

COVID-19: NETWORK EFFECTIVENESS OF INTERMUNICIPAL SELF-ORGANIZED RESPONSE IN CHILE

Karina ARIAS YURISCH
Karina RETAMAL SOTO
Camila RAMOS FUENZALIDA

Abstract

In the context of the Covid-19 pandemic, public officials are called on to implement different strategies in order to respond effectively. One of the lessons of emergency management research is that effective response is unlikely without collaboration. Research on collaborative emergency management has focused on measuring the effectiveness of intergovernmental and intersectoral relationships, but little is known about the performance of inter-jurisdictional collaboration. This paper seeks to measure the network effectiveness of intermunicipal self-organized response to Covid-19. It uses a network analysis approach to compare planned and actual emergency management networks operating in the Santiago Metropolitan Region of Chile. Content analysis of 202 formal agreements established by municipalities in 2009-2019 was used to capture the planned network. The actual network was depicted by collecting original data through an online survey that represented the 96% of the local governments located in this Latin American city. The results show a structural gap between planned and actual networks and reveal effectiveness problems associated with the disaster preparedness phase. However, an emergent intermunicipal network has supported collaborative response to the Covid-19 pandemic. The study provides lessons for policy-makers, public managers and researchers in the collaborative emergency management field.

Keywords: emergency management, intermunicipal cooperation, network effectiveness, local governments, network analysis.

Karina ARIAS YURISCH (corresponding author)

Assistant professor, PhD, Department
of Management and Public Policy,
University of Santiago, Santiago, Chile
Tel.: 0056-9-6495.3327
E-mail: karina.arias@usach.cl
<https://orcid.org/0000-0001-9820-6581>

Karina RETAMAL SOTO

Ph.D. Candidate in Sociology and Anthropology,
Complutense University of Madrid, Madrid, Spain
Researcher at University of Santiago, Santiago, Chile
E-mail: karina.retamal@usach.cl
<https://orcid.org/0000-0001-8663-6744>

Camila RAMOS FUENZALIDA

MA in Management and Public Policy,
University of Chile, Chile
Researcher at University of Santiago, Santiago, Chile
E-mail: camila.ramos@usach.cl
<https://orcid.org/0000-0002-7974-4891>

1. Introduction

Few disasters have the capacity to significantly disrupt the economic and social underpinnings of society (French and Raymond, 2009; Kapucu *et al.*, 2009). However, a public health emergency such as an influenza pandemic or the current coronavirus can do so (Weible *et al.*, 2020). In fact, ‘a pandemic has the potential to cause more deaths and illness than any other public health threat’ (Milgrim, 2007, p. 13).

Since the response to emergencies of this type depends primarily on public agencies, emergency management has become a central issue in the public administration and policy sciences field in the last three decades (Brudney and Gazley, 2009; French and Raymond, 2009; Somers and Svara, 2009; Comfort *et al.*, 2012; Dzigbede *et al.*, 2020; Weible *et al.*, 2020). Emergency management is a complex task, requiring much more than a rapid response and entailing four phases that are common to all disasters: mitigation, preparedness, response and recovery (Petak, 1985; Waugh, 1994; Waugh and Streib, 2006; Brudney and Gazley, 2009; French and Raymond, 2009; Kapucu *et al.*, 2009; French, 2011).

The organization required for these four phases frequently cuts across jurisdictional boundaries, calling for collaboration between actors from different sectors and authorities at all levels of government (Waugh, 1994; French, 2011; Jung and Song, 2015; Abassi and Kapucu, 2016). As a result, current research has focused on the complex context of disasters by emphasizing the need for collaborative and network perspectives (Waugh and Streib, 2006; Kapucu *et al.*, 2009; Kapucu and Garayev, 2016; Dzigbede *et al.*, 2020). In the emergency management field, these emerging collaborative structures for confronting disaster are commonly referred to as emergency management networks (EMNs) (Du *et al.*, 2020).

