



# The use of documentary data for network analysis in emergency and crisis management

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## Abstract

The use of network analysis to understand relationships among actors and organizations in coordinated actions has grown in recent years. Examining the network structure and functions in disaster response has gained particular attention. Different methods of data collection and analysis are utilized in network research. The use of documents as a data source has also gained traction. Scholars utilize content analysis of documents to uncover network structure, i.e., core “nodes,” and functions. This is especially critical in emergency and crisis management as the associated network involves complex set of actors from different sectors and jurisdictions, and first-hand recollections of representatives might not be inclusive of every interaction and specific actors they worked with. With augmented utilization, there is a need to understand the methodological process of document use as a primary means of data analysis in emergency management. This study fills that gap by providing a systematic literature review of empirical studies across a broad range of subjects that have discussed document collection and use for network analysis. Furthermore, this study provides a detailed example of the method of document identification and collection, data generation and organization process, and network visualization and analysis in an emergency and crisis management context. The study concludes with answering, for disaster response networks, what types of documentary data are utilized and how they are used, the types of disasters that have been prevalent in utilizing this method, and the process undertaken to analyze and visualize networks.

**Keywords** Networks · Network data · Content analysis · Network analysis · Network visualization · Disaster

## 1 Introduction

The way organizations could best respond to disasters shifted in the 1990s, when the traditional, hierarchal, top-down approach gave way to a more nuanced and collaborative approach, making way for network analysis and study (Comfort 2019; Jones and Faas

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2016; Kapucu et al. 2022). This included the focus on providing empirical analyses of the complex decision processes rather than simply “thick” qualitative case study methods, and one of the prevailing methods for this was the use of documentary data (Cunningham et al. 2016; Uhr et al. 2008). The use of documents in creating, visualizing, and analyzing network data is increasingly common in emergency and crisis management (Du et al. 2020a, b; Zhang et al. 2018). Several scholars in emergency and crisis management have utilized policy and planning documents, as well as after-action reports, to understand how systems and organizations are designed and operate in response to disasters (Comfort 2019; Comfort and Haase 2006; Kapucu 2006; Resodihardjo et al. 2018). However, a systematic guide and analysis on the process of collecting and using documents to gather and analyze the rich data is lacking (Butts et al. 2012). This paper will use the context of interorganizational linkages in a network to perform necessary emergency response tasks as the basis of review of documentary source analysis.

Compared to surveys or interviews, documents are reliable and valid sources for network data, especially in dynamic environments of emergencies and crises (Comfort et al. 2020; Du et al. 2020a, b; Gerber and Robinson 2009; Hu et al. 2014; Yeo et al. 2021). As a disaster strikes, professional emergency and crisis managers must address the urgent problems caused by disasters (Kapucu et al. 2022). In that instant, it is difficult for researchers to collect data during response operations from emergency managers and others involved in response operations due to the challenging nature of emergency response, and the extent to which a disaster impacts a community (e.g., terrorist event, devastating storm causing physical damages and danger). Similarly, reaching out to emergency managers and first responders and collecting network data after disasters may result in incomplete information due to unwillingness to participate, inability of respondents to remember every actionable detail of the event, or unplanned, ephemeral implementation networks structures. For instance, Butts et al. (2012) addressed the “dearth of “standard” procedures for the collection and processing of interorganizational data from online documents” (p. 4) by providing a more detailed data collection process of their study. In the case of disasters, documents such as after-action reports or news reports on response activities are useful and valuable sources of data, especially for network research in the field of disaster studies (Comfort et al. 2020; Zhang et al. 2018).

The use of documentary analysis for networks drawn in emergency and crisis management has been evident for a couple of decades. From the ability to discern the network actors that were included or excluded, to the levels of interactions occurred, documentary data have provided extensive data to map disaster-time responses (Clark-Ginsberg 2020; Kapucu et al. 2017; Comfort and Zhang 2020; Yeo and Comfort 2017; Yurisch et al. 2020). Tang et al. (2017) noted, “the emergency operation plans specif[ied] each organization’s roles, responsibilities and tasks, and provide[d] guidance to coordinate efforts of participating organizations in each government level during emergency management” (p. 1554), which is essential in building the planned disaster network. Yeo et al.’s (2021) work further supports the need for networks visualized as a result of document analysis, because their study depicted how policy and plan documents served as frames of reference during the response coordination practice after a hurricane. While not an empirical study, this research demonstrates the value of the use documents in generating and using data for network analysis to document how organizations interact, exchange information and resources, and coordinate in response to disasters (Kapucu et al. 2010a, b; Siciliano and Wukich 2017).

Coordination as an outcome is widely used as a measure for networks in analyzing the success or quality of response operations. The prime use of documentary data

for coordination is to determine disparities between the designed or planned disaster response and the actual implementation of the plans and policies as documented in the after-action reports and other governmental reports (Yurisch et al. 2020). The content analysis of documents for emergency and crisis management provides an in-depth look and timeline of disaster response effectiveness in coordinating tasks and resources as indicated in the plans, policies, and frameworks (Schweinberger et al. 2014).

This analysis method is salient not only because it provides historical “snapshots” of actors or organizations but also because documents are more readily available compared to participants (Kapucu and Demiroz 2011). This method also reduces internal biases that may result from participant selection (Butts et al. 2012). The benefits of this method are reflected in the ability to create and analyze a disaster response network without reliance on responders that may be too overwhelmed during disaster response or unwilling to participate after the fact. While some empirical studies in the literature review mentioned the document collection process, data organization, or network visualization process, none provided a comprehensive explanation of the process using content analysis. With this in mind, research questions addressed in this paper are: What type of documents are used in studying networks in emergency and crisis management? What types of disasters have been studied using data collected by document analysis? What is the process of data collection and analysis for networks in emergency and crisis management? How is document data utilized for network data analysis visualization? Document content analysis provides an understanding of existing or emergent structures and relationships, and provides policy, planning, and practical implications based on the use of these documents during crises.

This paper provides a systematic review of network research using documents in emergency and crisis management and an example to provide some guidance for future studies. Additionally, this review presents the process of the use of documents in creating and analyzing network data in emergency and crisis management. An exemplar of the documentary data process is provided with a case study of the East Central Florida Regional Planning Council region’s documents, such as comprehensive emergency management plans (CEMPs), policies, and frameworks at all levels of government. The paper contributes to the methodology of documentary data use for network studies in general applications, and in emergency and crisis management in particular. For better interorganizational network and coordinated response research, it is critical to understand what types of documents are utilized, and how they are utilized, in networked response to different types of disasters.

The paper is organized in the following manner: An overview of the systematic literature and background on networks is provided, along with how documentary data is organized, utilized, and used to visualize networks, and the practical implications of emergency response networks are examined. The case of a County CEMP is presented as an example for a planned response network visualization using content analysis, network matrix development, and visualization. Using background information, systematic review, and case analysis, this paper presents the importance of and method for document use and analysis for study of disaster response networks.

## 2 Literature review and background

Studies in the last couple of decades have provided compilations of research and bibliometric analyses on the topic of networks; however, the documentary method of the network data collection, analysis, and visualizations has not been thoroughly examined. As

highlighted by Hu et al. (2016) “[r]elatively few articles have explained the emergent process by collecting...the qualitative data to understand” how network figures are created (p. 604). While theory testing is necessary, the empirical approach to how the network is built for analysis is equally pertinent. Even more scarce is the understanding of how to use documents to create networks for emergency management and disaster response. Emergencies activate organizational response plans, but most organizations have general “all-hazards” approaches, or very high-level agencies within their CEMPs. The implementation of these plans during a disaster may find a greater network than what was designed or planned (Guo and Kapucu 2015; Siciliano and Wukich 2015; Yurisch et al. 2020). This can be due to a number of reasons, including the unexpected scale of a disaster, or the ability for unexpected organizations to better support Emergency Support Functions (ESFs) (Kapucu et al. 2022). This systematic literature review will provide an explanation for the process of documentary data identification, collection, analysis and network visualization for emergencies and crises.

