Network Governance for Coordinated Disaster Response

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Abstract
The paper addresses the important role of interorganizational coordination and network governance in implementing disaster response policies facing complex environments of emergencies and crises. The paper analyzes the National Response Framework (NRF) in the U.S. and its role in disaster response coordination. A network perspective is utilized to understand functional coordination based on the emergency support functions (ESFs), and to evaluate the role of the NRF in coordinating disaster response at the federal level. Based on the roles and coordination structures defined by the ESFs, interorganizational networks and affiliation networks are presented in the paper. In the context of the COVID-19 pandemic, this paper illustrates how the ESFs, especially ESF #7 – Logistics and ESF #8 – Public Health and Medical Services, operated in response to the crisis.

Keywords: Network Governance, interorganizational coordination, national response framework, disaster response

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Introduction

The paper addresses the application of network governance for better interorganizational coordination in complex environments of emergencies and crises. Recent large-scale disasters are a constant reminder that it is crucial for public administrators to understand interorganizational coordination in emergency management. We first introduce what coordination and interorganizational networks mean in public policy and administration, and then address why we need to study interorganizational networks and how network governance can contribute to interorganizational coordination. In particular, we examine the following questions: What is the critical role of coordination in disaster response? How is coordination structure defined in the National Response Framework? What are the key

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organizations and key emergency response functions identified at the federal level pertaining to response to public health emergencies?

Interorganizational coordination and network arrangements play a substantial role in public administration and public policy. Research in networks and interorganizational coordination has gained substantial interest in the field (O'Toole, 1997; Popp, Milward, MacKean, Casebeer, & Lindstorm, 2014; Provan & Milward, 2001). Crises and disasters necessitate interorganizational and cross-sector coordination (Gray, 1985; 1989; Kapucu & Hu, 2020). Interorganizational coordination in response to disasters is no longer an anomaly, but rather, an expectation and often a necessity for better mobilization, coordination, and utilization of resources in a timely manner.

The National Response Framework (NRF) provides guidance on how the nation responds to all types of incidents. The NRF includes 15 Emergency Support Functions (ESFs) and specifies roles and coordination structures for federal agencies. This paper addresses how the NRF defines coordination, the key stakeholders in disaster response, and specific responsibilities and roles (e.g., primary, coordinating, and supporting) that different actors play. The community elements within the NRF and their coordination with governmental agencies are also discussed. The NRF and the utilization of its core functions were major issues in response to COVID-19. The U.S. did not fully utilize strong policy, planning, and management practice in its emergency management in response to a major public health emergency or in coordination of federal, state, and local response (Hertelendy & Waugh, 2021).

Network analysis has been used as a framework and an analytic tool in understanding interorganizational coordination in emergency management (Kapucu & Demiroz, 2011). In this paper, organizations in the NRF, their coordination relations with other organizations, and their primary function assignments are analyzed using UCINET, the network analysis software program (Borgatti, Everett, & Freeman, 2002). This paper will discuss how networked coordination works, with frameworks that include actors or "nodes", and the relationships that exist amongst them (Hu & Kapucu, 2020; Borgatti, Everett, & Johnson, 2013). We also include the analysis of two critical emergency support functions, namely ESF #7 – Logistics and ESF #8 – Public Health & Medical Service, and how they were utilized in the context of COVID-19 response. The paper contributes to the big question of coordination in public administration using emergencies and crises context as examples.

Coordination and Interorganizational Coordination

The expanded role of government brings additional challenges and opportunities when working with a wide range of nongovernmental organizations. Unlike the traditional hierarchical and bureaucratic structures, the networked environment requires government agencies to learn how to manage and facilitate within network arrangements for better service delivery and public policy implementation. Under stressful and dynamic environments of emergencies and crises, effective coordination has become much more critical as government agencies need to work with many public, nonprofit, and private organizations in a timely manner.

Coordination can be addressed at intraorganizational and interorganizational levels. Our focus here is more on the interorganizational level. This "network (horizontal) approach...can foster the growth of trust and social capital, an important contributing factor for effective coordination" (Kapucu & Hu, 2020, pp. 168-169). Many of the wicked problems today require a wide range of services, policy tools and respondents, thus an integrated approach amongst the providers to address these problems. A collective group of diverse stakeholders engage in 'interorganizational coordination' when they have planned and practical roles in the solution process (Hu & Kapucu, 2020). Interorganizational coordination often occurs organically in situations where a specific need will create a reason for partners to rely on each other for assistance (Cristofoli, Macciò, & Pedrazzi, 2014), but it needs to be more methodical in crisis and emergency situations. Plans and policies like the NRF have acknowledged this need to evolve and are continually updating to include those interorganizational coordination networks in their core capabilities (prevention, protection, mitigation, response, and recovery).

Interorganizational Coordination Under Stress

Policies and plans provide formal frameworks for effective interorganizational coordination and disaster response for emergency managers. In order for interorganizational networks to function under stress, prior relationships and trust and flexibility are also critical factors (Lecy, Mergel & Schmitz, 2013; Klijn & Koppenjan, 2006; Hooge & Marks, 2003). Trust requires one actor to take that leap of faith in believing that the other actor(s) will reciprocate (Kapucu & Hu, 2020). Building trust is very difficult to achieve in the first place, as it requires actors to plan, communicate with each other, and be prepared to adapt to dynamic environments of disasters flexibly. It also means that "exact patterns of interaction are not repeatable" in complex emergency situations due to the nature of crises (Kapucu, 2009, p. 1). The coordination among organizations must be a consideration in plans for effective response to disasters. The NRF provides this guideline with the expectation of interorganizational coordination in response to disasters regardless of size and magnitude. Flexibility on the other hand is necessary because "networks are superior to individual organizations in achieving... efficiencies" such as adaptive efficiency, which in turn fosters flexibility (Agranoff & McGuire, 2001, p. 305). This is a necessity for organizations in a network because they often have rapidly changing situations and approaches to respond and the rapidly changing situations will have outcomes impacted by the response.

