to leadership felt this was part of their role. Further assessment of the data determined that this was the result of roles not always being consistent, not all positions available or present, and that more than one role felt responsible for personnel safety due to a tiered command structure. As one respondent stated, *"in a leadership role of field teams, I notify staff of impending hazards in order to ensure safety."* Furthermore, another participant responsible for a multitude of situational awareness tasks, stated that *"I brief field operations on weather impacts to the operating area and monitor the weather, alerting operations and field personnel of weather threats and impacts as necessary."* Another participant best summarized this notion by stating that *"I am looking to make sure the FEMA responders don't become one of the survivors."*

Going beyond utilization for short term situational awareness, weather information and data is also important "*to do long term planning*." In this study, it was specifically mentioned with reference to monitoring and assessing impact potential "*mostly as it relates to spring flooding*." However, long term planning for all hazards, as is feasible and relevant, is valuable by extending the advanced timeframe from which to prepare. Essentially, personnel are monitoring not only for personal safety and the impacts on ongoing operations, but also for potential threats, how future events could impact a newly modified disaster area, and how best to plan and prepare for possible seasonal events accordingly.

Ultimately, situational awareness associated activities were conducted to support decision making. For example, as one person noted *"we provide weather phenomenon information to the regional directors for decision making as well as provide weather data support to our deployed personnel."* Inherent within the support provided is the decision to deploy field personnel. *"As an 'IMAT' (Incident Management Assistance Team) member, weather determines our readiness to deploy. Once our team is in place, we monitor weather for changing conditions that affect our situation and operations."* Although decision making will be discussed more in depth later, situational awareness and decision making are directly tied together as showcased in the conceptual framework.

Analysis and Assessment

Maintaining situational awareness was found to be pervasive throughout Federal emergency management. Tasks pertaining to analysis and assessment were also found to be a vital piece of the overall picture being established. Although related to situational awareness, these activities require more than monitoring and disseminating information. Rather, these items focus on interpretation, risk and vulnerability, and impact mapping. Respondents that were tasked with the application or extension of situational awareness most notably indicated activities as follows:

- **Interpretation:** hazards/threats, information/data, text/graphic products, forecasts, outlooks, alerts/watches/warnings/advisories
- **GIS mapping/modelling:** scope, extent/coverage, area/location
- **Risk Assessment:** vulnerabilities, historical data, historical review
- **Threat Assessment:** potential hazards/threats, recommendations
- **Impact Assessment:** potential impacts, recommendations
- **Damage Assessment:** disaster declaration requests, assistance

These activities include analysis of current or future threats along with ongoing events as well as implications for existing or potential vulnerabilities. Aside from interpretation, these tasks were generally spread across a variety of more specialized positions and not a responsibility of all. However, these tasks were determined to be cross cutting across the divisions within FEMA and relevant throughout all of the CEM phases

Interpretation was mentioned as being conducted for preliminary, brief review to know what to include in situational awareness products as well as discussed as a more in-depth analysis of past, current, and future weather data. Feedback from one survey stated that *"we (FEMA) analyze and interpret weather information and data for our situational awareness reports and briefs to national/regional leadership. We also use said information and data to project current and potential future impacts to an area."* In addition, *"Planning utilizes weather information in development of GIS products."* GIS mapping of threats is a critical component of the decision making process and can assist with the interpretation process along with other visuals. Furthermore, another response indicated that *"in GIS, weather drives the support we provide and products that are developed, which involves preplanning, response, mitigation and recovery."*

Interpretation and GIS mapping were identified as advanced elements of situational awareness, yet essential to weather analysis overall. The more substantial components were the four primary assessments: threat, impact, disaster and risk. Survey responses mentioned these four assessments based on role as well as timeframe. The 'Threat Assessment' determines the possible threats/hazards an area may face with regards to future planning. What is noted as the 'Impact Assessment' concerns current or ongoing events and emphasizes impacts based on vulnerabilities, demographics, etc. After a disaster, some respondents indicated responsibilities associated with conducting 'Damage Assessments' in order to administer funds. Lastly, 'Risk Assessment' was discussed in the data as important for pre-identifying and planning for vulnerabilities.

Utilizing CEM, and in accordance with FEMA divisions and timelines, a 'Threat Assessment' would be performed in the preparedness phase, while a 'Risk Assessment' would be in the mitigation phase. The more urgent assessments would be the 'Impact Assessment' in the response phase with the 'Damage Assessment' primarily in the recovery phase. Keeping in mind that these phases are continuous, despite the separation of phases, often times there is overlap among the different activities. As such, it is imperative that each group work together throughout the disaster lifecycle and across divisions.

Through these assessments, respondents indicated they are attempting to identify potential hazards and vulnerabilities and quantify impacts and damages (i.e. - "*how does or could this impact my region? how bad?*"). It was also determined that the impact and damage assessments rely largely on current data, while the threat and risk assessments rely more on historical data. Consequentially, analysis indicated that 'Threat Assessments' assist with preplanning and preparing for potential disasters and make use of climatological data. Similarly, it was determined that 'Risk Assessments' assist with identifying or determining potential areas of concern that can be useful for mitigation projects and response and recovery operations. As was indicated by the data analysis and will be discussed in a later section, respondents felt that historical and climatological data was the most difficult to locate and many felt it was not as readily available as current weather data. Although useful for these assessments, it was also found to be important for other tasks.

A respondent who occupied a position with Mitigation stated that *"I mostly utilize historical weather data. It goes into the Risk Assessment/Management* *portion of our response plans."* It was explicitly stated by one respondent that at FEMA *"NOAA/NWS data is used for the risk assessment and hazard profiles for hazard mitigation plans"* and that *"local mitigation plans rely on NCEI data to develop their risk assessments"* as well. For *"mitigation plan review, we (FEMA) need a good understanding of hazard analysis with impacts and probabilities along with historical data."* This statement exemplifies how areas within emergency management are intertwined. A position may be delegated certain responsibilities, yet a team effort is required to accomplish the goal. As was indicated by the previous weather usage experience and training discussion, many respondents indicated doing these tasks without inherent knowledge of weather and climate. Respondents indicated that a variety of resources are utilized to accomplish these tasks, hence weather training and understanding along with collaboration is essential.

Communication

In addition to situational awareness and analysis and assessment, communication of information is also essential. The communication category contains a variety of aspects of including infrastructure, visuals, dissemination, and messaging, as determined from the data analysis. Maintaining and restoring communication infrastructure was assessed to be imperative, along with the below identified components, as FEMA supports disaster response with a life safety mission.

- **Infrastructure:** maintaining/managing
- **Visuals:** development of products/graphics/displays

- **Dissemination:** communicate information to leadership/partners
- **Messaging/Outreach:** threats and assistance via media, social media, briefings, press conferences

During analysis, communication or form of, was often listed in conjunction with situational awareness. Respondents indicated that upon completion of monitoring, collecting, interpreting, and analyzing information, it must then be communicated appropriately to relevant audiences, along with pertinent visual aids. As weather and disasters have a spatial element, visuals greatly assist with the understanding of the potential impacts. One example of the overall process was described as such, *"we (FEMA) produce an operations brief and a situational awareness report daily. Each product details potential weather impacts and includes weather warnings and watches."* Extending FEMAs reach beyond internal personnel and partners, data highlighted the importance of messaging threats, actions, and available support. One response best summarized this notion stating that *"as the Federal emergency management entity providing assistance, the public and authorities depend on FEMA for information and guidance. As such, operable infrastructure and redundancy are imperative."*

The survey for this study focused on characterizing weather information usage and training elements. However, respondents frequently mentioned discomfort with communicating weather information. As one respondent noted, they had a desire to learn *"techniques for communicating information about weather hazards."* Another stated that they wanted to learn *"how to report the weather when you are not a meteorologist."* It was determined that while FEMA personnel are predominately not meteorologists with little weather background, it is imperative for them to understand and communicate weather information effectively, as it plays such an integral role in the decision making process. One participant noted, *"I utilize weather information daily as our section is responsible for interpreting and communicating the impacts weather will have on our operations and actions."*

Situational awareness, analysis and assessment, and communication are key components throughout the disaster lifecycle and are inherent within planning support activities. As one respondent noted, "*as a member of the planning section unit, I analyze information, explain in products, and provide updates at senior leadership meetings."* Although a wide variety of roles and responsibilities encompass emergency management, planning is the lifeline. Without planning, responding to and managing disasters would be far more arduous and haphazard. Not only does *"FEMA Planning prepare briefings and reports for Senior Leaders regarding potential weather impacts",* but they also carry out a variety of other mission critical activities.

Planning

Provided the wide array of elements, demands, and factions, further inquiry determined that planning activities across FEMA reside amongst a multitude of branches and divisions dependent upon the type and purpose further solidifying the value and crucial contributions of planning across all disaster phases (and FEMA divisions). Among FEMA and coincident with emergency management in general, some of the primary planning functions discerned from the data are:

- **Crisis planning:** resource tracking, situation reports, regional support plan, incident action plans
- **Deliberate planning:** non-crisis plans, all hazards plan
- **Hazard Mitigation planning**
- **Continuity of Operations (COOP) planning**
- **Exercises/Scenarios:** develop, conduct

Determined to be the most urgent of the planning functions, crisis planning is activated to manage an ongoing disaster response. As one respondent summarized, "t*he planning section utilizes weather information during activations and for field/JFO activities to ensure the staff is aware of any conditions that could impact operations. This information is used in the IAP and SPOT reports on any significant events."* During activation, it was assessed that the planning unit will monitor the situation, track resources and assets, and provide reports regarding incident activities. Along with crisis planning, deliberate planning was discerned as being tasked to the response division. These plans were identified as being developed as a framework for managing a disaster response for all hazard types. Furthermore, as was briefly mentioned earlier, local and state hazard mitigation plans are developed in close coordination with FEMA personnel according to existing FEMA policy within the mitigation division. Lastly, "d*evelopment of scenarios for planning based on weather impacts to assess plans*" as one respondent noted along with COOP plans are often coordinated out of the preparedness division. COOP plans ensure that mission critical operations will continue despite some a catastrophic failure or inaccessibility to facilities.

Weather information was deemed to be utilized in all of the aforementioned planning types and plays a crucial role in planning for disasters in both the short and long term. Development and utilization of various plans support emergency managers before, during, and after a disaster. Plans provide a disaster response structure and assist with decision making yet can be adapted as needed. Data analysis revealed that directly supporting planning efforts, are the assessments mentioned in the previous section. Comprehensive assessments will facilitate and refine planning efforts, and ultimately an efficient, effective response and recovery.

Disaster Assistance

Once a disaster occurs, as noted previously, FEMA provides funds to Federal, State, Territory, Tribal and local entities through the disaster assistance programs discussed in Chapter 2. In order to receive assistance from these programs, generally speaking, FEMA must assess the damage and make a determination if an applicant qualifies based on pre-determined thresholds. Review of the data elicited three primary tasks, during this process that require weather information and data. They are as follows:

- **Preliminary damage assessments:** conduct, extent, location, severity
- **Event summaries for declaration requests:** develop, FMAGs, Emergency Declarations, Major Disaster Declarations
- **Disaster assistance and grant determinations:** substantiate, eligibility, type of assistance (IA, PA, HAZMIT)

According to the process, FEMA must first assess the damage, extent, and severity of an event. Pending the assessment, upon completion the State, Territory or Tribal government may then submit a request for a disaster declaration. If received, FEMA must then verify the information by researching the event for write-ups and recommendations in the final submission to the President. As was indicated through interviews with FEMA leadership, this is frequently done through or in conjunction with the NWS. During the review process, FEMA must substantiate the information provided to determine whether an applicant is eligible and for what types of assistance. Throughout this process, respondents indicated that FEMA utilizes weather information to identify areas to conduct damage assessments, develop event summaries, and assess assistance eligibility.

Decision Making

Inherent among these activities, decision making for disaster support is the finality of all of these functions. Throughout the disaster life cycle, personnel are continuously performing these functions in support of FEMA Leadership, States, Territories, Tribal Nations and other partners for "m*ajor events that overwhelm, result in or potentially could result in requests for assistance from State and Tribal partners."* A miscommunication or information breakdown can result in errors, inadequate response, legality issues or even life-safety concerns. Despite varied representation, not all decisions were discussed in this data set as more extensive analysis is required. However, the primary emergent decisions included:

- **Posture/Activation:** determine level of support/staffing, develop activity plan of available resources, alert personnel, deployments.

- **Resource allocation:** personnel, assets (equipment requirements, facilities, mobilization plans, commodity movement/distribution)
- **Support/Mission Assignments:** assess needs, evacuations, transportation, mass care, life safety, levee/dam support
- **Field applications:** establish support, State liaison, IMAT, JFO

Upon event occurrence or just prior to, one of the initial decisions that leadership indicated they needed to make was determining posture/activation. Further review of the date revealed this could include assessing the level of support required, determining staffing levels, alerting or deploying personnel, and deciding who to mobilize where. Data yielded a variation for each event and according to FEMA Leadership as well as expected potential impacts (discussed further in the next section). Taking many things into consideration, leadership must decide whether or not to establish field support. The size and format of which will be guided by the severity of the event and how widespread the impact. This may be done in advance of an event, such as a hurricane or after an event, such as an earthquake. As stated by a member of regional leadership, *"when an event happens, HQ Leadership will sometimes request an activity plan with what/who we have available for deployment. Depending on which detachment we are augmenting or the event, the assets may vary as to what may be needed."*

Carried out in communication with relevant partners, FEMA leadership indicated the need to assess shortfalls, support, and the status of 'lifelines' to facilitate "*lifesaving and life sustaining*" missions, administer "*mission assignments*" (delegation of support to subject matter experts), and *"determine* *actions to take."* In relation, resource allocation regarding both personnel and assets was also deemed critical. Provided examples included equipment staging, facility availability, mobilization plans, and commodity movement and distribution. Once in the field, personnel and leadership must decide *"how best to make protective action decisions/recommendations in a deployed environment."* For example, one individual noted having to work with officials to *"order enough flood protection (i.e. – sandbags)."*

Overall, the primary goal is to determine *"what the impacts are for FEMA"* and the *"relevance of impacts to FEMA operations" (i.e. – "how does this impact 'my' region?", "how do 'we' respond?")*. Frequently, *"decisions have to be made with incomplete data"* and "*getting decision makers to not use model data*" was a concern noted from one respondent. *"Developing plans for decision making", "anticipating conclusion to mobilize personnel",* and *"making critical decisions"* were among the most frequently mentioned associated activities, yet also identified among the most challenging.

Decision making at FEMA was determined to not only be relegated to the urgency of threats and incidents, but something that is carried out daily as it is inherent across all functions. As was indicated by leadership, FEMA is not always and in fact often not, the lead for a decision, but rather a support system. Specific examples listed frequently in the dataset related to evacuations and associated information and triggers. It can be *"difficult to see how FEMA should respond"* to an event, particularly those that *"FEMA doesn't usually respond to."* One example provided in the survey responses was drought. A few individuals expressed the opinion that FEMA *"can't do much about drought."* While FEMA may not assist as much as they could with drought currently, this is certainly an area that has been identified for further review and discussion.

Concluding this section, utilization of weather information within FEMA is pervasive and a primary guiding factor, yet it is not a standardized element amongst training nor is meteorological expertise prevalent. It does not consist of standalone tasks, but rather a cyclical pattern and iterative process that involves a multitude of collaborations and partners. To summarize this section best, one individual noted that *"I utilize graphics, forecasts, analyses, discussions, and historical data from various NWS products. These products allow me to produce quality products of my own that keep leadership informed of real-time weather situations and potential issues in the near future. They also allow them to make informed decisions when it comes to preparedness, emergency activation, staffing, and deployments, as well as commodity movement/distribution and advising State and local emergency managers and leaders."*

5.2.3 INFORMATION: RESOURCES AND REQUIREMENTS

Review and discussion of how FEMA utilizes weather information leads into the next topic of what information they are in need of and how they receive/disseminate information. Not only did the analysis indicate a tremendous amount of information being utilized, but it also indicated that respondents are seeking information from a vast amount of resources. Having copious amounts of information available to them in 'the information age' further complicates the already complicated scenario of navigating a multitude of NWS resources, products, tools, and services.

Information Resource Channels and Mechanisms

NWS products were found to be the most widely utilized across the agency. However, there were also a myriad of other resource outlets that personnel frequently visited. As one individual stated, *"'we' utilize the active alerts and warning map, as well as the National Forecast map as an at a glance SA tool for potential 'severe' weather around our region. We also monitor many local news sites from around the region for what is happening on the ground."* Below is the complete list of all channels mentioned in the data set, listed from the most to least frequently mentioned:

- **NWS** (resources/websites/calls/briefings/tools)
- **Local/National Media/Television/Radio**
- **FEMA** (briefings/reports/liaisons/field)
- **Social Media**
- **State EM offices** (web systems/EM calls/Local officials)
- **Open source media** (photos/videos)
- **Phone Apps/FEMA App**
- **Private sector** (internet/apps/software)
- **Other Agencies:** U.S. Geological Survey (USGS), U.S. Department of Agriculture (USDA), U.S. Forest Service (USFS), U.S. Army Corps of Engineers (USACE), National Aeronautics and Space Administration (NASA), National Interagency Fire Center (NIFC)

I conducted analysis for the five weather types (severe, tropical, winter, water, and fire) individually as well as overall. All of the above channels were found to be a commonality across all weather types. However, respondents listed additional resources for fire weather not included in these categories and usage of additional non-governmental sources for tropical weather. Weather information usage frequency according to specific sources was not overtly addressed in the survey for this study; however, response feedback indicated that the majority engaged in daily usage for situational awareness although the frequency of each mechanism was not determined. Inspection of the data implicated personal preference, positional role, and knowledge of resource availability influenced utilization patterns. For example, some respondents indicated usage of apps or engagement through social media while others did not. Responses also indicated that some roles require more frequent or different usage than others. As training for weather navigation was determined to be primarily through others or oneself, source knowledge was limited to what was inherent to different areas and regions.

Overall, all of these channels were consistently accessed across the board as a collective group either directly or indirectly. No discernable pattern of channel usage was able to be assessed for each specific position or role. Although, due to their situational awareness role, FEMA Watchstanders utilized the greatest number of resources most frequently. Respondents who served in a role other than Watchstander were more likely to access weather information on an as needed basis aside from the daily situational awareness briefings and reports. Further review of the FEMA leadership interview data collected confirmed this notion.

National Weather Service

Due to proprietary reasons, I will not name any specific private sector resources or for profit entities. However, with regards to the NWS products, services, and tools, many respondents indicated that they "*need more resources*", while others stated that "*there are too many resources.*" Below are the NWS resources explicitly listed in the survey responses:

- **National:** National Weather Service (NWS), Climate Prediction Center (CPC), Weather Prediction Center (WPC), Storm Prediction Center (SPC), National Hurricane Center (NHC), Central Pacific Hurricane Center (CPHC), Advanced Hydrologic Prediction Service (AHPS), National Center for Environmental Information (NCEI), National Operational Hydrologic Remote Sensing Center (NOHRSC)
- **Region:** River Forecast Centers (RFC), Regional Operation Centers (ROC)
- **Local:** Warning Forecast Offices (WFO)
- **Tools:** NWSChat, Enhanced Data Display (EDD), Radar, iNWS, NOAA Weather Radio, Damage Assessment Toolkit (DAT)

One of the participants noted that "*we (FEMA) can only use authorized sites for information such as NOAA.*" However, a variety of other sources are also being referenced. In part, this is likely due to the increase in available information, as media and social media are more readily available and accessible. These channels are also utilized as they provide user friendly and less technical products. Reasoning for the usage of each venue was not specifically addressed and will require further study. One perspective for going external to the NWS was that "*they* *(non-NWS) seem to have a much better track record than the NWS*", which could be legitimate in some cases. More likely this is attributable to misunderstanding the information provided or the design of the weather enterprise in addition to personal experience.

Information Requirements

Describing the utilization of information by FEMA personnel is imperative for advancement toward a greater understanding of the decision making process. Reviewing information resources, they access and identifying the information requirements is an important piece for developing training and enhancing decision support. Analysis of the data revealed four primary information categories:

- **Weather Information:** historical data, forecast/predictions, current conditions/situation overview
- **Non-weather information:** general information, time of year, confidence/uncertainty, topography/terrain, flood maps/plains, levee/lock/dam data
- **Communication:** visuals, overviews/summaries, outreach/education
- **Impacts:** life safety, critical infrastructure, property damage, human, insurance losses, environmental, agriculture and livestock, economic

Respondents placed heavy emphasis on impact information, yet the remaining three categories provide an in-depth overview of the required information as reported by the respondents. While communication and visuals provided good insight into needed graphics, the non-weather information category showcased some of the required fundamental elements along with additional geographic and system data. The largest of the remaining categories, 'Weather Information', was further broken down into three subcategories: (1) forecast/predictions, (2) current conditions/situation, and (3) historical data. All of which were comprised of a multitude of in-vivo codes within each subcategory.

Weather Information

A review of the responses from the information section of the survey, was conducted utilizing the five primary hazard types. However, the differences only occurred in some of the specific codes for each hazard with the same resulting categories and subcategories. Some of the codes were also redundant across the weather types. Overall, there were more similarities than not and not enough specific codes to refine this analysis by weather type. As such, for this purpose all data was categorized according to past, present, and future as per below:

- **Forecast/Predictions:** precipitation type and amount, daily temperature, humidity/RH, fronts and pressure systems, threats/hazards, NWS advisories/watches/warnings, wind speed and direction, fuels, expected crests/surge/inundation, models/comparison, and GIS data
- **Current Conditions/Situation Overview:** antecedent conditions, soil saturation, drought status/end drought, gauge levels, reservoir capacity, flow levels and release rates, water content of snowpack and rate of snowmelt, ice jams, storm reports, radar/satellite, and the size of active fires with acreage burned and percentage contained and spread projection

- **Historical Data:** historical record, past events, past impacts, local climate info/microclimate and flood stages and associated known information

The forecast/prediction subcategory is comprised of basic weather factors and atmospheric parameters along with any relevant associated data and alerting products. General weather conditions and information pertaining to existing or ongoing events are contained within the current conditions/situation overview subcategory. Furthermore, climate data and event history reside within historical data. As one respondent noted, "*there is a need for both historical occurrences of events and information on their impacts.*"

Non-weather Information

Most of the non-weather category is comprised of general information (i.e. - what, where, when, size, duration, severity, and track). Many respondents also indicated that "*time of year*" was important along with "*confidence/certainty.*" As one individual noted, *"I need to know how bad and how likely",* while another stated that *"I need a sense of certainty and factors that effect this."* Additional codes included some geographic details (i.e. – topography, type of land, flood plains/flood maps). Information regarding levee and dam systems was also mentioned as described below. To some extent, differing factors play a more/less important role for differing hazards, but as one respondent noted *"it is all pretty much the same for all hazards."*

- **General Information:** what, when/timing/timeline, duration, where/location, size/coverage, intensity/severity, path/track/direction

- **Time of year**
- **Confidence:** certainty/uncertainty, sense of
- **Topography:** terrain, type of land
- **Flood maps/plains**
- **Levees/Locks:** levee data, locks, USACE products on dams

"It is important to know where, who, and what to deploy as weather approaches." All of the discussed information is helpful along with *"direction of the storm, landfall, timeframe, wind speeds, surges, etc. – as we need to know if more equipment needs to be flown in advance, or if we need to call for assistance from other regions."* In relation, there was also an implied need among other sections of the data for information regarding transportation and "*escapes routes*." *"Deployments to or within areas of concern pose threats for personal safety and safety in the field."* It is important to *"obtain data to determine the safest route of travel to an affected area prior to and during weather." "We need conditions between where we are located and where our personnel are driving to."* Therefore, is it imperative to monitor "*weather between 'us' and our destination with trucks and personnel and what they will encounter when they arrive at that location."* This also holds true for *"islands being hit and coordinating delivery of supplies when infrastructure is down."* Additionally, one respondent noted the need for *"training to deal with and manage weather events."*

Communication

Furthermore, a variety of items were mentioned in the data regarding various aspects of communicating weather information. Inputs included contextual information, messaging, verbiage, as well as visual displays and depictions as described below. Utilization of these items depends upon one's ability to locate and understand the information, hence challenges ensue as are discussed in the next section.

- **Visuals:**
  - Maps/graphics/charts – monitoring, situational awareness, assess magnitude/extent/scope/scale, tracking/tornado tracks, validation/confirmation/verification
  - Radar/satellite imagery
  - GIS maps/data/products – from local, State, FEMA, FS
  - Areal/ground truth photos/videos/reports
- **Overview/Summaries:** text/discussions, terms/language, wording
- **Outreach/Education:** messaging, early warning, advanced notice

One of the most frequently mentioned items was the need for visual products, both before and after an event. Before an event there was a need for graphical displays to support framing and conceptualization. For example, "*river flood gauge maps to pinpoint where problems exist which may be compounded by QPF graphics and excessive rainfall graphics.*" A continued need after events was also identified to assist with things such as assessment, tracking, and verification. Verbiage to accompany these visuals was also requested to assist with explanations and understanding for the development of reports and the execution of briefings. For example, there is a need for *"graphics indicating areas under a flood watch along with text describing flood potential and expected impacts* *based on previous flooding."* Of particular note was in reference to flash flooding with one respondent stating that *"we need to figure out a better way to make leadership happy about this."*

To further assist with the communication process, respondents desired products or services regarding *"available messaging to assist the public."* It is important to know *"how big is big, how bad is bad and getting the word out to residents – having a clear method that is understood by citizens so that they know what to do."* In addition, early warning to support leadership decision making and *"advanced notification for FEMA to deploy prior to an event when possible would be helpful."* In summary, *"anything that keeps me ahead of CNN."*

All of the aforementioned informational items discussed are important, but ultimately, as was quoted by a member of leadership, *"for FEMA, it's not the what, it's the so what."* The hazard may drive the potential impacts and essence of a disaster, but ultimately what happens or what may happen despite the cause is what matters. The hazard combined with population, other demographics, and vulnerabilities will provide the risk and initial guidance towards preliminarily understanding the 'so what' factor. As one survey respondent stated, that regardless of the phenomena, *"weather that impacts communities is most important"* vs. weather that impacts less densely populated areas.

Assessment and identification of risk and potential threats through a variety of products, maps, and analysis were found to be instrumental for the FEMA decision making process. The larger the disaster, the larger the number of personnel, resources, etc. required and vice versa. Although some incidents are unanticipated, the goal is to be as best prepared as possible. Since all disasters can be approached with many of the same guiding principles and priorities, this helps to streamline the process. Additionally, aside from small perturbations among specific incidents, impacts were found to be essentially standardized.