There is a need to utilize an organized method of data collection of disaster-related documents that allows for in-depth understanding of the data, where it comes from, and what task it represents in the grander response scheme—hence the use of networks (Robins 2015). Specific to disaster studies, documents provide significantly detailed information about response. Additionally, data analysis is often interpreted by the researcher based on the types of interactions being extracted from the documents (Hollstein 2013). The World Trade Center disaster, for instance, was unprecedented because plans “never envisioned the need to respond to an event whose impacts resembled those of a major disaster and... that was also a crime scene, a national security emergency, and a potential environmental disaster” (Tierney and Trainor 2004, p. 165). This disaster had rich data for analysis and policy implications due to the extensive collection of various documents, such as field notes, interviews, after action reports, and meeting notes, naming established and emergent organizations that responded in the immediate aftermath (Tierney and Trainor 2004). Furthermore, “[c]ontent analyses of [these] documents help us understand the contexts and meanings of network ties” (Hu 2015, p. 83). The scope of use for documents as rich data for a variety of subjects has tangible benefits for research and policy implications.

## 2.1 Method of the systematic literature review

The existence and utilization of documents have given scholars and practitioners insight into the successes, failures, and opportunities for future organizational response. For disasters, scholars have analyzed networks at different levels and have ascertained that disaster-time organizational network ties are often observed or recollected, for which archival data are imperative (Kadushin 2005; Prell et al. 2009; Varda et al. 2009). A systematic review of the subject supports the importance of document use for network data collection and analysis and provides insight to researchers and practitioners about the benefit of this type of data collection (Seo et al. 2021). To ensure exhaustiveness of the literature examined for this review, multiple databases and queries both broad and narrow were utilized.

We focused on identifying articles that specifically looked at document analysis for network research in public administration and policy. The first query with keywords selected was “document analysis for network research//data AND content analysis for network research AND network visualization from documents AND creating network data from documents AND emergency.” This resulted in 739 peer-reviewed works in the Primo

database. Further assessment of the titles and abstracts in these results led to a few additional filters—“AND document collection AND policy documents,” “NOT tweet NOT social media.” This resulted in 193 peer-reviewed works. Studies that referenced computer technology, Internet of Things, or data science as “networks” were omitted. This resulted in 12 studies relevant to the search scope.

Two additional peer-reviewed queries were applied in the Primo database, with broader key terms. The second query utilized the key terms: “document analysis” AND (disaster OR crisis) AND network,” populating 577. After reviewing the title, abstract, and introduction of these works, 26 studies remained. From there, a review of the main text was conducted to determine if document collection and network figures were of significant importance within the studies, resulting in five (5) relevant articles. The third query included “network analysis” AND (“content” OR “document analysis”) AND “network research” AND “policy” NOT “bibliometric.” This yielded 1315 results. After excluding results that were related to science & technology, environmental sciences, and business and economics, 811 results remained. Review of these results’ title, abstract and introduction led to 13 studies relevant for the research scope.

A fourth and final concentrated search in public administration and policy was also undertaken with the databases: ABI/INFORM, Policy File Index, Politics Collection, Social Sciences Database and Worldwide Political Science Abstracts. The key terms for these databases were: ab(“document analysis” OR “content analysis”) AND ab(“network analysis”) NOT “social media” NOT “survey.” Out of 148 results from this query, 12 articles were determined relevant through review of titles and abstracts.

The final list of sources from the queries were then searched on Google Scholar to further locate peer-reviewed articles that cited them in Google Scholar and specifically used the key terms: “document analysis” OR “content analysis” AND “network.” These articles resulted in an additional range of 2–28 articles per source that were relevant to this research, with many results redundant across multiple of the original query search articles.

The result of all these queries was 104 articles. These articles were read in entirety by the first researcher and deemed either “relevant” (52), “not relevant” (34) or “maybe relevant” (18). This determination was based on the following factors: mention of documentary data utilized for research, mention of data collection, specific to disaster/crises, and use of network analysis and visuals. The articles were then examined by the second researcher for agreement or disagreement of primary assessment. After examination by both researchers, 61 articles were selected as relevant. The list of relevant articles and draft systematic literature search method was shared with the remaining two researchers for their feedback, and any additional key sources that the first two researchers may not have captured. None more were determined relevant for the final review list.

These articles reflect the use of document or content analysis of policy/procedure documents, news articles and reports for network research and analysis, along with various other data collection methods. The purpose of this extensive literature search was to understand how network research underscores the importance of document collection and the use of it in analysis and visualization of network figures, and eventually, the specific implications for policy and practice. One of the researchers went through each relevant article and coded how many of the 61 relevant articles from the systematic literature review explicitly met each of the criterion set by the study, as indicated in Table 1.

**Table 1** Count of systematic review studies that mentioned the type of disasters

| Type of disasters          | Count |
|----------------------------|-------|
| Chemical incident          | 2     |
| Cyclone/earthquake         | 1     |
| Earthquake                 | 5     |
| Flooding                   | 1     |
| Hurricane                  | 16    |
| Influenza/earthquake       | 1     |
| Pandemic                   | 3     |
| Pollution                  | 1     |
| Power plant                | 1     |
| Terrorist attack           | 5     |
| Terrorist attack/hurricane | 1     |
| Typhoon                    | 1     |
| Typhoon/earthquake         | 1     |

## 2.2 Types of disasters studied

Table 1 demonstrates the extensive list of disasters that were studied by scholars using documentary data.

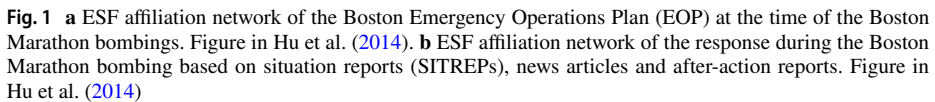
With scholars like Kapucu (16 studies) and Comfort (8 studies) as the most active on the use of documentary data for interorganizational networks in emergency response, a majority of the disasters reflected in the systematic review were either hurricanes (17 studies), earthquakes (8 studies), or terrorist attacks (6 studies). Of the 61 sources, 39 of them specified a disaster for a case study. Documentary data are an ideal source for disasters because they can serve as “tools for detecting and responding to threats”, and as such, are “living documents...[that] need to be revised along with the changes in threats” (Fan and Nie 2018, pp. 21–26). Similarly, Abbasi and Kapucu’s (2016) study of the 2004 hurricanes detailed how different documents were utilized to record data and determine the organizational relationships during preparedness, response and recovery stages of a disaster.