Interorganizational Coordination in Response to Disasters

Effectively responding to disasters requires actors to have a level of understanding in both preparation and response. Ansell & Boin (2019) note that those who are successful in responding to disasters understand that "uncertainty is inherent to crisis" (p. 1081). These actors understand that interorganizational coordination is integral to the preemptive planning of such situations. Interorganizational coordination during a disaster response

demands focusing on the specific tasks that are assigned, as well as what actors are engaged in the completion of those tasks. This "task interdependency [is] a scenario where two tasks require exploitation of some common resource and/or activity" (Bodin & Nohrstedt, 2016, p. 185). Task-oriented perspectives and behaviors determine organizational and interorganizational performance and leadership success (Van Wart, 2014). This is especially critical in disaster response as time, pressure and uncertainty make task completion challenging. During emergencies, response plans such as the NRF include broad overviews of the tasks assigned to either organizations or sectors, and then rely on the plans of those sectors and organizations to reflect the tasks that will require coordination and interdependency to carry out. This interdependency and task-oriented approach not only provides a better guideline for actors, but also supports any uncertainty that is sure to arise due to the dynamic nature of disasters.

Frameworks and Plans for Better Coordination

The National Planning Frameworks, such as the NRF, provide coordination structures for networks of organizations in response to emergency situations. Frameworks help understand the relationships amongst actors, and how these interactions assist in better coordination have consistently focused on the strength of the relationship and the different types of relationships between different types of actors within the network. For disaster response, frameworks such as the NRF can help explain how coordination works amongst organizations, as well as amongst functions assigned to each agency.

Among three types of network governance models (Provan & Kenis, 2008), for the purposes of disaster response, "lead organization network" (p.245) is most likely applicable, where the nodes have strong relationships with the lead organization but have weaker relationships with other nodes in the network. This is not to say that there is no interorganizational coordination amongst nodes in a network, but they are strongest in their relationship with the lead organization for that specific function. During a disaster response, support agencies often receive their tasks and assignments from the primary or coordinating agency, hence the network is called lead organization network. These task-oriented and function-based platforms are characterized as functionally collaborative networks to better facilitate interorganizational coordination (Kapucu & Garayev, 2012).

In addition to primary and support organizations, a more comprehensive network framework can be created from the inclusion of coordinating actors that serve as liaisons between primary and supporting agencies for ESFs. In the case of the NRF, many of these coordinating agencies serve primary functions to build a more connected network that allows agencies to rely on one another for necessary resources, as opposed to the traditional vertical and hierarchical models. It is important to understand the distinctions that exist even within networks (i.e., Interactions of actors, if networks cause events or events create networks) in order to determine the frameworks that best fit the situation (Carpenter, Li, & Jiang, 2012). To better frame the coordination network of the NRF, we discuss both the organizational coordination and functional and task affiliation of the organizations based on the NRF (Hu & Kapucu, 2020). Aligning with the tenets of the National Incident

Management System (NIMS), the NRF clearly describes the federal-level coordination structures, but it also provides enough flexibility and construct guidance for other levels of government, as well as non-public entities to frame their emergency response plans to go in line with the NRF. The larger the incident, the greater the responding network needs to be.

The NRF "builds on the response approach in previous editions to address national security emergencies" (p. iii). It specifies in what capacity agencies listed within the framework serve necessary roles and responsibilities during catastrophic incidents, so that coordinating structures can include private sector and other nonprofit plans to further mitigate potential of "cascading failures" (p. iii) due to increasing threats to U.S. infrastructure. With seven community lifelines that make up the necessary response structure of the NRF, various organizations are expected to coordinate to stabilize each lifeline. For instance, the transportation lifeline requires not just agencies that deal with transit, but also those that deal with public safety (for roadway guidance), public works (debris), health & human services (for those requiring medical attention) and even security (protection of infrastructure and people). Agencies under the transportation lifeline in the NRF would build a network to ensure that all aspects relating to transportation (infrastructure, resources, persons) are encompassed and addressed to respond to a disaster and get to the point of recovery. This is reflected throughout the framework, with the utilization of coordination of agencies within ESFs to address the determined community lifelines that must be accomplished for stabilization.

Network Governance and Interorganizational Coordination

Network governance "focuses attention on the interaction processes between interdependent actors and the complexity of objectives and strategies" with a specific attention to how the institutions effect the context of interactions (Klijn & Koppenjan, 2006, p. 139). Isett, Mergel, LeRoux, Mischen, & Rethmeyer (2011) discuss this idea of resolving problems within a governance network and specify that this type of network "focus[es] on the coordination of organizations toward a common goal" (p. i158). These interdependent actors in a network rely on each other through arrangements such as memorandum of understandings (MOUs) and contracts to solve "wicked" problems that are too challenging for one organization to solve, thus promulgating the concept of interorganizational coordination (Agranoff & McGuire, 2001). Emergency and crisis management frameworks such as the NRF and Comprehensive Emergency Management Plans (CEMPs) are expected to facilitate coordination among different levels of government and with the private and nonprofit sector organizations.

Network governance model is more horizontal, with a less rigid power structure, which is a benefit to the fields that often require multiple actors and high levels of adaptability to respond (Kapucu & Hu, 2020). However, this also means that organizations within a network governance structure must be able to "negotiate their relationships" (Mischen, 2015, p. 382) amongst each other using social capital to use their resources wisely and for the common goal. Referring back to Boin & Bynander (2015)'s perspectives on coordination types, while NIMS has a top-down approach, the NRF also

embraces the horizontal perspectives; many coordinating and primary ESF agencies also serve as supporting agencies, leaving flexibility for agencies to initiate horizontal coordination. This bottom-up approach to coordination is far more relevant in the NRF, as the current iteration of the document emphasizes the importance of capabilities built through the inclusion of communities in governmental planning. This creates the opportunity for the use of the bottom-up approach to coordination or hybrid coordination in response to large-scale disasters (Hu et al., 2020; Nowell & Steelman, 2019).

Interorganizational Coordination in the National Response Framework

The NRF was designed as a doctrine for governmental response to incidents, including the support and coordination of all relevant stakeholders that would have roles and responsibilities in responding to an incident. The NRF notes that "the larger or more complex the incident, the greater the number and variety of organizations that must respond" (FEMA, 2019, p. 2). This cooperation amongst organizations requires cohesive response of activities, and the NRF utilizes the 'established networks' within its plan to coordinate with each other to respond to incidents. It is also important to note the introduction of Emergency Support Function (ESF) #14 – Cross-Sector Business and Infrastructure to the most recent edition of the NRF. This addition specifically addresses the notion of coordination across sectors and how integral it is to espouse the normality of multi-sector response for natural or man-made disasters as we continue to see a more networked world and more large-scale disasters and extreme events.

Interorganizational coordination in the NRF has not only evolved to include non-governmental actors but has also made it a necessary component of the framework (Kapucu, 2009). Within the larger scope of the mission areas of incident response, the NRF connects existing emergency planning with an eventual seamless recovery from the incident, where coordination is accomplished among key stakeholders including private and nonprofit partner organizations in response to disasters (FEMA, 2019). As Kapucu and Hu (2020) discussed, the NRF here is used to "illustrate how formal networks are defined...as well as how formal affiliation network and interaction network can be drawn from the NRF" (p. 177). The following section discusses the key stakeholders and actors identified in the NRF as coordinating, primary, and supporting agencies at the federal level.