Impacts

Correspondingly, questions addressed the impacts of concern overall, and for each specific weather type. Analysis of the data revealed no discernable differences between the impact information requested for each specific type. Primarily, this can be attributed to the characterization of disasters, FEMA policies and procedures, declaration requirements, and disaster support and assistance. Generally speaking, impacts included *"storm surge damage, wind damage, tornado damage, flooding damage, evacuation issues, human and animal safety, power interruption, damage to infrastructure, damage to transportation routes, and interruption of food/water supply."* Below is the compiled list of impacts from respondents, categorized primarily between infrastructure and 'lifelines':

- **Consequence Management:** analysis, overall impacts, areas of impact
- **Life/public safety:** life sustaining, threat to public, mass casualties/life losses/lives, personnel/field safety
    - public health/healthcare
    - evacuations, routes, transportation, ability to evacuate in time
    - mass care: sheltering needs, survivors, evacuees, food and water
    - stranded people/water rescues/rescue operations
    - emergency services/medical care

- **Human impacts:** communities/population centers/people/urban areas/rural areas affected/displaced/homes displaced, vulnerabilities/functional needs
- **Critical Infrastructure:** schools, hospitals/medical, dam/levee breeches/failures, transportation (roads, barges, rivers, ports, railroads, airports, shipping, closures, navigation), utilities (nuclear, oil and gas, electric generation/power outages/downed lines, water and sewer)
- **Property Damage/Debris:** homes/protection of property/structure damage/amount of debris/debris management
- **Losses:** individual vs. public, NFIP/uninsured damage/rebuilding per NFIP/compliance
- **Environmental**
- **Agricultural:** loss of livestock/animals/pets/plants
- **Economic:** private sector, lost businesses

Consequence Management in general or the overall impacts from an event, along with activities associated with property damage, infrastructure disruption, and life safety were listed most frequently. As one participant characterized, "c*onsequence management: life safety, evacuations, mass care, impacts to critical infrastructure, etc., things out of the norm."* It is important to understand *"current and anticipated activities, what is happening and where, and what will be the impact."* Of the utmost importance, feedback indicated the *"threat to life and* life safety", which encompasses those activities that directly contribute "*to life-saving and life sustaining"* missions for both survivors and responders to prevent *"injuries", "loss of life"* and *"mass casualties."* This would include healthcare and medical services, evacuations, mass care, and rescue operations. For example, *"the ability to evacuate population in time and addressing evacuation and sheltering needs that will arise from those impacts."* Other examples mentioned were *"rapid snowfall that traps vehicles on highways resulting in rescue operations"* or *"impacts affecting prior recovery operations."* Local emergency management or public safety officials and responders primarily manage these functions in coordination with a variety of partners and the State. FEMA provides support for all these functions through personnel, resources, and funds. How widespread or severe an event is will dictate FEMA support. Communication of this most urgent information is imperative for a timely and efficient operation to prevent casualties.

Human impacts, which includes population and demographics, also affect life safety. Some of the contributing factors mentioned include the amount of people impacted and population displaced, type of communities (i.e. - urban vs. rural, new vs. old, low vs. high economic status, etc.) affected along with those who with other vulnerabilities or functional needs. Case in point, *"power outages and transportation – especially for vulnerable populations without heat."* All of these factors combined indicate the level and types of resources that will be or will potentially be required to fully support each incident. For example, *"a large densely populated area being hit by tropical weather"* will require a different level of support than a more isolated, smaller scale event. As each disaster is different, having a good idea of such information assist FEMA and partners' ability to right-size each event accordingly, based on need, and determine the types of disaster assistance available to jurisdictions and/or individuals.

Related to life safety and human impacts respondents indicated impacts associated with *"infrastructure and infrastructural damage",* such as *"damage to critical infrastructure and structures (i.e. - power, hospitals, water and waste water, transportation, etc.) and amount of debris."* Comprised of medical facilities, transportation modes, utilities, schools, flood walls/levees, etc., after an event this infrastructure is crucial for the re-establishment of critical services for further reduction of casualties and the path to recovery. For example, *"wind that knocks out power, therefore home heating"* and *"impacts to roads and bridges to get resources into an area or near an area to provide assistance."* Identifying which sectors have been impacted and how badly will facilitate efforts to restore critical services through determination of the type and extent of damage and identification of required resources. For example, *"not having power for long periods of time will create a demand for many of our resources (i.e. -power outages in evacuations, shelter openings, food/water, and generator transportation."* Even without an impending event, this infrastructure is monitored to avoid potential harm and mitigation projects completed to further prevent or reduce impacts. Of particular note are *"impacts to the public such as roads, power grids, and long-term future flooding."*

"The protection of property" and *"structural property damage"* both personal/individual (i.e. – homes, apartments, etc.) and otherwise (i.e. – government, private, etc.), was mentioned as a concern for debris management, immediate response, and long-term recovery solutions. The continuous monitoring and communication of this information was found to be important for ensuring coordination of appropriate partners for debris removal and life safety

missions. For the longer term, this information was also determined to be important for providing disaster assistance to survivors and jurisdictions alike and assessment of mitigation measures that could be implemented. Based on previously discussed FEMA policy, the distinction between individual and public losses, insurance coverage (including home, flood, etc.), and the type of structures is important information in order to determine availability of funds, resources, and assistance. Additionally, data indicated that during the rebuilding phase, eligible recipients of disaster funds will also be monitored for compliance and adherence to existing policy and program guidelines according to type of funds appropriated.

The remaining three impacts respondents mentioned in the survey include environmental, agricultural, and economical. While these are not typically as imperative for urgent lifesaving missions and initial stabilization, they are critical elements of long-term recovery and sustainment. Environmental impacts will need to be addressed in order to prevent further harm to both the ecosystem and humans. They could also lead to further agricultural concerns, beyond the economic loss of plants, crops, and livestock. Furthermore, economic impacts would also include the private sector, loss of businesses, lack of spending, damage or loss of goods, and rebuilding in general. These three categories were listed as important in order to assist personnel with enacting or developing appropriate recovery plans, assessing qualifications for mitigation projects, and performing relevant mitigation projects to build toward future resiliency.

The greatest concerns respondents frequently mentioned were *"what are the unmet needs that 'we' need to provide or be prepared to provide via 'our' State, Territory and Tribal partners"* and "*continuous monitoring for anything that will* *hamper or halt field operations."* This includes *"other threats or incidents that may occur as a result of the 'severe' weather, how it may affect operations in the area, and State and local resource gaps in responding to the event."* Regarding consequence management overall, leadership best summarized *"'we' would be most concerned about impacts to life, property, and infrastructure (specifically transportation, electric generation, water treatment, nuclear, etc.). For FEMA, damage impact is most important as the amount of damage to property affects our deployments."*

To summarize the 'Information: Resources and Requirements' section overall, the information FEMA requires consists of *"where, when, severity, was it pre-identified or no notice, people affected or potentially affected, other incidents that may occur as a result of the 'severe' weather, how it may affect operations in the area, State and local resource gaps in responding to the event, road closures, electrical and water outages, and transportation concerns."* Respondents indicated that they obtain this information through a variety of sources, yet the significant amount of available information and large number of resources makes data collection and analysis quite difficult. Educational outreach, training elements, and development of additional weather and impact products relevant to FEMA may not resolve all of these issues but would certainly enhance current practice.

5.2.4 CHALLENGES

Among all of the sections in this chapter and chapters within this dissertation, the 'Challenges' portion elicited the greatest amount of discussion within the survey responses. Overall, the primary concerns pertained to difficulties associated with maintaining situational awareness and how they complicate decision making. The implications were inherent across various portions of the data. Closely related, was the notion that hazard occurrence varies across regions and personnel may not have the most relevant experience for all hazards. As was best stated by a regional respondent, *"our Region is reliant on the requirements of those Regions affected by tropical weather since 'we' aren't directly affected by tropical weather."* Therefore, some challenges and needs may be unknown, i.e. – *"what are the obstacles in my way."*

Despite this caveat, many challenges mentioned in the data can be easily remedied, providing further evidence of the need for development of weather training along with additional weather support and products. Given the overabundance of input, the analysis was substantially more time consuming, requiring multiple iterations of data coding. The feedback could have been coded into different categories, according to the researchers' perception, experience, background, etc., yet ultimately, analysis yielded the categorizations as follows:

- **Equipment and Technical:** timeliness, security and compatibility, and equipment
- **Resource Navigation:** data collection, resource availability, too many resources, and products and alerts
- **Knowledge and Understanding:** roles and services, prioritizing hazards and threats, weather phenomena and basic meteorology concepts, weather phenomena, and education and training

- **Interpretation, Trends, and Analysis:** informational and geographical, interpretation, trends and analysis, demographics and vulnerabilities, and impacts
- **Communication:** visuals, inconsistency, dissemination and format, messaging, and terminology

After extensive review of the data, five definitive and overarching categories emerged consisting of resource navigation, knowledge and understanding, interpretation and analysis, communication and equipment, and technical issues. One of the respondents best summarized the challenges overall as *a "general lack of understanding of weather and weather products, the inability to effectively communicate weather-related information to leadership and constituents, and the lack of preparedness to interpret weather information during active situations."* Encompassing the majority of the primary challenges concisely, this statement is largely representative of many of the responses put forth by many of the respondents and across all disaster phases.

Resource Navigation

The most frequently mentioned challenges were incorporated under the 'Resource Navigation' category, which includes data collection, resource availability, too many resources, and products and alerts. Described below in more detail, these challenges were fundamentally problematic for weather utilization:

- **Data collection:** locating/finding/collecting info/where to get/getting all the info needed, data in rural areas, historical data/archival data, confirmed tornado reports/info/tornado track data, GIS data/needed format/some not available/some not through services, local forecasts/incident specific.

- **Resource availability:** where to get info/where to find answers/don't know where to look/lack of knowledge of where to locate info/which websites to use/where to go for what information, resource support, what are the best resources/most critical information/good/best info sources.
- **Too many resources:** lots of info/too much info available, speed/too little time/takes too much time/finding info quickly/overwhelmed, reviewing multiple products/finding all needed info in one place/too many reporting systems to sort through.
- **Products and Alerts:** explaining the difference between products/product confusion, unaware of new products/services/changes, non-standardized/lack of Standardization, alert differences/meaning, EM not understanding watch/warning thresholds, difficulty sifting through watches and warnings nationwide/keeping track of alerts/alert changes.

Some of the challenges identified were *"reading maps, finding information, and knowing sources",* in addition to being *"not sure which product is easiest or knowing which website to use."* Difficulty with *"not knowing where to find data and a lack of understanding of what data means",* nor *"a good understanding of where to locate the products 'I' need"* was also established. Historical data, rural data, local data, tornado tracks, and reports as well as GIS data and services were among the most frequently listed problem areas. Examples of more specific data location challenges include: agriculture/vegetation cover/moisture, storm surge information, hotspots/fire induced weather/fire information in differing area of responsibility, flood maps/what is flooding/estimated levels of precipitation, river/flash flooding/ice jams information, past 24-hour snowfall/how much/depth reports/rates/totals, and icing amounts. Additionally, a lag in determination of recent snowfall was identified as an issue for some respondents along with the speed of fire spread vs. reporting (untimely or inconsistent fire updates).

Knowing where to locate information and what is available is first and foremost throughout the situational awareness and decision making processes. Nonetheless, at FEMA, the gap between knowing what the best weather sources are vs. the information required was identified, with little support available. As a tremendous amount of weather information exists via an array of outlets, personnel can easily be overwhelmed by the time it takes to navigate and compile the data. *"Not knowing what resources are out there, with information scattered across multiple sources, it makes it difficult to sift through quickly to find the most relevant information."* Overall, the consensus was that, *"'I' would like to be able to get the whole weather story in one location, but analysis requires going to several NOAA sites."* Frustration and the inability to locate required information led some respondents to seek out non-governmental sources. However, one response noted that *"while navigating NWS/NOAA websites is a pain, it is the only way to ensure valid information, but nearly impossible to find what you really want."*

Not only are there *"too many products"*, but there are also a variety of supporting entities such as *"multiple river forecast centers, which require several searches" and "multiple sites for one state."* Further complications arise as there is little to *"no standardization among weather offices"* across all NWS levels (WFO vs. Region vs. National vs. Center), or between agencies (NWS vs. FEMA vs. USACE vs. USGS). For example, "not all offices have 'weather stories'" and "there are too many NWS regions for 'my' FEMA region." It is difficult to *"review multiple texts, summaries, and correlations for regional assets and keep track of new watches and warnings"* while attempting to compile all relevant information into one coherent COP. In fact, there currently is no mechanism in place to do so.

Furthermore, confusion among the respondents regarding differences between forecast products was observed. Case in point, *"'I' lack an understanding of what products are telling me and their meaning/impact. 'I' am not sure if 'I' am interpreting them correctly and 'I' would like to have more confidence in 'my' analysis."* Data analysis determined that the meaning of or thresholds for the different NWS alerts (watches, warnings, advisories, etc.) are not well understood or are confusing. A few examples noted are *"what conditions lead to red flag warnings?", "what is a severe thunderstorm watch?",* and *"what does advisory mean?"* Some respondents also expressed concern about being unable to maintain current on relevant or related NWS product or service updates and felt out of the loop or unaware of new products and services or modifications to existing ones.

Knowledge and Understanding

The challenges grouped within the 'Resource Navigation' category focused on understanding and knowledge issues, among others, encountered specific to weather resources. However, several general, more scientifically based knowledge and understanding challenges were also identified in addition to confusion over supporting agencies and responsibilities. Areas include education and training, roles and services, prioritizing hazards and threats, basic meteorology concepts, and weather phenomena as listed and described below. The first four categories (education and training, roles and services, prioritizing hazards and threats, basic meteorology concepts) describe the overall, widespread concerns as expressed by the group of respondents. The last category, 'weather phenomena', is a listing of more specific issues respondents have encountered and therefore represents a more individualistic perspective rather than a collective viewpoint.

- **Education and training:** how/where to obtain training/what's available, for situational awareness/analyze/need better understanding to assist with a more informed analysis/understanding, how to use tools, leaderships understanding/leaders want info/answer than doesn't exist.
- **Roles and services:** difference between NWS, USACE, USGS, etc./don't know what they do/who they are/what do they provide/who does what/what resources do they have, who to contact/availability of SMEs/how to utilize liaisons/staying connected.
- **Prioritizing hazards and threats**: what to monitor/what not, figuring out/identifying primary hazards/threats, hazard/threat/risk assessment, don't know what is most important/critical, not knowing what to request.
- **Basic meteorology concepts:** overall/in general, cause and effect, context/impact, intensity/severity, forecast/prediction, understanding limitations of the forecast/predictability/ambiguity in forecasts/why forecasts change, what the technical/details mean, the differences in

scales/categories/how they are defined/what do they mean/what determines the classifications.

- **Weather phenomena:** lack of knowledge of tropical weather/surge products/how wind impacts surge/wobbling of hurricane track/factors in steering/movement/intensity/explaining that category is not the only factor in a storm, tornado probabilities, fire behavior/factors affecting fire weather, dynamics/hydrology in relation to flash flood/saturation/river observations/forecasts, impact of rapid snowmelt with rainfall, drought mitigation from snowpack levels/what it will take to end drought.

As was previously mentioned, most respondents indicated they had no formal weather training despite weather playing such a crucial role at FEMA. Likewise, respondents indicated they acquired the necessary skills on the job, through other colleagues, and via trial and error. Part of this issue can be attributed to the fact that suitable weather training components and requirements are lacking, yet respondents also indicated they did not know from whom to obtain training. Respondents overwhelmingly supported the notion, all but one survey response, to develop such training so as to provide better situational awareness, learn about available resources and tools, and assist leadership. Although none of Senior Leadership took part in the survey, respondents indicated that leadership would also benefit from weather training due to a perceived a disconnect between leadership and weather information demands. Succinctly stated, *"there is a lack of understanding by leadership, they often want information that simply isn't available like definite answers on impacts."*

With the background of most FEMA personnel stemming from primarily non-weather factions, they lack an understanding of the overall weather enterprise and associated partners. Case in point, as one participant noted, they have the disadvantage of *"not knowing NWS people or services"* or whom to contact and what services might be available to them. Limited background and training combined with limited access to support and expertise has forced limitations on their level of understanding and stunted knowledge progression.

One of the more significant shortfalls identified was the inability of respondents to prioritize hazards and threats. The challenge was in *"not knowing what weather pattern/incident to monitor and what not to monitor"* and in deciphering the most critical elements. This was true on both the short- and longer-term timescales as many struggled to understand the hazards, threats, and risk their region faces and associated frequency, seasonality, etc. Due to the lack of understanding, knowing what to request and from whom was deemed onerous.

A more extensive discussion of training content will be discussed in Chapter 7. However, a brief overview of the most relevant topics within basic meteorology concepts and weather phenomena discerned form the data analysis is discussed in this section, as it addresses more specific challenges related to understanding. For example, *"flooding classifications and cresting", "drought indices and finding a good index with drought duration/intensity"* and *"radar interpretation/interface understanding."* Aside from general meteorological parameters, such as weather patterns, scales, terminology, etc., respondents had difficulty *"understanding the accuracy and limitations of forecasting"* and associated predictability and ambiguity. There was also a myriad of knowledge gaps and questions related to more specific weather phenomena gaps mentioned in the data, as is listed above.

In summary, the lack of experience and availability of training, in conjunction with the challenges discussed compromises FEMA's capability to adequately support the mission. Weather training and educational components at all levels was deemed to be a valuable endeavor and a much-needed area for development, given the critical function of the subject matter with nationwide implications. Furthering this point, the lack of weather training is not only of concern among FEMA personnel, but among partners and emergency managers in general. Several respondents noted that when needed, *"we (FEMA) are training/teaching emergency managers and others"* about different weather-related topics such as "*an overview and explanation of storm surge products*." This is just one indicator of the need for audience based, appropriate weather training across the growing field of emergency management and related fields/disciplines.

Interpretation, Trends, and Analysis

Provided the shortfalls identified among 'Resource Navigation' and 'Knowledge and Understanding', correspondingly complications extended beyond to 'Interpretation, Trends, and Analysis'. Addressing the previously discussed challenge areas through developed educational components will further contribute to enhanced skills among these areas as well. However, some of the elements may require additional or more advanced components that are beyond the scope of this work and will be reserved for consideration in future studies. Nevertheless, the five primary components identified within this area consist of 'Informational and Geographical', 'Interpretation', 'Trends and Analysis', 'Demographics and Vulnerabilities', and 'Impacts', all of which are further discussed in detail below.

- **Informational and Geographical:** details/specifics, what kind, timeline/timeframe/timing/onset/when/lead time/time of impact/time to locations/more exact timing, duration of hazards/how long/speed of events, location/exact location/where/distances to locations, where is it going to land/track/direction, topography/geography/diverse region, spread out region, being familiar with an area, region specific information.
- **Interpretation:** how to interpret/interpreting weather information/data properly, what data means/model analysis/one vs another, misinterpretation by EMs and the public, able to read/reading graphics/diagrams/charts/identification of map features.
- **Trends and Analysis:** trends/projections/providing analytical projections with accuracy/correctly by state and locals, severity/how bad/how much/extent/size of possible impacted area, assessing potential impact/what it will impact/projected impacts.
- **Demographics and Vulnerabilities:** population/how many people/home counts, identifying vulnerabilities/those with functional needs/non-native speakers/danger to lives, evacuation numbers/needed shelters, evacuation time/timeframe/triggers.
- **Impacts:** 'real' vs. 'bogus' impacts, obtaining/finding/locating observed/accurate/real time/current hazard event impacts/reports/

information/getting states to report impacts, lodging options/availability, transportation/facilities/utilities/public transit/compiling power outage info/power failures, when are roads clear for travel/road closures/icy roads/safety for ‘us’/public/determining safe travel routes.

Generally speaking, the ‘Informational and Geographical’ challenges identified through data analysis are associated with detail-oriented aspects and geographical considerations specific to an area of concern. As was previously discussed in the information section of this chapter, challenges concerning the informational requirements such as *“when? where? how bad? what kind? and how long will the weather last?”* Consternation regarding timing, timelines and duration of hazards/threats was the most frequently mentioned overall. Examples include, *“timeframe to crest and recede”, “timing of downstream water from mountains for snow events”, “when has flash flooding subsided”* and *“when will severe threat exit ‘my’ region.”* Further issues identifying or locating information related to incident location, track, and areal coverage were also evident. One specific issue that was noted several times is the interest in tornado track data. However, such data is not readily available immediately following an incident. As one respondent noted, *“leadership wants tornado track data, but ‘we’ are always asked to provide it quicker than it is available.”* Collectively, all of these issues are particularly notable for regional requirements within an area of responsibility (AOR) since weather products are not designed specifically for FEMA needs. Furthermore, one respondent also noted that *“not being familiar with an area further complicates awareness at times.”*

Aside from the 'Informational and Geographical' concerns, as noted, *"how to interpret information relating to weather overall is a challenge."* 'Interpretation' issues involve a variety of areas such as forecasts, radar data, river gauges, models, etc., with one individual referencing a "*vagueness in fire products."* In relation, a good portion of the respondents reported having difficulty reading and interpreting the various weather graphics and maps available. One example discussed was *"trouble finding flood graphics and maps and being able to read them."* Otherwise, a few responses indicated that the potential for misinterpretation is of concern not only for FEMA, but also for emergency managers in general and the public. Specifically mentioned was the suite of tropical weather products (i.e. – cone of uncertainty, storm surge, etc.).

Extending beyond 'Interpretation' and transitioning to 'Trends and Analysis', one individual best expressed the concern that *"'I' am not sure if 'I' am interpreting correctly and 'I' would like to have confidence in my analysis."* The 'Trends and Analysis' category consists of identified challenges associated with monitoring trends and conducting assessments. FEMA personnel indicated utilizing a multitude of available data and tools to assess the potential of an impending or ongoing event. Review of the data determined issues among accurate and correct assessment of the severity and extent of the hazard/threat as well as for the impact projections. Specific examples included "*surge, current flooding, what is flooding"* and *"accurate assessments of acreage burned, spread potential and fire line/area of fire map."*

Related to the 'Trends and Analysis' challenges are those associated with 'Demographics and Vulnerabilities'. I considered combining the two categories, but ultimately decided the components differed enough to be separated. Review of the data revealed ambiguities when attempting to identify the potential number of homes and population impacted as problematic for decision making. Of greater concern, are issues related to assessing and managing vulnerable populations (i.e. - functional needs, non-native speakers, etc.). Evacuations are particularly challenging with regards to the *number of people, needed shelters, timeframe* and *triggers*.

The first four components within the 'Interpretation, Trends, and Analysis' category ('Informational and Geographical', 'Interpretation', 'Trends and Analysis', and 'Demographics and Vulnerabilities') focused on a wider, more holistic view. The final component 'Impacts' has a more specific and timelier or urgent perspective. In general, the overall challenges respondents indicated were in obtaining actual impact information and deciphering between credible vs. non-credible reports. As was discussed in the 'Information Requirements" section, impacts are what matter most. Therefore, *"not knowing the damages following an incident is a problem for FEMA activities and deployments."* However, compiling impact information is difficult as one must determine needs, assess relevance, and evaluate sources. Congruent with previously discussed impact information needs, important elements identified were impacts primarily associated with the aforementioned areas of critical infrastructure, transportation, and that which poses a threat to life safety (i.e. - facilities, utilities, roads, etc.). Specific elements within each area are described in more detail above.

Communication

The first three 'Challenges' categories ('Resource Navigation', 'Knowledge and Understanding', 'Interpretation, Trends, and Analysis') essentially build upon one another. Therefore, shortfalls or gaps within one area will create problems in others. Likewise, many of the issues discussed so far can be overcome through improved education and training. Aside from a few exceptions, the final two 'Challenges' categories ('Communication' and 'Equipment and Technical') provide insight into areas of needed improvement across the weather enterprise, and how to best serve FEMA, partners, emergency managers, etc. The communication category focuses on five communication principles, detailed below as per the respondents, that include 'Visuals', 'Inconsistency', 'Dissemination and Format', 'Messaging', and 'Terminology'.

- **Visuals:** visual graphics not available/not the graphics needed, better graphics/visuals/with radar/not user-friendly products/graphics, colors are difficult to read/color coding, need timing across region/states, region specific information/graphics/just my area of responsibility.
- **Dissemination and Format:** dissemination of information in an easy to understand/more user-friendly format/easy to understand information/format, dissemination during a large geographic response, providing and receiving important information, preparing for dissemination/briefings/reports, communication in general, jurisdiction issues/who reports what.

- **Messaging:** convey information and impacts/effective communication of threats/explain/brief weather/models in briefings/reports to senior leadership/others, knowing what to include/pass along and not to, summarizing products/information, language barriers/more Spanish products/translating information and severity.
- **Terminology:** complex information, technical forecasts/scientific lingo/too much use of technical jargon/have to spend time deciphering the language, use of acronyms, shorthand used in products, need definitions.
- **Inconsistency:** conflicting/varying/inconsistent messages/information between NWS/media/state/county, forecasters providing conflicting information/interpretation from different forecasters, conflicting reports from media/eyewitnesses, hype/sensationalism/inflation/overexcitement of media/partners/leadership, etc., de-conflicting info.

Issues concerning 'Visuals' were the most frequently mentioned of the five communication subcategories. Overall, items that were mentioned included the desire for more visually appealing graphics that utilize appropriate color schemes and incorporate timing information along with more user-friendly maps. As one respondent stated, *"maps may have multiple layers and information that is broader than what my audience needs."* Many respondents felt that the graphics they needed were not available. The primary gap identified among graphical displays was the lack of graphics specific to their area of responsibility (AOR), which is usually correlated with a FEMA Region or State. The demand for more appropriate, relevant regional and State graphics is growing as *"management is* *requesting more predictive weather and graphical weather stories"* that are not widely available or unavailable entirely. Greater coverage of inundation maps is one example, yet enhancement of graphical products in general is desired.

Identified FEMA communication requirements consist of "*disseminating data to FEMA, translating to leadership the situation and stressing the severity."* However, *"products are not always brief friendly or produced in a manner to be briefed graphically."* As such, *"FEMA needs a product that is simple enough to share vs. too complex to communicate to others if they are not weather-versed."* Generally speaking, review of the data identified challenges in both dissemination and reception of information and communication as a whole. Additionally, issues with communication of information and format during a large disaster and across multiple domains were also mentioned. Development of enhanced and relevant visuals according to their needs, enhanced information flow, and consolidation of appropriate resources is the end result for resolving these difficulties.