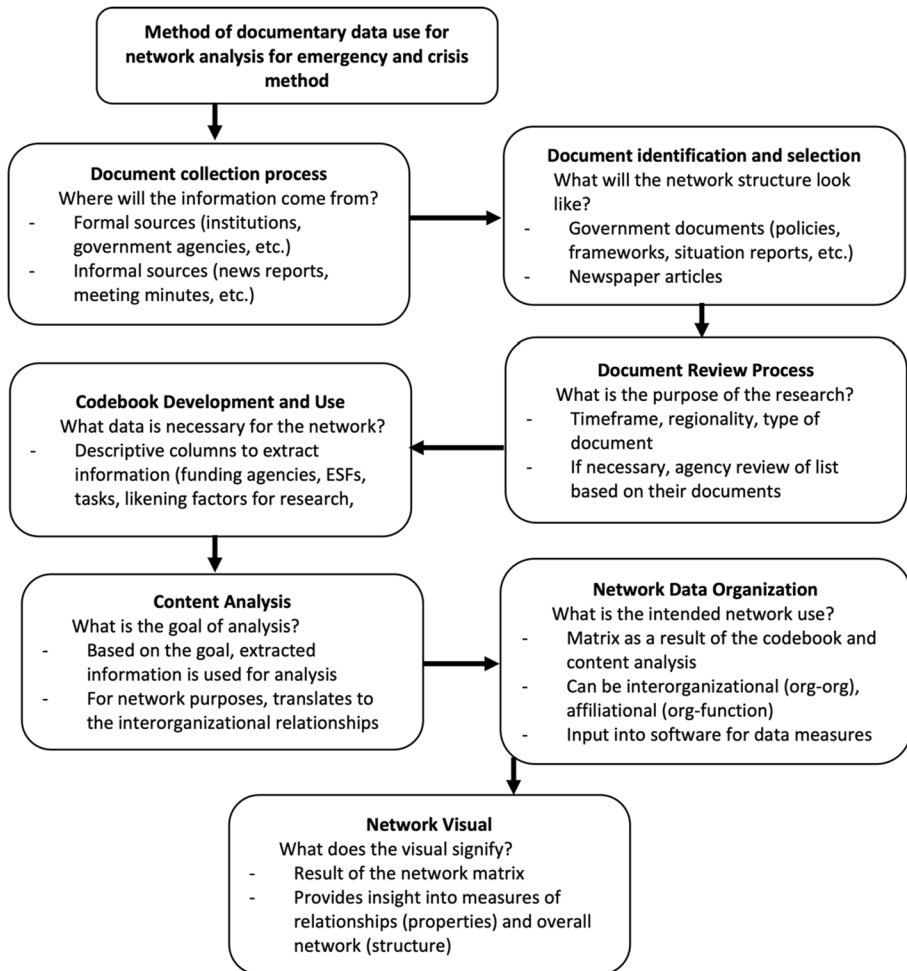
## 2.3 Types of documents used

The type of document used can shape the purpose of the information extracted. For instance, Abbasi and Kapucu (2016) specified the use of local newspapers for their study of the 2004 hurricane season because “a fuller picture of the local response...could be identified” (p. 54) using these documents. The difference between Fig. 1a and b, from Hu et al. (2014), clearly depicts how planned and implemented networks can vary, and how documents provide a comprehensive view for comparative purposes. While Fig. 1a highlights how the Boston EOP depicted their organizational affiliations for *in case* of any disaster, Fig. 1b showcases a significantly more interlinked affiliation network *as a result* of the Boston Marathon bombings. Network perspective help practitioners and scholars to capture potential gap and improve implementation for potential future use.

A predominant number of sources in the literature (40 out of 61) utilized government documents, whether they were policy plans, or situational and after-action reports. Thirty-four included the use of news media in their studies. News media can provide political leaning viewpoints as well as a non-governmental perspective of emergency response as it



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**Fig. 2** Step-by-step process of process of documentary data collection, analysis and use to visualize network visuals for emergency and crisis management

## 2.4 Document collection process

Perhaps the most widely known difference of networks can be demonstrated through 9/11 response network figures. Tierney and Trainor (2004) outlined the extensive response and recovery field work that resulted in SITREPs, rosters, and journalistic accounts. Kapucu and Demiroz's (2011) study of the September 11, 2001, response agencies provided insights to how documents obtained from formal sources (e.g., situation reports) versus informal sources (e.g., newspapers) showcased slightly different networks. The collection process includes document identification, collection and review, codebook and matrix, and network analysis.

The documentary data process begins with document identification, including why a specific type of document was selected for that study. Next, the collection and review



processes occur, where parameters may be set (e.g., For newspaper articles, it could be timeline restrictions; for governments, it could be only certain agency response documents). Once the documents for use are identified, a codebook is created to extract the necessary data for the research, with codebook columns based on the research needs. Codebook data are then coded into a matrix, to provide the necessary information for network “nodes.” The matrix data are then input into a software application that creates the network visuals for analysis.

## 2.5 Document identification and selection

Primary documents used in the studies were government documents (policies, after-action reports, frameworks) and newspaper articles. They were identified using the search terms “document,” “content analysis,” “report,” and “paper” and used with the justification that any mention of documentary data use would utilize at least one of these terms. The purpose of proper document identification for networks is to methodologically look at the evolution, development, and structure of networks that can then be mathematically computed (Hu et al. 2016). Magsino (2009) specified that data collection for network studies is “similar to surveillance mechanisms” (p. 48) in that it could be associated with a point in time or longitudinal. For instance, Butts et al. (2012) utilized Hurricane Katrina as a case study and used “archival material” (p. 1) documents to trace the implementation response network that formed as a result of the disaster. Kapucu et al. (2009) specified a mix of government, affiliated institutions, and news reports to study the responding agencies under the Emergency Management Assistance Compacts (EMACs) in response to Hurricane Katrina in Mississippi and Louisiana. Others compiled newspaper news articles of specific disasters for weeks after an event to ensure that the full range of responding agencies were captured (Comfort et al. 2013; Comfort and Zhang 2020; Wang 2019). Based on the type of network analysis being pursued, additional agencies for document identification would be selected. For instance, within some governmental entity CEMPs, there may be agencies that are non-governmental but included for various ESFs, such as the American Red Cross (ARC), Amateur Radio Emergency Services (ARES), or major utility companies. These non-governmental agency documents could be relevant for the network as well. Knowledge of the purpose of documents identified for use can shape the study’s results.

For planned emergency response networks, ideal documents would include CEMPs, mutual aid agreements, local mitigation strategy plans, operational plans that cover the various aspects of disasters (radios, shelters, evacuation), required non-governmental agencies’ emergency plans (e.g., ARC ARES), and any other governmental Incident Specific Plans (Du et al. 2020a, b; Fan and Nie 2018; Guo and Kapucu 2015; Kapucu et al. 2011; Meng et al. 2019). For an implemented disaster network, documents may include after-action reports, situation reports, agency-wide response and recovery meeting notes, news reports, or social media data (Butts et al. 2012; Comfort et al. 2013; Comfort and Kapucu 2006; Marx et al. 2020). Essentially, any organizational documents that capture the responding agencies when a disaster strikes would fit the criteria for the implemented network (Haase et al. 2017). The importance of planned and implemented networks is to understand retrospectively what relationships should have looked like, which were utilized, what was done well, and what gaps and

**Table 2** Documents identified, used, and justified in network studies

| Values                                                                 | Count |
|------------------------------------------------------------------------|-------|
| Mentions document identification                                       | 28    |
| Discusses the data collection process                                  | 23    |
| Used government documents                                              | 39    |
| Used news media                                                        | 34    |
| Used other data collection (survey, interview, social media, websites) | 32    |
| Use of codebook                                                        | 15    |
| Used network analysis                                                  | 50    |
| Network visualization                                                  | 47    |
| Case study                                                             | 39    |

discrepancies existed in the response (Comfort 2007). Table 2 provides an overview of the documents identified, selected, justified, and specifically mentioned in the studies reviewed. The use of specific types of documents is included, with government documents (39 studies) and news media articles (34 studies) as the most commonly used.