Emergency Support Functions (ESF) in the NRF

Emergency response requires "evolving networks" because of the high stress involved in such situations (Abbasi & Kapucu, 2016, p. 47). In the NRF, agencies have been organized by the ESF function that must be addressed, as well as specific emergency response functions that some organizations must have. These ESFs "deliver core capabilities to stabilize community lifelines for an effective response" (NRF, 2019, p. 8). For instance, if there was a large-scale wildfire that required the mobilization of the interorganizational coordination of agencies, those that were within ESF #4 – Firefighting would be expected respondents, but there may also be other agencies that have other emergency response functions, such

as U.S. Department of Agriculture or its U.S. Forest Service. These agencies may not have direct response functions, but may support logistically, or with wildlife support. ESFs provide the necessity for organizations that may not normally perform a certain function to respond because the network system would benefit from this. These functions make up a majority of the core capabilities that organizations must meet in order to effectively and efficiently respond to disasters. The list of ESFs in the NRF are provided in Appendix 1.

ESFs also serve as guiding structures for interorganizational coordination. This is evident in the number of agencies within the NRF that are related to each other through the response to the needs of specific ESFs. The NRF specifies that as a coordinating structure, ESFs "have proven to be an effective way to organize and manage resources to deliver core capabilities" (2019, p. 21). While the agencies listed are Federal agencies or nationally organized nonprofits that have Federal contracts, the applicability of the functions that must be accomplished for crisis response is not exclusive to this level of government. States, communities, regions, tribal, territorial and insular area agencies are encouraged to use the ESF construct in order to ensure their coordination with Federal agencies is responsive for the needs of each situation. The core capabilities of organizations under ESFs are designated as coordinating, primary and supporting agencies, to additionally designate authorities and necessary resources. Many agencies outside the Federal level utilize the ESF 'construct' to better support the coordinating mechanism when a disaster does occur that requires the activation of specific ESF(s) by FEMA.

Key Stakeholders and Actors in the NRF

Keeping in mind the addition of ESFs that nationally address the inclusion of cross-sector organizations from businesses to the nonprofit sector and infrastructure, the NRF makes clear distinctions of the key stakeholders, actors within organizations, and the roles that must be fulfilled in situations of stress caused by disasters. Kapucu & Hu (2020) depicted an organizational interaction network within the NRF based on their inclusion of each of the ESFs. The NRF lists organizations and their relationships between the stakeholders, indicating that key stakeholders often have multiple roles and responsibilities between the various ESFs and organizational interactions. The core philosophy behind stakeholders' engagement in the NRF is to engage the whole community to strengthen the response capabilities for preparation, responding to and recovering from disasters (FEMA, 2019).

The NRF outlines governmental agencies at all levels, nonprofits partners, and the private sector with agency roles of either primary, coordinating, or supporting functions. These agency roles are not singular in that an organization could serve as both a primary agency for one function and a supporting for another. The goal of these functions and agency roles are to utilize ESFs to "stabilize community lifelines for an effective response" and decision-making (FEMA, 2019, p. 8). As a national framework, while the NRF incorporates larger federal agencies and cooperatives specifically, it provides a broader overlook of "types" of agencies that hold general roles and responsibilities for disaster response. The NRF also provides flexibility in certain response functions (i.e., Having not only primary and supporting agencies but coordinating ones as well). We can expect some

different dynamics in the network structure and functioning as "inter-organizational coordination network structures are not fixed and vary in each period during a disaster depending on the needs" (Abbasi & Kapucu, 2016, p. 47).

Coordinating Agencies. Coordinating agencies connect primary and support agencies for each ESF. Coordinating agencies utilize the necessary planned strategies to tap into the support agencies listed for each ESF in order to disseminate information, mass care, human services and other resources as needed during an emergency response. The NRF specifically notes that ESF coordinators respond with open communication lines (i.e., meetings, trainings, and calls) with support and primary agencies, serve as the liaison in working with nonprofit organizations and private sector partners, engage in cross-sector sharing and monitor ESF progress (FEMA, 2019, p. 37). This function has become increasingly prevalent in disaster response in recent years as cross-sector operational response has become integral to the National Planning Frameworks. Often times, coordinating agencies serve primary functions as leads for specific needs, but coordinate those open communication lines across agencies as well. For instance, the FEMA Regional Response Coordination Center has 10 regional offices, and each one is staffed by FEMA, but supported by other federal agencies around the time when incidents will/do occur. There are taken over by federal, state, territorial and insular area operations "once unified coordination is established" (2019, p. 23).

Examples of coordinating agencies include the National Response Coordination Center (NRCC), a "multiagency coordination center" at FEMA headquarters for all-natural disasters (FEMA, 2019, p. 24); the National Business Emergency Operations Center (BEOC) within the NRCC, utilized to share information with stakeholders across sectors; the National Military Command Center (NMCC) within the Department of Defense (DOD), responsible for monitoring and coordinating worldwide military operations, and includes the Chairman of the Joint Chiefs of Staff, Secretary of Defense, and the President to perform missile warning, attack assessment, and peacetime management; And the Cybersecurity and Infrastructure Security Agency (CISA) Integrated Operations Coordination Center, which includes National Cybersecurity and Communications Integration Center, National Infrastructure Coordinating Center and National Coordinating Center for Communication and provides situational awareness to all levels of government with actional cyber-information about communications infrastructure.

Primary Agencies. According to the NRF, primary agencies are responsible for "orchestrating support...managing mission assignments...monitoring progress in delivering core capability and other ESF missions...[and] promoting physical accessibility, programmatic inclusion and effective communication" (FEMA, 2019, p. 38). These agencies have some coordinating functions as primary agencies; however, their larger responsibility is oversight and delegation of resources and operations. For instance, the Joint Operations Center (JOC), established and led by FBI (on-scene commander – OSC) is the "focal point for strategic management and direction of on scene law enforcement activities and

coordination with local, state, tribal, territorial, and insular area authorities" (FEMA, 2019, p. 23).