Messaging, as it relates to conveying weather and hazards, also emerged as a common theme within the analysis. Among many of the FEMA personnel who completed the survey, *"communicating complex information to other people with a wide range in experience/knowledge"* is a significant responsibility within their role. The overall difficulty resides in needing guidance on summarizing, conveying, and explaining weather information to leadership, partners, and others. As one respondent noted, *"I have trouble translating weather information into briefings and knowing what to show."* On a related note, product availability in other languages, of particular interest is Spanish varieties, is limited. Translation to other languages can be time consuming and tedious, assuming there is an appropriate translator available. Availability of information in other languages or access to appropriate experts would bolster information dissemination and assist with the life safety and disaster assistance missions.

In conjunction with messaging, terminology further complicates matters. Communicating scientific information is challenging in general, particularly for FEMA and partners as most do not have a science background. Many publicly available weather products are technical and contain jargon, shorthand, and acronyms that are not widely understood outside of the field. Deciphering the verbiage can be time consuming and hinder understanding and interpretation as well as conveyance. As was noted by one respondent, "*it is difficult to simplify the technical jargon to clearly understand the impact without oversimplifying*." In this case, educational components along with readily available resources (i.e. – definitions, links, etc.) would facilitate the process along with development of more user friendly, less technical products designed for a laymen audience.

Inconsistencies or conflicting information amongst weather reports, forecasts, and sources was a frequently specified issue. As was best summarized by one of the respondents, *"it seems that often there will be different forecasts from different sources…who do you trust."* Examples provided mentioned all types of sources, such as the state or county, the NWS and forecasters, and the media (to include social media). Conflict examples of inconsistency included occurrence between one another (i.e. - NWS vs. media vs. other), within each sector (i.e. NWS vs. NWS, media vs. media) or at different levels (i.e. – National vs. Regional vs. State vs. local). Furthermore, *"conflicting reports from the media and eyewitnesses"* were also discussed in the data. The process of de-conflicting information or reports can be overwhelming and force personnel or leadership to make assumptions that are erroneous, invalid, or misleading. Lastly, the widely known challenge of hyping or sensationalizing an event, across a wide array of outlets, was also mentioned in the data. The effects of engaging in such acts are prevalent within communication literature, culminating in reception and assessment of information complications and potentially influencing decision making negatively via apathy and/or complacency.

Equipment and Technical

All of the aforementioned items discussed so far in this section depend on the availability of technology and communications to function. In finality, although not directly related to weather information utilization, 'Equipment and Technical' challenges respondents identified are problematic for the transmission of information and data as well as the life safety mission. The components in this category are the least numerous yet possess the ability to significantly impede information flow and facilitate catastrophic communication failure. Comprised of 'Timeliness', 'Security and Compatibility', and 'Equipment', these challenges, described in more detail below, can directly impact operational areas.

- **Timeliness:** current/accurate/up to date/timely/speed of info/receiving info in a timely manner/timeliness/too often or too little, updated forecasts based on observations/pop up situations/late/delayed/no notifications/updates, graphics/data slow to load, websites/resources not updating/refreshing timely/being kept current.

- **Security and Compatibility:** firewalls/can't use google platform, software/compatibility issues, interfaces/tools/systems unavailable/not working, too many updates/upgrades.
- **Equipment:** broken/frozen gauges, technical data/hydrographs not available/gauge non-working, gauge accuracy/reliability, communication issues/loss of equipment, computers not updated/working.

One of the most frequently encountered technical issues as indicated by FEMA personnel concerns website refresh rates. Respondents indicated that websites often do not refresh or update as they should or in a timely manner, sometimes requiring manual assistance. Similarly, respondents also indicated an issue with graphics and data intensive files being slow to load and at times even requiring repeated attempts to do so. Additionally, analysis revealed a seemingly mismatch between user desired information issuance vs. actual information issuance, regarding the overall timeliness of weather information availability. Although a wide variety of perspectives emerged, addressing a breadth of resources and inclusive of multiple aspects, no real consensus emerged through data analysis. Not enough details of the actual items in question, description of the problem or perceptual view was provided to address this specific challenge area. Nonetheless, the notion of '*timeliness*' was repeatedly observed in the data.

Furthermore, respondents indicated a high level of security and safeguarding of FEMA computing infrastructure, resulting in access to external systems being blocked by firewalls. Most notably mentioned was the inability to access the Google platform, which NOAA/NWS utilizes extensively. Along with firewall restrictions, data analysis determined that strict software guidelines tend to cause compatibility issues. In turn, this presents an obstacle for running certain interfaces and tools and limiting access to some systems. Additionally, maintenance of such infrastructure requires a consistent flow of updates to implement the most current security upgrades. Although necessary, respondents indicated that they often result in workflow delays and a variety of potentially time-consuming errors during the installation process.

Lastly, within the equipment realm, not communication or infrastructure, respondents also discussed malfunctioning gauges and hydrograph/data issues. Interruption of gauge monitoring systems were indicated to be problematic for accurate assessment completion. For example, a non-reporting gauge in a flooded area inhibits impact assessment, while erroneous data may result in unexpected consequences. Provided the technical expertise required to address this specific concern and all of the challenges in this category, resolution recommendations are not provided for these areas.

Summarizing, dependence on technology availability and functional communication is critical. Loss of or damage to equipment or towers (i.e. - radios, phones, computers, etc.) and disruption of services, internet, signal, etc., poses a significant operational challenge. These complications often accompany disasters, resolution of which, even if temporary, will facilitate responders' abilities to assist survivors (i.e. – repaired/replaced devices, rebuilt/re-established infrastructure, restoration of services, etc.). Examples where this is most valuable includes rescue operations, supplies (i.e. – food, water, etc.), casualties, evacuations, and life-threatening hazards (i.e. – hazmat incidents, weather, power lines, etc.).

Not specifically addressed in this work, several communication influencers were also described in the data as contributing factors that pose a hindrance to effective and efficient communication, situation awareness, and decision making. Intermingled amongst the survey and interview feedback responses, notions mentioned were uncertainty, accuracy, reliability, credibility, trust, apathy, validation, verification, and confidence. Often affiliated with one another, these elements contribute to information utilization and communication (reception and dissemination) aspects. Ethereal by nature, these areas are difficult to overcome yet pervasive throughout information management and communication processes. Despite the inability to completely eradicate these factors, measures to limit the effects can be implemented.

One of the more widely known challenges of communicating weather and climate information revolves around the inherent uncertainty within forecasts. Review of the data identified a desire for forecast uncertainty to be explicitly expressed, yet many respondents indicated it was either lacking or not well understood. The 'unknown' or 'misunderstood' uncertainty is difficult to convey when communicating threats to leadership and partners. Although person dependent, responses indicated that sometimes leaderships' lack of understanding further exacerbates the problem. While forecast uncertainty is expressed, hazard variance and probabilistic conveyance is challenging. Understanding is deficient due to the variation between hazards combined with the statistical nature of uncertainty. Responses indicated textual or less statistical uncertainty notions are of greater value and preferred as they are more easily understood. Additionally, complexity of such scenarios is non-trivial, yielding further complications.

Furthermore, forecaster/forecast confidence and within oneself in regard to interpretation and analysis, was also regarded as an influencing factor, along with accuracy among forecasts and predictions. *"At FEMA there is a demand for fast, accurate weather information and data. Understanding the accuracy and limitations of forecasts is helpful for relaying information",* noted one individual. Provision of weather forecast accuracy in general, prior to an event, as well as event specific concerns enhances understanding, facilitating the communication and decision making processes. Beyond forecasting, accuracy along with reliability of information and reports/reporting is important. As one respondent noted, this is of particular concern for *"rural areas, where timely information on conditions can be limited and the flow of information slow."*

Hazardous weather and disasters often amplify miscommunication of accurate, reliable information. Resulting from technological innovations and the rise of social media, an overabundance of information is readily available through a multitude of outlets, both official and non-official. Therefore, while this influx facilitates information collection, *"validating and verifying information and reports in a timely manner"* has been hindered. Although, official partner or media sources are primarily utilized by FEMA versus other open source outlets, non-factual or unsubstantiated information and reports remain problematic. For all reported information, one must *"determine who/where is this coming from and locate a source to validate it."* Likewise, trust and credibility, dependent upon one's experiences, perspective, etc., among sources was also discussed within the data as an influencing/guiding factor, particularly as it relates to accuracy from their perspective.

CHAPTER 6: FINDINGS AND CONCLUSIONS

Chapter 5 provided an overview of the data analysis and results from the surveys and interviews of FEMA personnel I conducted for this study. Subsequently, this chapter extends the analysis by providing additional findings and conclusions through an in-depth review of the results from the perspective of the conceptual framework I proposed in Chapter 4. In particular, this analysis and review focuses on the applicability of the framework at the Federal level by providing an initial FEMA decision making model through the phases of CEM including decisions/actions and influencers as assessed from the data (section 6.1), a discussion of identified information and communication flow and proposal of an adaptation of the CERC communication model applicable to FEMA (section 6.2), an overview of identified FEMA weather utilization (section 6.3), an overview of the identified FEMA situational awareness structure (section 6.4), and ending with findings of FEMA personnel weather usage experience and training background (section 6.5).

The major questions this research sought to answer were: (1) How is weather information utilized within FEMA?, (2) What are the primary elements and influencers of FEMA leadership decision making regarding weather?, and (3) How can FEMA best prepare for disaster operations for weather events? To address these questions, I investigated the following:

1. What is the FEMA decision making process?
    a. What are the key elements FEMA requires for decision making?
    b. What are their decisions/actions/thresholds?

c. What factors influence decision making?

d. What are the policy implications?

2. What is the communication flow of weather information at FEMA?

a. From whom/where do they receive information?

b. To whom/where do they disseminate information?

c. What are the communication challenges?

d. How can communication be improved?

3. How does weather information influence decision making within FEMA?

a. How do they utilize weather information?

b. What are the critical pieces of information? Why are they critical?

c. What information resources/channels/mechanisms do they utilize?

d. What are the challenges associated with weather information?

4. How does FEMA maintain situational awareness?

a. What impacts are they most concerned about? Why those impacts

b. What is their situational awareness structure?

c. What are the barriers to maintaining situational awareness?

d. How can enhanced situational awareness be accomplished?

5. What is the status of weather knowledge and training among FEMA?

a. What is their weather experience/background?

b. What weather training have personnel received?

c. What weather training is available?

d. What weather training is needed?

Data collection for this study occurred through a variety of mechanisms including surveys, interviews, observations, literature and policy reviews, evaluations, and existing weather and disaster databases. Analysis of the data provided a vast amount of insight into these questions, from which, I was able to formulate a wide spectrum of FEMA weather information processes including utilization, communication, situation awareness and decision making. Results of this work provide substantial foundational knowledge to build and expand upon for emergency management as a whole within academia. This is particularly valid for FEMA, as there is currently not a substantial body of knowledge in existence.

6.1 FEMA WEATHER DECISION MAKING THROUGH CEM PHASES

The contribution of weather information within the decision making process at FEMA is fundamentally mission critical and pervasive across all areas. Having discussed the many relevant components and processes relevant to the proposed conceptual framework of FEMA decision making, this section provides additional context and an overview of FEMA decision making (Q#1) including: (a) key decision elements, (b) decisions/actions, (c) influencing factors, and (d) decision support/policy implications.

6.1.1 WEATHER INFORMATION AND DECISION MAKING

Study participants consisted of various roles across FEMA from within situational awareness, operations, planning, historical preservation, threat, hazard, and risk assessment, disaster assistance, and field operations, among other roles. While participants occupied various roles, usage of weather information was required in a multitude of ways that were positionally dependent. Based on analysis, the inherent value of weather information within FEMA and among partners is evident. Specific to decision making, weather information was incorporated through a variety of decision making elements. Included among them are as follows:

- **Threat Monitoring:** situational awareness, potential immediate/long term threats/impacts from upcoming weather, potential after affects/impacts, life safety, operational impacts, what will lead to secondary disasters?
- **Assessment:** event/incident assessment, level/scope/severity of event, debris/damage assessment/management
- **Mission:** field applications/relevance to impacts to FEMA operations, how does this impact my region/impacts for FEMA, difficult to see how FEMA would respond/how do 'we' respond
- **Support:** State/local resource needs/gaps, what are the unmet needs?, State/local capacity, assessing necessary needed assistance, those events that may involve FEMA
- **Operations:** prior recovery operations, effect/impacts on current operations, government closure, status notifications, field operations
- **Assistance:** potential for declarations/requests for assistance/FMAG declarations/requests
- **Life Safety:** travel (smoke/visibility, debris, winter weather, floods), ongoing operations, potential threats

- **Resources and Personnel:** people/deployments (staff RRCC, deploy IMAT, deploy to field offices), resource movement/supply delivery coordination

Threat monitoring and assessment of, were identified as the first steps of the decision making process toward understanding what if any decisions need to be made according to the mission. The primary areas identified include needed support, operational impacts, disaster assistance administration, life safety, and resource and personnel management. First and foremost, the most significant factor determined regarding FEMA decision making is assessing capacity and providing required support to State, Territory, Tribal and local jurisdictions before, during and after a disaster. As a result, all of the other factors either contribute to or depend on the level/type of support needed. Through the assessment of an event or potential event, the extent of the possible disaster and impacts can be determined which will guide the disaster assistance process. Depending upon the outcome of the qualification of disaster assistance, resources and personnel can be allocated appropriately to establish operations accordingly. Throughout this process, life safety of both survivors and personnel was determined to be important and is continuously monitored. Additionally, threat monitoring and assessment was also identified as being critical before an incident occurs, to provide situational awareness of potential disasters and possible requested support and/or assistance as well as during and following a disaster for secondary impacts.

Decision making influencers will be discussed in a follow-on section. However, all of the aforementioned factors emerged from the data analyses as contributing to the FEMA decision making process and thus require utilization and a good understanding of weather and climate information and data as a whole. Findings revealed that different roles and phases of a disaster require different decisions to be made and actions to be taken. Many of these activities frequently happen concurrently yet can be more cyclical in nature and may be revised as things change or more information becomes available.

6.1.2 DECISIONS AND ACTIONS

Data analysis revealed that activities at FEMA constitute a vast amount of short- and long-term decisions and associated actions requiring different informational elements. Although the decision making process itself was found to be consistent, the decisions themselves were more fluid. Feedback discussion often centered on damage incurred, impacts/potential impacts, threat, and State/Tribe/Territory requests. Overt discussions of concrete decision thresholds within the data were limited as respondents indicated that decisions were often subjectively dependent upon various factors. A variety of aspects influenced the process, as is discussed in the next section, complicating the process and making it difficult to standardize policies and procedures. Essentially, each scenario is unique with different contributing factors. However, the decisions themselves were indicated to remain fairly constant. Based on the analysis, a preliminary FEMA descriptive decision making model through all stages of the disaster lifecycle/CEM was developed. Described below in Table 6.1, information usage and decisions/actions vary between CEM phases/FEMA divisions.

PHASE	DESCRIPTION	INFORMATION	SOURCE	DECISION/ACTION
MITIGATE	Assessment, prevention, elimination and reduction of risk, impacts from hazards and disasters.	Historical data/record Past events/impacts Local climate information Flood stages/impacts	NOAA/NWS NOAA/NCEI USACE USGS State/Tribe/Territory	Project eligibility NFIP guidelines Award grants Prioritize focus
PREPARE	Exercises, training and educational activities to enhance disaster response capabilities and risk/ hazard awareness.	Threat/Hazard information Climate information	NOAA/NWS Private Sector Academia Educational Institutions State/Tribe/Territory	Exercise development THIRA Outreach options Training efforts
RESPOND	Planning for and management of the impacts from a hazard and support of disaster relief operations and life safety.	Forecast/Predictions Current conditions Watches/Warnings GIS data Reservoir capacity Potential/Impacts Projections	NOAA/NWS USACE USGS State/Tribe/Territory ESFs/Partners Media/Social Media/Apps Private Sector	Planning Monitor/Awareness Alert/Deployments Life safety/travel Resources/Tracking Assessment/GIS Operations/Field Logistics
RECOVER	Repairing, rebuilding, and restoration of services, infrastructure and property from damage due to impacts sustained from a hazard in support of disaster resiliency.	Forecast/Predictions Current conditions Watches/Warnings GIS data Event summaries/status Antecedent conditions Damage/Impact reports	NOAA/NWS USACE USGS State/Tribe/Territory ESFs/Partners Media/Social Media/Apps	Damage assessments Declarations/Requests Disaster assistance Project eligibility

Table 6.1. Initial descriptive FEMA decision making model through CEM phases based on survey and interview data analysis. Created by Somer A. Erickson.

6.1.3 INFLUENCING FACTORS

Data analysis determined that the FEMA weather decision making process was similar to the process for all hazards and hazard types. To start with, Leadership must assess the threats and determine personnel, resources, posture, support, and assistance needs, among others. Tasked with a critical life safety mission, FEMA is a highly visible entity and their efforts are profoundly scrutinized. Designated with a multitude of functional facets which complicate the decision making process, a myriad of influencing factors emerged from data analysis conducted and are categorized as follows: (1) organizational, (2) individual, (3) operational, (4) informational, (5) impact, and (6) hazard. In addition, new information, event occurrence, and greater needs were also identified as influencing actions as they may cause a change in priorities, options or needs (Figure 6.1).

Hazard factors identified include the actual hazard, timing, location, intensity, extent, likelihood and duration. The hazard itself was determined to be important to guide efforts and anticipate possible needs (i.e. – hurricane vs. tornado). Timing and location were deemed important as they may pose further complicating factors, while intensity, extent, and duration contribute to possible impacts. Additionally, the likelihood of an event was found to influence whether to act or not; however, the likelihood may also cause uncertainty. As a result, this uncertainty was found to hinder or delay decisions. Hence, a balance among components must be considered as leadership indicated that some decisions are required before and acceptable certainty level is garnered.

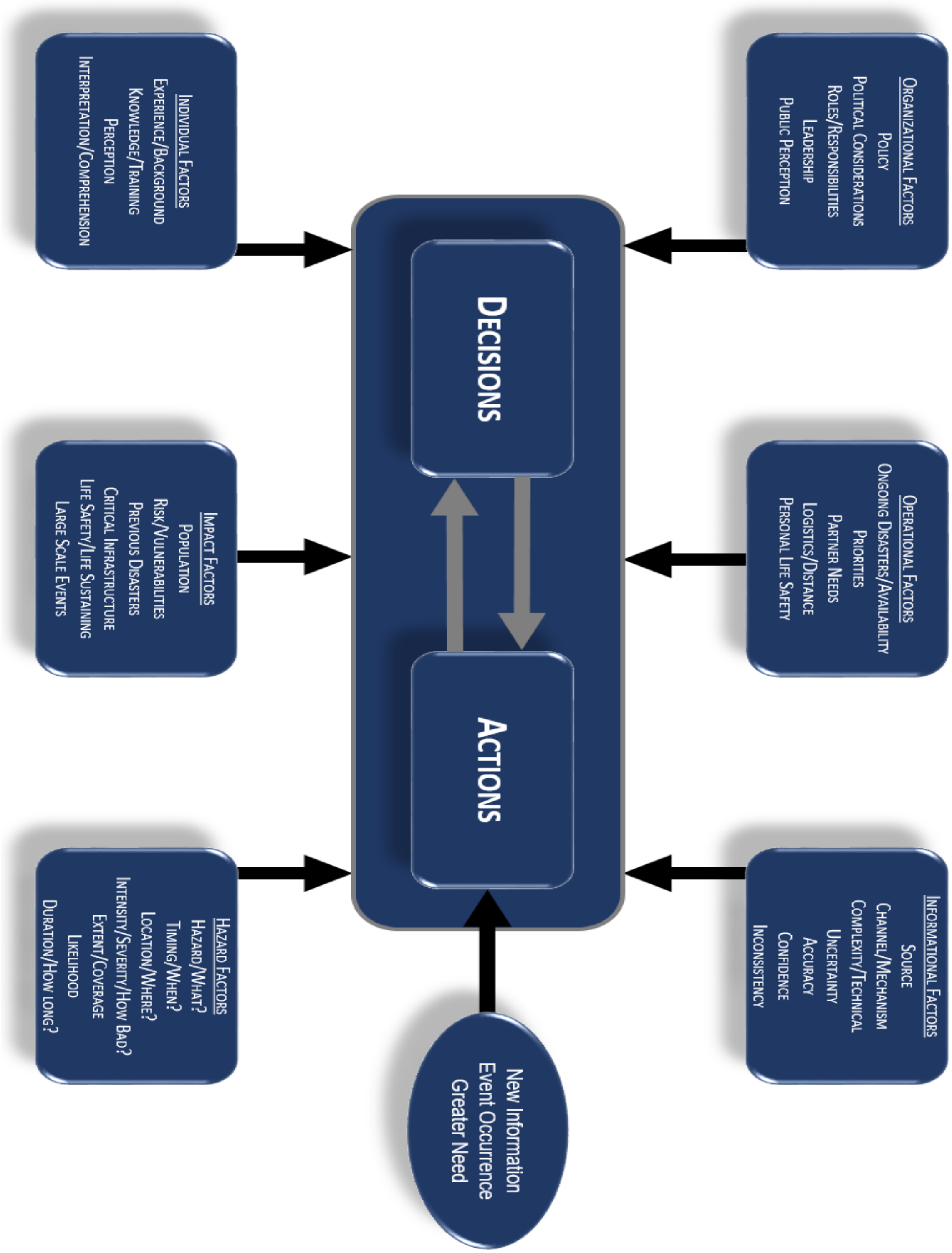

Figure 6.1. Identified FEMA decision making influencers resulting from survey and interview data analysis conducted. Black arrows indicate influences, while gray arrows indicate a feedback loop between decisions and actions as needed based on new information, event occurrence or greatest need. Created by Somer A. Erickson.

Through leadership interview data analysis, FEMA involvement was found to depend greatly on the severity and dispersion of human impacts, with further identification of important factors as those that cause or have the potential to cause greater impacts. Impact factors identified included population, risk/vulnerabilities, previous disasters, critical infrastructure, life safety/life sustaining, and large-scale events. The greater the population, the greater potential impacts and assistance required, including large scale events such as major sporting events, concerts, political conventions, etc. Existing vulnerabilities or those induced by previous disasters were also deemed a concern as they pose a threat to life safety and affect required support. Provided that a significant portion of the FEMA mission is dedicated to aiding recovery towards resiliency, impacts to and restoration of critical infrastructure is extremely influential.

On a related note, data analysis revealed that informational factors such as source, channel/mechanism, complexity/technical, uncertainty, accuracy, confidence and inconsistency, also influence FEMA decision making. The source of information was found to be related to credibility. If a decision maker believed one source to be more credible than another, then they perceived the information differently. Furthermore, uncertainty and accuracy were mentioned in the data as contributing to credibility, while confidence in the information provider was also distinguished as influencing decisions. Lastly, information inconsistencies further lead to uncertainty, while complex or technical information is difficult to understand. Misunderstanding information can lead to faulty decision making and subsequently negative consequences.

Data analysis of leadership interviews determined that translating these decisions into actions creates additional operational considerations including ongoing disasters/personnel availability, priorities, partner needs, logistics/distance, and personal life safety. Ongoing disasters can limit personnel availability at times, which may require additional support from another FEMA regions or headquarters. Hence varying support efforts such as life safety vs. stabilization were found to influence prioritization and decisions. One scenario provided in the data concerned logistics, as travel distance requires advanced consideration, decisions may need to be made on a specific timeline. For example, a tropical system impacting an island will cause a greater amount of logistical issues than a landlocked region with multiple access points. In reference to any operational decision, one member of leadership noted that "*first and foremost is personal safety*."

Furthermore, both individual and organizational factors were identified as influencing FEMA decision making. Individual factors revealed from the data analysis include experience and background, knowledge and training, perception, and interpretation, and comprehension. Organizational factors identified include policy, political considerations, roles and responsibilities, leadership, and public perception. The decision makers experience or background with weather information and events along with knowledge and training influences perception, interpretation, comprehension, and self-efficacy. Beyond the individual are the organizational influences. Roles and responsibilities of the decision maker as well as leadership input were discussed as guiding establishment of priorities. Often, these priorities are also driven by associated policy and doctrine. Additionally, public perception may contribute to decisions made and actions taken in certain circumstances. One example provided in the data is the notion of leadership deploying personnel to a State for the duration of a potential incident should any need arise. Having on-site personnel shows solidarity with the State and is often viewed favorably. Furthermore, data analysis assessed the influence of politics and political agendas as being intertwined at the highest levels. Further review of the data revealed that political influence at times impedes progress, yet it also accelerates progress on other occasions, depending on the scenario and political nuances.

All of the aforementioned factors were derived from the data as influencers of FEMA decision making which ultimately contributes to disaster prevention, support, and resiliency. In addition, this process also depends on developing and maintaining relevant public policies and operational procedures. Due to the interdisciplinary nature of disasters, emergency managers must act as liaisons between various departments, agencies, organizations (both non-profit and for profit), and the public in order to carry out the policies and procedures put forth in support of the FEMA mission. Review of these policies and procedures determined reliance on many individuals with varying levels of expertise requirements and whom play a major role throughout the phases of the disaster life cycle.

6.1.4 POLICY IMPLICATIONS

A variety of decision making factors and influencers were revealed through the analysis. Furthermore, all of these tasks and activities link to doctrine and policy. Unlike planning, which serves as a disaster support guide, policy provides the legal authority and formalities to accomplish such tasks. Actual discussions of decisions thresholds among the data were limited, but respondents implied they were often subjective depending upon various aspects. Although a thorough policy analysis was not completed for this study, a vast amount of Federal emergency management policy exists. Given the relationship of policy to this work, a brief overview of certain policies and legal authorities was discussed in Chapter 2.

While extensive planning, exercising, and training is imperative for effective disaster response, it also depends on developing and maintaining relevant public policies and operational procedures. Political agendas complicate matters, as there are varying perspectives and priorities including finances and public perception. Emergency management is highly politicized for two reasons, (1) disaster events affect the public and (2) the bulk of the financial support funnels through government sources. Unfortunately, emergency management issues are frequently not a high priority for elected public officials. Due, in part, to the high level of uncertainty surrounding hazards and low probability of event occurrence compared with daily concerns within a community. Best stated by McEntire (2004), "the major dilemma here is that we are confronted with a choice between more common, but less consequential events versus infrequent, but higher impact occurrences." Furthermore, McLoughlin (1985) noted that "while emergency management issues have to compete with other serious issues for the time and attention of responsible officials, decision makers must become knowledgeable of key issues in order to make informed policy decisions and to support the emergency program manager in the implementation of policy initiatives."

6.2 COMMUNICATION

Respondents indicated a need not only for situational awareness training, but communication training as well, as many felt they lack this skillset. Communication is an important element of the information-situation awareness-decision making process. Therefore, it is important to assess the communication flow of weather information (Q#2) to include (a) information reception, (b) information dissemination, and (c) communication challenges. This section not only addresses these areas, but also proposes a mechanism for (d) improving communication.