## 2.6 Document review process

Document collection and review are integral components for document use to analyze network data, because they determine what the research is looking for, identify what organizations are involved in the network, and provide a guide for any integral information or subsequent organizations that may not be reflected (Yeo 2020). The datedness of the documents, possibility of agencies being “assumed” to be involved (e.g., FEMA, Department of Health), or consolidated in CEMPs under private agencies (i.e., businesses) are all reasons why the collection process should be detailed, and the documents reviewed by participating organizations (if possible). Content analysis is an integral part of the document review process, as it determines what information is extracted for the codebook, matrix, and network visual. The “how” of the data collection process in Table 2 is accounted for in the 23 studies that specified how data was collected (e.g., academic databases, emergency plans in one region, specific time frame to capture certain aspects of disaster response, filtering sources based on keywords). For instance, Butts et al. (2012) specified that their review process only included situation reports (SITREPs) because they “are extensively employed by responding organizations...[and] specify the time period” (p. 6). Similarly, Hu et al. (2014) reviewed two major newspapers because their “nationwide media coverage and local media portrayal” of the studied disaster (p. 702) was extensive. Document review of extracted agencies by the participating organization provides an opportunity to add any agencies missing in the reviewed documents, or to remove agencies that may not be within the network or are only listed for the interest of representation within emergency documents (e.g., all local government communications). This also provides validation of what agencies are or should be included in the network. While many studies noted the use of government documents, none specified that agencies were provided with an agency list extracted from their documents for review and confirmation.

## 2.7 Codebook development and use

The overall purpose of the codebook development and use was to ensure the source list of identified organizations was comprehensive for purposes of analyses and visuals. Among the studies included in the review, 15 mentioned the use of a codebook format to organize the reviewed documents. A documentary data codebook has key descriptive sections for agencies, standardized contact information for document identification purposes, and any likening factors that may be important for the research (e.g., the ESF that the agency most likely refers to in the tasks and transactions that occur for that specific response). This codebook can be created in any spreadsheet-function software, but MS Excel was most common (Celik and Corbacioglu 2018; Haase et al. 2017; Hu et al. 2014; Rivera 2021; Wang 2019; Ward et al. 2018; Wolbers et al. 2021). Each column would refer to a distinct marker that is necessary for additional analysis potential. For instance, Kapucu and Demiroz (2011) “numbered and catalogued organizations” with the specific ESFs, interactions, sources of funding and contacts (p. 556). Marx et al. (2020) codebook was developed to support the utilization of Twitter data from media organizations and journalists during Hurricane Harvey, highlighting the necessity of social media as a documentary data source. Mayring (2014) emphasized the utilization of content analysis from a variety of texts and denoted the use of codebooks as “a deductive category application procedure” (p. 123). Considering codebook columns that specifically filter certain “factors” (e.g., FEMA mission area, ESFs), there are many different uses for data that is input into a comprehensive codebook. The extensiveness of collected data means that the use of a codebook with this specifically defined and extracted information helps organize further analysis (Kapucu and Demiroz 2011).

Meng et al. (2019) outlined the multi-step verification and analysis of their collected documents, stressing that having two coders for the analysis would create a more “detailed examination” (p. 6). This was supported by Siciliano and Wukich (2017) and Ward et al. (2018), to ensure the coding process had no discrepancies. The codebook is used as a reference to determine which agencies fulfilled the same transaction for a specific purpose (e.g., ESF)—and these agencies would be marked as such for the relationship. For example, Haase et al. (2017) assigned “each organization a numerical identifier and an acronym” (p. 8) and added relevant funding, jurisdiction, and interaction information. Codebooks in studies were utilized as a basis for content analysis by designating identifiers for information that the research needed (e.g., directionality of relationships, frequency of terms, agency sector).

## 2.8 Content analysis

Content analysis “identifies the critical content categories by systematically analyzing and making inferences from various texts” (Du et al. 2021b, p. 11) and “enables researchers to gather large data sets that would be difficult to collect in a qualitative [only] approach” (Tiwari et al. 2019, p. 1846). This could utilize software that codes the documents (e.g., NVivo) or social network data software that creates network visuals from matrices (e.g., UCINET). Most social network analysis literature using qualitative data emphasizes “content analysis” (Mayring 2014; Scott 2013). The first step of content analysis is to understand what the goal of the analysis will be (Kapucu and Demiroz 2011). It could be an analysis of a singular event and the centrality degree relational to agencies within the network, or a comparison of planned and implemented networks (Abbasi and Kapucu 2016;

Guo and Kapucu 2015; Hu et al. 2014; Kapucu and Demiroz 2011; Yeo et al. 2021; Yurish et al. 2020). For the purposes of an organizational network analysis, the same could be said about extracting content to understand how agencies have been described as a part of the network itself (Hu 2015). In disaster settings specifically, the dynamic nature of the environment can lead to the existence of varied contents from varied sources, and the systematic collection, coding and eventual analysis provide a natural progression flow of how agencies might have interacted from start to finish during emergency situations (Kim et al. 2021). Content analyses based on the developed codebook were used for network data organization, analysis, and visualization.

## 2.9 Network data organization and analysis

Matrix creation from a codebook-based content analysis is a seamless process of quantifying the codebook information in a de-duplicated manner for the given research needs (e.g., counties, cities, states). The purpose of the matrix is to showcase relationships between agencies within the codebook using a type of binary system (Celik and Corbacioglu 2018). A matrix makes it easier to visualize the number of relationships agencies have with the same Emergency Support Function (ESF) designation and transactional role, even with different tasks to accomplish them within these parameters. According to Varda et al. (2009), the essence of network analysis is to utilize mathematical factors to quantify if the network connections exist, to what degree, and how that is translated to qualitative factors like communication. Matrices can either be created in or imported into software package(s) to then provide the quantifiable computations for analysis and a social network visual (Celik and Corbacioglu 2018; Clark-Ginsberg 2020; Haase et al. 2017; Ireni-Saban 2019; Kapucu 2006; Kapucu et al. 2011; Koon 2020). Wu et al. (2021) manually reviewed documents to extract agencies and then created “adjacency matrixes” (p. 36) to determine interactions amongst government agencies at certain points in time before, during, and after a disaster.

There are several measures within software programs that can be utilized to implement “network analytic routines” and “general statistical and multivariate tools” (Kapucu et al. 2011, p. 91). Many studies cited UCINET for this (Celik and Corbacioglu 2018; Ireni-Saban 2019; Kapucu et al. 2010a, b; Williams and Shepherd 2017). Measures such as “degree centrality” (how many ties organizations have), “closeness centrality” (closeness of actors to each other), and “betweenness centrality” (dependency and communication strength between actors) quantify the relationships within networks. Similarly, Koon

| Organization Name                                       | Closeness |
|---------------------------------------------------------|-----------|
| American Red Cross                                      | 0.35      |
| U.S. Federal Emergency Management Agency (FEMA)         | 0.32      |
| Emergency Management Assistance Compact                 | 0.32      |
| Salvation Army                                          | 0.31      |
| Missouri Emergency Management Agency (EMA)              | 0.3       |
| Colorado Division of Emergency Management (DEM)         | 0.29      |
| Georgia State Operations Center                         | 0.29      |
| Texas State Operations Center                           | 0.29      |
| Virginia State Emergency Operations Center (SEOC)       | 0.28      |
| Texas Governor’s Division of Emergency Management (DEM) | 0.28      |

**Fig. 3** Top 10 organizations during Hurricane Katrina response by closeness centrality, meaning these organizations “have the shortest paths to all other actors in the network” (Butts et al. 2012, p. 22, Table 7)

(2020) utilized Gephi, an open-source software for social network visualization, to determine “focal actors in a given network, and edge-lists, the ties between nodes that represent relationships or flows between actors” (p. 380). Butts et al. (2012) utilized the R statistical computing system for similar network tie information, but also compared the “types” of organizations (i.e., government, non-profit, for-profit) reflected in each source document. Figure 3 from Butts et al. (2012) highlights this, with the ARC (non-profit) having the highest rated closeness centrality, followed by FEMA (government agency), and the EMAC (mutual aid agreement among US states and territories).