Additionally examples include the National Operations Center (NOC), which houses coordination as well as primary agencies, which is the "principal operations center for Department of Homeland Security (DHS), coordinates and integrates information from NOC components to provide situational awareness and a common operating picture" (FEMA, 2019, p. 24) for all levels of government as the central point of information collection and synthesis, and the National Security Council (NSC), the "principal policy body for consideration of national security policy issues requiring Presidential determination" (FEMA, 2019, p. 25). These examples and others within the NRF indicate that primary agencies are largely specific to the type of incident that occurs, and have the authority based on Federal Codified Laws and Acts to declare the specified emergency. Additionally, primary agencies within the NRF may typically serve coordinating functions for the same ESF as well. For instance, the U.S. Department of Health and Human Services (HHS) is listed as both ESF coordinator and primary agency for ESF #8 – Public Health and Medical Services for public health emergencies.

Supporting Agencies. Supporting agencies are the pillars that hold up the directives of the primary agencies and the necessary functions as requested by coordinating agencies. These agencies are the "boots on the ground" that utilize the disseminated information, personnel, and resources to respond to the incident and get to the recovery mission area, both short- and long-term. This largely includes the private sector, nonprofits and more specialized agencies that have the capacity and technical expertise to respond effectively given each individual emergency situation. For instance, Federal Executive Boards, tribal governments, and other federal, state, territorial, and insular area operations and coordination centers assist with development of situational awareness to Regional Response Coordination Centers (RRCC); Or the Domestic Emergency Support Team and Strategic Information and Operations Center (SIOC) are responsible for supporting FBI with varied degrees of involvement. The Domestic Emergency Support Team would work with the OSC at the JOC with interagency technical or scientific expertise, while the SIOC serves as the FBI's EOC and maintains situational awareness of all incidents and crises (domestic and foreign), and provides FBI headquarters, shares information and intelligence with all other EOCs, serves as point of command for FBI's operational resources, develops connectivity to field command posts and JOCs and activates Weapons of Mass Destruction Strategic Group. The Weapons of Mass Destruction Strategic Group serves as an "interagency crisis action team that supports information exchange and the deconfliction of counterterrorism activities" (p.25) within the SIOC and can be considered one of those 'specialized function' agencies.

In addition to HHS as a coordination and primary agency, the NRF lists several other federal agencies such as the U.S. Department of Agriculture (USDA), the U.S. Department of State (DOS) and American Red Cross to mobilize federal support to local, state, tribal, and territorial areas in response health emergencies including the ones with potential international implications.

Coordinating with Other Levels of Government and Private and Nonprofit Sectors.

The NRF specifically refers to the roles and responsibilities of communities, private sector entities, nonprofits and even households as they relate to the interorganizational coordination network. While these community elements generally have a supporting role in ensuring they have prepared and are ready to be resilient to the disaster at hand, many of them also have responsibilities to work with emergency managers at the local level to be a part of the active response and recovery efforts. While no private entities are listed specifically, they are as a whole expected to "engage in incident response through their own internal response and continuity actions...have a direct link to emergency managers and other relevant officials...restor[e] economic activity in an impacted area" (FEMA, 2019, p. 15). The NRF documents "coordinating structures" such as the BEOC within the private sector to ensure this engagement takes place in a disaster response.

Nonprofit organizations are integral response partners to the government during emergencies, and the NRF lists a few that are either chartered or contracted by Congress to be a partner during all five mission areas of FEMA's emergency readiness goals so that they are able to effectively respond to the necessary core capabilities. The American Red Cross has the legal status of a "federal chartered instrumentality" (p. 29) and as such, is an instrumental network partner within all government disaster planning activities. The National Voluntary Organizations Active in Disaster (NVOAD) and National Center for Missing & Exploited Children (NCMEC) are examples of nonprofits specifically listed within the NRF to provide "delivery of services to communities impacted by a disaster" (FEMA, 2019, p. 29) because of their collective service delivery ability and specialization.

Interorganizational Networks in the NRF

Interorganizational and intergovernmental coordination and cross-sector partnerships and networks provide additional mechanisms to hierarchical systems in response to disasters (Kapucu & Hu, 2020). Within the NRF, interorganizational networks represent the "organizations listed on the NRF and the interactions among them" (Kapucu & Hu, 2020, p. 178). These interorganizational networks have an added layer as either primary, coordinating, or supporting agencies, which dictates the type of engagement they provide in the response of an incident for each ESF listed. The NRF is focused on formal networks, "clearly defined network arrangements created by formal documents" (Kapucu & Hu, 2020, p. 40).

Even though the NRF primarily focuses on the mobilization of federal resources in support of local and state agencies as well as the nonprofit and the private organizations, the coordination creates layered relationships when involving different jurisdictions. Agencies with primary, coordinating or supporting functions within the NRF often have overlapping roles across specific ESFs, and this creates a wider network of response that represents the flexibility needed for interorganizational coordination under stress.

We primarily used the NRF document to create network figures and demonstrate interorganizational relationships in coordinating federal level response. The NRF has

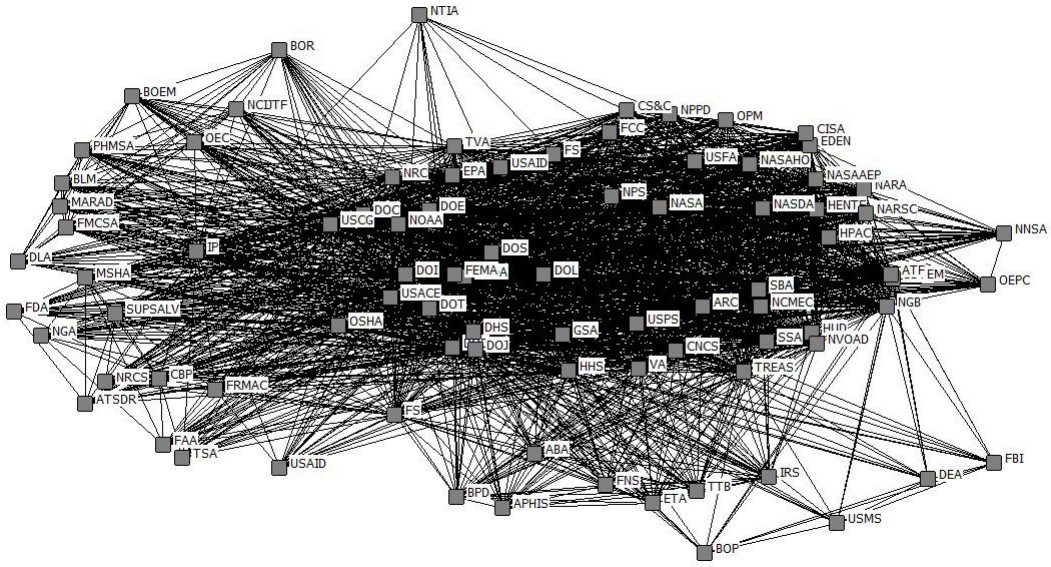
compiled agencies involved in the activation of each ESF in separate annexes, therefore the data for the interorganizational interaction and functional/affiliation networks of all these agencies was pulled from the annex documents, subsequently coded into a matrix and produced through UCINET (Borgatti, Everett, & Freeman, 2002). The NRF ESF annexes provide detailed information on the organizations that would respond with specific actions and roles if that particular ESF was activated during a disaster.