In recent decades, EMNs have become an essential tool for dealing with complex extreme events (Waugh, 2004; Caruson and MacManus, 2006; Waugh and Streib, 2006; McGuire and Silvia, 2010; Kapucu and Demiroz, 2011; Kapucu and Garayev, 2016). In fact, Waugh and Streib (2006) argue not only that collaborative networks are necessary for addressing emergency management issues, but also that ‘an effective response is unlikely to happen without collaboration’.

Scholars who have studied EMNs have focused mostly on vertical intergovernmental relationships (e.g. Caruson and McManus, 2006; McEntire and Dawson, 2007; Guo and Kapucu, 2015) or horizontal intersectoral relationships (e.g. Bowman and Parson, 2009; Brudney and Gazley, 2009; Wachhaus, 2016). However, little is known about interjurisdictional network arrangements formed to address emergency events.

Disasters often exceed a single jurisdiction and are seldom neatly contained within a single city’s or local government’s boundaries (McGuire and Silvia, 2010). In this scenario, the authority is fragmented and the decisions of one local government inevitably affect outcomes of concern to the other units (Waugh, 1994; Waugh and Streib, 2006).

Local governments are the first and most significant points of contact between citizens and their governments so they have considerable responsibility in ensuring that

their communities can deal with any kind of disaster and in managing critical duties associated with the emergency (Waugh 1994; Schneider, 1995; Caruson and MacManus, 2006; Waugh and Streib, 2006; Bowman and Parsons, 2009; French and Raymond, 2009; French, 2011; Dzigbede *et al.*, 2020). Additionally, municipalities often lack the administrative capacity, in terms of resources and specialization in emergency management, to implement an effective disaster policy in line with their responsibilities (Cigler, 2007; Waugh and Streib, 2006; Somers and Svara, 2009; French, 2011).

A potential solution to this dilemma is for local officials to build collaborative relationships to maximize the agency's capacity and address mounting concerns regarding risk, vulnerability and resilience (Savitch, 2003; Bowman and Parsons, 2009). In this case, local officials voluntarily negotiate and coordinate solutions with officials in neighboring jurisdictions (Waugh, 1994). These self-organized arrangements can produce collective benefits that would be more elusive if each jurisdiction acted individually (Bowman and Parsons, 2009).

Interjurisdictional relationships have been studied in the form of horizontal self-organized networks and intermunicipal cooperation. This phenomenon is generally defined as voluntary collaboration between local governments to solve a common problem or jointly provide a service (Teles, 2016; Arias Yurisch *et al.*, 2019). Intermunicipal networks are expected to increase an agency's capacity to handle complex public or 'wicked' problems such as emergency events (Weber and Khademian, 2008), take advantage of economies of scale in the provision of public services (Agranoff, 2007), and promote innovation by integrating the knowledge of a diversity of actors (Provan and Lemaire, 2012). The effectiveness of those outcomes, however, is directly proportional to network operation and functionality.

The emergency management field presents a unique domain for the study of network effectiveness in which the problems, responses and underlying resource systems become highly interconnected. Amidst the unfortunate scenario posited by the coronavirus pandemic, this paper studies the effectiveness of intermunicipal networks in the Santiago Metropolitan Region of Chile. It examines the structure of planned emergency management networks established by municipal governments over the past decade and compares them to the structure of the actual intermunicipal networks operating in the context of the pandemic. This comparison allows us to understand and evaluate the networks' effectiveness.

The paper is arranged in four main sections. The first section presents a review of the emergency management literature on collaborative networks and network effectiveness while the second section provides a brief description of the Chilean intermunicipal context. The methods of data collection and analysis are then summarized before going on to outline the findings and present the discussion and conclusions.