6.2.1 INFORMATION RECEPTION

Numerous sources and mechanisms, as determined through assessment of the data, are utilized by FEMA (Figure 6.2) throughout the information and knowledge management, situational awareness, and decision making processes. Among these sources, a variety of mechanisms were utilized to access weather information including (1) emails/reports, (2) briefings, (3) phone, (4) television/radio, (5) computer/internet/websites, (6) social media, (7) tools/programs/software, as well as (8) personnel. This information is then further communicated according to the process outlined in Figure 6.3, as discerned from data analysis. The two primary sets of FEMA personnel involved in this process were determined to be FEMA Watchstanders and FEMA Leadership (i.e. – administrators, division directors, etc.). In addition, field operations personnel also contribute to this process when active/deployed. Externally, States/Tribes/Territories and other partners/ESFs were found to be the primary core partnerships through which information is communicated through. Data review indicated that, typically, the ESFs do so as standalone entities, while local emergency managers communicate information to the State/Tribe/Territory, who communicates it to FEMA. Some of the supporting ESF agencies may also work with the public (i.e. – the Red Cross). Local officials connect with the public as well, as do States/Tribes/Territories indirectly through local jurisdictions, media events, community meetings, etc.

Figure 6.2: FEMA information mechanisms resulting from survey and interview data analysis conducted. Created by Somer A. Erickson.

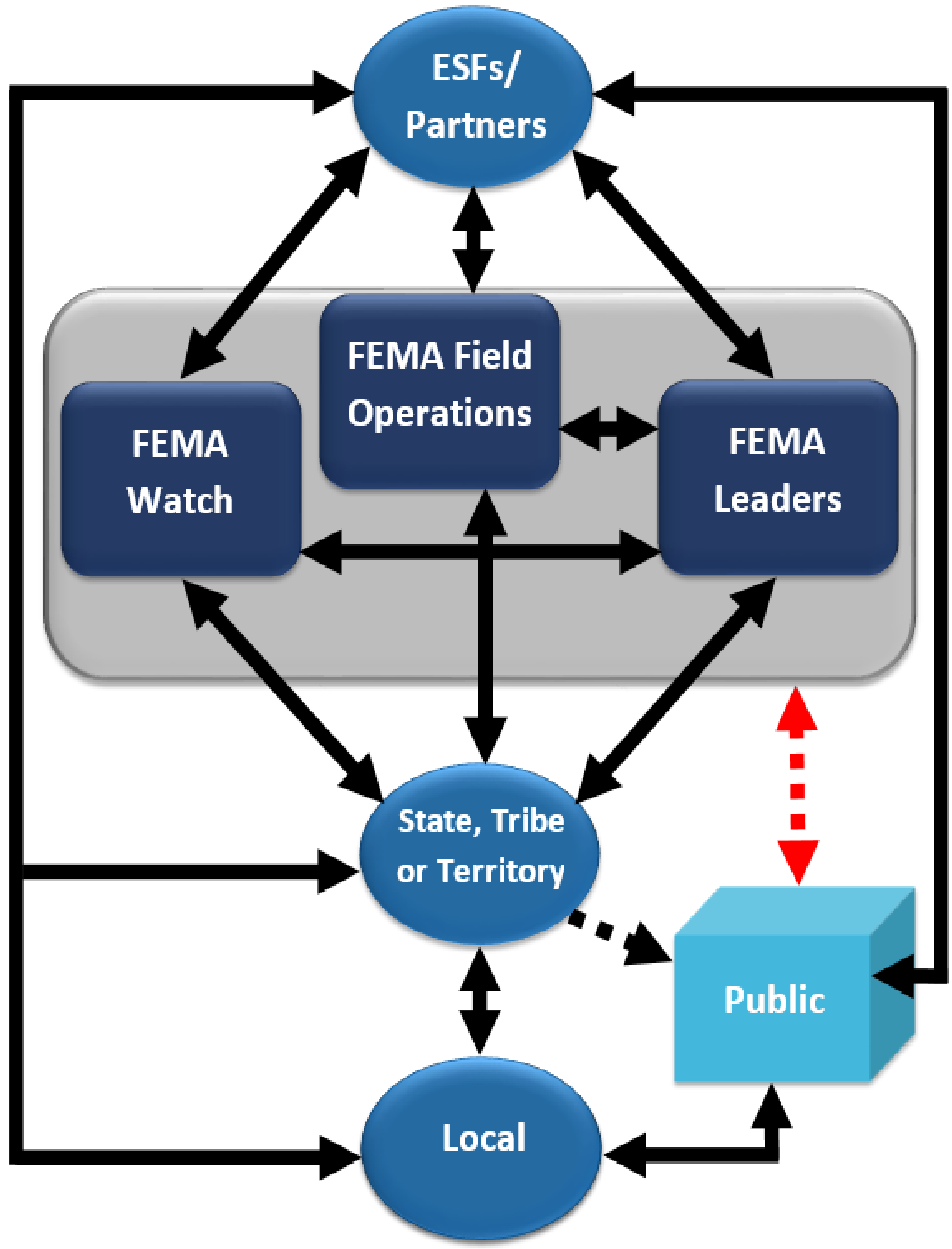

Figure 6.3: FEMA communication process based on survey and interview data analysis conducted. Solid black arrows indicate communication flow, while the dashed black arrow indicates indirect communication and the red dashed arrow indicates a disconnect. Created by Somer A. Erickson.

6.2.2 INFORMATION DISSEMINATION

FEMA respondents indicated directly disseminating information to partners/ESFs and States/Tribes/Territories. From there, relevant information is disseminated onward to local jurisdictions. However, respondents indicated that a breakdown sometimes occurs in passing information along to local officials having the State/Tribe/Territory as the conduit and vice versa. FEMA not directly communicating with local officials, at times results in information that is 'lost in translation'. Additionally, while the public may have to work with FEMA after a disaster, FEMA has not historically communicated well with the public. Information is primarily passed to the local jurisdictions through the State/Tribe/Territory to be disseminated to the public. Personnel indicated during data collection that a lack of effective communication has led to misconceptions of programs, support availability, etc. Consequentially, communication between the public and FEMA was one area for improvement identified during data analysis to facilitate greater understanding of what FEMA provides. Doing so would provide critical information to better prepare the public by enhancing awareness of disaster assistance programs, qualifications, procedures, and timelines to more effectively manage expectations. Enhanced FEMA communication could also ease the negative perception that is frequently conveyed about the agency. Not all, but many issues and concerns from the public could be remedied. Doing so before an event when communication is more readily available would be most effective, rather than after when communication mechanisms are compromised. Ideally, people should not receive such information for the first time during and after an event. However, communication during and after an event remains an important function.

Extending beyond dissemination, it is important to listen and have two-way communication. FEMA personnel indicated there is no formal, widely available mechanism or process in place to collect feedback, answer questions or address information requests from the publics, aside from Disaster Recovery Centers (DRC) instituted after an event to assist survivors and National Processing Service Centers (NPC) designated to register survivor applicants for assistance. Currently, information is collected more ad-hoc through media and social media outlets, and various engagement opportunities through committees, groups, functions, etc. Any feedback that is acquired may or may not be properly reviewed or considered by relevant personnel. However, there are several logistical obstacles hindering implementation of a standardized feedback collection system. While all of the communication channels available today (i.e. – social media) make it is easier to reach a greater number of individuals, it is far more difficult to address a large quantity of specific inputs. It can also be difficult to serve a variety of audiences as FEMA deals with multiple publics. Inundation of data would likely ensue requiring management of elicited feedback. Compilation, review, assessment, sorting, distribution, and delegation of the input would require additional personnel, resources, and support. None of which were identified as readily available.

6.2.3 COMMUNICATION CHALLENGES

Additional communication challenges identified via data analysis include (1) visuals, (2) messaging, (3) terminology, (4) dissemination and format, and (5) inconsistency. More thoroughly discussed in Chapter 5, this section provides a brief overview and extension of the communication challenges as described below.

- **Visuals:** visual graphics not available/not the graphics needed, better graphics/visuals/with radar/not user-friendly products/graphics, colors are difficult to read/color coding, need timing across region/states, region specific information/graphics/just my area of responsibility.
- **Messaging:** convey information and impacts/effective communication of threats/explain/brief weather/models in briefings/reports to senior leadership/others, knowing what to include/pass along and not to, summarizing products/information, language barriers/more Spanish products/translating information and severity.
- **Terminology:** complex information, technical forecasts/scientific lingo/too much use of technical jargon/have to spend time deciphering the language, use of acronyms, shorthand used in products, need definitions.
- **Dissemination and Format:** dissemination of information in an easy to understand/more user-friendly format/easy to understand information/format, dissemination during a large geographic response, providing and receiving important information, preparing for dissemination/briefings/reports, communication in general, jurisdiction issues/who reports what.
- **Inconsistency:** conflicting/varying/inconsistent messages/information between NWS/media/state/county, forecasters providing conflicting information/interpretation from different forecasters, conflicting reports from media/eyewitnesses, hype/sensationalism/inflation/overexcitement of media/partners/leadership, etc., de-conflicting info.

Weather graphics across the board are not consistent in terms of format, color schemes, availability, etc. They are also not publicly available to meet specific users' needs. Currently, there are no widely available graphics or forecasts specifically tailored to and designed for FEMA regional areas. This shortfall requires personnel to compile information from a multitude of sources, interpret and analyze accordingly as relevant, and utilize multiple visuals to depict the overall scenario. These activities take both time and resources to conduct and allow for potential human error. Given the non-meteorological background of most participants yet provided the critical role of communicating weather information, this was identified as a primary challenge along with messaging and terminology.

Data analysis highlighted the lack of adequate weather training among FEMA respondents with limited to no background experience working with weather products and subsequent terminology, nor do they possess an understanding of basic weather concepts and phenomena. Weather products are often complex and highly technical, making use of acronyms and sometimes shorthand. As such, it can be difficult for FEMA to understand the information, translate it, and communicate it. Adding to this conflict, respondents described encountering informational inconsistencies. Observationally speaking, inconsistencies or perceived inconsistencies of weather information and sources can be rampant at times, further complicated by hype. Emotional inputs or over/under excitement from the weather community were determined as influencers that can confuse and impact FEMA decision making, actions, and operations, especially if wide spread variations exist amongst source outlets or personnel.

Several additional communication elements were also identified via data analysis as influencing factors for communication perception. These include (1) uncertainty, (2) accuracy, (3) confidence, (4) trust, (5) credibility, (6) reliability, (7) validation and verification, and (8) apathy. Establishing trust and credibility is widely known to be important within the communication literature along with reliability. However, as weather is not an exact science, uncertainty, accuracy and confidence complicate matters. These complications motivate personnel to validate and verify information and data through other sources, which may aid in resolution or further hinder the disparity. Furthermore, repeated null or perceived null events also lead to apathy amongst all users, made more complex by each individual's perspective and perception.

6.2.4 COMMUNICATION IMPROVEMENTS: FEMA AND CERC

FEMA occupies the unique role to facilitate disaster management activities, yet they also serve as a 'crisis manager' of sorts. Although they are not responsible for the disaster event happening, they are often blamed for various components. The aforementioned discussed communication gaps contribute to this misunderstanding, consequently damaging their credibility. These gaps remain constant and therefore continually perpetuate a negative reputation. As such, communication is important for both public information, and reputation management. In the case of FEMA, while they are not at risk of losing profits per say, there are implications with regards to their ability to effectively serve the public, assist survivors, and complete their mission.

FEMA could enhance mission critical activities, public perception, and program utilization by more effectively communicating their mission (i.e. – what do they do?), processes and procedures (how do they do it?), timeframes (i.e. – deliverables), and Federal, State/Tribe/Territory and local efforts and activities (i.e. – ongoing efforts). Not only would this assist the public, but also the media, partners, etc. A communication process needs to be implemented across all phases and levels of emergency management to advance the FEMA mission of assisting those impacted by disasters through increased awareness of what can, what is, and what will be accomplished in order to elicit appropriate actions.

In the public health sector, practitioners from the CDC in conjunction with academic subject matter experts developed the Crisis and Emergency Risk Communication (CERC) framework (discussed in detail in Chapter 3). The CERC model is a good fit to be utilized in conjunction with CEM as it covers a broad spectrum of areas and is inclusive of all phases. Combining elements of both structures, a guiding framework for communication practices within FEMA and emergency management is proposed (Table 6.2). This proposed communication model serves as a companion to the descriptive decision making model discussed in the previous section. Adoption of the CERC model in emergency management for weather hazards would streamline communication across all stakeholders. It would also provide a structured framework that can be utilized for a variety of threats beyond weather and health hazards. In applying this model within emergency management, FEMA would be a good lead agency for the field as the CDC is for public health professionals. Along with training components, this model aims to improve communication effectiveness.

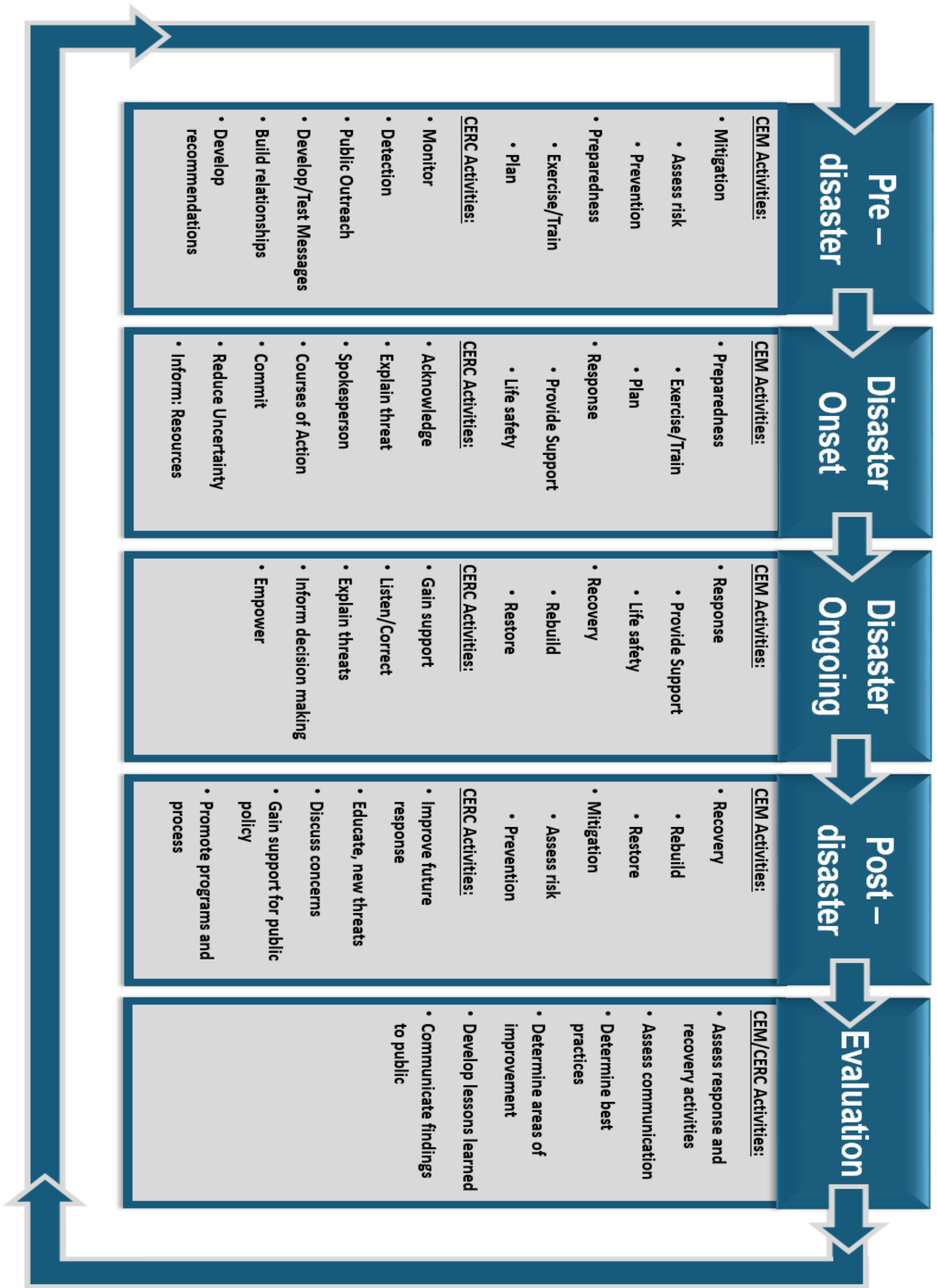

Table 6.2: Adaptation of the Crisis and Emergency Risk (CERC) model for FEMA implementation based on Reynolds & Seeger (2014) as proposed by Somer A. Erickson.

While public health and weather events are very different types of hazards, they present similar yet complex communication challenges. Both types of hazards must be managed through varying phases of risk and crisis. As is the case with health threats, when dealing with weather threats it can be difficult to motivate people to action before the threat emerges. Once a threat is imminent for either threat type, additional information is required for awareness and life safety. Realization of a threat then brings about additional response or support with continued communication and information flow to elicit appropriate actions. Following a health threat or weather event it is important to assess what happened and evaluate communication and operational activities to identify ways to advance support and improve communication mechanisms.

Following from risk and crisis communication and management and the nature of disasters, efforts in line with pieces of the CERC model are already utilized across the emergency management spectrum. However, they are done so on a less consistent and much more haphazard basis. Given the similarities between both health and weather threats, the CERC model is applicable for weather hazards, but has not been widely utilized in this capacity. Utilization of the CERC framework for weather threats is particularly valuable within emergency management and FEMA. It is within these associated agencies that all levels of public safety officials not only respond to and manage events but also must prepare and inform their jurisdictions for potential or impending threats. Maintaining communication with all types of stakeholders throughout all phases of a threat and event is crucial for success of the mission.

The CERC model emphasizes six communication principles: (1) Be First, (2) Be Right, (3) Be Credible, (4) Express Empathy, (5) Promote Action, and (6) Show Respect (Reynolds & Seeger, 2012). Each of these components are important for effective risk and crisis communication. However, sometimes these priorities conflict with one another and one may have to decide which one(s) are more important or feasible. For example, it can be difficult to be first with information if an event occurs or a threat has materialized. Additionally, there might be a tradeoff between being first and being right. Nevertheless, communicating relevant information in any capacity is still valuable. Reception of information is also going to depend on the publics' perception of the source of information, agencies or entities involved, among other areas. For this reason, working together as a team and showing solidarity with one another in all forms of public communication serves to increase the impact and strengthen credibility. Doing so will also provide a venue for standardized, consistent messaging vs. conflicting or mixed messages.

In congruence with the underpinnings and based on the nuances within the emergency management sector, the following modifications to the overarching guiding principles of the CERC model are proposed:

1. **Be Timely (First):** Make sure to communicate facts in a timely manner. First is best, yet not at the expense of accuracy. FEMA is often not the first to communicate, as they are not the originator, but rather a supporter.
2. **Be Honest (Right/Credible):** Being right, honest establishes credibility. Be sure to include what is known and what isn't and when it might be.

3. **Be Empathetic (Show Respect):** Be sure to express empathy/show respect as survivors have suffered a trauma and are likely emotional. Convey what actions are being conducted.
4. **Be Informative (Promote Action):** Provide relevant information regarding available assistance and support along with action-oriented information (self-efficacy/uncertainty).
5. **Be Understandable:** Know your audience, use common terminology and include appropriate personnel and partners.

Utilizing CERC is this context and narrowing the principles from six to five makes it a bit easier for practitioners to remember and enforce. There was also some overlap between some of the existing principles, as such, relevant areas were combined when possible. In addition, some of the principle's titles were changed to more accurately reflect the topic of each and ease memorization. These newly proposed changes provide a more refined, robust set of guiding principles for more effective communication throughout the disaster lifecycle. In conjunction with the adaptation proposed in Table 6.2, the results of these proposed modifications offer further advancement and utilization of the CERC model within FEMA and emergency management. Furthermore, CERC coincides well with the National Incident Management System and National Response Framework, previously discussed, which provides the general template for the management and structure, respectively, for all types of incidents nationwide.

Furthermore, for emergency management and FEMA, the CEM framework accounts for the CERC stages differently, yet can be categorized within.

Accordingly, the pre-disaster stage includes mitigation and preparedness, the disaster onset stage includes preparedness and response, the disaster ongoing stage includes response and recovery, and the resolution stage includes recovery and mitigation. The final stage evaluation is not specifically accounted for as a CEM phase, although it is present in various forms throughout and often carried out following a disaster. To highlight the importance of evaluation throughout all phases, and the value of incorporating those findings back into operations, activities, and efforts, I propose adding evaluation as a component within the CEM phases (Figure 6.4).

Figure 6.4: Adaptation of Comprehensive Emergency Management (CEM) based on NGA (1979) as proposed by Somer A. Erickson.

6.3 FEMA WEATHER UTILIZATION

Existing literature suggests that misaligned disaster responses are often associated with information shortfalls. However, all types of threats, hazards, and disasters involve utilization of weather information in some capacity, regardless of cause. As such, weather information and data are a critical element of FEMA decision making. To gain an understanding of how weather information influences FEMA decision making (Q#3), it is important to understand information (a) utilization, (b) requirements, (c) sources, and (d) challenges.

6.3.1 WEATHER INFORMATION UTILIZATION

Starting with utilization of weather information, the six primary areas identified in the data analysis include (1) situational awareness, (2) analysis and assessment, (3) communication, (4) planning, (5) disaster assistance, and (6) decision making. Further described below, each area consisted of several additional refinements for each category. The details of which were previously discussed in Chapter 5.

- **Situational Awareness:** Monitoring, Reporting, Briefings, Life safety of field personnel/Impact on operations, and Climate/Trends/Patterns.
- **Analysis and Assessment:** Interpretation, GIS mapping/modelling, Risk Assessment, Hazard Assessment, Threat Assessment, and Damage Assessment.
- **Communication:** communication infrastructure, development, information dissemination, and Messaging/Outreach.

- **Planning:** Crisis planning, Deliberate planning, Hazard Mitigation planning, Continuity of Operations (COOP) planning, and Develop/conduct exercise scenarios
- **Disaster Assistance:** Preliminary Damage Assessments, Develop Event Summaries, and grant determinations/eligibility.
- **Decision Making:** Posture/Activation, Resource allocation, Assess needed support/Mission Assignments, and Field applications.

Through inspection of the data, weather information utilization across the agency was found to be considerable and significant. It was determined that virtually all FEMA types of personnel are required to utilize weather information. Assessment revealed that each positional role utilizes weather information for different goals and at varying levels of complexity. One of the underlying yet extremely critical elements FEMA personnel utilize weather information for is to maintain situational awareness amongst FEMA and partners. Associated with the situational awareness component, communication of such information to a variety of users was also determined as important. More technical or advanced users within the agency indicated requiring weather information and data for more refined analysis, assessment, and mapping. All of which supports planning efforts, mitigation measures, determination of disaster assistance qualifications and eligibility, and overall decision making.

As weather information is essential across all phases of disaster, a brief overview of weather information utilization within FEMA is provided as follows, according to CEM phase:

Mitigation

During this phase, meteorological data is utilized to assess hazards in an area and when combined with vulnerabilities, understand the potential impacts. Jurisdictions use these risk assessments to identify and prioritize any necessary projects and formulate or modify relevant policies and/or plans accordingly.

Preparedness

During this phase, weather information is utilized to assist emergency management and the public alike. Emergency management officials utilize weather information for planning purposes, based on the risk assessment, and for conducting outreach with the public. Planning activities support response efforts by ensuring a coordinated response while educating the public regarding the hazards they face and precautions to take for their safety.

Response

When the need arises to respond to an incident, monitoring weather conditions is necessary to ensure safety and identify any additional threats for both responders and survivors. Weather information is also used to determine required response level and provide any necessary support and assistance.

Recovery

As in mitigation, meteorological data and associated risk assessment during recovery can identify any new projects and assist with formulation or modification of plans/policies accordingly. It also aids in the effort to restore communities after an event has occurred and rebuild them more resiliently.

6.3.2 INFORMATION REQUIREMENTS

Information requirements identified consisted of four primary components (1) weather information, (2) non-weather information (i.e. – environmental), (3) communication items, and (4) impacts. Each component consisted of additional sub-components, as listed below. Furthermore, an extensive amount of specific informational requirements emerged from the data which are categorized within each sub-component which were previously discussed in more detail in Chapter 5.

- **Weather Information:** Historical Data, Forecast/Predictions, Current Conditions/Situation Overview
- **Non-weather information:** General Information, Time of year, Confidence/Uncertainty, Topography/Terrain, Flood maps/plains, Levee/Lock/Dam data
- **Communication:** Visuals, Overviews/Summaries, Outreach/Education
- **Impacts:** Consequence Management, Life Safety, Human, Critical Infrastructure, Property Damage, Insurance Losses, Environmental, Agriculture and Livestock, and Economic.

Identified weather information requirements were easily categorized into (1) historical data, (2) current conditions, and (3) forecasts/predictions. Related to, but not comprised within the weather information component were a few additional non-weather factors, to include those within the environmental system (i.e. – what, where, time of year, etc.). This sub-component also included areas such as topography, flood plains, levee systems, etc. As information was determined to be communicated to a variety of audiences and users, elements of communication were also implicated as requirements, such as (1) visuals, (2) verbiage, and (3) outreach products. Lastly, provided the mission of FEMA, impact information was crucial for decision making and action taking. Discussed more extensively in Chapter 5 and below, the overall impact components included life safety along with infrastructure and property damage.

6.3.3 SOURCES OF INFORMATION

A multitude of sources to acquire weather information and data were referenced by FEMA respondents, as depicted in Figure 6.5. Primarily, the internet and television were listed as the most frequently accessed mechanisms along with partners (i.e. – NWS, States, ESFs, etc.). The distribution of sources and mechanisms is a reflection of personal preference, role and responsibility, tasks/goals, along with location and conditions present when accessing weather information. For example, field personnel conducting damage assessments were determined as more inclined to utilize phone apps for personal/life safety vs. a Watchstander who monitors all venues of information from a specialized, uniquely designed, and technologically advanced facility.

- **NWS:** National, Region, and Local websites, calls, briefings, and tools
- **Television/Radio:** local and national
- **Social Media:** Facebook and twitter
- **State EM offices:** web systems, EM calls, and local officials
- **Private sector:** internet, apps, and software
- **Open source media:** photos and videos
- **Apps:** FEMA, Local/national media, and private sector

- **FEMA:** briefings, reports, liaisons, and the field
- **Other Agencies:** USGS, USDA, USFS, USACE, NASA, NWCG, NIFC

Figure 6.5: FEMA sources of information resulting from survey and interview data analysis conducted. Created by Somer. A. Erickson. (Note: National (NA), Regional (RE), Local (LO), Facebook (FB), Twitter (TW), Weather (WX), Other (OT)).