The ESF annexes document covers 15 ESFs, including transportation (ESF # 1), communication (ESF # 2), public works and engineering (ESF # 3), firefighting (ESF # 4), emergency management (ESF # 5), mass care, emergency assistance, housing, and human services (ESF # 6), logistics management and resource support (ESF # 7), public health and medical services (ESF # 8), search and rescue (ESF # 9), oil and hazard materials response (ESF # 10), agriculture and natural resources (ESF # 11), energy (ESF # 12), public safety and security (ESF # 13), long-term community recovery (ESF # 14), and external affairs (ESF # 15). For instance, under ESF # 8 public health and medical services, HHS is the coordinator and primary agency, and the support agencies include the Department of Defense, Department of Energy, DHS, Department of the Interior, Department of Justice, Department of Labor, Department of State, Department of Transportation, Department of Veterans Affairs, Environmental Protection Agency, General Services Administration, U.S. Agency for International Development, U.S. Postal Service, and American Red Cross.

The coordinator, primary, and support agencies are coded as affiliated with ESF # 8. An affiliation tie is created between each of these organizations and ESF # 8 in an excel spreadsheet to be further analyzed in UCINET. Similarly, in another excel spreadsheet, interaction ties are created between all the pairs of organizations that are affiliated with the same ESF to create the interorganizational coordination network. The NetDraw function of the UCINET software is used to analyze these two excel spreadsheets and visualize the affiliation and interaction networks. The affiliation networks show organizations that work under different ESFs, and the interorganizational interaction networks display the shared affiliation with the same ESFs among a wide range of public, nongovernment, and business organizations. This descriptive analysis can be useful in visualizing and depicting the defined coordination structures. In the 2019 NRF, more agencies have been included in the network to reflect additional shared responsibilities and communication, since the 2008 NRF.

Figure 1 depicts the NRF interorganizational network for all organizations reflected within the ESFs, where the relationships are extensive and highly relational. This interaction network is comprised of 87 agencies across the governmental and nonprofit sector, as listed under fifteen ESF functions in the NRF.

Figure 1. An Organizational Interaction Network Based on the NRF



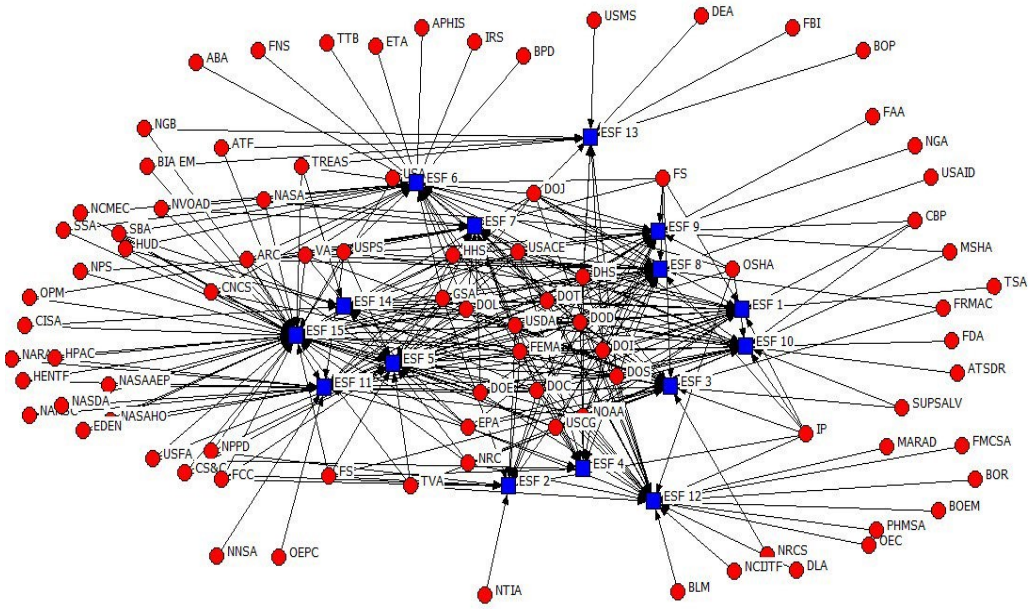
This is significantly greater than the 38 organizations listed in the 2008 NRF and can be attributed to many factors. The first includes the need for tighter networks that include more relevant actors that are in a position to serve emergency management functions, as well as the focus on "the paramount importance of sustaining essential community lifelines" (2019, p. ii). Secondly, the 2008 NRF was a result of the DHS having constructed the NRF without inclusion of state and local government and emergency managers' responsibilities for disasters ("National Response Framework") (Government Technology, 2010). Thirdly, the DHS only listed 10 planning scenarios at the time that included state participation, whereas today, the scope of state and local government for the variety of disasters has expanded (FEMA, 2008). For instance, there is an interaction between the Department of Commerce (DOC) and Department of Justice (DOJ) because both organizations are listed as support agencies under multiple ESFs. List of organizations are provided in Appendix 2.

Functional Networks in the NRF

Within the NRF, functional/affiliation networks utilize the nodal relationship between organizations and each of the ESFs. Within these affiliation networks, an agency may have multiple ESF relationships at varying capacities of engagement. As depicted in figure 2, the NRF functional/affiliation networks for all ESFs represent the relationships between agencies through the shared response to specific ESFs. Kapucu & Hu (2020)'s NRF affiliation network utilized the 2008 NRF and depicted 38 agencies for the 15 ESFs (p. 177). The 2019 version depicts 87 agencies across those same 15 ESFs. A report from the IAEM (2020) noted that FEMA administration needs to continue to keep the communication lines open with NEMA, IAEM and other emergency management

professional organizations and associations, as the issue has yet to be resolved. With a greater affiliation network and shared responsibilities amongst agencies, there is a greater chance of more conducive communication for disaster management. This is especially critical in response to heath emergency response such as the COVID-19 pandemic, where the health sector can learn a great deal of information from the well-established professional emergency management field.