## 2.10 Network visual of data collected

The network visual is created by inputting the matrix information into a coding software such as NetDraw (Ireni-Saban 2019; Kapucu 2006, 2011; Kapucu et al. 2011; Williams and Shepherd 2017) or Gephi (Koon 2020). The use of documents to extract data can be utilized to create network visuals that have both qualitative and quantitative uses (McCulloh et al. 2013; Scott and Carrigan 2011; Prell 2012; Wasserman and Faust 1994; Wasserman and Galaskiewicz 1994). For instance, Abbasi and Kapucu (2012)’s use of news articles provided a network visual of the evolution of responding organizations over a period of time during a hurricane. Du et al. (2020a, b) provided a similar network evolution visual, but specified the different sectors of responding agencies with the use of a variety of government and non-governmental documents. Many scholars were able to use document analyses to create network visuals that provided a comparison of both planned and implemented response networks during disasters (Guo and Kapucu 2015; Hu et al. 2014; Liu et al. 2020; Yeo et al. 2021). This is a useful visual for practitioners, as being able to see how their response relationships differed from plans to actual response can better support future planning of response. Alternatively, scholars like Hu et al. (2016), Sweileh (2020), and Tiwari, Ilavarsan, and Punia (2019) used documents to visualize literature evolution in emergency management. This is pertinent because as the research and field of emergency management grows, understanding the “how” can provide both scholars and practitioners with an understanding of the emergent and evolving processes that will further efficiencies in emergency management. Kapucu et al. (2011) specified how instrumental “archival,” or documentary data was to visualize different sectors, and even agencies within certain organizations (i.e., National Voluntary Organizations Active in Disaster (NVOAD) members). The relationships that network visuals provide as a result of documentary data, whether they are agencies, scholars, key terms or literature have the ability to inform the historical basis of future decisions.

## 3 Demonstration example

Exemplary of the above steps, the researchers utilized the central Florida region for a National Science Foundation (NSF) awarded study. One of the goals of the study was to characterize the relationships between stakeholders, in order to capture the effect of the disasters on integrated community networks. This required the use of content analysis of community resilience policy and planning documents with a focus on extracting organizational network connectedness, hence the use of these documents for the demonstration example for this article.

### 3.1 Types of documents used

Since the goal for the study dictates what “types” of documents would need to be used, for this study that need was “policy and planning documents” (Comfort et al. 2013, p. 21). The researchers focused on the collection of policy and planning documents, which could provide background information for interorganizational and affiliational relationships in the central Florida region.

### 3.2 Document collection, identification, and selection process

The collection and identification process for the CEMPs was straightforward due to the specific governmental agencies that were utilized and the support these documents would provide towards examining the planned networks for resilient communities. The East Central Florida Regional Planning Council (ECFRPC) provided access to these publicly available documents. The researchers collected CEMPs of eight (8) counties, one (1) city and the state for the study.

### 3.3 Document review

Document review was not specified in the literature reviewed; however it was an essential component for specific agency document use. For instance, one central Florida county emergency manager noted that the organizational agency list that was extracted from their county CEMPs was missing the Florida Department of Health (FDOH). Upon further inspection, the researchers found that this critical agency, while noted as such by the Director, was only reflected in the CEMP once under the distribution list. This indicates that while the document collection and coding are essential, document review is just as critical to help determine the visible differences between the planned and implemented networks.

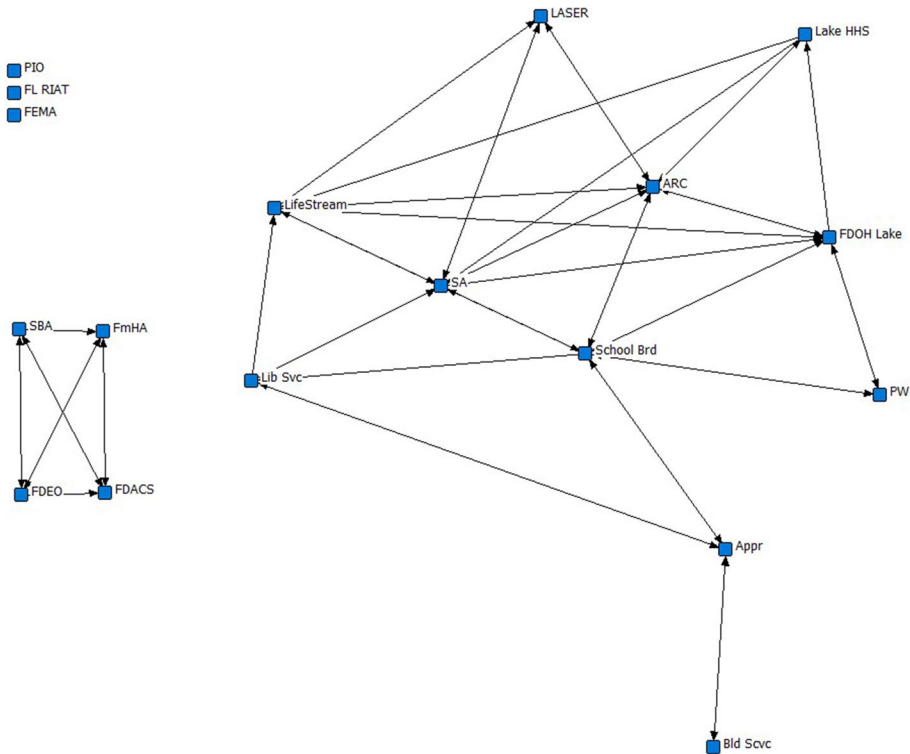
### 3.4 Codebook development and use

The document codebook and content analysis are essential components to ensure that the appropriate data will be utilized for the analysis and visual of the organizational network. Many codebook components were similar to previous studies (Butts et al. 2012; Comfort, et al. 2013; Kapucu and Demiroz 2011; Yeo et al. 2018) and are reflected in Fig. 4. Specific to this case study, the codebook included columns for organizational contact information (for document that was obtained), funding mechanisms, federal ESF designation, transactions and tasks for those organizations listed for the specific ESFs, agency name, ESF role (primary, supporting, coordinating), county-specific ESF (may differ from Federal ESF), type of document (CEMP, Strategic Plan, etc.), and document category (local government CEMP, state CEMP). This allows the researchers flexibility to designate relationships based on the different ESFs. Once the codebook is finalized and content analysis included, the matrix can be created.