6.3.4 WEATHER INFORMATION CHALLENGES

Multiple sources of information and communication mechanisms can be helpful, yet they can also pose a challenge for navigation, communication and information collection, processing, and management. The most frequently mentioned issue was locating information and navigating resources. Many respondents indicated that there was too much information, that it was not always well understood where to get it from, and that they had to collect information from too many different resources. Once information is located, it was also determined that it is not always well understood, as they had difficulty interpreting and analyzing the information and subsequently communicating the information. As FEMA regional offices are nationally and regionally based, they are not usually located in the disaster area or are as familiar with an area as would be ideal. This adds an extra layer of complication to correctly assessing a situation as some of the demographics, vulnerabilities, and local nuances may not be easily or adequately captured or accounted for in the decision making process. Beyond these components, equipment and technical issues proved to be a challenge either preventing access or stymieing the process. Although equipment and technical issues along with website design complexities are difficult to overcome beyond the organizational level, both internally and externally, other problem areas identified can be addressed through training, decision support, and enhanced product development.

- **Resource Navigation:** data collection, resource availability, too many resources, and products and alerts

- **Knowledge and Understanding:** roles and services, prioritizing hazards and threats, weather phenomena and basic meteorology concepts, weather phenomena, and education and training
- **Interpretation, Trends and Analysis:** informational and geographical, interpretation, analysis, demographics and vulnerabilities, and impacts
- **Communication:** visuals, inconsistency, dissemination and format, messaging, and terminology
- **Equipment and Technical:** timeliness, security and compatibility, and equipment

6.4 FEMA SITUATIONAL AWARENESS

Maintaining situational awareness was deemed instrumental throughout the decision making process and CEM phases. As such, it is important to understand how FEMA maintains situation awareness (Q#4) to include (a) important impacts, (b) situational awareness structure, (c) barriers, and (d) improving situation awareness. This section not only addresses these areas, but also proposes recommendations for (d) improving situation awareness within FEMA.

6.4.1 IMPACTS

Not only has weather information been deemed an important component of FEMA decision making, but impacts as well, as they contribute significantly to situational awareness for potential response. Impacts significantly drive emergency management and FEMA activities, which guides and facilitates the decision making process. Primarily discussed within the data were impacts that influence life safety and sustainability, hinder response and recovery operations, and preclude resiliency. Although assessed among different weather hazard types (i.e. – winter, severe, etc.), data analysis revealed general similarities in the results. Consequence management as a whole was referenced, to include analysis, overall impacts, and areas of impact (Figure 6.6). Some respondents discussed these aspects in more general terms, while others provided specific details. Two main areas identified include life safety/human impacts and infrastructure/structural damage. In addition, there was also mention of environmental, agricultural, and economic impacts along with discussion of insured vs. uninsured losses in reference to the NFIP. A more detailed discussion of impacts is also provided in Chapter 5.

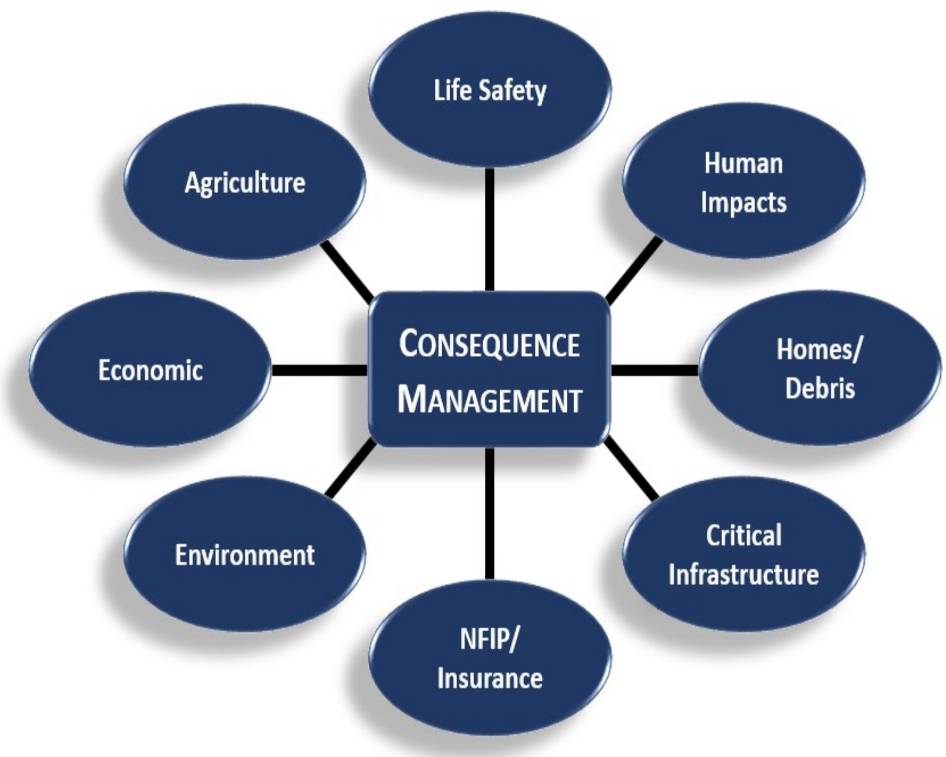

Figure 6.6: FEMA impact concerns resulting from survey and interview data analysis conducted. Created by Somer A. Erickson.

- **Consequence Management:** analysis, overall impacts, areas of impact
- **Life/public safety, life sustaining, threat to public, lives/mass casualties/life losses, personnel/field safety**
    - public health/healthcare
    - evacuations, routes, transportation, ability to evacuate in time
    - mass care: sheltering needs, survivors, evacuees, food and water
    - stranded people/water rescues/rescue operations
    - emergency services/medical care
- **Human impacts:** communities/population centers/people/urban areas/rural areas, affected/displaced/homes displaced, vulnerabilities/functional needs
- **Critical Infrastructure:** schools, hospitals/medical, dam/levee breeches/failures, transportation (roads, barges, rivers, ports, railroads, airports, shipping, closures, navigation), utilities (nuclear, oil and gas, electric generation/power outages/downed lines, water and sewer)
- **Property/homes/damage/protection of property/structure damage/amount of debris/debris management**
- **Individual vs. public losses, NFIP/uninsured damage/rebuilding per NFIP/compliance**
- **Environment impacts**
- **Loss of livestock/animals/pets/agriculture/plant impacts**
- **Economic impact/private sector/lost businesses**

6.4.2 SITUATIONAL AWARENESS STRUCTURE

The situation awareness process consists of three primary stages (1) perception, (2) comprehension and (3) projection (Endsley 1988), utilizing inputs from the environment and decisions/actions as outputs. Included within the conceptual framework I proposed in this study, the information system serves as the mechanism that processes environmental inputs to produce standardized, refined, and explainable inputs for the situation awareness process. Furthermore, the situation awareness structure refers to the overall system in place to support and maintain situational awareness, with communication pivotal throughout.

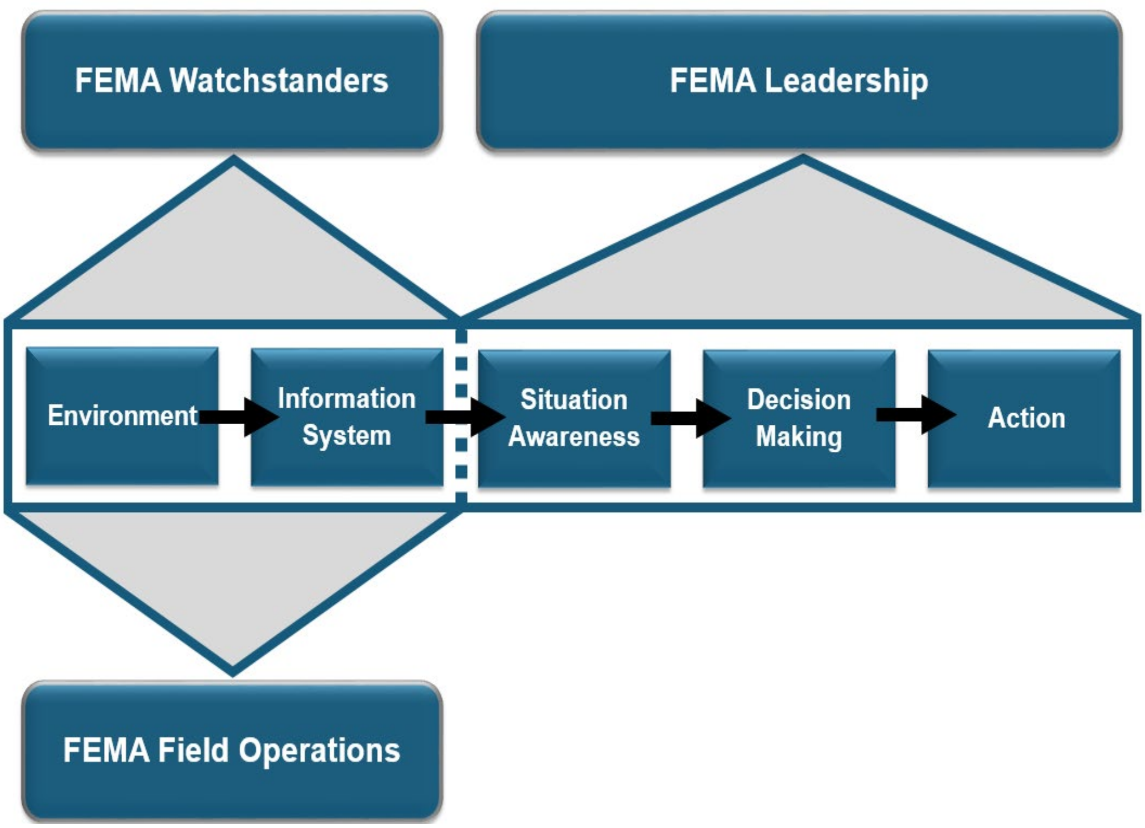

Figure 6.7: FEMA situational awareness structure as determined from survey and interview data analysis conducted. Dashed blue line indicates the separation between inputs and application as well as a transition from non-leadership to leadership roles. Created by Somer A. Erickson.

Maintaining situational awareness is a significant function within FEMA, in fact it is incorporated into the NRF (2008). Comprehensive, timely, and understandable information and visuals were deemed imperative for FEMA decision making. Incorporating a variety of elements, partners, and sources, the system is designed to ensure effective, efficient, and consistent processing, output, and flow. Based on data analysis, the overall FEMA situational awareness structure (Figure 6.7) relies primarily on Watchstanders and field personnel to manage the information and produce systematic outputs for Leadership. The structure relies heavily on information and knowledge management processes and utilizes WebEOC software, a Crisis Information Management System (CIMS), as a repository.

The FEMA information management process identified consist of five primary elements (1) monitor, (2) collect, (3) interpret, (4) analyze, and (5) disseminate (Figure 6.8). These elements are congruent with the Incident Command System (ICS) which (1) collects (monitor and collect), (2) evaluates (interpret and analyze), and (3) disseminates information (DHS, 2017c). A variety of information sources are monitored throughout this continuous process. Data and information are collected, interpreted, and analyzed from among the various sources as relevant. The newly created information is then compiled and disseminated. Once received by leadership, the information is then processed into knowledge and situational awareness through the three stages of (1) perception, (2) comprehension, and (3) projection (Endsley 1988).

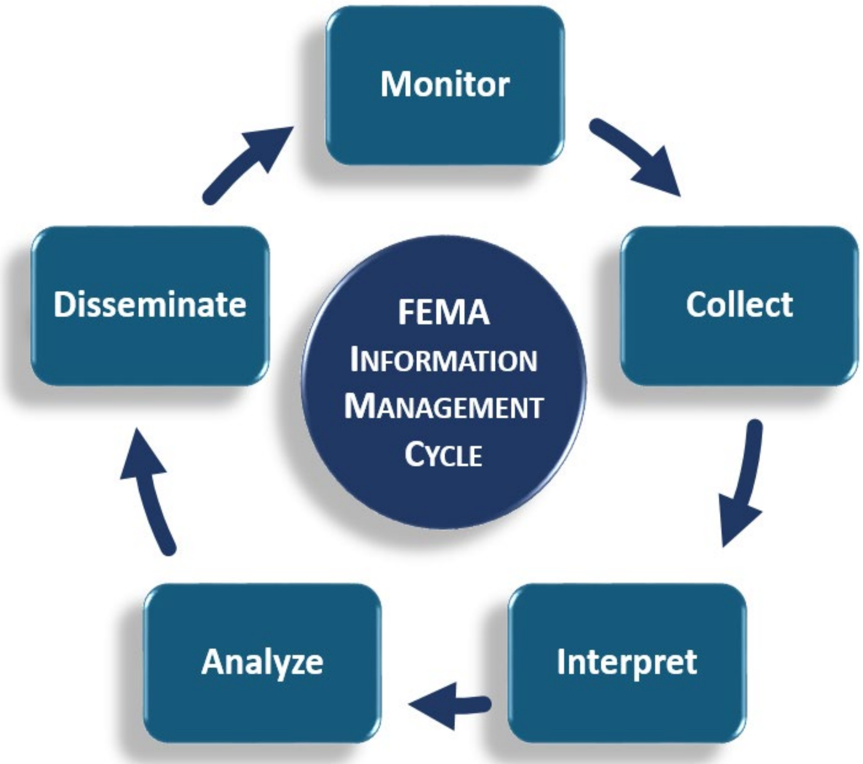

Figure 6.8: Continuous and constant FEMA information management cycle as determined from survey and interview data analysis conducted. Created by Somer A. Erickson.

6.4.3 SITUATIONAL AWARENESS BARRIERS

Identified barriers in maintaining situational awareness consist of a variety of aspects ranging from issues associated with knowledge and information to perception and comprehension to technological. First, knowing what sources to monitor and what to monitor was a concern as something might be missed or overlooked. In relation, it was identified that being able to navigate resources in a timely manner as well as determine availability of required information was important. Inability to locate information or impacts or unavailable information or impacts hinders the overall process. Too many resources complicates the process further, timewise, and injects uncertainty. Likewise, too much or too little information produces the same results. Once information is located, having an understanding of basic weather concepts and terminology for appropriate interpretation and analysis is critical. In addition, analysis and projection depend on knowledge of geographical and topographical features along with demographics, vulnerabilities, and local nuances. Furthermore, the communication and dissemination of information throughout this process was deemed essential in the data, yet can be problematic due to inconsistencies, lack of relevant/understandable visual displays, and overall effective communication practices. Furthermore, all of these identified areas can be compounded by technological and equipment failures as well as incompatibility between partner systems and vice versa.

Further complicating this process, Watchstanders, field personnel, and leadership all indicated receiving information from a variety of sources and mechanisms. Respondents also identified as having different experiences and training backgrounds, which further contributes to their interpretation, perception, comprehension, and projection as relevant. Some of these influences overlap among the three groups which allows additional opportunities for the system to breakdown. If something breaks or is incorrectly interpreted, analyzed, applied, or conveyed, the error could be perpetuated to the decision making and action stages with potentially devastating results. Additionally, uncertainty can result from a number of factors, such as weather information, understanding and comprehension, interpretation and analysis, projection, etc. Effectively communicating this uncertainty can also be quite difficult as well as managing it during the decision making process.

6.4.4 IMPROVED SITUATIONAL AWARENESS

Enhanced mechanisms for ensuring and maintaining 365/24/7 effective situational awareness were put into place following Hurricane Katrina as a result of PKEMRA (2007). Since then, FEMA has been working to standardize the facilities, personnel, functions, operations, policies, and procedures. Two problem areas identified in this study were standardization differences and training. Regions with fully functional, operational, and dedicated 'Watch' centers, were observationally notably more knowledgeable, thorough, skillful, and proactive in comparison to those that are not. Thus far, six of the ten regions plus headquarters have been standardized, leaving four regions more vulnerable. Some of the elements of the standardization effort continues; however, leadership has since changed along with priorities and budgets. Emphasis on continuation of the full standardization process to remain a priority is recommended to enhance situational awareness for those four regions and to better serve FEMA partners and constituents. Not only would this assist with situational awareness in those areas, but since the agency/regions are interconnected, it would enhance communication, situational awareness, and decision making agency wide.

Additionally, despite weather playing such a crucial role for the FEMA mission, weather experience and training is lacking within the agency with limited access and availability. Training development and requirements provide the necessary knowledge and skills required for working with weather. However, varying types of training and exercises is needed for the different levels and users. The training developed in conjunction with this study and discussed in detail in Chapter 7, serves as a foundational module for all types of personnel. Shorter, topic-based components designed for leadership in order to better serve their limited time availability and informational requirements have also been developed and are starting to be piloted. Assessment also revealed the need for an advanced module for higher end GIS, data intensive, analytical, and technical users as well as refresher modules for personnel to maintain currency. The latter two modules are currently in development. Furthermore, awareness through participants, announcements, and conducted offerings has grown, garnering interest in adaption and tailoring of these weather training modules for other audiences, which I have also addressed and continue to do so upon request.

6.5 FEMA WEATHER EXPERIENCE AND TRAINING

First and foremost, training was determined to be an integral component of the initially proposed communication, situation awareness and decision making conceptual framework (Figure 4.1). As such, primary emphasis was placed on understanding current weather experience of FEMA personnel, training availability, and potential needs to support development of training elements. Chapter 7 discusses the weather training development in more refined detail. However, this section provides an overview of the overall status of weather knowledge and training among FEMA personnel (Q#5), based on survey and interview data analysis, including: (a) experience, (b) previous training, (c) available training, and (d) needed training.

6.5.1 EXPERIENCE AND BACKGROUND

Experience and/or background play an important role in the decision making process as contributing factors of risk perception. Additionally, education also effects interpretation, comprehension, and understanding of the threat and decisional outcomes. Experience wise, of the defined ranges, ~40% overall indicated having five years or less of weather experience, with ~15% indicating more than twenty-five years, most of whom indicated military tenures (Table 6.3). Educationally, ~83% of survey participants had acquired at least a bachelor's degree (Bachelor's ~46%, Master's ~37%, Doctorate ~1%), with ~12% less than.

WEATHER EXPERIENCE	TOTAL
Less than 1 year	11%
1 to 5 years	29%
6 to 10 years	15%
9 to 15 years	16%
16 to 20 years	3%
21 to 25 years	7%
More than 25 years	15%
No Response	3%

Table 6.3: Total survey participants weather information usage experience based on results from the data analysis conducted.

6.5.2 WEATHER TRAINING RECEIVED

Although educated with some weather usage experience, the lack of formal weather training among survey participants was evident. The majority of participants (~82%) listed 'on the job' experience via other colleagues (~53%) or self-taught through 'trial and error' (~29%) as their primary sources for weather knowledge. Further supporting the need for development of educational weather components, only 4% had received formal weather training (Table 6.4) via the NWS SkyWarn program, a state emergency management conference, and/or one of the military branches (army, navy, air force, marines, coast guard, national guard, etc.). Furthermore, although not necessarily representative of FEMA Leadership in general due to small sample size (N = 8), those personnel whom participated in the interviews also did not indicate having a vast amount of weather training. However, they did all indicate having weather experience or background for at least fifteen years or more.

WEATHER TRAINING	TOTAL
Colleagues/On the job training	53%
Self-taught/Trial and error	29%
Formal weather training	4%
None	5%
No Response	6%
Other: SkyWarn Spotter Training (2), Military (2), State EM Conference	4%

Table 6.4: Total survey participants weather training sources based on results from the data analysis conducted.

6.5.3 WEATHER TRAINING AVAILABLE

Review of existing literature, emergency management related degree programs, and FEMA training doctrine, yielded a few available weather training options, with far fewer geared towards emergency management officials. Some modules were designed to be topic specific (i.e. – tornadoes, hurricanes, etc.), while others were inclusive of all hazards. One of the more robust options for emergency managers is the 'OK-First' program developed and conducted through the Oklahoma Mesonet. Offered as in resident courses primarily for state and local personal, the course is limited in scope and does not address the needs of FEMA personnel.

The University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado, also hosts a more inclusive weather module entitled "Anticipating Hazardous Weather and Community Risk", that is offered via online. FEMA incorporated this module as part of the online Independent Study (IS) course suite through the Emergency Management Institute (EMI) (IS-2.71) (FEMA, 2019a). EMI also offers a few additional topic specific weather courses via online and in-resident. More recently, since 2010, the FEMA sponsored National Disaster Preparedness Training Center (NPTC) located with the University of Hawai'i, has also developed topic specific weather modules for emergency management and related disciplines. All of these aforementioned training options are also suited more towards local and state officials, as many are too specific and technical. Additionally, some of the degree programs offer weather education elements, but not all do currently, are limited, and not always required.

6.5.4 WEATHER TRAINING NEEDS

At FEMA, weather training needs were determined to differ slightly between user types, dependent on roles and responsibilities. For example, GIS personnel require data intensive modules that most others do not. Some need more understanding, while others need more navigation. Leadership also has different needs than others further complicating training development. Non-leadership personnel primarily requested a three to five day in-resident course covering all hazards. The online format of the UCAR/EMI weather module is helpful for accessibility, yet the in-resident format of an OK-First like program is generally preferred due to the more technical subject matter, availability of subject matter experts, and greater access to real-world scenarios. However, leadership personnel who are also in need of weather training, will not attend such time intensive offerings. As such, hearing their concerns of time, needs, demands, and span of responsibility, alternative educational mechanisms are being employed. The next chapter (Ch. 7) discusses operationalization of the FEMA training component inclusive of understanding weather information and phenomena, as well as navigating resources, with discussion focused on data analysis, development of curriculum, and course evaluation assessment. As weather is such a vital part of disaster operations, yet lacking in educational components among emergency management, particularly FEMA, it is my intent to continue to develop training modules addressing various meteorological elements to be included as part of the FEMA Qualification System (FQS) that has recently undergone significant creation and revision.

CHAPTER 7: FEMA WEATHER AND CLIMATE TRAINING

This chapter provides an overview of the resultant "Weather and Climate for Situational Awareness" training I developed for FEMA personal and partners as determined from the data analysis. This chapter starts with discussion of additional data collection, analysis, and findings of weather topics of interest assessed from the data analysis (section 7.1), weather information personnel/respondents are unable to locate (section 7.2), data analysis indications of weather information they do not understand (section 7.3), and skillsets respondents hope to acquire regarding weather usage (section 7.4). Section 7.5 provides an overview of the training I developed, followed by a discussion of the After Action Review (AAR) I conducted from course evaluations and discussions I administered in conjunction with course offerings (section 7.6).

Survey respondents were asked to identify items within four primary areas: (1) topics of interest, (2) items they are unable to locate, (3) areas they do not understand, and (4) skills they hope to acquire. Expectedly, some redundancy exists among these categories versus those previously discussed and some overlap amongst each other. Overall, the data analysis of responses for this section validated findings from other sections and allowed for different categorization and hence comparison. The ideas discussed furthers the notions discussed previously and provides a foundation from which to build FEMA and emergency management weather curriculum and training.

7.1 TOPICS OF INTEREST

A variety of topics evolved from the data analysis resulting in the emergence of the following categories: NWS products, basic meteorology, weather phenomena, climate/climatology, space weather, and earthquakes and tsunamis. While many respondents provided more specific interests, one individual stated that they were looking for *"anything that may be useful that we typically wouldn't think to look at or for."*

- **Products:** overview/availability/issuance of current/experimental/new NWS products, products that can be used with local/state partners, weather monitoring products, differences between alerts/products, alert overview/how alerts are developed/reasoning/science behind watches/warnings/advisories, be more comfortable with weather related reports/diagrams, read/understand/use/know weather/events/sources of information/information resources/NWS products
- **Basic Meteorology:** meteorology, hazard/weather scales, jet stream, high/low pressure systems, fronts/how they move/interact, impact of water temperature on weather, weather forecasts/predictions overview/science, geographical influences, weather maps, characteristics of weather trends/patterns/systems, important forecast/weather factors/variables/indicators, terminology
- **Weather Phenomena:** knowledge of phenomena/threats/impacts
    - **Fire Weather:** drought, determine when fuel redirection helps

    - **Severe Weather:** models, tools, products, severe thunderstorms, high winds, microbursts, tornado origins/behavior/indicators, tornado reports/assessments
    - **Tropical Weather:** surge, slosh/inundation models, hurricane characteristics/formation/track/behavior, models, tools, products
    - **Water Weather:** outlooks/products/hydrographs, precipitation, monsoons, river flood prediction/gauges, flood/inundation mapping, areal/flash/riverine flooding/hydrology overview/key indicators/causes, snow melt/spring runoff/impacts/effects
    - **Winter Weather:** winter storms, precipitation totals/amounts, snowfall/ice/types, resources/products/probability graphics
- **Climate/Climatology:** historical data/sources for, storm summaries, long range forecasts, El Niño/La Niña impacts, climate change/trends, implications/how climate affects weather severity, how can we plan
- **Space weather**: what space weather means for me, hazards, impacts
- **Earthquakes and Tsunamis**

Products were the most frequently mentioned topic of interest, as most respondents indicated a desire for an overview of weather associated products/alerts, resources, tools, etc. (i.e. – availability, time of issuance, updates). As one respondent noted, *"I' would like an overview of NWS products to expand my knowledge of available information and websites related to weather and data"*, while another noted wanting a *"greater comfort level with 'my' ability to read, understand, and use weather products."* Respondents generally expressed an interest in understanding the difference between products and the various ‘alerts’ (i.e. – watches, warnings, advisories). Regarding alerts specifically, data analysis indicated a desire to understand how alerts are developed or what the reasoning/science is behind them. All items discussed included current, experimental, and new products with specific mention to weather monitoring and those products that could be used with local/State partners. Essentially, anything that would assist with their functions and ability to support the agency was primarily of interest, i.e. – *“tools or resources that would help me understand weather and climate information to be used in my briefings/reports.”*

Numerous items categorized among basic meteorology and weather phenomena were also discussed. Basic meteorology consisted of primarily foundational weather concepts and principles (i.e. – highs/lows, fronts, jet stream, etc.) associated with *“weather phenomena, threats, patterns, systems.”* For example, on response stated, “how fronts affect overall weather, the different types of fronts and the anatomy of a frontal system combined with a storm.” Best summarized, respondents wanted to know *“how do air masses, clouds, precipitation, temperature and the jet stream all work together/against one another?”* Within the weather phenomena category, items were categorized according to the specific type of weather (fire, severe, tropical, winter, water) each area involved. A variety of further specific topical requests were identified including but not limited to terms, resources, processes, characterization, causes, associated hazards, and impacts.