Figure 2. A Formal Affiliation Network Based on the NRF



Similar to the interorganizational interaction networks, this can be attributed to the inclusion of additional agencies that the NRF has deemed critical to the response of disaster operations. For instance, ESF #1 – Transportation, unsurprisingly lists the Department of Transportation as the primary and coordinating agency for this function. It subsequently lists 19 supporting agencies listed in appendix 3.

DHS, FEMA and DOD, had ties to every other organizations listed as either the coordinating, primary or supporting agency. An additional 5 agencies, USDA, DOC, DOI, USACE and DOT, had high centrality, with ties to most other agencies in some capacity.

The Role of NRF in Coordinating COVID-19 Response

Even though the paper is not intended to be an empirical one, we provide a brief observation of the role of NRF in coordinating response to the COVID-19 pandemic. The complexity and the severity of the COVID-19 heath crisis in the U.S. required the mobilization of resources and deployment of federal agencies utilizing the NRF mechanism (Buck, 2021). This unprecedented public health emergency required substantial logistical coordination and supply chain stabilization. The Center for Diseases Control and Prevention

within the U.S. Health and Human Services Agency with its emergency operation center (EOC) could have worked with FEMA early enough and bring its expertise in coordination and logistics through ESF #7 – Logistics and ESF #8 – Public Health and Medical Service). The US emergency management system is one of the most established in the world with policies, frameworks, and plans. Unfortunately, these plans and polices were not effectively executed. The CDC EOC was not fully resourced and FEMA's expertise in logistics and coordination was not utilized in a timely manner and integrated to public health emergency response (Buck, 2021).

One of the most obvious public health challenges in the U.S. was the inability of health systems' personnel and resources to keep up with the growing number of cases. Despite the HHS and FEMA's guidance, it was difficult for states to invoke their Emergency Management Assistance Compact (EMAC) and work closely with NEMA, because this pandemic has affected all 50 states at the same time rather than typical disasters that are localized to specific regions. Otherwise, EMAC as a major horizontal state-to-state coordination initiative would have been particularly useful in addressing coordination need in response to COVID-19 (Kapucu, Augustin, & Garayev, 2009). Additionally, while the NRF provides guidance on the communication inter-agencies that must take place, the U.S. saw a lack of federal facilitation of coordination between states' requests for resources from each other (Hu, Zhang, Kapucu & Chen, 2020). This exacerbated the pandemic in many states that could have controlled it better with additional resources and displayed the glaring issue with the NRF network: it does not work very effectively if the federal government does not follow the guidance of public health and emergency management agencies (Hertlendy & Waugh, 2021).

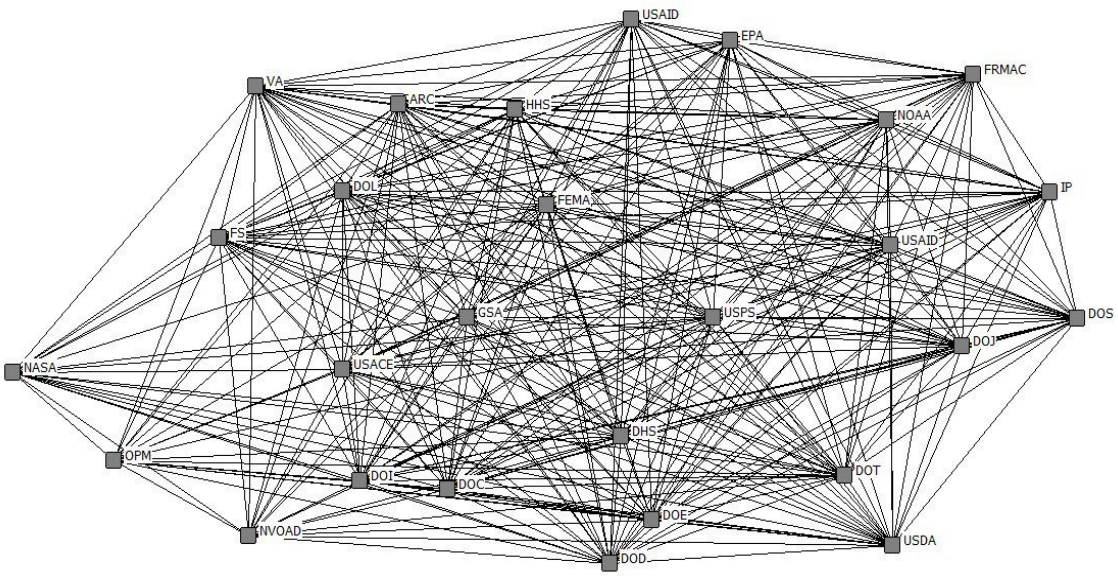
As a guide for emergency management, the NRF is structured to assist agencies at all levels, from the federal to the local/insular, in determining what their roles will be during different disasters in coordination with other agencies. The NRF design provides high-level mobilization and asset deployment information, with specific roles for federal agencies, and certain cooperative nonprofit organizations. It also notes that "operational coordination occurs across all of these levels and consists of actions and activities...to determine appropriate courses of action" (2019, p. 15). Within the NRF, agencies listed under one ESF may also be referenced for specific roles and functions that may be necessary under a different ESF, indicating that agencies coordinate for the fulfillment of the needs of the ESF(s) of specific incidents using their agency specialty. To build the national preparedness and resilience of the nation, Federal agencies and other partners "are encouraged to develop a shared understanding of broad-level strategic implications" (NRF, 2019, p. 51) of the decisions they make, because these decisions have a ripple effect on each other's responses during crises.

The COVID-19 pandemic has not only encouraged but compelled the examination of better networks for response. There have been significant logistical and medical challenges to determining where it came from, how to contain and cure it, and how to prevent it from happening again. Hence, ESF #7 – Logistics and ESF #8 – Public Health and Medical Service are utilized from the 2019 NRF ESF annex document as exemplar networks to demonstrate what agencies are and should participate in resolving this crisis. Logistics (ESF

#7) and Public Health and Medical Service (ESF #8) have many of the same supporting agencies, and each have the other's coordinating/primary agency in supporting function. While the Department of Health & Human Services (HHS) provides medical supplies and contracts for medical response teams under ESF #7, the Department of Homeland Security (DHS)/FEMA provide "logistical support for deploying ESF #8 medical elements" and situational awareness (NRF ESF Annex, 2008, p. 13). This indicates that while DHS/ FEMA served a logistic role for Public Health and Medical Services in coordination with HHS under ESF #8, HHS served its purpose as a resources annex for medical logistic purposes under ESF #7.