|                                                  | Lake County Public Information Office | Lake County Office of Building Services | Lake County Property Appraiser's Office | State of Florida Rapid Impact Assessment Team | Lake County Office of Emergency Management | Lake County Public Works Department | FDOH - Lake County | Lake County Office of Library Services | ARC | Lake County School Board | Lake and Sumter Emergency Recovery (LASER) | Lake County Office of Housing and Human Services | FEMA | Florida Department of Economic Opportunity | FmHA | FDACS | SBA | LifeStream Behavioral Center | Salvation Army |
|--------------------------------------------------|---------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------------|--------------------------------------------|-------------------------------------|--------------------|----------------------------------------|-----|--------------------------|--------------------------------------------|--------------------------------------------------|------|--------------------------------------------|------|-------|-----|------------------------------|----------------|
| Lake County Public Information Office            |                                       |                                         |                                         |                                               |                                            |                                     |                    |                                        |     |                          |                                            |                                                  |      |                                            |      |       |     |                              |                |
| Lake County Office of Building Services          |                                       |                                         |                                         | 1                                             |                                            |                                     |                    |                                        |     |                          |                                            |                                                  |      |                                            |      |       |     |                              |                |
| Lake County Property Appraiser's Office          |                                       | 1                                       |                                         |                                               |                                            |                                     |                    | 1                                      |     | 1                        |                                            |                                                  |      |                                            |      |       |     |                              |                |
| State of Florida Rapid Impact Assessment Team    |                                       |                                         |                                         |                                               |                                            |                                     |                    |                                        |     |                          |                                            |                                                  |      |                                            |      |       |     |                              |                |
| Lake County Public Works Department              |                                       |                                         |                                         |                                               |                                            |                                     | 1                  |                                        |     | 1                        |                                            |                                                  |      |                                            |      |       |     |                              |                |
| FDOH - Lake County                               |                                       |                                         |                                         |                                               |                                            | 1                                   |                    |                                        | 1   | 1                        |                                            | 1                                                |      |                                            |      |       |     | 1                            | 1              |
| Lake County Office of Library Services           |                                       |                                         | 1                                       |                                               |                                            |                                     |                    |                                        |     | 1                        |                                            |                                                  |      |                                            |      |       |     |                              |                |
| ARC                                              |                                       |                                         |                                         |                                               |                                            |                                     | 1                  |                                        |     | 1                        | 1                                          | 1                                                |      |                                            |      |       |     | 1                            | 1              |
| Lake County School Board                         |                                       |                                         | 1                                       |                                               |                                            | 1                                   | 1                  | 1                                      |     |                          |                                            |                                                  |      |                                            |      |       |     |                              | 1              |
| Lake and Sumter Emergency Recovery (LASER)       |                                       |                                         |                                         |                                               |                                            |                                     |                    |                                        | 1   |                          |                                            |                                                  |      |                                            |      |       |     | 1                            | 1              |
| Lake County Office of Housing and Human Services |                                       |                                         |                                         |                                               |                                            | 1                                   |                    | 1                                      | 1   |                          |                                            |                                                  |      |                                            |      |       |     |                              |                |
| FEMA                                             |                                       |                                         |                                         |                                               |                                            |                                     |                    |                                        |     |                          |                                            |                                                  |      |                                            |      |       |     |                              |                |
| Florida Department of Economic Opportunity       |                                       |                                         |                                         |                                               |                                            |                                     |                    |                                        |     |                          |                                            |                                                  |      |                                            | 1    | 1     | 1   |                              |                |
| FmHA                                             |                                       |                                         |                                         |                                               |                                            |                                     |                    |                                        |     |                          |                                            |                                                  |      |                                            | 1    |       | 1   | 1                            |                |
| FDACS                                            |                                       |                                         |                                         |                                               |                                            |                                     |                    |                                        |     |                          |                                            |                                                  |      |                                            | 1    | 1     |     | 1                            |                |
| SBA                                              |                                       |                                         |                                         |                                               |                                            |                                     |                    |                                        |     |                          |                                            |                                                  |      |                                            | 1    | 1     | 1   |                              |                |
| LifeStream Behavioral Center                     |                                       |                                         |                                         |                                               |                                            |                                     | 1                  |                                        | 1   |                          | 1                                          |                                                  |      |                                            |      |       |     |                              | 1              |
| Salvation Army                                   |                                       |                                         |                                         |                                               |                                            |                                     | 1                  |                                        | 1   | 1                        | 1                                          |                                                  |      |                                            |      |       |     | 1                            |                |

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**Fig. 6** Sample network visual based on the partial matrix in Fig. 5

For this case study, the content analysis of the CEMPs was done manually with the focus on coding any organizations that were listed in the documents with a specific task, whether they were related to other organizations or not. Figure 5 reflects a sample matrix of a county's codebook, with clusters of clearly related agencies, and some unrelated organizations (e.g., Lake County Public Information Offices (PIO), FEMA, and FL Rapid Impact Assessment Teams (RIAT)) with tasks but no relationships with other organizations (within the example provided). Williams and Shepherd (2017) noted that researchers can “content analyze document[s] to [then] derive social network matrices” (p. 274) based on the needs of the study.

### 3.6 Network analysis and visualization

As depicted in Fig. 5, the matrix for the case study utilized a “nodelist format” (Borgatti et al. 2018) with binary coding, similar to Celik and Corbacioglu (2018). Unlike Celik and Corbacioglu (2018), whose coding specified “frequency of interactions,” this case study was only concerned with the existence of at least one interaction. Organizations for each CEMP were organized horizontally and vertically, and then those with the same transactions within a federal ESF were regarded as having a “relationship.” For instance, if a CEMP denoted seven agencies were involved with ESF 9 Search and Rescue, with a transaction to “address the process of conducting and coordinating search and rescue actions

following disasters” (Lake County 2018, p. 200) these agencies would all have a “1” in relation to each other in the matrix, even if the tasks for each organization within were different. Figure 6 depicts a network visual based on the partial matrix that was utilized of Lake County (Fig. 5). Within this visual, there are “isolated” agencies (Public Information Office, FL Rapid Impact Assessment Team and FEMA) that did not have any interactions with the other identified entities; a cluster of four state agencies (Small Business Administration, Farmers Home Administration, Florida Department of Economic Opportunity and Florida Department of Agriculture and Consumer Services) that only had interactions within themselves; and a larger network of coordinating agencies. Network visuals of policy and plan documents like that of Fig. 6 can depict how the interorganizational network of agencies *should* interact and provide a comparison to the differences of similar network visuals based on actual interorganizational networks of agencies that *did* interact as a result of a disaster. This visual was created using NetDraw in UCINET. A network visual not only provides a graphical view of the organizational connections but provides a method of “logical interpretation of the data available” (Comfort and Zhang 2020, p. 988) whether it is the centrality of an organization compared to others in the network, the cohesion of the relationships or support for further analysis of why there may be limited or complex interactions amongst agencies.

This case study was an ideal example to outline the use of documentary data for network analysis because many of the identification and collection steps were streamlined, but the process can be simple even for more complex networks as long as the research is clear on the purpose of the research and how documents can be used to fulfill that purpose.

## 4 Conclusion

Using a systematic literature review of studies that have utilized documents to study a range of disasters, this work provided a step-by-step process for the identification, collection, use, analysis and visualization of documentary data. Scholars have looked at the importance of network visualization and their ability to quantify the importance of certain organizations over others during a disaster, the “strength” of relationships between agencies in a network, and the ties that need to be reassessed (Benzi and Boito 2020; Cross et al. 2009; Prell et al. 2009). This is especially pertinent to the context of disasters because documents provide much needed detail about the involvement of different actors for disaster response.

There are a variety of documents that are used to study networks in emergency and crisis documents, ranging from Comprehensive Emergency Management Plans (CEMPs) to situation reports to newspaper articles to agency websites. All of these documents provide a different value of information to the research based on the information sought by the researcher. While a heavy majority of the disasters studied have been hurricanes, earthquakes and terrorist attacks have seen increasing study using documentary data analysis. The process of data collection and analysis first includes asking questions about the purpose of the research needs that can be met by the types of data. The process also includes appropriate coding mechanisms created to identify the relevant information to then build the matrices and network visuals. Coding the documentary data consistently to build the matrix and then create a visual provides an understanding of how collaborations should and do impact disaster response. These documents can showcase the organizational and affiliation plans of networked response, as well as reconstruct how the networked response

occurred. This in turn can help compare the two networks to support the updating of policies and plans as necessary to reflect stronger responses in the future.