Climate/Climatology, Space Weather and Earthquakes were the final three topics of interest mentioned. Many respondents in the initial survey indicated they had little or no understanding of climate and utilized such products infrequently. Many mentioned this as an area of interest and hoped to learn what comprises climate/climate change, trends, and implications with a desire to learn how to plan for climate. Sources of climate information and forecasts were also listed along with the need for historical data and storm summaries. Space weather was briefly discussed in the initial survey section as it is monitored by FEMA for communication impacts. In this context, respondents requested a space weather overview along with associated hazards and impacts and any regional implications. Lastly, earthquakes and tsunamis were also a requested topic. Although there are some alert elements tied to the NWS and these phenomena are natural hazards, it was not explicit as to why this topic was requested. Possible explanations include confusion over what 'weather' hazards encompassed, a desire for an all-encompassing natural hazards training, or review of those elements tied to NWS protocols. Further study is required to determine the actual reasoning and line of thinking. All of the topics discussed in this section were initially included in the pilot training course, including the last three. However, over time the space weather and earthquakes and tsunamis units were eliminated as per evaluation feedback further discussed below.

7.2 UNABLE TO LOCATE

Similarly, items that respondents had difficulty locating were categorized among resources, space weather, climate/climatology, basic meteorology, and weather phenomena (fire, severe, tropical, winter, water). Issues encountered in this section depended upon role and experience. Those with more experience typically provided more input, while those with less experience didn't all respond. As one respondent best stated, *"I am not very experienced with gathering weather information, so I have difficulty with locating most information and summarizing."* Another response, not categorized, stated that *"I don't know the program, but it used to be open to the public for free, but now it is only available privately and cost money."* With no indication of the program referenced or the area this relates to, there is no way to provide a resolution. Otherwise, most input for this section was highly specific and problem based. Some of the items listed are not actually available, rather than just not known. Regardless, feedback informed training development and provided additional areas for improvement.

- **Resources:** links for Alaska, weather stories for Ohio, reliable weather map with explanation, best location for archived radar data, cumulative impacts for weather events, projected rainfall estimates for multi-day events, FEMA regional specific weather forecasts/graphics, new databases of information to develop better products, euro model data, weather terms/terminology/definitions/symbols/color coding, tidal/temporary wind/tide/stage gauge data, rural data, local data, crop property damage data/agriculture/vegetation cover/moisture data, GIS data/unavailable services hinders mapping, weather data from commercial aircraft
- **Space Weather:** information that explains data
- **Climate/Climatology:** La Niña/El Niño, historical data, projections
- **Basic Meteorology:** current wind speed/direction for an area/specified time period, timing information for Region-wide activity

- **Weather Phenomena**
  - **Fire Weather:** reliable fire threat information in differing area of responsibility, hotspots/fire induced weather information, speed of fire spread vs. reporting with untimely or inconsistent fire updates
  - **Severe Weather:** confirmed tornado information (too much lag)/tornado tracks and reports, lightning data
  - **Tropical Weather:** surge estimates/storm surge information, pacific typhoon information/analysis
  - **Water Weather:** estimated levels of precipitation, flooding data, information relating to floods, current information/specific areas/how much flooding/what is flooding, river hydrology navigation, flood maps, extended river flood projections/projected inundation levels/impact projections/ updated impact statements, best source of water levels/estimated levels/depth of river/flash flooding, ice jam information
  - **Winter Weather:** snowfall totals for a specific system (i.e. – 2013 blizzard), snowfall observed amounts/snow totals for previous 24 hours/past 24-hour snowfall/how much/greatest amounts/depth reports, rates, ice amount/accumulation/conditions, cold weather data, snow/snowfall of record, snow melt page

7.3 DO NOT UNDERSTAND

Likewise, as was the case with the two previous sections, items that respondents do not understand were categorized among the following: tools, models, space weather, climate, basic meteorology, and weather phenomena. Once again experience and role were factors as was indicated by the responses. Two respondents highlighted this notion stating that *"with little experience, at this time I am unsure of what I don't know"* and *"being from the operations world, I don't directly access information. I typically ask Planning, but I don't know what to ask for."* As was the case with the previous section, much of the feedback was more specific, with some similarities among other category responses. However, there is one new addition among the discussions that have taken place in this study, the notion of weather models.

Not much was mentioned on the topic of weather models elsewhere, yet survey responses in this portion indicated a desire to understand weather models, composition, differences, and result variations. Since this topic was not specifically addressed in the survey or study not much is known about FEMA utilization of models. However, one respondent provided limited insight stating that, *"weather models are extremely important for development of reasonable actionable intelligence, especially during nationally impactful incidents."* Another respondent relayed a reservation of FEMA model usage stating that *"sometimes models cause more concern than help, especially when broadcast to the public."* Further study of this topic within FEMA is needed to assess the utilization of such information as it goes beyond the extent of this research. Given concerns regarding untrained personnel utilizing model information, this subject was not included in the weather training. In the future an abbreviated unit covering models may be considered if further study reveals relevancy and a need.

- **Tools:** HURREVAC, HAZUS, satellites/water vapor/imagery/pictures – what does it mean? How is it used? What effects does it describe? doppler radar – reading radar images/reflectivity/best display to use, ASOS
- **Weather Models:** why different models have vastly different results, what is the difference in modeling systems, little readily available information on NOAA/NWS models, history of reliability of models
- **Space Weather:** anything/everything, a mystery/cryptic, SWPC graphs, Coronal Mass Ejections (CME) and the disruption, solar weather reports
- **Climate:** El Niño/La Niña, Climate Change/Global Warming, prediction
- **Basic Meteorology:** barometric pressure, dew point/humidity, cloud types/structures/what they can do, weather related concepts, scales for different weather, interrelationship of high/low pressure, split flow regime, impacts of wind, progression/magnitude of watches/warnings, terms/terminology/acronyms/shorthand (i.e. - favorable conditions, 'wedges', upper trough), symbols on weather/convective/wind maps
- **Weather Phenomena**
    - **Fire Weather:** fire/humidity scales, droughts to floods cycle
    - **Severe Weather:** anything by SPC, Convective Outlook/forecast discussion terminology, severe probabilities/what do percentages mean/information discussed within mesoscale discussions, tornado/severe weather met terms – mesoscale, mesoanalysis, mesocyclone, convection/convective, Tornado Emergency, wedge, cells, supercells, derecho, wind shear, helicity values/significance in tornado potential and severe weather events

- **Tropical Weather:** PSURGE/slosh model/inundation data, pineapple express, hurricane track/what factors determine track
- **Water Weather:** hydrology, 20% chance of rain, arid vs plains vs coastal, estimated precipitation, river hydrologic information, flood warning (river), Cubic Feet per Second (CFS) flow rates/how that impacts downstream/upstream gauges/floodgates/locks/dams, GIS inundation mapping products, high water marks, flood gauges/locations, flood plains/100 vs 200-year flood zones/NFIP
- **Winter Weather:** nor'easters, alberta clipper, naming winter storms seems confusing, mixing terms (i.e. - snow showers used to be a snow vs. rain term), snow water equivalent/change confusing

In congruence with the 'Topics of Interest' section, tools were among the areas mentioned as not well understood. Items listed within the 'Tools' category in the 'Topics of Interest' section included a spectrum of all hazards. In this section, respondents more heavily emphasized those associated with hurricane analysis (i.e. – HURREVAC, HAZUS). Additionally, difficulty understanding space weather and climate was again prevalent, as discerned from the data analysis. Furthermore, although some ideas within the 'Basic Meteorology' and 'Weather Phenomena' categories were repeated from other areas, there were also a few new mentions, as described below. Aside from discussion of new terms, feedback focused on more scientific and statistical notions. The understanding of the concepts discussed in this section are vital for effective communication and decision making. Enhanced awareness of these areas would support a more informed decision making process.

7.4 HOPE TO ACQUIRE

Of the four study areas addressed in this chapter (Ch. 7), this section elicited the most extensive data and consequentially more substantial findings for training development. Data categorizations included the NWS, navigation, knowledge and understanding, interpretation and analysis, communication, and support and decision making. A variation among roles and responsibilities and experience levels of survey respondents supported a more comprehensive view of FEMA weather skills and needs in general. The resulting weather training was designed utilizing these primary desired skillsets as the overall guiding objectives in conjunction with findings from all of the elements included in this study.

- **NWS:** mission/overview/process/function/what they do/what they can provide, build better relationships/collaboration/coordination, learn dissemination mechanisms from NWS to FEMA, how NWS uses social media, how to receive alerts, meeting/knowing/connecting to weather people/networking/contacts
- **Navigation:** resource/tool/NWS website navigation/location/where to find/usage, tips and tricks/strategies/practice/comfort finding resources, resource availability/best/helpful/good, where to get the best data/data sources/data acquisition, information/data/tools for briefings/reports, difference between radar and Infrared/Visible/Water Vapor Satellites, decipher/interpret/science/capabilities/limitations of Radar/Satellite, technical/technology knowledge/capabilities to support FEMA operations, decision support tools/products for impacts/decision making

- **Knowledge and Understanding:** general/basic weather/climate patterns/concepts/events/information, most important items to report, weather systems/phenomena/threats/effect/impacts, weather forecasting process, reliability/accuracy of models/forecasts/predictions, common terminology/terms/proficient/recognition, products/resources/tools
- **Interpretation and Analysis:** ability to read maps better/basic weather interpretation/translation, identify key trends/identifiers, interpret data/websites correctly to real life expectations/make informed analysis, enhance data analysis skills/assess 'so what', 'what does bad look like', utilize weather databases/what they mean, how to map weather in GIS/GIS mapping/KML in google earth, identify current/potential impact of weather types/how hazards impact/may impact/effects on public
- **Communication:** how to report the weather when not a meteorologist/speak meteorologist/technique to communicate weather information/messaging a forecast/briefing tips/present/communicate weather accurately, how best to provide information to public, confidence/more comfort with weather information/more confident in information I provide, ability/ideas to create/learn to develop better weather products using NOAA information
- **Support and Decision Making**: incorporate/use/apply weather in my role, how weather pertains to FEMA Mission/applications in the field, provide better/more situational awareness of weather/help with the decision making process, report to leadership/answer RA questions, support the RRCC, acquire information/resources for state/local mitigation

plans/what can be done to mitigate risks/knowledge of data/information for mitigation planning decisions, long range planning input/products/understanding to make better planning decisions, discussion of trigger points for posture/deployments/future concerns affecting our readiness/how weather will impact team readiness

FEMA's extensive usage of NWS information, data, tools, products, and services solicited an interest in learning about the NWS from many of the respondents, i.e. - *"what office is responsible for what."* As one respondent noted, *"I would like to see a description of who is doing what within the National Weather Service. Having a clear understanding of where to go for information will help in future research and inquiries."* Another noted that, *"I want to have a better understanding of NWS, how they collaborate with FEMA, what this looks like for the N-IMAT teams, and a better understanding of weather, weather patterns, and how and where to gather the information I want."* Not only did respondents express an interest in learning about the mission and function of the NWS, but also what they can provide. Ultimately, increased awareness of the NWS and associated products and services facilitates the situation awareness and decision making processes at FEMA.

Navigation was one of the more frequently mentioned areas, as most participants indicated difficulty in navigating NWS websites, products, resources, tools, etc. Data analysis identified difficulty in locating resources, knowing the best available, and acquiring data. Furthermore, respondents desired instruction on manipulating and working with weather/NWS information, data, and tools. As one response stated, there were issues with the *"functionality of NWS websites, very difficult to find specific products. Websites are hard to navigate, necessitating keeping a list of links for easier reference."* Another response stated that *"all of the NWS websites are overly complicated, especially the local offices sites. Different formats from office to office makes it difficult to coordinate regional level products. Sometimes just local NWS forecasts tend to get lost in the website jungle."* Other individuals requested assistance on *"how to access and simplify the copious data produced by NWS for consumption by the normal population of adults in the region."* Furthermore, respondents requested assistance with utilization and navigation of weather support tools. Examples of tools mentioned in the data include, HURREVAC, NWSChat, EDD, Radar, Satellite, etc.

As with the 'NWS' and 'Navigation' categories, the next two categories, 'Knowledge and Understanding' and 'Interpretation and Analysis' are related. These two categories build upon each other leading to the final two categories 'Communication' and 'Support and Decision Making'. Many respondents reported an interest in gaining knowledge and understanding of basic weather and climate concepts, phenomena, hazards, impacts, and terms. In relation, there was also a desire to understand weather predictions and associated accuracy and reliability, along with the forecasting process in general. These two areas were mentioned in conjunction with gaining an overall perspective on weather related products, resources, and tools and knowing what is most important to monitor and report. As one respondent noted, there is a desire for *"better general knowledge and understanding of weather concepts"*, while another stated interest in gaining *"an overall awareness of weather and climate, weather patterns, and forecasting."*

Extending beyond knowledge and understanding, respondents conveyed the requirement to interpret and analyze weather hazards, threats, and events for FEMA. As such, survey responses indicated a need for further insight into reading weather maps, interpreting weather information, translating weather data, and identifying key trends. Collectively, adequate training in these areas support respondents' desires to "enhance data analysis skills" and "make informed analysis" in accordance with "real life expectations." These stipulated requests from respondents were found to be consistent with findings previously discussed in Chapter 5, concerning analysis of interview data collected from members of FEMA leadership. The data indicated that personnel need to acquire a "better understanding of the 'so what'" and "what does 'bad' look like", which is assessed and decided based on analysis of *"current or potential weather impacts or effects on the public and FEMA's mission."*

More specialized respondents indicated an interest in gaining experience utilizing weather databases to enhance GIS mapping capabilities. A skillset only relevant for personnel in certain positions, the goal to visualize analysis through GIS mapping has further reaching implications. Unlike 'Watchstanders' who manage a 24/7/365 operation, GIS personnel indicated serving more on an 'on-call' basis. As such, despite not having an active GIS role, many 'Watch' personnel respondents indicated they too wanted the knowledge and capability to do so in order to facilitate the process. In addition to 'Watchstanders', this was also found to be true for other roles such as planning, recovery, mitigation, etc. Non-GIS respondents as a whole indicated collaborating with relevant GIS personnel accordingly to complete requested mapping tasks.

Overall, as one respondent best summarized, *"FEMA personnel are looking for a greater understanding of weather impacts, weather threats and NWS products."* However, two additional categories emerged from this section, 'Communication' and 'Support and Decision making'. The 'Communication' category primarily consisted of aspects surrounding respondents' abilities to communicate weather information to senior leadership, partners, and the public. This included being comfortable and having confidence doing so and developing appropriate products to assist. Focusing more on the weather elements and flow of information, the survey did not specifically address this aspect. However, the topic was discussed by a multitude of respondents with relevancy to their roles and responsibilities.

Lastly, the final category for this section revealed through data analysis, 'Support and Decision making', was fairly robust, containing various elements. While decision making as a whole was discussed in further detail in Chapter 6, this section provides a brief overview of the related skills respondents hope to acquire for this purpose. In general, respondents were hoping to gain a more informed perspective of how to incorporate, utilize, and apply weather in their respective roles, the field, and to support the FEMA mission. Generally speaking, respondents hope to enhance their situational awareness capabilities in order to facilitate the decision making process in support of the National/Regional Response Coordination Centers (N/RRCC), States/Territories/Tribes, FEMA Senior Leadership and beyond. In addition, respondents indicated looking for ways to mitigate risks, support planning efforts, enhance team readiness and provide better assessments for deployments and future concerns.

7.5 WEATHER TRAINING COURSE OVERVIEW AND DESIGN

Weather directly accounts for nearly all Federally declared disasters, yet remains integral throughout all phases of disasters, regardless of type. Essential, weather information is utilized in a multitude of capacities from steady-state/ monitoring to NRCC/RRCC activations through designation of Joint Field Offices (JFOs). Weather information is mission critical for maintaining situational awareness at FEMA through the information management cycle described in Chapter 6, life safety/life sustaining missions, and for conducting various assessments to support decision making regarding operations, planning, disaster assistance, etc. It is imperative that personnel understand weather phenomena and terminology, appropriate application of this knowledge, and navigation of weather products and resources to adequately serve leadership and partners.

There is a limited amount of readily available weather training currently, and existing courses do not adequately serve the operational needs of FEMA. To address this gap, I developed a weather training course for FEMA personnel utilizing results of the survey data analysis I conducted. Initially designed to specifically address the operational needs of FEMA 'Watchstanders', I conducted a pilot course entitled "Weather and Climate Analysis for Situational Awareness." Pilot course participants included two 'Watchstanders' from each of the ten FEMA regions and five from FEMA HQ. Each region is designated approximately ten 'Watch' personnel while HQ has approximately twenty-five, hence the initial equivalent participant allotment of 20% per location.

Feedback and data analysis from the initial survey administered to 'Watchstanders' guided early development of the piloted course. Subsequent course evaluations in conjunction with additional survey data collection and analysis, advanced development of the FEMA weather training component toward standardization. Designed to support monitoring, collection, interpretation, analysis and dissemination of weather information and data, the course now serves as the weather training component for the qualification program established for FEMA 'Watch' staff. Since the piloted course, numerous FEMA personnel occupying a myriad of positions and tasked with differing roles and responsibilities have also found the training beneficial, in addition to various partners.

The first four sections discussed in this chapter in conjunction with results from other sections served as a guide for training development. Based on survey responses and subsequent data analysis, the course is designed around the five primary weather types (fire, severe, tropical, water, winter), yet also includes an NWS and product overview, activities inclusive of communication concepts and practices, as well as several resource and tool navigation opportunities. The goal of the course is to advance skillsets and qualifications for improved hazard assessment, resource navigation and communication through enhancement of weather knowledge, interpretation, and analysis. Course objectives area as follows:

- **Increase knowledge of basic weather concepts and principles**
- **Enhance navigation of weather resources, information, and data**
- **Facilitate understanding of weather products and services**
- **Improve weather analysis and interpretation capabilities**

Meteorological topics addressed basic meteorology components along with various weather phenomena and associated hazards including flooding, winter weather systems, tropical storms and hurricanes, severe storms and tornadoes, drought and fire weather. There is also a unit covering climate along with seasonal influences and patterns. Additional non-weather units include a course overview, NWS overview, and navigation of available resources and tools. Sessions and associated activities were designed to address:

- **NWS product and service availability**
- **Fundamentals of weather and climate**
- **Hazardous weather monitoring and resource navigation**
- **Weather information and data analysis and interpretation**
- **Information reception, dissemination, and communication**
- **Practical application**

Based on initial survey data analysis, identified topics resulted in development of thirteen units. Following each unit, there was an associated activity culminating with a practical exercise at the end of the course. Activities include applying knowledge, navigating resources, and/or utilizing relevant tools. The final exercise was designed to engage the participants in a realistic scenario through application of the knowledge they gained, and performance of functions as required in the real-world. Preliminary units developed for the piloted course included fundamentals in addition to topic specific units and associated overviews and resources as outlined in Table 7.1.

PILOT FEMA WEATHER COURSE UNITS
UNIT 1: Course Overview
UNIT 2: National Weather Service Overview
UNIT 3: Weather Resources and Tools
UNIT 4: Basic Meteorology, Phenomena, and Hazards
UNIT 5: Severe Weather and Radar
UNIT 6: Tropical Weather
UNIT 7: Winter Weather
UNIT 8: Water Weather
UNIT 9: Fire Weather
UNIT 10: Space Weather
UNIT 11: Earthquakes and Tsunamis
UNIT 12: Communication Principles and Practices

Table 7.1: Pilot 'Weather and Climate for Situational Awareness' course units based on results from the data analysis conducted on the initial survey.

Further analysis of administered course evaluations (discussed in greater detail in the next section) identified needed revisions, resulting in modifications being made accordingly. Additional modifications have been made over time based on continued feedback, evaluation, and audience. However, fundamental components and format have not changed. Adjustments implemented overall, primarily served to refine and focus the course, as well as update relevant content. For the pilot course, space weather and earthquakes and tsunamis were included as units but were later removed from the training for the final version of the course (Table 7.2), based on follow-up course evaluations conducted. A climate section was also added to address the lack of understanding and utilization discovered in the initial survey data analysis. Additionally, various elements from the communication session were absorbed into other areas of the training, versus a standalone unit.

FINAL FEMA WEATHER COURSE UNITS
UNIT 1: Course Overview
UNIT 2: National Weather Service Overview
UNIT 3: Weather Resources and Tools
UNIT 4: Basic Meteorology, Phenomena, and Hazards
UNIT 5: Severe Weather
UNIT 6: Tropical Weather
UNIT 7: Winter Weather
UNIT 8: Water Weather
UNIT 9: Fire Weather
UNIT 10: Climate

Table 7.2: Final 'Weather and Climate for Situational Awareness' course units based on results from the survey data analysis and course evaluations.

Several types of assessments were administered throughout this iterative process to establish knowledge gained, identify weather needs, and evaluate course objectives. In addition to the survey, a pre and posttest were administered to determine baseline knowledge and evaluate course effectiveness. Test questions were formatted as multiple choice, matching, true/false, and essay. Overall, participants improved their multiple choice, matching, and true/false scores by 20% on average. Additionally, all participants scored greater than 75% on the essay portion, which required participants to apply knowledge gained through analysis and interpretation of scenarios and assess hazards and impacts. Results from the pre-test further verified a need for the course, while the post test results showed significant improvement. One participant noted an additional benefit, stating that "*the test showed 'me' how much I didn't know and need to learn*." Furthermore, to identify strengths and areas for improvement, course evaluations were conducted daily as well as overall. Questions addressed areas determined by the course objectives to assess participants overall satisfaction, guide revisions, as well as determine future directions and ideas for course evolution.

7.6 WEATHER TRAINING EVALUATIONS AND AFTER ACTION REVIEW

The purpose of the pilot course review was to refine the course and revise content for future offerings. Analysis of course discussions, evaluations, and assessments identified several strengths and areas for improvement. Results suggest that the course was very well received yet extending the course from three and a half days to four or five would enhance future offerings. Overall, these findings support course evolution and serve to guide future development of additional trainings, materials, etc. as deemed necessary. Additionally, recommendations and best practices are discussed to enhance the course, address identified gaps, and determine future directions.

Following completion of the pilot course, open ended evaluations were conducted. The intent of these evaluations was to provide an overall assessment of the pilot course offering. Analysis of these evaluations guided revisions to ensure an effective course design and relevant content. Participant responses were compiled and coded accordingly. After several rounds of coding the solicited feedback, the analysis revealed four primary categories: (1) Content and Materials, (2) Presentations and Personnel, (3) Functional Activities and Exercise, and (4) Logistics. Pulling from organizational learning, I then utilized an After Action Review (AAR) framework. Frequently utilized in emergency management for exercise and disaster response assessments, I found this framework more appropriate for the data collected and easier for structuring analysis and results. I categorized the data within the four categories that emerged from the data analysis and then derived strengths, areas for improvement, recommendations, and best practices.

7.6.1 CONTENT AND MATERIALS

Within this category, three strengths and two areas for improvement were identified along with associated recommendations and/or best practices for each.

Strengths:

1. Weather hazards addressed were inclusive of all FEMA Regions.
2. Training manual designed to allow participants the ability to take notes and serve as a reference/resource manual for future informational needs.
3. Provided tools and resources along with demonstrations and navigation assisted with interpretation and information/product location.

Areas for Improvement:

1. Enhance impact assessment and evaluation of weather hazards.
2. Incorporate daily weather briefings.

Participants felt that the subject matter presented, addressed the weather-related concerns for all regions with only minor suggestions for enhancement. Additionally, the group felt that special care had been taken regarding their needs in terms of collecting and interpreting information. Many participants also noted that some of the content was new to them, which they felt expanded their perspective of situational awareness.

The training manual was very well received, as one participant noted "*it was very professionally done, useful, and informative*." Each unit of the course was included, which consisted of the PowerPoint slides accompanied by main points, resource links, terminology, and designated space for notes. In addition, the final sections included activity and assessment handouts as well as available resource guides and quick reference sheets.

Resources were discussed throughout the presentations as relevant, with an additional session dedicated to intensive navigation of tools, existing products as well as experimental ones. Participants were more familiar with some resources, yet they were unaware of others that are also available. The resource session allowed participants to voice their opinions and address questions or challenges faced with regards to resource and information navigation. Participants found the resources provided to be extremely informative and helpful for their duties and responsibilities. Additionally, participants indicated the NWS overview and decision support session was helpful for gaining an understanding of how the NWS can assist FEMA throughout the disaster lifecycle.

Furthermore, participants felt that enhancing discussion of impacts from each specific weather hazard would assist them with performing assessments on the job. Some of the session materials and presentations addressed hazard specific impacts, yet others were lacking. Although some units may not have adequately addressed impacts, group consensus showed that the activities were geared specifically toward application and analysis to determine threats and impacts.

In addition to the units, a weather briefing was provided on the first day of the course as part of the facility tour. Many of the participants suggested a weather briefing be included in the curriculum each morning during the duration of the course. Data analysis findings indicated that doing so would provide an opportunity for participants to learn from the presenters regarding ways to articulate weather hazards, identify the most relevant information, and presentation structure, as well as provide an opportunity to address pertinent questions.

Best Practices:

1. Continue to include climate/seasonal content for long-term situational awareness.
2. Due to the eco-friendly/green initiative, budget constraints, and travel, providing training manual and materials in an electronic format is helpful.
3. Providing a supplemental resource, terminology, and note-taking manual, is helpful as the training manual is distributed electronically.
4. Conduct daily weather briefings specific for the course or attend briefings conducted by other entities each morning.

Recommendations:

1. Briefly navigate the most important/utilized websites at the beginning of the course with a follow-up session later regarding miscellaneous and experimental resources.
2. Include extreme and historical events as a reference point to enforce the range of severity/intensity and support threat and impact assessment.
3. Incorporate added discussion and provide guidance on impacts associated with each weather type to include examples and "what if" scenarios.
4. Utilize examples and real-life scenarios including case studies.
5. Implement a practical session designated to address communication skills and assessment of briefing style, structure, design, and format.

7.6.2 PRESENTATIONS AND PERSONNEL

For this category, two strengths and one area for improvement were identified along with associated recommendations and/or best practices for each.

Strengths:

1. Use of subject matter experts as presenters from NOAA/NWS centers located throughout the nation as well as those within the local area.
2. Professional, consistent, and well-designed materials.

Area for Improvement:

1. Utilization of more plain language/layman's terms to describe and explain weather phenomena, associated hazards, and concepts.

Session instructors were chosen for their ability to communicate and area of expertise. Each instructor was responsible for developing materials required for their unit based off of the guidance I provided to them. When relevant, National expertise was utilized via video and/or teleconference (i.e. - a hurricane specialist from the National Hurricane Center (NHC)). Regarding the chosen instructors, one participant stated that the "*NWS instructors were very professional, passionate, and knowledgeable about their topic*", while another stated that "*the passion and knowledge of the instructors made me want to learn more*."