2. Collaborative networks for emergency management

Emergency management is a complex task, requiring much more than a rapid response to the emergency and entailing four phases that are common to all disasters: mitigation, preparedness, response and recovery (Petak, 1985; Waugh, 1994; Waugh and Streib, 2006; Brudney and Gazley, 2009; French and Raymond, 2009; Kapucu *et al.*, 2009; French, 2011). Mitigation activities involve evaluation of the risk posed by a potential disaster and efforts to minimize or eliminate these hazardous conditions (French and Raymond, 2009). Preparedness implies developing a response plan based upon the risk assessment, training response personnel, arranging for necessary resources, making arrangements with other jurisdictions for sharing resources, clarifying jurisdictional responsibilities and so on. Responding to emergencies means implementing plans and reducing the potential for secondary damage. It calls for creativity and flexibility in dealing with circumstances that cannot be fully anticipated (Somers and Svara, 2009). Finally, recovery includes reestablishing life support systems such as temporary housing, food and clothing (Waugh, 1994).

The emergency management field has incorporated these four phases and, in doing so, has been evolving into a more collaborative enterprise (Brudney and Gazley, 2009; Gerber and Robinson, 2009; Kapucu *et al.*, 2009; McGuire and Silvia, 2010; Kapucu and Demiroz 2011). In the wake of the 9/11 attack and Hurricane Katrina in the United States, China's SARS outbreak and the Wenchuan earthquake (Hu *et al.*, 2014), practitioners and policymakers have understood that emergency management depends to a great extent on their ability to fully comprehend the complexities of political and administrative networks during the different disaster phases (Waugh and Streib, 2006; Brudney and Gazley, 2009). In addition, researchers have gradually looked beyond the classic command-and-control mechanisms and the top-down bureaucratic model, shifting their attention to a dynamic and flexible network model that facilitates multi-organizational, intergovernmental and intersectoral cooperation (Waugh and Streib, 2006; Kapucu *et al.*, 2009).

These collaborative structures for confronting disaster (EMNs) have become essential for effective emergency management (Gerber and Robinson, 2009; Du *et al.*, 2020). Collaboration can be described as the process of facilitating multi-organizational actions for solving problems that cannot be achieved, or achieved easily, by single organizations (Agranoff and McGuire, 2003). Collaboration is the driving motive for EMNs (Kapucu and Demiroz, 2011). Thus, collaborative networks can be understood as those structures built by two or more public organizations, engaged in a non-hierarchical relationship, in order to facilitate the achievement of common goals (Agranoff, 2007; Provan *et al.*, 2007; Provan and Lemaire, 2012).

The scope and nature of EMNs, however, varies depending on the needs and goals of the collaborating parties. Researchers on emergency management have mostly focused on either vertical intergovernmental collaboration between federal, state and local levels of government or horizontal intersectoral interactions between public

agencies and private and non-profit actors (e.g. Caruson and McManus, 2006; McEntire and Dawson, 2007; Bowman and Parsons, 2009; Brudney and Gazley, 2009; Guo and Kapucu, 2015; Wachhaus, 2016). There are few studies focused on emergency management that involves jurisdictional interactions (Gerber and Robinson, 2009; Jun and Song, 2015).

Given the interjurisdictional nature of emergency management, it has become important to study horizontal self-organized cooperation between local governments in the form of inter-local agreements or intermunicipal cooperation (Gerber and Robinson, 2009; Arias Yurisch *et al.*, 2019). In particular, when disasters are large in scope, affect a large population or require an immense amount of resources, horizontal arrangements across jurisdictions can serve to identify better ways of mitigating, preparing for, responding to and recovering from disaster situations in a shared territory (Savitch, 2003; Bowman and Parsons, 2009; French, 2011).

The self-organizing phenomenon has its own particularities. In contrast to mandated networks, intermunicipal self-organized networks stress the autonomy of the parties and the voluntary nature of the relationships (Jun and Song, 2015). Compared to hierarchical networks, self-organized arrangements offer more flexibility in providing a service or coordinating actions (Feiock and Scholz, 2010); this is especially important in emergency contexts (Kapucu and Garayev, 2016).

Intermunicipal self-organized networks can, moreover, take different forms depending on the context (Arias Yurisch *et al.*, 2019; Swianiewicz and Teles, 2019). They can be informal or formal, bilateral or multilateral, and specific or general oriented, implying different degrees of complexity in the collective decision-making process.