Future research can expand the scope of methods by utilizing various types of documents simultaneously, whether formal or informal, to reconstruct different types of networks for insights and more cohesive responses. Additionally, Table 2 indicates a large amount of research using documents for data analysis and visuals focused on hurricanes. Future research could utilize this method for other disasters that require increasingly networked responses, such as wildfires. Several scholars have been conducting studies on this type of disaster (i.e., Nowell, Comfort), and utilizing documents to visualize the networks for these disasters support better networked response in the long term. Lastly, the use of information and communication technologies (ICTs) to assist with the capacities of how organizational operations interact, communicate using different mechanisms, and store relevant information for future reflection can further support the development and growth of network analysis (Comfort, 1993; Hu and Kapucu 2016). With the increase of social media (e.g., Twitter) as viable sources of information during emergencies (Abedin and Babar 2018; Karimzian et al. 2022), ICT and the use of big data analysis for disaster networks would be fruitful as well.

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## Declarations

**Conflict of interest** There are no competing interests in the submission of this article.

**Consent to Participate** There were no participants involved in this study.

**Consent to Publish (Ethics)** There are no ethical declarations for publishing this manuscript.

## References

- Abbasi A, Kapucu N (2012) Structural dynamics of organizations during the evolution of interorganizational networks in disaster response. *J Homel Secur Emerg Manage* 9(1):1–19
- Abbasi A, Kapucu N (2016) A longitudinal study of evolving networks in response to natural disaster. *Comput Math Organ Theory* 22(1):47–70
- Abedin B, Babar A (2018) Institutional vs. non-institutional use of social media during emergency response: a case of twitter in 2014 Australian bush fire. *Inform Syst Front* 20(4):729–740.
- Benzi M, Boito P (2020) Matrix functions in network analysis. *GAMM Mitteilungen* 43(3):1–36.
- Borgatti SP, Everett MG, Johnson JC (2018) *Analyzing social networks*, 4th edn. Sage, Philadelphia
- Butts CT, Acton RM, Marcum CS (2012) Interorganizational collaboration in the Hurricane Katrina response. *J Soc Struct* 13(1):1–37
- Celik S, Corbacioglu S (2018) Organizational learning in adapting to dynamic disaster environments in Southern Turkey. *J Asian Afr Stud* 53(2):217–232

- Clark-Ginsberg A (2020) Disaster risk reduction is not ‘everyone’s business’: evidence from three countries. *Int J Disaster Risk Reduct* 43(1):1–12
- Comfort LK (1993) Integrating information technology into international crisis management and policy. *J Contingencies Crisis Manage* 1(1):15–26
- Comfort LK (2007) Crisis management in hindsight: cognition, communication, coordination, and control. *Public Adm Rev* 67(1):189–197
- Comfort LK, Haase TW (2006) Communication, coherence, and collective action: the impact of Hurricane Katrina on communications infrastructure. *Public Works Manag Policy* 10(4):328–343
- Comfort LK, Kapucu N (2006) Inter-organizational coordination in extreme events: the world trade center attacks, September 11, 2001. *Nat Hazards* 39(2):309–327
- Comfort LK, Zhang H (2020) Operational networks: adaptation to extreme events in China. *Risk Anal* 40(5):981–1000
- Comfort LK, Haase TW, Ertan G, Scheinert SR (2020) The dynamics of change following extreme events: transition, scale, and adaptation in systems under stress. *Administration Soc* 52(6):827–861
- Comfort LK, Oh N, Ertan G, Haase T (2013) Network evolution in disaster management: a comparison of response systems evolving after the 2005 and 2008 gulf coast hurricanes. In *2013 IEEE 2nd Network Science Workshop (NSW)* (pp. 42–49). IEEE, New York.
- Comfort LK (2019) *The dynamics of risk: Changing technologies and collective action in seismic events*. Princeton University Press, Princeton.
- Cross JE, Dickmann E, Newman-Gonchar R, Fagan JM (2009) Using mixed-method design and network analysis to measure development of interagency collaboration. *Am J Eval* 30(3):310–329
- Cunningham D, Everton S, Murphy P (2016) Understanding dark networks: a strategic framework for the use of social network analysis. Rowman & Littlefield, Washington
- Du L, Feng Y, Tang LY, Kang W, Lu W (2020a) Networks in disaster emergency management: a systematic review. *Nat Hazards* 103(1):1–27
- Du L, Feng Y, Tang L, Lu W, Kang W (2020b) Time dynamics of emergency response network for hazardous chemical accidents: a case study in China. *J Clean Prod* 248:119239
- Fan B, Nie S (2018) Coproduction design of contingency planning in emergency governance structure: qualitative metasynthesis of Chinese local government. *Nat Hazard Rev* 19(4):04018021
- Gerber BJ, Robinson SE (2009) Local government performance and the challenges of regional preparedness for disasters. *Public Perform Manag Rev* 32(3):345–371
- Guo X, Kapucu N (2015) Network performance assessment for collaborative disaster response. *Disaster Prev Manag* 24(2):201–220
- Haase TW, Ertan G, Comfort LK (2017) The roots of community resilience: a comparative analysis of structural change in four gulf coast hurricane response networks. *Homeland Security Affairs* 13(9):1–26
- Hollstein B (2013) Qualitative approaches. In: Scott J, Carrington PJ (eds) *The sage handbook of social network analysis*. Sage Publications, Philadelphia, pp 404–416
- Hu Q (2015) Conducting content analysis of documents in network research: a review of recent scholarship. *Complex Govern Netw* 2(1):83–102
- Hu Q, Kapucu N (2016) Information communication technology utilization for effective emergency management networks. *Public Manag Rev* 18(3):323–348
- Hu Q, Knox CC, Kapucu N (2014) What have we learned since September 11, 2001? A network study of the Boston marathon bombings response. *Public Adm Rev* 74(6):698–712
- Hu Q, Khosa S, Kapucu N (2016) The intellectual structure of empirical network research in public administration. *J Public Admin Res Theory* 26(4):593–612
- Ireni-Saban L (2019) Diplomacy in times of disaster: Management through reputational capital. *J Manage Policy Pract* 20(3):99–114
- Jones EC, Faas AJ (eds) (2016) *Social network analysis of disaster response, recovery, and adaptation*. Butterworth-Heinemann, UK.
- Kadushin C (2005) Who benefits from network analysis: ethics of social network research. *Soc Netw* 27(1):139–153
- Kapucu N (2006) Interagency communication networks during emergencies: boundary spanners in multi-agency coordination. *Am Rev Public Admin* 36(2):207–225
- Kapucu N (2011) Collaborative governance in international disasters: Nargis cyclone in Myanmar and Sichuan earthquake in China cases. *Int J Emerg Manage* 8(1):1–25
- Kapucu N, Demiroz F (2011) Measuring performance for collaborative public management using network analysis methods and tools. *Public Perform Manag Rev* 34(4):551–581
- Kapucu N, Augustin ME, Garayev V (2009) Interstate partnerships in emergency management: emergency management assistance compact in response to catastrophic disasters. *Public Adm Rev* 69(2):297–313