A presentation template was developed for the course materials, which provided consistency throughout the course regardless of instructor. Subject matter experts were instructed to make use of graphics, videos, and animations as appropriate to balance needed textual information. Instructors were also encouraged to populate associated training manual pages with main points to enhance understanding, provide explanation for reference, and limit note taking.

Furthermore, participants varied regarding perception of conveyance of complexities inherent to weather analysis. Although many instructors did utilize common terminology and provided definitions, some of the units were a bit in-depth, regarding technical descriptions and explanations, then was necessary.

Best Practices:

1. Continue to utilize NOAA/NWS subject matter experts from across the country. Involve National centers and other NWS regions if/when possible.
2. Utilize the format of the training manual and presentations in future development.

Recommendations:

1. Enhance participant involvement during sessions by encouraging more responsive rather than passive engagement. Incorporate additional participant response elements (i.e. – questions).
2. Ensure all sessions balance technical descriptions and plain language explanations.
3. Monitor field specific terminology usage, defining terms when necessary, and include in the resource guide glossary.

7.6.3 ACTIVITIES AND EXERCISE

Participants provided the most amount of feedback for this category with four strengths and two areas for improvement identified through data analysis, along with associated recommendations and/or best practices for each.

Strengths:

1. Functional activities reinforced material learned, provided interactive opportunities, and were relevant to participants' roles and responsibilities.
2. Pilot course provided participants opportunities to interact with fellow FEMA 'Watchstanders' and NWS personnel.
3. Tabletop exercise allowed participants direct interaction with NWS personnel while in small groups.

Area for Improvement:

1. Organization and format of regional briefings conducted after the tabletop exercise.

2. Test and evaluate participants' skills and ability to apply course concepts during steady-state/monitoring, N/RRCC activation and to support JFOs.

Participants felt that activities situated with each session were valuable and helpful for applying the concepts learned, enhancing navigation skills of the resources provided, and furthering understanding of material. Activities, such as weather Jeopardy and the online NWS resource scavenger hunt, were highly touted by the participants. Participants indicated these activities allowed for interaction amongst the group while "*helping to test and teach*" as one participant noted. Participants were encouraged to interact with the NWS team members whom were floating around assisting and checking with participants on troubleshooting. Doing so allowed participants the opportunity to ask questions and engage with NWS personnel.

Provided the missions and associated responsibilities and services the 'Watch' offices provide, participants feel they have limited ability and options to associate with other FEMA regional Watchstanders. However, respondents indicated frequent coordinate with one another via email and phone. Participants found that the course allowed them to meet with fellow FEMA counterparts and discuss operations as well as make valuable connections within the NWS.

For the practical exercise, NWS team members facilitated small groups of five or less and proposed various scenarios to elicit information usage, resource navigation, and impact assessment. The exercise was geared toward stimulating discussion and advancing participant application of knowledge learned. Participants indicated the exercise was extremely valuable, allowing them to think through different scenarios in order to identify challenges regarding understanding, information usage, and resource location. As one participant noted, "*the small group size and immediate availability of the NWS mentors/instructors helped me to focus and apply appropriate NWS products and share knowledge*."

Utilizing the information gathered throughout the tabletop exercise, the participants were asked to apply the current weather of the day to their region and provide a briefing to the group. Participants found the session useful for reviewing others briefing procedures, yet several challenges were identified. Encountered challenges included time, briefing templates, graphical depiction, and difficulty applying current weather conditions and threats to their region. Templates and materials spurred discussion regarding regional variations, yet assessment of briefing procedures and operations between regional counterparts was not streamlined, standardized, nor clearly defined.

FEMA 'Watchstanders' require a versatile set of skills as was previously discussed. Course activities in conjunction with the tabletop exercise at the conclusion of the course, addressed many functional aspects of their roles and responsibilities. Nevertheless, more realistic scenario portrayal through a functional exercise would allow for a more complete evaluation of applied knowledge and provide a more thorough assessment of participants abilities, while testing key functions within the overall response system.

Recommendations:

1. Develop and incorporate additional functional activities.

2. Include other potential partners such as the United States Geological Survey (USGS), the United States Army Corps of Engineers (USACE), etc.
3. Request participants bring regional briefing templates.
4. Provide regionally based scenario packets that include both text and graphical materials for usage in participant briefings.
5. Develop a methodology and/or metrics to streamline assessment of briefing structure, format, style, information, etc.

7.6.4 LOGISTICS

Participants provided the least amount of feedback for this category with only one strength and two areas for improvement identified through data analysis, along with associated recommendations and/or best practices for each.

Strengths:

1. It was helpful to be outside of our normal working facility and location.

Areas for Improvement:

1. Provide prerequisites and additional information to course participants in advance for completion and/or review to prepare them for the ideas, concepts, and resources that will be discussed during the course.
2. Extend course from 3.5 days to 4 or 5 days to allow adequate time for sessions, completion of activities, functional exercise, and additional networking opportunities.

Overall, participants were complimentary of the format consisting of presentations, activities, and breaks with interactive learning opportunities interspersed throughout the course, culminating in a tabletop exercise and briefing session on the final day. Time constraints restricted sessions and activities from fully engaging participants or ensuring thorough understanding. Additional time would have helped to maintain a slower pace, inclusion of additional activities to extend application of learned concepts, and networking. Additionally, the course was designed to be an in-resident, beginner course regarding foundational concepts of weather, water, and climate. However, some participants asked for possible inclusion of pre-requisites such as completion of existing online courses, review of relevant materials, and/or resource list familiarity, among others.

Best Practice:

1. Continue to provide the local area handout but distribute to participants before arrival so they have time to review policies and important information as well as learn about the area and facility.

Recommendations:

1. Provide a list of resources/websites for participants before arrival to familiarize themselves with resources utilized during the course.
2. Assess how this training can be integrated into the FEMA training concept and establish an inclusive program that addresses the needs of FEMA personnel with consideration for other methods, levels, budget, etc.
3. Consider course expansion to allow adequate time for questions, activity completion, resource navigation, and explanation of complex concepts.
4. Review course content and identify potential efficiencies that can be achieved through development of FEMA Independent Study (IS) modules.

The pilot course succeeded in incorporating content relevant for FEMA 'Watchstanders', communicating complex weather concepts effectively, and providing standardized materials through the training manual. Several participants compared experiences with other pilot courses noting that the "Weather and Climate analysis for FEMA Watchstanders" course was consistent amongst presentations, carefully reviewed for formatting and typos, as well as professionally designed and well organized. As one participant noted, "*a lot of hard work, time, and effort went into this course and it shows*", while another commented that "*it was a fantastic first class by first rate instructors*."

The greatest challenge participants indicated was the desire and need for additional time. Extension of the course would allow sufficient time for knowledge absorption, completion of activities, extension of application and additional networking opportunities. Furthermore, development and completion of pre-requisites before arrival would conserve time spent on fundamental concepts and allow ample time for discussion of complex topics and application. Additionally, review of mechanisms to introduce foundational concepts prior to the course, would further solidify concepts during the in-resident portion. Nonetheless, despite the time constraint, participants were overwhelmingly generous with positive feedback stating repeatedly how relevant, helpful and informative the course was for FEMA functional requirements. All but one of the participants stated they would recommend the course to others and felt that "*it was a good use of time*" noting they planned to share the materials with their fellow colleagues. As noted by one participant, it as an "*excellent, very well-done pilot course with great potential*."

CHAPTER 8: SUMMARY AND FUTURE WORK

This study examined FEMA utilization and communication of weather information for maintaining situational awareness in support of decision making. The culmination of this work advances the profession and discipline of emergency management by providing a sound methodology and decision making framework for FEMA, in relation to weather information. The utilization of which is applicable for FEMA beyond the scope of this study and can be extended analogously to be inclusive of all hazard types. The implication of this work is enhancement of FEMA leadership weather decision making capabilities in support of timely, relevant decisions and more effective, efficient operations to ensure their ability to mitigate, prepare for, respond to, and recover from disasters leading to saved lives and property.

Since beginning this work, FEMA has simplified their mission to "helping people before, during, and after disasters" (FEMA, 2019d), yet overall the agency remains not well understood externally by the people they serve. Review of the survey and interview data collected indicated the majority of FEMA respondents have a non-weather background and are hired, rather, for other skills. Although demographics were not a focus of this study, many emergency management officials predominantly have a background in law enforcement, public safety, etc. FEMA is no exception as the majority of personnel are comprised of former or current military service members. Many come to the agency with little to no background or experience in meteorology or weather hazard usage and having completed no formal weather training. Therefore, the assumption of FEMA personnel as laypersons is valid, as they rely heavily on others for weather interpretation, assessment, and communication.

In addition, the educational background of the respondents varies from high school to graduate degrees, with the majority ceasing education at the bachelor's degree level. Frequently, personnel indicated having obtained higher education atypically through a variety of programs available to them later in life. The range of disciplines of those that indicated possessing some form of higher education, varies greatly and comes from a wide variety of fields. A wide variety of emergency management degree programs have come into existence over the past two decades. While many FEMA personnel have taken advantage of that option, those programs have yet to permeate the agency. Furthermore, many of those degree programs exclude weather and climate as a pivotal part of the curriculum.

The primary focus for training within FEMA and partners, places emphasis on operations, planning, policy, and procedures. Currently, there are no qualification requirements or training available with regards to weather, despite its criticality to the sustainability of the mission and resiliency of the nation. Provided the extensive usage of weather information for their roles, in conjunction with their overall lack of weather training, respondents expressed interest in educational opportunities. Collectively, responses indicated a desire to acquire "*more general weather information*", enhance their "*ability to read weather maps better*" and learn "*website navigation, strategies, and practices*." In relation, data analysis revealed a few recommendations for areas of improvement with regards to NOAA/NWS. Ideas conveyed within the feedback suggested, "*more* *plain language briefings*", "*working on website consistency*", and "*making the website format easier to use so I don't need a three-day class to use it.*"

Although warning systems have improved over the last several decades, navigating disaster response continues to present various challenges due to communication, a lack of outreach/education, too much information, multiple sources, etc. Additionally, emergency management perspectives in academia are not well defined. For emergency management, there is an increased need for multi and interdisciplinary research. Hence, I choose an interdisciplinary route for this exploratory study using qualitative research methods to gain an in-depth perspective of weather information utilization and decision making influences.

Through data analysis it was determined that informational needs depend on the types of decisions that need to be made and the actions that need to be taken. Furthermore, the influencing factors identified through data analysis further substantiate the conceptual framework proposed in Chapter 4 of this work, which in turn drives training development. Ensuring that decision makers fully understand weather information is imperative for the FEMA mission overall. Providing greater decision support for FEMA and all emergency managers, along with implementation of weather training mechanisms, enhances situational awareness and hence decision making capabilities.

Data analysis of qualitative surveys and interviews yielded several findings. First and foremost, (1) operational decision making at FEMA is heavily influenced by a multitude of factors including (a) organizational, (b) operational, (c) individual, (d) informational, (e) impact, and (f) hazard. Further complicating matters, FEMA utilizes a variety of information sources and communication mechanisms including media/social media, State/Tribe/Territory, private sector/ apps, television/radio, internet/web, ESFs/partners, NWS, and other agencies, yet (2) a communication gap exists between FEMA and the public. Furthermore, (3) utilization of weather information across FEMA is substantive for the purposes of (a) situational awareness, (b) analysis and assessment, (c) communication, (d) planning, (e) disaster assistance, and (f) overall decision making. (4) Maintaining situational awareness of weather hazards is an essential and mission critical FEMA function requiring (a) environmental information (weather and non-weather information), (b) impact information, and (c) communication elements, through an information management process of (a) monitoring, (b) collecting, (c) interpreting, (d) analyzing, and (e) disseminating. However, (5) FEMA personnel lack weather experience, knowledge and training overall, posing significant challenges.

These findings resulted in (1) a proposed decision-making conceptual framework, in conjunction with a (2) descriptive decision making model, and (3) identification of associated influencers. Extending this work beyond theoretical notions into praxis, (4) an adaptation of the CDC's Crisis and Emergency Risk Communication (CERC) model is proposed for FEMA utilization, and (5) operationalization of a FEMA weather training module for situational awareness was designed and implemented. Additional recommendations from these findings and results include: (1) development of weather driven FEMA decision/support policy for standardized coordination, (2) implementation of CERC principles within FEMA and emergency management for enhanced and continuous communication practices, (3) incorporation of evaluation into the Comprehensive

Emergency Management (CEM) framework as a standalone element in accordance with CERC, and subsequent incorporation of evaluation findings consistently within FEMA for advancement of programs and procedures, (4) enhanced decision support and development of State and FEMA Region weather products, graphics, and overviews, etc. for improved situational awareness, and lastly, (5) inclusion of weather training requirements within FEMA qualifications for increased knowledge and awareness in support of more effective decision making and operations.

Knowledge of emergency management in general is limited academically among the literature as it has more tacitly evolved over time. Extensive gaps exist regarding the discipline itself, theoretical notions, and understanding of general constructs, behavior, and processes within the field. Knowledge of behavioral decision making along with policy considerations and ramifications within emergency management and FEMA is lacking. Extending the research conducted in this work, reviewing climate information utilization, needs, gaps, and influences would be valuable for advancement of climate resiliency and incorporation within the agency. Additionally, further detailed study of FEMA decision making with regard to specific hazards, disasters, groups, and partners, as well as extension through policy recommendations is required for advanced contribution to the discipline.

Several identified areas for additional future work include (1) continued development and validation of the proposed FEMA decision making framework, (2) assessment of the effectiveness of FEMA and emergency management decision making, (3) further review of influencing factors and to what extent each affects decisions, (4) determine effectiveness of the "Weather and Climate for Situational Awareness" training and the implications/influence on FEMA decision making, (5) advancement of CERC and utilization within emergency management, (6) as well as development of FEMA response/support policy for specific weather hazards. Going forward, I plan to focus on these areas through collaboration with scholars among various disciplines to advance the field and begin to formulate theories in support of all levels of emergency management and throughout all phases of the disaster life cycle.

REFERENCES

Adamski, T., Kline, B., & Tyrrell, T. (2006). FEMA reorganization and the response to hurricane disaster relief. *Perspectives in Public Affairs*, *3*, 3-36.

Alexander, D. (2003). Towards the development of standards in emergency management training and education. *Disaster Prevention and Management: An International Journal*, *12*(2), 113-123.

Argote, L. (1982). Input uncertainty and organizational coordination in hospital emergency units. *Administrative science quarterly*, 420-434.

Babrow, A. S., Kasch, C. R., & Ford, L. A. (1998). The many meanings of uncertainty in illness: Toward a systematic accounting. *Health communication*, *10*(1), 1-23.

Babrow, A. S., Hines, S. C., & Kasch, C. R. (2000). Managing uncertainty in illness explanation: An application of problematic integration theory. In. B. Whaley (Ed.), *Explaining illness: Research, theory and strategies* (pp. 41–67). Mahwah, NJ: Lawrence Erlbaum Associates.

Barton, A. H. (1969). *Communities in disaster: A sociological analysis of collective stress situations* (Vol. 721). Garden City, NY: Doubleday.

Baumgart, L. A., Bass, E. J., Philips, B., & Kloesel, K. (2008). Emergency management decision making during severe weather. *Weather and Forecasting*, *23*(6), 1268-1279.

Bell, D. E., Raiffa, H., & Tversky, A. (1988). Descriptive, normative, and prescriptive interactions in decision making. *Decision making: Descriptive, normative, and prescriptive interactions*, *1*, 9-32.

Benight, C., Gruntfest, E., & Sparks, K. (2004). Colorado Wildfires 2002. Quick Response Rep. 167. *Natural Hazards Center, University of Colorado Boulder*.

Birch, J. (1994). New factors in crisis planning and response. *Public Relations Quarterly*, *39*(1), 31.

Blanchard, B. W., Canton, L. G., Cwiak, C. L., Goss, K. C., McEntire, D. A., Newsome, L., ... & Waugh, W. L. (2007). Principles of emergency management supplement. *Emergency Management Public Safety, Public Trust*, *4*.

Boholm, A. (1998). Comparative studies of risk perception: a review of twenty years of research. *Journal of risk research*, *1*(2), 135-163.

Bradac, J. J. (2001). Theory comparison: Uncertainty reduction, problematic integration, uncertainty management, and other curious constructs. *Journal of Communication*, *51*(3), 456-476.

Bradshaw, M., & Stratford, E. (2010). Qualitative Research Design and Rigour. In I. Hay (Ed.), *Qualitative Research Methods in Human Geography* (3rd ed., 69-80). Ontario, Canada: Oxford University Press.

Brashers, D. E. (2001). Communication and uncertainty management. *Journal of communication*, *51*(3), 477-497.

Brehmer, B., & Joyce, C. R. B. (Eds.). (1988). *Human judgment: The SJT view* (Vol. 54). New York, NY: Elsevier Science Publishers.

Bumgarner, J. B. (2008). *Emergency management: a reference handbook*. Santa Barbara, CA: ABC-CLIO.

Butler, D. (2007). Focusing Events in the Early Twentieth Century: A Hurricane, Two Earthquakes, and a Pandemic. In C. B. Rubin (Ed.), Emergency Management: *The American Experience 1900-2005* (2nd ed., pp. 11-48). Fairfax, VA: Public Entity Risk Institute.

Canton, L. G. (2007). *Emergency Management: Concepts and Strategies for Effective Programs*. Hoboken: NJ: John Wiley & Sons, Inc.

Carr, L. J. (1932). Disaster and the sequence-pattern concept of social change. *American Journal of Sociology*, *38*(2), 207-218.

Clemen, R. T. (1991). *Making hard decisions: An introduction to decision analysis*. Boston, MA: PWS-Kent.

Coombs, W. T. (2007). Protecting organization reputations during a crisis: The development and application of situational crisis communication theory. *Corporate Reputation Review*, 10(3), 163-176.

Coombs, W. T. (2008). *Ongoing Crisis Communication: Planning, Managing and Responding*. Los Angeles, CA: Sage Publications.

Courtney, J., Cole, G., & Reynolds, B. (2003). How the CDC is meeting the training demands of emergency risk communication. *Journal of health communication*, *8*(S1), 128-129.

Cressman, G. P. (1971). Uses of public weather services. *Bulletin of the American Meteorological Society*, *52*(7), 544-547.

Creswell, J. W. (1998). *Qualitative research and research design: Choosing among five traditions.* Thousand Oaks, CA: Sage Publications.

Creswell, J. W. (2012). *Qualitative inquiry and research design: Choosing among five approaches* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Creswell, J. W., & Creswell, J. D. (2014). *Research design: Qualitative, quantitative, and mixed methods approaches*. Los Angeles, CA: Sage publications.

Demuth, J. L., Lazo, J. K., & Morss, R. E. (2011). Exploring variations in people's sources, uses, and perceptions of weather forecasts. *Weather, Climate, and Society*, *3*(3), 177-192.

Demuth, J. L., Morss, R. E., Morrow, B. H., & Lazo, J. K. (2012). Creation and communication of hurricane risk information. *Bulletin of the American Meteorological Society*, *93*(8), 1133-1145.

Demuth, J. L., Morss, R. E., Lazo, J. K., & Trumbo, C. (2016). The effects of past hurricane experiences on evacuation intentions through risk perception and efficacy beliefs: A mediation analysis. *Weather, Climate, and Society*, *8*(4), 327-344.

Department of Homeland Security. (2008a, December). *National Incident Management System.* Washington, DC.

Department of Homeland Security. (2008b, January). *National Response Framework.* Washington, DC.

Department of Homeland Security. (2011, January). *FEMA Incident Management and Support Keystone.* Washington, DC.

Department of Homeland Security. (2013a, January). *National Incident Support Manual.* Washington, DC.

Department of Homeland Security. (2013b, May). *National Response Framework.* (2nd Ed.). Washington, DC.

Department of Homeland Security. (2015a, February). *Hazard Mitigation Assistance Guide. Hazard mitigation grant program, pre-disaster mitigation program, and flood mitigation assistance program.* Washington, DC.

Department of Homeland Security. (2015b, September). *National Preparedness Goal.* (2nd Ed.). Washington, DC.

Department of Homeland Security. (2016a, June). *National Response Framework.* (3rd Ed.). Washington, DC.

Department of Homeland Security. (2016b, June). *National Disaster Recovery Framework.* (2nd Ed.). Washington, DC.

Department of Homeland Security. (2017a, January). *Disaster Operations Legal Reference.* (3rd Ed.). Washington, DC.

Department of Homeland Security. (2017b, November). *Incident Management Handbook.* Washington, DC.

Department of Homeland Security. (2017c, October). *National Incident Management System.* (3rd Ed.). Washington, DC.

Department of Homeland Security. (2018a, April). *Public Assistance Program and Policy Guide.* Washington, DC.

Disaster Relief act of 1950, Pub. L. No. 81-875, 64 Stat. 1109 (1950)

Disaster Relief act of 1966, Pub. L. No. 89-769, 80 Stat. 1316 (1966)

Disaster Relief act of 1969, Pub. L. No. 91-79, 83 Stat. 125 (1969)

Disaster Relief act of 1970, Pub. L. No. 91-606, 84 Stat. 1744 (1970)

Disaster Relief act of 1974, Pub. L. No. 93-288, 88 Stat. 143 (1974)

Disaster Mitigation Act of 2000, Pub. L. No. 106-390, 114 Stat. 1552 (2000)

Donner, W. R. (2008). Decision making as community adaptation: a case study of emergency managers in Oklahoma. *Disasters*, *32*(2), 292-302.

Drabek, T. E. (1986). *Human responses to disaster: An inventory of sociological findings*. New York, NY: Springer.

Drabek, T. E. (1999). Understanding disaster warning responses. *The Social Science Journal*, *36*(3), 515-523.

Drabek, T. E. (2004, June). Theories relevant to emergency management versus a theory of emergency management. In *A paper presented at the annual Emergency Management Higher Education Conference, National Emergency Training Center, Emmitsburg, Maryland*.

Drottz-Sjöberg, B. M. (1991). *Perception of risk: Studies of risk attitudes, perceptions and definitions.*

Dutton, J. E. (1988). Patterns of interest around issues: The role of uncertainty and feasibility. *Academy of Management Journal*, *31*(3), 663-675.

Dynes, R. R. (1970). *Organized behavior in disaster*. Heath Lexington Books.

Endsley, M. R. (1988). Design and Evaluation for Situation Awareness Enhancement, Human Factors Society.

Endsley, M. R. (1995). Toward a theory of situation awareness in dynamic systems: Situation awareness. *Human factors* 37(1). 32-64.

Endsley, M. R., & Garland, D. J. (2000). Theoretical underpinnings of situation awareness: A critical review. *Situation awareness analysis and measurement*, *1*, 24.

Endsley, M. R., & Robertson, M. M. (2000). Training for situation awareness in individuals and teams. *Situation awareness analysis and measurement*, 349-365.

Endsley, M., & Bolte, B.J. (2003). *Designing for situation awareness: an approach to user-centered design*. New York, NY: Taylor Francis.

Evans, J. S. B. (2008). Dual-processing accounts of reasoning, judgment, and social cognition. *Annual Review of Psychology*, *59*, 255-278.

Exec. Order No. 12127, 3 C.F.R. 376 (1979).

Federal Emergency Management Agency. (2010a). About the agency. Retrieved from https://www.fema.gov/about-agency.

Federal Emergency Management Agency. (2010b). FEMA Regions. Retrieved from https://www.fema.gov/fema-regional-contacts.

Federal Emergency Management Agency. (2010c). Glossary of Terms. Retrieved from https://www.fema.gov/glossary-terms.

Federal Emergency Management Agency. (2012a). Federal Insurance and Mitigation Administration. Retrieved from www.fema.gov/fima.

Federal Emergency Management Agency. (2012b). U. S. Fire Administration. Retrieved from www.usfa.fema.gov/data.

Federal Emergency Management Agency. (2012c). Urban Search and Rescue. Retrieved from www.fema.gov/urban-search-rescue.

Federal Emergency Management Agency. (2014a, January). *FEMA Watch Guide.* Washington, DC.

Federal Emergency Management Agency. (2014b). IS-11. A: Animals in Disasters: Community Planning. Retrieved from https://training.fema.gov/is/courseoverview.aspx?code=IS-11.a.

Federal Emergency Management Agency. (2017a). Organizational Structure. Retrieved from https://www.fema.gov/media-library/assets/documents/28183.

Federal Emergency Management Agency. (2017b). NIMS Frequently Asked Questions. Retrieved from https://www.fema.gov/nims-frequently-asked-questions.

Federal Emergency Management Agency. (2018a). Disasters. Retrieved from www.fema.gov/disasters.

Federal Emergency Management Agency. (2018b). Disaster Declaration Process. Retrieved from https://www.fema.gov/disaster-declaration-process.

Federal Emergency Management Agency. (2018c). Fire Management Assistance Grants. Retrieved from www.fema.gov/fire-management-assistance-grant-program.

Federal Emergency Management Agency. (2019a). IS-271.A: Anticipating Hazardous Weather and Community Risk (2nd ed.). Retrieved from https://training.fema.gov/is/courseoverview.aspx?code=IS-271.a.

Federal Emergency Management Agency. (2019b). IS-800.C: National Response Framework, an Introduction. Retrieved from https://training.fema.gov/is/courseoverview.aspx?code=IS-800.c.

Federal Emergency Management Agency. (2019c). The College List. Retrieved from https://training.fema.gov/hiedu/collegelist/.

Federal Emergency Management Agency. (2019d). About the agency. Retrieved from https://www.fema.gov/about-agency.

Fischer, P., Schulz-Hardt, S., & Frey, D. (2008). Selective exposure and information quantity: How different information quantities moderate decision makers' preference for consistent and inconsistent information. *Journal of Personality and Social Psychology*, 94(2), 231-244.

Fischoff, B. (1984). Eliciting information from experts. *Research Needs for Human Factors* (pp. 33-48). Washington, DC. National Academy Press.

Fischhoff, B. (1995). Risk perception and communication unplugged: twenty years of process. *Risk analysis*, *15*(2), 137-145.

Fischhoff, B., Watson, S. R., & Hope, C. (1984). Defining risk. *Policy sciences*, *17*(2), 123-139.

Fink, S. (1986). *Crisis Management: Planning for the Inevitable*. New York, NY: AMACOM.

Flin, R. H. (1996). *Sitting in the hot seat: Leaders and teams for critical incident management*. Chichester, United Kingdom: John Wiley & Sons, Inc.

French, S., and Turoff, M. (2007). Decision Support Systems. Communications of the ACM, 50(3), 39-41.

Garrison, J. (1998). Toward a pragmatic social constructivism. *Constructivism and education*, 43-60.