3. Effectiveness of intermunicipal networks in emergency management

Intermunicipal self-organizing networks are expected to increase local capacity (Weber and Khademian, 2008), take advantage of economies of scale (Agranoff, 2007; Provan and Lemaire, 2012) and improve the effectiveness of disaster plans and response (Kapucu and Garayev, 2016). The fulfillment of these expectations cannot be taken for granted since this depends to a large extent on the network's functionality and performance. Given that intermunicipal networks are constituted by diverse actors and operate in the absence of hierarchical authority, it is not clear how they maintain participants' commitment, remain integrated over time and effectively achieve their collective goals (Provan *et al.*, 2007; Provan and Lemaire, 2012).

To explore network operation and effectiveness, scholars have mostly studied the role and abilities of network managers (Agranoff and McGuire, 2001, 2003; McGuire, 2002; Agranoff, 2007) and the structural characteristics of the network that facilitate or hamper the achievement of goals (Provan and Milward, 1995; Provan *et al.*, 2007). The latter approach has become popular among emergency management scholars due to the usefulness of network analysis techniques in dealing with the complexities and interdependencies of the emergency field.

Many studies have used network analysis to study patterns of interaction among actors involved in disaster phases and, particularly, in a bid to understand the dynamics of emergency operation (Kapucu, 2006; Brudney and Gazley, 2009; Kapucu *et al.*, 2009). Through network methods, it is possible to identify the key actors and measure the strengths and direction of the relationships (Kapucu, 2006; Brudney and Gazley, 2009; Kapucu *et al.*, 2009; Kapucu and Demiroz, 2011; Comfort *et al.*, 2012).

Scholars have suggested network analysis as a tool for measuring network performance (Choi and Brower, 2006; Choi and Kim, 2007; Kapucu and Demiroz, 2011; Hu *et al.*, 2014). The traditional criterion for evaluating a network is its contribution to the participant organizations, which implies micro-level analysis of the extent to which the collaborative action contributes to the achievement of each participant's goals. However, this basic evaluation does not suffice when assessing a collaborative network where interdependency shapes the overall performance. For instance, if a partner fails, this may trigger a decrease in the operation not only of an organization but also of the network as a whole (Kapucu and Demiroz, 2011).

In order to assess the effectiveness of a whole network, interorganizational relations need to be examined. Scholars have suggested different network measures such as the strength of ties within the cliques (Provan and Sebastian, 1998) or the thickness of relations between the members of the network (Provan and Milward, 2001) to determine the network effectiveness (Kapucu and Demiroz, 2011). In particular, current research has measured the network effectiveness of emergency management by comparing the network characteristics associated with the planned networks versus the actual ones (Choi and Brower, 2006; Choi and Kim, 2007; Kapucu and Demiroz, 2011; Hu *et al.*, 2014).

A planned network is defined as a formal collaborative structure which is legally established before the emergency occurs (i.e. the disaster preparedness phase) to guide collaborative actions across jurisdictions (Lutz and Lindell, 2008; Du *et al.*, 2020; Comfort and Zhang, 2020). These formal agreements specify the participants, tasks, procedures, responsibilities and the resources that will be activated in an emergency (Abbasi, 2014; Jung and Song, 2015; Du *et al.*, 2020). In this way, the partners can anticipate how they should behave, support each other and work together to provide successful response actions (Kapucu and Demiroz, 2011).

The actual network, on the other hand, is the aggregation of all the actors' interactions during the emergency response phase. It includes the activated planned arrangements and the informal and spontaneous relationships that participants improvise without prior plans (Drabek *et al.*, 1981). Actual networks may incorporate unanticipated participants who have relevant information or resources to facilitate an opportune response (Drabek and McEntire, 2003).