- Kapucu N, Arslan T, Collins ML (2010a) Examining intergovernmental and interorganizational response to catastrophic disasters: toward a network-centered approach. *Admin Soc* 42(2):222–247
- Kapucu N, Bryer T, Garayev V, Arslan T (2010b) Interorganizational network coordination under stress caused by repeated threats of disasters. *J Homel Secur Emerg Manage* 7(1):1–30
- Kapucu N, Yuldashev F, Feldheim MA (2011) Nonprofit organizations in disaster response and management: a network analysis. *Euro J Econ Polit Stud* 4(1):83–112
- Kapucu N, Hu Q, Khosa S (2017) The state of network research in public administration. *Admin Soc* 49(8):1087–1120
- Kapucu N, Ozerdem A, Sadiq A (2022) Managing emergencies and crises: global perspectives. Jones & Bartlett Publishers, Boston
- Karimiziarani M, Jafarzadegan K, Abbaszadeh P, Shao W, Moradkhani H (2022) Hazard risk awareness and disaster management: extracting the information content of twitter data. *Sustain Cities Soc* 77:103577
- Kim Y, Oh SS, Ku M, Byeon J (2021) Interorganizational coordination and collaboration during the 2015 MERS-CoV response in South Korea. *Disaster Med Public Health Prep* 15(4):409–415
- Koon DSV (2020) Education policy networks: the co-optation, coordination, and commodification of the school-to-prison pipeline critique. *Am Educ Res J* 57(1):371–410
- Lake County (2018) Comprehensive emergency management plan. Lake County, FL
- Liu J, Hao J, Shi Z, Bao HX (2020) Building the COVID-19 collaborative emergency network: a case study of COVID-19 outbreak in Hubei Province, China. *Nat Hazards* 104(3):2687–2717
- Magsino SL (2009) Applications of social network analysis for building community disaster resilience. National Academy of Sciences, Washington, DC
- Marx J, Mirbabaie M, Ehnis C (2020) Sense-giving strategies of media organisations in social media disaster communication: findings from Hurricane Harvey [Paper presentation]. Australasian Conference on Information Systems, Sydney Australia. <https://arxiv.org/pdf/2004.08567.pdf>
- Mayring P (2014) Qualitative content analysis: theoretical foundation, basic procedures and software solution, p 43
- McCulloh I, Armstrong H, Johnson A (2013) Social network analysis with applications. Wiley, New York
- Meng F, Chen Z, Wu J (2019) How are anti-air pollution policies implemented? A network analysis of campaign-style enforcement in China. *Sustainability* 11(2):1–17
- Prell C, Hubacek K, Reed M (2009) Stakeholder analysis and social network analysis in natural resource management. *Soc Nat Resour* 22(6):501–518
- Prell CK (2012) Social network analysis: History, theory & methodology. Sage Publications, Philadelphia
- Resodihardjo SL, Van Genugten M, Ruiter MN (2018) A theoretical exploration of resilience and effectiveness requirements' compatibility in formal and permanent emergency networks. *Saf Sci* 101(1):164–172
- Robins G (2015) Doing social network research: Networked-based research design for social scientists. Sage Publications, Philadelphia.
- Saban LI (2015) Entrepreneurial brokers in disaster response network in Typhoon Haiyan in the Philippines. *Public Manag Rev* 17(10):1496–1517
- Schweinberger M, Petrescu-Prahova M, Vu DQ (2014) Disaster response on September 11, 2001 through the lens of statistical network analysis. *Soc Netw* 37(1):42–55
- Scott J (2013) Social network analysis. Sage Publications, Philadelphia
- Scott J, Carrington PJ (2011) The sage handbook of social network analysis. Sage Publications, Philadelphia
- Seo HJ, Son M, Hong AJ (2021) Trends in civic engagement disaster safety education research: systematic literature review and keyword network analysis. *Sustainability* 13(5):1–18
- Siciliano MD, Wukich C (2015) Network features and processes as determinants of organizational interaction during extreme events. *Complex Govern Netw* 2(1):23–44
- Siciliano MD, Wukich C (2017) Network formation during disasters: exploring micro-level interorganizational processes and the role of national capacity. *Int J Public Adm* 40(6):490–503
- Spiro ES, Acton RM, Butts CT (2013) Extended structures of mediation: re-examining brokerage in dynamic networks. *Soc Netw* 35(1):130–143
- Sweileh WM (2020) Bibliometric analysis of peer-reviewed literature on climate change and human health with an emphasis on infectious diseases. *Glob Health* 16(1):1–17
- Tang P, Deng C, Shao S, Shen GQ (2017) Leveraging intergovernmental and cross-sectoral networks to manage nuclear power plant accidents: a case study from China. *J Clean Prod* 162(23):1551–1566
- Tierney KJ, Trainor JE (2004) Networks and resilience in the World Trade Center disaster. MCEER.
- Tiwari P, Ilavarasan PV, Punia S (2019) Content analysis of literature on big data in smart cities. *Benchmarking Int J* 28(5):1837–1857.

- Uhr C, Johansson H, Fredholm L (2008) Analysing emergency response systems. *J Contingencies Crisis Manage* 16(2):80–90
- Varda D, Forgette R, Banks D, Contractor N (2009) Social network methodology in the study of disasters: Issues and insights prompted by post-Katrina research. *Population Res Policy Rev* 28(1):11–29
- Wang WJ (2019) Disaster response after extreme events in Taiwan: the influence of formal institutions on inter-organizational interaction. *Risk Hazard Crisis Public Policy* 10(1):74–101
- Ward KD, Varda DM, Epstein D, Lane B (2018) Institutional factors and processes in interagency collaboration: the case of FEMA Corps. *Am Rev Public Admin* 48(8):852–871
- Wasserman S, Faust KL (1994) *Social network analysis: methods and applications*. Cambridge University Press, Cambridge
- Wasserman D, Galaskiewicz J (eds) (1994) *Advances in social network analysis: research in the social and behavioral sciences*. Sage Publications, Philadelphia
- Williams TA, Shepherd DA (2017) Mixed method social network analysis: combining inductive concept development, content analysis, and secondary data for quantitative analysis. *Organ Res Methods* 20(2):268–298
- Wolbers J, Kuipers S, Boin A (2021) A systematic review of 20 years of crisis and disaster research: trends and progress. *Risk Haz Crisis Public Policy* 12(4):374–392
- Wu M, Gao X, Cao M, Papa E, Zhu X (2021) The changes of intergovernmental collaboration dynamic in post-disaster destination management: network analysis. *J Hosp Tour Manag* 48(3):32–45
- Yeo J (2020) Beyond immigration and customs enforcement: understanding interorganizational collaboration for border management. *J Borderlands Stud* 35(1):1–23
- Yeo J, Comfort LK (2017) An expected event, but unprecedented damage: structure and gaps of large-scale response coordination of the 2011 Thailand floods. *Disaster Prevent Manage Int J* 26(4):458–470
- Yeo J, Comfort L, Jung K (2018) Timely assessment of disaster and emergency response networks in the aftermath of superstorm Sandy, 2012. *Online Inf Rev* 42(7):1010–1023
- Yeo J, Haupt B, Kapucu N (2021) Alignment between disaster policies and practice: characteristics of inter-organizational response coordination following 2016 hurricane Matthew in Florida. *Nat Hazard Rev* 22(1):1–8
- Yurisch KA, Soto KR, Fuenzalida CR (2020) Covid-19: Network effectiveness of intermunicipal self-organized response in Chile. *Transylvanian Rev Adminis Sci* 16(SI):5–23
- Zhang Q, Lu Q, Zhong D, Ye X (2018) The pattern of policy change on disaster management in China: a bibliometric analysis of policy documents, 1949–2016. *Int J Disaster Risk Sci* 9(1):55–73

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