For instance, within ESF #8, many supporting agencies specifically served technical roles for "logistical" support to achieve the needs of the ESF. This interconnectedness requires coordination and "communications support" (NRF ESF Annex, 2008, p.13), something that was lacking during the pandemic response (Hertlendy & Waugh, 2021). While logistics is a more general ESF, it is a necessary component of public health and medical service provision, and while public health and medical services have a specific type of provision, they must participate logistically in order to disseminate as needs arise—hence agencies must coordinate to serve the needs of each ESF.

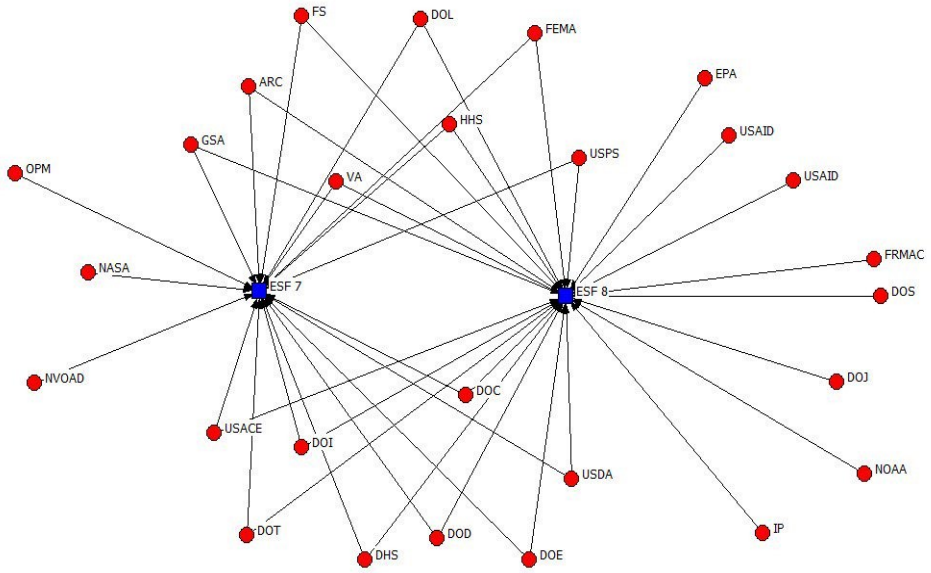
Figure 3. An Organizational Interaction Network Based on the NRF's ESF 7 Logistics and ESF 8 Public Health & Medical Service



Of the organizations within the interaction network, a network analysis of figure 3 provides a less tight organizational interaction network based on the NRF's ESF #7 – Logistics and ESF #8 – Public Health and Medical Service (FEMA, 2019). The figure demonstrates an ideal coordination scenario assuming all the agencies at the federal level are coordinating their actions and activities in response to COVID-19 as described in the

NRF's ESF #7 and ESF #8. Figure 4 demonstrates each organization taking responsibilities for ESF #7 and SF #8.

Figure 4. A Formal Affiliation Network Based on the NRF's ESF 7 Logistics and ESF 8 Public Health & Medical Service



NRF and the National Preparedness Report

The National Preparedness Report (FEMA, 2020) utilizes the 15 ESFs to report on the necessary core capabilities within each that must be achieved by the participating agencies in their planning and responding to disasters. The report highlights four areas of critical consideration with 24 target impacts that must be met for the 32 core capabilities to manage risks, including consideration of cascading impacts of disasters, public-private partnerships in reestablishing networks, vulnerable populations' access and functional needs, and long-term housing capabilities after disasters.

The report "identifies the threats and hazards that pose the greatest risk as the benchmark against which to assess preparedness" (FEMA, 2020, p. 6). The report breaks down the types of risks that may occur (both natural and man-made) and instances of capabilities that have been utilized to mitigate those risks. For instance, the state of California has mandated that all Internet of Things (IoT) devices sold in the state going forward "must have 'reasonable cybersecurity measures' embedded" (FEMA, 2020, p. 38) to mitigate cybersecurity threats that we are increasingly facing. The report briefly lists what the primary responding agency would be in a cybersecurity threat instance, but highlights how many communities are prioritizing the efforts to deal with this particular threat. The report focuses on large-scale disasters that lead to destruction of property, loss of resources and displaced peoples, with a mention of cybersecurity threats in relation to responding agencies.

The report highlights the importance of coordination, noting that in 2019, FEMA funded $267.5 million for agencies focused on "operational coordination", the 2nd most awarded category behind planning capabilities. There are successes and failures of coordination also noted within the report, within infrastructure, service and safety provision and innovation. For instance, the report focused on the necessity for private sector inclusion in preparedness planning, considering many capabilities such as "critical infrastructure, including communications and power installations, are privately held and managed. Strengthening these relationships...are crucial to effective disaster response" (FEMA, 2020, p. 36).

The report expanded on the NRF's summary about the detriments to society when disaster response agencies fail to consider needs of certain populations. For instance, in 2019, California's major electricity providers implemented "public safety power shutoffs" due to impending inclement weather that could cause fires. This led to gross mismanagement of communication with people reliant on life-saving powered machinery, and could have been mitigated through better communication through other organizations in a network, along with the consideration of this type of disaster response and its ripple effects on people. The report noted that the "cascading impacts of a power outage" go farther than just a general lack of electricity, but can impact mass care, the economy, and continuity of essential public functions. This failure of response and the subsequent impacts on the chain of organizations and sectors connected to electricity solidifies the necessity for preparedness in a cohesive and coordinated manner by all agencies public, private, and nonprofit. The report recognized that "progress is being made through broader coordination between federal and state agencies and the establishment of information-sharing centers, outreach programs, and federal planning and financial resources" (2020, p. 75), along with the inclusion of partnerships. The annual reports can be used in determining performance of coordination based on ESFs in the future.

Conclusion

Coordinated disaster response continues to grow in complexity as the types of crises proliferate. Interorganizational coordination in the face of disasters must align with the necessities of each incident, as well as with the other responding agencies. The use of network frameworks provides a clearer look at the responsive actors and the relationships amongst them for the necessary functions. This paper utilized the discussion of interorganizational coordination and networks with the exemplar of the NRF, and how organizational and affiliation networks function within it. The paper also discussed the recently published NPR, and how its purpose as a performance reporting tool for disaster readiness can be compared to the NRF. For effective coordination based on ESFs and integrating a whole community approach in disaster preparedness and response, emergency management agencies should build relationships and create an inclusive platform to engage community and private sector organizations in serving impacted people from disasters.