In an emergency event, participants are expected to establish ties in accordance with plans. However, this does not always happen (Abbasi and Kapucu, 2016; Song, 2018). Especially when the incident is large and complex, emergency actors are often unable to follow standard procedures and response plans and this produces a gap

between planned and actual networks; this gap reveals information about the effectiveness of emergency management networks.

This method of measuring network effectiveness was first used by Kapucu and Demiroz (2011) in the context of Hurricane Katrina. It has subsequently been used by Hu, Knox and Kapucu (2014) to study the case of the Boston Marathon bombings and by Choi and Brower (2006) to examine local response to emergencies in the State of Florida. These studies focused mainly on planned networks involving hierarchical levels, in which a single participant or group of key participants is mandated to coordinate emergency response. In these cases, the emergency management authorities are expected to be the central actors in emergency management networks given their coordinating role (Abbasi, 2014).

Marking a difference with current research, this article focuses on intermunicipal self-organized planned networks. Given that these networks rest on horizontal relationships characterized by autonomy and their voluntary nature, there are no theoretical expectations about who should be the key actors in the network structures. This innovation in the operationalization of the planned networks also allows us to incorporate characteristics of the Latin American context where intermunicipal mechanisms have been promoted since the 1990s.

The present study measures the effectiveness of intermunicipal emergency management networks in the Santiago Metropolitan Region of Chile in the context of the coronavirus pandemic. Specifically, it examines the structure of what was planned and formalized in inter-local agreements and compares this to the actual and emergent intermunicipal emergency management network. A brief description of intermunicipal collaboration in the Santiago Metropolitan Region is provided in the following section.

4. Context of the study

In many Latin American countries, pro-intermunicipal collaboration institutional frameworks have proliferated, and Chile is no exception. Since its return to democratic rule in 1990, the legislative and policy frameworks regulating municipal activities have promoted intermunicipal collaboration in the form of inter-local agreements and municipal associations. Inter-local agreements take the form of bilateral or multilateral contracts, established to coordinate actions to solve common problems and exchange information, resources and equipment in specific situations. By contrast, municipal associations are official arrangements, created by three or more municipalities to increase institutional capacity, jointly provide public services, develop common infrastructure and coordinate actions to promote development.

Nearly all Chile's municipalities (345) currently participate in at least one municipal association and have at least one inter-local agreement (Arias Yurisch and Garrido-Vergara, 2019). Despite the proliferation of these intermunicipal agreements, we know little about how they perform in an emergency. In a bid to fill this gap, this

paper analyzes the intermunicipal networks operating in the context of the coronavirus pandemic.

Chile confirmed its first case of Covid-19 in March 2020. On March 19, the national government declared a state of emergency which, as of end-July, remained in force. According to the official records of the Health Ministry (MINSAL), the number of cases peaked between the end of May and the beginning of June. However, as of July 2020, the country ranked as the fourth nation most affected by the pandemic, according to the John Hopkins University Report (Coronavirus Resource Center, 2020).

The public health emergency has been most acute in the Santiago Metropolitan Region, which accounts for around 74% of the total cases (336,345) reported in the country (MINSAL, 2020). In this context, the region's local governments have played a significant and critical role, implementing a wide range of initiatives and drawing national attention to issues that need to be addressed at the local level.

This study focuses on local response to the pandemic by examining collaborative interactions among local governments. The research design of the study and, specifically, the data collection and analysis processes took place simultaneously with the national government's definition of a reopening plan. In the following section, the data and methodology are detailed.

5. Data and methodology

This paper uses a network approach to explain the patterns and dynamics of intermunicipal emergency management networks in the Santiago Metropolitan Region of Chile. The whole network of intermunicipal collaboration is taken as the unit of analysis. To measure the effectiveness of the whole network, this study analyzes and compares the planned and actual intermunicipal networks operating in the context of emergency response to the pandemic.

The planned network is operationalized as the set of formal and voluntary relationships among municipalities, officially established under some written agreement, to solve collective problems and/or jointly provide public goods and services in emergency contexts. The actual network is defined as the set of informal relationships among municipal officials that emerges to respond to the pandemic regardless of the pre-existence of formal agreements.