Gonzalez-Herrero, A., & Pratt, C. B. (1995). How to manage a crisis before-or whenever-it hits. *Public Relations Quarterly*, *40*(1), 25.

Gonzalez-Herrero, A., & Pratt, C. B. (1996). An integrated symmetrical model for crisis-communications management. *Journal of Public Relations Research*, *8*(2), 79-105.

Gouran, D. S. (1982). *Making decisions in groups: Choices and consequences*. Pearson Scott Foresman.

Grothman, T., & Reusswig, F. (2006). People at risk of flooding: Why some residents take precautionary measures while others do not. *Natural Hazards*, *38*, 1-2.

Guth, D. W. (1995). Organizational crisis experience and public relations roles. *Public Relations Review*, *21*(2), 123-136.

Haddow, G. D., Bullock, J. A., & Coppola, D. P. (2017). *Introduction to emergency management* (5th ed.). Waltham, MA: Butterworth-Heinemann.

Hammond, K. R., Stewart, R. T., & Brehmer, B. (1975). Social Judgment Theory. In M.F. Kaplan & S. Schwartz (Eds.), *Human Judgment and Decision Processes* 271-312.Academic Press.

Harrald, J., & Jefferson, T. (2007, January). Shared situational awareness in emergency management mitigation and response. In *2007 40th Annual Hawaii International Conference on System Sciences (HICSS'07)* (pp. 23-23). IEEE.

Hay, Iain (Ed.) (2010). *Qualitative Research Methods in Human Geography* (3rd ed.). Canada: Oxford University Press.

Hermann, C. F. (1963). Some consequences of crisis which limit the viability of organizations. *Administrative science quarterly*, 61-82.

Hickman, L., Neubert, S., & Reich, K. (Eds.). (2009). *John Dewey between pragmatism and constructivism*. Fordham University Press.

Hoekstra, S., & Montz, B. (2017). Decisions under duress: factors influencing emergency management decision making during Superstorm Sandy. *Natural Hazards*, *88*(1), 453-471.

Homeland Security Act of 2002, Pub. L. No. 107-296, 116 Stat. 2135 (2002).

Intergovernmental Panel on Climate Change, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (2014). *Climate Change 2014: Synthesis Report*. Geneva, Switzerland: Cambridge University Press.

Jacob, S. A., & Furgerson, S. P. (2012). Writing interview protocols and conducting interviews: Tips for students new to the field of qualitative research. *The qualitative report*, *17*(42), 1-10.

James, T. E., Long, P. O., & Shafer, M. A. (2000). An independent evaluation of the OK-FIRST decision-support system. Preprints. In *Second Symposium. on Environmental Applications* (pp. 40-47).

Joslyn, S., Pak, K., Jones, D., Pyles, J., & Hunt, E. (2007). The effect of probabilistic information on threshold forecasts. *Weather and Forecasting*, *22*(4), 804-812.

Kasperson, R. E. (1986). Six propositions on public participation and their relevance for risk communication. *Risk analysis*, *6*(3), 275-281.

Kasperson, R. E., Renn, O., Slovic, P, Brown, H. S., Emel, J., Goble, R., Kasperson, J. X., & Ratick, S. (1988). The Social amplification of risk a conceptual framework. *Risk Analysis*, 8, 177-197.

Katz, R. W., & Murphy, A. H. (Eds.). (2005). *Economic value of weather and climate forecasts*. Cambridge University Press.

Kearns, R. A. (2010). Seeing with Clarity: Undertaking Observational Research. In I. Hay (Ed.), *Qualitative Research Methods in Human Geography* (3rd ed., 241-258). Ontario, Canada: Oxford University Press.

Klein, G. A. (1989). Recognition-primed decisions. In *W.B. Rouse (Ed.), Advances in man-machine system research (*pp. 47-92). *Greenwich, CT, JAI Press*. *5*.

Klein, G. (2008). Naturalistic Decision Making. *Human Factors*, 50(3), 456-460.

Lincoln, Y. S., & Guba, E. G. (1985). *Naturalistic inquiry*. Thousand Oaks, CA: Sage Publications.

Lindsay, B. R. (2012). Federal emergency management: A brief introduction. Congressional Research Service, Library of Congress.

Kolfschoten, G. L., & Appelman, J. H. (2006). Collaborative engineering in crisis situations. *ISCRAM-TIEMS Summer School, Tilburg, Netherlands*.

Kowalski-Trakofler, K. M., Vaught, C., & Scharf, T. (2003). Judgment and decision making under stress: an overview for emergency managers. *International Journal of Emergency Management*, *1*(3), 278-289.

Kreps, G. A. (1984). Sociological inquiry and disaster research. *Annual review of sociology*, *10*(1), 309-330.

Krimsky, S., & Golding, D. (1992). *Social theories of risk*. Santa Barbara, CA: ABC-CLIO.

Lazo, J. K., Morss, R. E., & Demuth, J. L. (2009). 300 billion served: Sources, perceptions, uses, and values of weather forecasts. *Bulletin of the American Meteorological Society*, *90*(6), 785-798.

Lazo, J. K., Bostrom, A., Morss, R. E., Demuth, J. L., & Lazrus, H. (2015). Factors affecting hurricane evacuation intentions. *Risk analysis*, *35*(10), 1837-1857.

League, C. E., Díaz, W., Philips, B., Bass, E. J., Kloesel, K., Gruntfest, E., & Gessner, A. (2010). Emergency manager decision-making and tornado warning communication. *Meteorological Applications*, *17*(2), 163-172.

Lindell, M. K., & Perry, R. W. (1992). *Behavioral foundations of community emergency planning*. Washington, DC: Hemisphere Publishing Corp.

Lindell, M. K., & Perry, R. W. (2012). The protective action decision model: theoretical modifications and additional evidence. *Risk Analysis: An International Journal*, *32*(4), 616-632.

Lipshitz, R., & Strauss, O. (1997). Coping with uncertainty: A naturalistic decision making analysis. *Organizational behavior and human decision processes*, *69*(2), 149-163.

Lusk, C. M., Stewart, T. R., Hammond, K. R., & Potts, R. J. (1990). Judgment and decision making in dynamic tasks: The case of forecasting the microburst. *Weather and Forecasting*, *5*(4), 627-639.

Manoj, B. S., & Baker, A. H. (2007). Communication challenges in emergency response. *Communications of the ACM*, *50*(3), 51-53.

Mansvelt, J., & Berg, L. D. (2010). Writing Qualitative Geographies, Constructing Geographical Knowledges. In I. Hay (Ed.), *Qualitative Research Methods in Human Geography* (3^{rd} ed., 69-80). Ontario, Canada: Oxford University Press.

Manuel, J. (2014). Crisis and emergency risk communication: lessons from the Elk River spill. *Environmental Health Perspectives*. 122(8), A214 -A217).

McCaughrin, W. C., Mattammal, M., & Hixon, A. S. (2003). Perfect storm: Organizational management of patient care under natural disaster conditions/Practitioner application. *Journal of Healthcare Management*, *48*(5), 295.

McEntire, D. A. (2004, June). The status of emergency management theory: Issues, barriers, and recommendations for improved scholarship. Emmitsburg, MD. Retrieved from http://www.training.fema.gov/emiweb/downloads/David McEntire - Status of Emergency Management Theory.pdf

McEntire, D. A., & Marshall, M. (2003). Epistemological problems in emergency management: Theoretical dilemmas and implications. *Aspep Journal*, *10*, 119-129.

McLoughlin, D. (1985). A framework for integrated emergency management. *Public administration review*, *45*, 165-172.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. San Francisco, CA: John Wiley & Sons.

Mileti, D. S., & Sorensen, J. H. (1987). Why people take precautions against natural disasters. *Taking care: Why people take precautions*, 296-320.

Mileti, D. S., & Sorensen, J. H. (1990). *Communication of emergency public warnings: A social science perspective and state-of-the-art assessment* (No. ORNL-6609). Oak Ridge National Lab., TN (USA).

Mileti, D. S., & O'Brien, P. W. (1992). Warnings during disaster: Normalizing communicated risk. *Social Problems*, *39*(1), 40-57.

Mileti, D. S. (1999). *Disasters by Design: A Reassessment of Natural Hazards in the United States.* Washington, D.C., Joseph Henry Press.

Mileti, D. S., Bandy, R., Bourque, L. B., Johnson, A., Kano, M., Peek, L., Sutton, J. & Wood, M. (2006). Annotated bibliography for public risk communication on warnings for public protective actions response and public education*(revision 4). *Natural Hazards Center, University of Colorado at Boulder*.

Milliken, F. J. (1987). Three types of perceived uncertainty about the environment: State, effect, and response uncertainty. *Academy of Management review*, *12*(1), 133-143.

Mitroff, I. I. (1994). Crisis management and environmentalism: A natural fit. *California management review*, *36*(2), 101-113.

Mogford, R. H. (1997). Mental models and situation awareness in air traffic control. *The International Journal of Aviation Psychology*, *7*(4), 331-341.

Morris, D. A., Crawford, K. C., Kloesel, K. A., & Wolfinbarger, J. M. (2001). OK-FIRST: A meteorological information system for public safety. *Bulletin of the American Meteorological Society*, *82*(9), 1911-1924.

Morris, D. A., Crawford, K. C., Kloesel, K. A., & Kitch, G. (2002). OK-FIRST: An example of successful collaboration between the meteorological and emergency response communities on 3 May 1999. *Weather and forecasting*, *17*(3), 567-576.

Morss, R. E., & Ralph, F. M. (2007). Use of information by National Weather Service forecasters and emergency managers during CALJET and PACJET-2001. *Weather and forecasting*, *22*(3), 539-555.

Morss, R. E., Demuth, J. L., & Lazo, J. K. (2008). Communicating uncertainty in weather forecasts: A survey of the US public. *Weather and forecasting*, *23*(5), 974-991.

Morss, R. E., Demuth, J. L., Bostrom, A., Lazo, J. K., & Lazrus, H. (2015). Flash flood risks and warning decisions: A mental models study of forecasters, public officials, and media broadcasters in Boulder, Colorado. *Risk analysis*, *35*(11), 2009-2028.

Murphy, A. H., Lichtenstein, S., Fischhoff, B., & Winkler, R. L. (1980). Misinterpretations of precipitation probability forecasts. *Bulletin of the American Meteorological Society*, *61*(7), 695-701.

Murphy, B. L., McBean, G., Dolan, H., Falkiner, L., & Kovacs, P. (2005). *Enhancing local level emergency management: the influence of disaster experience and the role of households and neighbourhoods*. Toronto: Institute for Catastrophic Loss Reduction.

National Governors' Association Center for Policy Research and United States. Defense Civil Preparedness Agency. (1979). *Comprehensive emergency management: A governor's guide*. Washington, DC.

National Research Council (Ed.). (1989). *Improving risk communication*. Washington, DC: National Academies Press.

National Research Council. (2006). *Completing the forecast: Characterizing and communicating uncertainty for better decisions using weather and climate forecasts*. Washington, DC: National Academies Press.

National Fire Protection Association. (2007). NFPA 1600: Standard on Disaster/Emergency Management and Business Continuity Programs. Quincy, MA: National Fire Protection Association.

Neal, D. M. (1997). Reconsidering the phases of disasters. *International Journal of Mass Emergencies and Disasters*, *15*(2), 239-264.

Nilsen, T. R. (1974). *Ethics of speech communication* (2nd ed.). Indianapolis, IN: The Bobbs-Merrill Company.

Nonaka, I., & Von Krogh, G. (2009). Perspective - Tacit knowledge and knowledge conversion: Controversy and advancement in organizational knowledge creation theory. *Organization science*, *20*(3), 635-652.

Orasanu, J., & Connolly, T. (1993). The reinvention of decision making. Ablex Publishing.

Paton, D., Johnston, D., & Houghton, B. F. (1998). Organisational response to a volcanic eruption. *Disaster Prevention and Management: An International Journal*, *7*(1), 5-13.

Paton, D., & Flin, R. (1999). Disaster stress: an emergency management perspective. *Disaster Prevention and Management: An International Journal*, *8*(4), 261-267.

Patton, M. Q. (2002). Two decades of developments in qualitative inquiry: A personal, experiential perspective. *Qualitative social work*, *1*(3), 261-283.

Paton, D. (2008). Risk communication and natural hazard mitigation: how trust influences its effectiveness. *International Journal of Global Environmental Issues*, *8*(1-2), 2-16.

Perry, R. W., & Nigg, J. M. (1985). Emergency management strategies for communicating hazard information. *Public Administration Review*, *45*, 72-77.

Peters, G. P., Covello V. T., & McCallum, D. B. (1997). The determinants of trust and credibility in environmental risk communication: An empirical study. *Risk Analysis*, 17, 43-54.

Pidgeon, N., Kasperson, R. E., & Slovic, P. (Eds.). (2003). *The social amplification of risk*. Cambridge, United Kingdom: Cambridge University Press.

Post-Katrina emergency Management Reform Act of 2006, Pub. L. No. 109-295, 120 Stat. 1394 (2006)

Quarantelli, E. L. (1960). Images of withdrawal behavior in disasters: Some basic misconceptions. *Social Problems*, *8*(1), 68-79.

Quarantelli, E. L. (1978). *Disasters: Theory and research*. Thousand Oaks, CA: Sage Publications.

Quarantelli, E. L. (1989). Conceptualizing disasters from a sociological perspective. *International Journal of Mass emergencies and Disasters,* 7(3), 243-251.

Quarantelli, E. L. (1998). Major criteria for judging disaster planning and managing their applicability in developing countries.

Quarantelli, E. L. (Ed.). (2005). *What is a disaster? a dozen perspectives on the question*. London, England: Routledge.

Rabin, M. (2013). Risk aversion and expected-utility theory: A calibration theorem. In *Handbook of the Fundamentals of Financial Decision Making: Part I* (pp. 241-252).

Renn, O. (1992). Concepts of risk: a classification. In S. Krimsky & D. Goulding (Eds.), *Social theories of risk* (pp. 53-82). London, England: Praeger.

Renn, O., & Levine, D. (1991). Credibility and trust in risk communication. In *Communicating risks to the public* (pp. 175-217). Dordrecht: Springer.

Reynolds, B. (2002). Crisis and Emergency Risk Communication. Atlanta, GA: Centers for Disease Control and Prevention.

Reynolds, B. (2005). Crisis and emergency risk communication. *Applied Biosafety*, *10*(1), 47-56.

Reynolds, B., & Seeger, M. W. (2005). Crisis and emergency risk communication as an integrative model. *Journal of health communication*, *10*(1), 43-55.

Reynolds, B., & Seeger, M.W. (2012). Crisis and Emergency Risk Communication. Atlanta, GA: Centers for Disease Control and Prevention.

Richardson, B. (1994). Socio-technical disasters: profile and prevalence. *Disaster Prevention and Management: An International Journal*, *3*(4), 41-69.

Riebsame, W. E., Diaz, H. F., Moses, T., & Price, M. (1986). The social burden of weather and climate hazards. *Bulletin of the American Meteorological Society*, *67*(11), 1378-1388.

Robert T. Stafford Relief Act, 42 U.S.C. 5121 (1988)

Rohrmann, B. (2008, June). Risk perception, risk attitude, risk communication, risk management: A conceptual appraisal. In *15th International Emergency Management Society (TIEMS) Annual Conference*.

Roulston, M. S., & Smith, L. A. (2004). The boy who cried wolf revisited: The impact of false alarm intolerance on cost–loss scenarios. *Weather and Forecasting*, *19*(2), 391-397.

Roulston, M. S., Bolton, G. E., Kleit, A. N., & Sears-Collins, A. L. (2006). A Laboratory Study of the Benefits of Including Uncertainty Information in Weather Forecasts. *Weather and Forecasting*. 21, 116–122

Rubin, C. B. (Ed.). (2007). *Emergency Management: The American Experience, 1900-2005*. Fairfax, VA: Public Entity Risk Institute.

Salas, E., Driskell, J. E., & Hughes, S. (1996). The study of stress and human performance. In J. E. Driskell, and E. Salas (Eds.), *Stress and human performance* (pp. 1-45). Mahwah, NJ: Lawrence Erlbaum Associates.

Saldaña, J. (2015). *The coding manual for qualitative researchers*. Los Angeles, CA: Sage Publications.

Sandman, P. M. (1987). Risk communication: facing public outrage. *EPA Journal*, *13*, 21.

Sandman, P. M. (1993). *Responding to community outrage: Strategies for effective risk communication*. Fairfax, VA: American Industrial Hygiene Association.

Sandman, P. (2000). Open communication. *Risk Communication in Food Safety: Motivation and Building Trust*, 3-5.

Sandy Recovery Improvement Act of 2013, Pub. L. No. 113-2, 127 Stat. 4 (2013)

Schmitt, J. F., & Klein, G. (1999). How we plan. *Marine Corps Gazette*, *83*, 18-26.

Schraagen, J. M., & van de Ven, J. G. M. (2008). Improving decision making in crisis response through critical thinking support. *Journal of Cognitive Engineering and Decision Making*, 2(4), 311-327.

Seeger, M. W., & Gouran, D. S. (2002, July). Functional decision making under crisis conditions. In *Paper presented at the Division of Emergency Health Services of the National Center for Environmental Health.* Risk Communication workshop on effectively communicating protective actions and exposure information during an incident involving a release of radioactive material.

Seeger, M. W., Sellnow, T. L., & Ulmer, R. R. (2003). *Communication and organizational crisis*. Westport, CT: Greenwood Publishing Group.

Seppänen, H., Mäkelä, J., Luokkala, P., & Virrantaus, K. (2013). Developing shared situational awareness for emergency management. *Safety science*, *55*, 1-9.

Shaluf, I. M., Ahmadun, F. L. R., & Mat Said, A. (2003). A review of disaster and crisis. *Disaster Prevention and Management: An International Journal*, *12*(1), 24-32.

Siegrist, M., & Gutscher, H. (2006). Flooding risks: A comparison of lay people's perceptions and expert's assessments in Switzerland. *Risk Analysis*, *26*(4), 971-979.

Simon, H. A. (1957). *Administrative Behavior: A Study of Decision making Processes in Administrative Organization*. New York, NY: The Macmillan Company.

Simon, H. A. (1987). *Bounded rationality. The New Palgrave: A Dictionary of Economics*. London, England: Macmillan. Pp. 15-18.

Sjöberg, L. (1996). A discussion of the limitations of the psychometric and cultural theory approaches to risk perception. *Radiation protection dosimetry*, *68*(3-4), 219-225.

Sjöberg, L. (2000). Factors in risk perception. *Risk analysis*, *20*(1), 1-12.

Slovic, P. (1987). Perception of Risk. *Science*. 236, 280-285.

Slovic, P. (2000). *The perception of risk*. Sterling, VA: Earth.

Slovic, P., Fischhoff, B., & Lichtenstein, S. (1979). Rating the risks. *Environment*, 21(3), 14-39.

Son, J., Zeeshan, A., & Pena-Mora, F. (2007). Supporting disaster response and recovery through improved situation awareness. *Structural Survey*, 26(5) 411-425.

Sorenson, J. H. (2000). Hazard warning systems review of 20 years of progress. *Natural hazards review*, 1, 119-125.

Sorenson, J. H., & Mileti, D. S. (1987). Decision making uncertainties in emergency warning system organizations. *International Journal of Mass Emergencies and Disasters*, 5(1), 33–61.

Stake, R. E. (1995). *The art of case study research*. Thousand Oaks, CA: Sage Publications.

Steinar, K. (1996). *Interview: An Introduction to Qualitative Research Interviewing.* Thousand Oaks: Sage Publications.

Stewart, T. R. (1997). Forecast Value: Descriptive Studies. In R.W. Katz and A. H. Murphy (Eds.), *Economic Value of Weather and Climate Forecasts* (pp.147-181). New York, NY Cambridge University Press.

Stewart, T. R., Katz, R. W., & Murphy, A. H. (1984). Value of weather information: A descriptive study of the fruit-frost problem. *Bulletin of the American Meteorological Society*, *65*(2), 126-137.

Stewart, T. R., & Lusk, C. M. (1994). Seven components of judgmental forecasting skill: Implications for research and the improvement of forecasts. *Journal of Forecasting*, *13*(7), 579-599.

Stewart, T. R., Pielke Jr, R., & Nath, R. (2004). Understanding user decision making and the value of improved precipitation forecasts: Lessons from a case study. *Bulletin of the American Meteorological Society*, *85*(2), 223-236.

Stewart, A. E., Lazo, J. K., Morss, R. E., & Demuth, J. L. (2012). The relationship of weather salience with the perceptions and uses of weather information in a nationwide sample of the United States. Weather, Climate, and Society, 4, 172–189.

Sturges, D. L. (1994). Communicating through crisis: A strategy for organizational survival. *Management communication quarterly*, *7*(3), 297-316.

Sullivan-Wiley, K. A., & Gianotti, A. G. S. (2017). Risk perception in a multi-hazard environment. *World Development*, *97*, 138-152.

Sweeny, K. (2008). Crisis decision theory: Decisions in the face of negative events. Psychological Bulletin, 134(1), 61-76.

Swets, J. A. (1964). Signal detection and recognition in human observers: Contemporary readings. John Wiley & Sons

Swets, J. A. (2014). *Signal detection theory and ROC analysis in psychology and diagnostics: Collected papers*. Psychology Press.

Sylves, R. T. (2004). A précis on political theory and emergency management. *Journal of Emergency Management*, *2*(3), 27-32.

Tarrant, M. (2006). Risk and emergency management. *Australian Journal of Emergency Management, The*, *21*(1), 9.

Taylor-Gooby, P. (2002). Varieties of risk. *Health, Risk and Society*, *4*(2), 109-111.

Taylor-Gooby, P., & Zinn, J. O. (Eds.). (2006). *Risk in social science*. Oxford University Press.

Tellis, W. M. (1997). Application of a Case Study Methodology. *The Qualitative Report*, 3(3), 1-19.

Tobin, G. A., Montz, B. E., (1997). *Natural hazards: explanation and integration*. Guilford Publications.

Tsoukas, H. (1996). The firm as a distributed knowledge system: a constructionist approach. *Strategic management journal*, *17*(S2), 11-25.

Ulmer, R. R., Sellnow, T.L., & Seeger, M.W. (2007). *Effective Crisis Communication: Moving from Crisis to Opportunity.* Thousand Oaks, CA: Sage Publications.

Vaught, C., Mallett, L., Kowalski, K. and Brnich, M. (1997). Workers response to realistic evacuation training, The International Emergency Management Conference Proceedings, Riso National Laboratory, Copenhagen, Denmark.

Vaught, C., Brnich, M., Mallett, L., Cole, H., Wiehagen, W., Conti, R., Kowalski, K., & Litton, C. (2000). Behavioural and organizational dimensions of underground mine fires, Information Circular 9450, US Department of Health and Human Services, National Institute for Occupational Safety and Health (NIOSH) Publication dissemination, Cincinnati, OH.

Veil, S., Reynolds, B., Sellnow, T. L., & Seeger, M. W. (2008). CERC as a theoretical framework for research and practice. *Health Promotion Practice*, *9*(4_suppl), 26S-34S.

Viscusi, W. K., & Zeckhauser, R. J. (1996). Hazard communication: Warnings and risk. *The Annals of the American Academy of Political and Social Science*, *545*(1), 106-115.

Wachinger, G., Renn, O., Begg, C., & Kuhlicke, C. (2013). The Risk Perception Paradox-Implications for Governance and Communication of Natural Hazards. *Risk Analysis* 33(6):1049-65.

Wang, W. T., & Belardo, S. (2005, January). Strategic integration: A knowledge management approach to crisis management. In *Proceedings of the 38th Annual Hawaii International Conference on System Sciences* (pp. 252a-252a). IEEE.

Weber, E., & Hsee, C. (2000). Culture and individual judgment and decision making. *Applied Psychology*, *49*(1), 32-61.

Weick, K. E. (1988). Enacted sensemaking in crisis situations [1]. *Journal of management studies*, *25*(4), 305-317.

Weick, K. E. (1993). The collapse of sensemaking in organizations: The Mann Gulch disaster. *Administrative science quarterly*, 628-652.

Woodbury, G. L. (2005). Critical curriculum for emergency management leaders: Three essential themes. *Journal of Emergency Management*, *3*(2), 72-92.

Yates, J. F., & Stone, E. R. (1992). The risk construct. In J.F. Tayes (Ed.), *Risk-taking behavior* (pp.1-26). Chichester; Wiley.

Yates, J. F. (2003). *Decision management: How to assure better decisions in your company* (Vol. 29). San Francisco, CA: John Wiley & Sons.

Yin, R. K. (2009). *Case study research design and methods* (4th ed.). Thousand Oaks, CA: Sage Publications.

Zhang, D., Zhou, L., & Nunamaker Jr, J. F. (2002). A knowledge management framework for the support of decision making in humanitarian assistance/disaster relief. *Knowledge and Information Systems*, *4*(3), 370-385.

Zinn, J. (Ed.). (2008). *Social theories of risk and uncertainty: An introduction*. Malden, MA: Blackwell Publishing.

APPENDIX A: IRB APPROVAL

The UNIVERSITY of OKLAHOMA

Institutional Review Board for the Protection of Human Subjects

Approval of Initial Submission – Expedited Review – AP01

Date: March 07, 2018

IRB#: 8907

Principal Investigator: Ms Somer A. Erickson, MS

Approval Date: 03/07/2018
Expiration Date: 02/28/2019

Study Title: Communicating Weather and Climate Information for State and Federal Situational Awareness and Decision Support

Expedited Category: 6 & 7

Collection/Use of PHI: No

On behalf of the Institutional Review Board (IRB), I have reviewed and granted expedited approval of the above-referenced research study. To view the documents approved for this submission, open this study from the *My Studies* option, go to *Submission History*, go to *Completed Submissions* tab and then click the *Details* icon.

As principal investigator of this research study, you are responsible to:

- Conduct the research study in a manner consistent with the requirements of the IRB and federal regulations 45 CFR 46.
- Obtain informed consent and research privacy authorization using the currently approved, stamped forms and retain all original, signed forms, if applicable.
- Request approval from the IRB prior to implementing any/all modifications.
- Promptly report to the IRB any harm experienced by a participant that is both unanticipated and related per IRB policy.
- Maintain accurate and complete study records for evaluation by the HRPP Quality Improvement Program and, if applicable, inspection by regulatory agencies and/or the study sponsor.
- Promptly submit continuing review documents to the IRB upon notification approximately 60 days prior to the expiration date indicated above.
- Submit a final closure report at the completion of the project.

If you have questions about this notification or using iRIS, contact the IRB @ 405-325-8110 or irb@ou.edu.

Cordially,

Ioana Cionea, PhD
Vice Chair, Institutional Review Board