While the NRF provides crucial guidance for interagency coordination and cross-section coordination, practical coordination challenges remain, especially during disasters.

For instance, the recent pandemic would have immediately triggered the use of ESF #8 – Public Health and Medical Services; however, there were glaring communication and logistical gaps, as evidenced by the lagging and disjointed response to the pandemic noted by agencies, citizens and media outlets across the nation. While the NRF provides the necessary information for lower-level agencies and other sectors to plan their emergency response documents accordingly, there is no FEMA or other federal agency 'review' or inspection of these other networks' response documents, which makes it difficult to determine if many of these networks are effective in practice until disaster strikes. To ensure that multilayered coordination networks function during disasters, these organizations need to establish frequent communication and participate in coordination activities in the form of exercises, for example, prior to a disaster. Additionally, there are practical implications in understanding the design network of the NRF in that it serves as a baseline for further studies of the implementation of the networked coordination when specific ESFs are activated. For the pandemic, these organizational and affiliation design matrices can be further leveraged with implementation matrices, with implications for any network relationships that need to be examined and updated by FEMA based on evidence of gap between the design and actual implementation.

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Appendix 1

List of Emergency Support Functions (ESFs)

ESF #1: Transportation
ESF #2: Communications
ESF #3: Public Works and Engineering
ESF #4: Firefighting
ESF #5: Information and Planning
ESF #6: Mass Care, Emergency Assistance, Temporary Housing, and Human Services
ESF #7: Logistics
ESF #8: Public Health and Medical Services
ESF #9: Search and Rescue
ESF #10: Oil and Hazardous Materials Response
ESF #11: Agriculture and Natural Resources
ESF #12: Energy
ESF #13: Public Safety and Security
ESF #14: Cross-Sector Business and Infrastructure
ESF #15: External Affairs

Appendix 2

Agencies included in the NRF

Department of Transportation (DOT)
Department of Agriculture (USDA)
Department of Commerce (DOC)
Department of Defense (DOD)
Department of Energy (DOE)
Department of Homeland Security (DHS)
Department of the Interior (DOI)
Department of Justice (DOJ)
Department of State (DOS)
General Services Administration (GSA)
U.S. Postal Service (USPS)
U.S. Forest Service (FS)
Animal and Plant Health Inspection Service (APHIS)
American Bar Association (ABA)
Food and Nutrition Service (FNS)
National Oceanic and Atmospheric Administration (NOAA)
Customs and Border Protection (CBP)
Transportation and Security Administration (TSA)
Office of Infrastructure Protection (IP)
National Telecommunications and Information Administration (NTIA)
Navy Supervisor of Salvage (SUPSALV)
National Resources Conservation Service (NRCS)
Federal Radiological Monitoring and Assessment Center (FRMAC)
Office of Foreign Disaster Assistance (USAID)
National Geospatial-Intelligence Agency (NGA)
Mine Safety and Health Administration (MSHA)
Federal Aviation Administration (FAA)
Centers for Disease Control and Prevention/Agency for Toxic Substances & Disease Registry (ATSDR)
Food and Drug Administration (FDA)
Occupational Safety and Health Administration (OSHA)
Employment and Training Administration (ETA)
Alcohol and Tobacco Tax and Trade Bureau (TTB)
Bureau of the Public Debt (BPD)
Internal Revenue Service (IRS)
Office of Environmental Policy and Compliance (OEPC)
National Nuclear Security Administration (NNSA)
Defense Logistics Agency – Energy (DLA)
Office of Emergency Communications (OEC)
Bureau of Land Management (BLM)
Bureau of Reclamation (BOR)

Bureau of Ocean Energy Management, Regulation and Enforcement (BOEM)
Federal Bureau of Investigation - National Cyber Investigative Joint Task Force (NCIJTF)
Federal Motor Carrier Safety Administration (FMCSA)
Maritime Administration (MARAD)
Pipeline and Hazardous Materials Safety Administration (PHMSA)
Drug Enforcement Administration (DEA)
Federal Bureau of Investigation (FBI)
Federal Bureau of Prisons (BOP)
U.S. Marshal Service (USMS)
Bureau of Indian Affairs Emergency Management (BIA EM)
National Protection and Programs Directorate (NPPD)
Office of Cybersecurity and Communications (CS&C)
Federal Emergency Management Agency (FEMA)
Federal Communications Commission (FCC)
U.S. Army Corps of Engineers (USACE)
Department of Health & Human Services (HHS)
Department of Labor (DOL)
Department of Veterans Affairs (VA)
Environmental Protection Agency (EPA)
Nuclear Regulatory Commission (NRC)
Tennessee Valley Authority (TVA)
Corporations for National and Community Service (CNCS)
Forest Service (FS)
U.S. Fire Administration (USFA)
U.S. Coast Guard (USCG)
American Red Cross (ARC)
Department of Housing and Urban Development (HUD)
Department of the Treasury (TREAS)
Social Security Administration (SSA)
U.S. Small Business Administration (SBA)
National Center for Missing and Exploited Children (NCMEC)
National Voluntary Organizations Active in Disaster (NVOAD)
National Aeronautics and Space Administration (NASA)
Office of Personnel Management (OPM)
U.S. Agency for International Development (USAID)
National Park Service (NPS)
National Archives and Records Administration (NARA)
Advisory Council on Historic Preservation (HPAC)
Heritage Emergency National Task Force (HENTF)
National Alliance of State Animal and Agricultural Emergency Programs (NASAAEP)
National Animal Rescue and Sheltering Coalition (NARSC)
National Association of State Directors of Agriculture (NASDA)
National Assembly of State Animal Health Officials (NASAHO)

Extension Disaster Education Network (EDEN)
Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF)
National Guard Bureau (NGB)
Cybersecurity and Infrastructure Agency (CISA)

Appendix 3
ESF #1 Supporting Agencies
Department of Transportation (DOT)
Department of Agriculture (USDA)
Department of Commerce (DOC)
Department of Defense (DOD)
Department of Energy (DOE)
Department of Homeland Security (DHS)
Department of the Interior (DOI)
Department of Justice (DOJ)
Department of State (DOS)
General Services Administration (GSA)
U.S. Postal Service (USPS)
U.S. Forest Service (FS)
National Oceanic and Atmospheric Administration (NOAA)
Customs and Border Protection (CBP)
Transportation and Security Administration (TSA)
Office of Infrastructure Protection (IP)
Federal Emergency Management Agency (FEMA)
U.S. Army Corps of Engineers (USACE)
U.S. Coast Guard (USCG)