5.1. Planned network

To capture the planned intermunicipal network established to deal with emergencies, this research used archival data. In order to build this network database, official documents were collected for the period from 2009 to 2019. Using government's Transparency (www.portaltransparencia.cl) and Undersecretariat of Regional Development's (<http://asociativismo.subdere.gov.cl/registro-unico-asociaciones-municipales>) websites, we collected written documents related to bilateral/multilateral agreements and municipal associations involving 52 local governments. Through

this lengthy process, we collected 202 documents related to bilateral and multilateral agreements and 62 documents related to municipal associations.

Content analysis permitted identification of those formal arrangements established to collaborate in emergency contexts. Around 30% of the bilateral agreements (61 agreements of the data) envisaged collective actions in the case of a disaster or emergency. We did not find multilateral agreements or municipal associations with specific clauses related to emergency matters.

The selected formal agreements included a clause defining the will to collaborate in emergency situations by supporting each other in areas such as construction materials, machinery, transfers, food and social assistance. In general, these agreements are ‘adaptive’ since they are based on broad guidelines for collaboration, rather than being ‘restrictive’ and rule-specific. This is similar to experiences of intermunicipal emergency management in other countries (Spicer, 2015; Andrew and Hawkins, 2013).

5.2. Actual network

Information about the actual network was obtained through an online survey of different municipal officials, such as mayors, city managers, chief planning officers, natural disaster directors and community development directors. The aim was to cover a broad range of municipal actors, from generalists to specialists, with responsibilities in the local emergency management field in the Santiago Metropolitan Region of Chile.

We emailed the survey to 199 municipal officials over the course of one month (June/July 2020). A total of 72 responses was received, equivalent to a 36% response rate; these responses represented 96% of the municipalities in the Santiago Metropolitan Region.

To capture the actual networks emerging in the context of the pandemic, the survey included the following question: ‘From the following list, mark the municipalities you have collaborated with in the context of the coronavirus pandemic’. The respondents were able to select all of their collaborative partners from a list of the 52 local governments that exist in the Santiago Metropolitan Region.

5.3. Data analysis

Network analysis was performed using R software to analyze and assess the effectiveness of Chilean intermunicipal emergency management networks in the face of the pandemic. In particular, the study measured and compared the network properties of planned and actual intermunicipal networks as a way of examining the effectiveness of whole networks. It included measures of the networks’ density, centralization and fragmentation.

The measure of density describes the overall level of cohesion in an entire network in terms of the connectedness of its actors. It is calculated by dividing the actual number of links in a network by the maximum possible number of links (Wasserman

and Faust, 1994). Similarly to density, the measure of centralization provides information about the compactness of a network's overall structure. It assesses the extent to which one or a few organizations in the network are considerably more centrally connected than others (Provan *et al.*, 2007). In this sense, it reflects the differences between the centrality of the most central actor and that of all others in the network, and is calculated as a ratio of the sum of these differences to the maximum possible sum of differences (Abbasi and Kapucu, 2016).

The measure of fragmentation indicates whether all or most of the network's members are connected or the network is broken into fragments of unconnected nodes and cliques (Provan *et al.*, 2007). Networks that are fragmented exhibit organizations that are isolated or interactions among organizations that are themselves unconnected. Fragmentation is measured as the proportion of pairs of nodes that cannot reach each other.

In addition to these network properties, measures of centrality complement the analysis. Two types of centrality measures were used to identify powerful and important actors in the planned and actual networks: degree and betweenness (Wasserman and Faust, 1994; Kapucu and Demiroz, 2011). Degree measures a participant's centrality in a network by counting the other points in the network to which that participant is directly connected (Freeman, 1978). Betweenness centrality, by contrast, reveals the positional power of actors because its calculation takes into account indirect as well as direct ties. An actor with betweenness power serves as a bridge between two other actors or two subgroups without which a serious breakdown of communications for those two actors or subgroups might occur (Comfort and Haase, 2006; Kapucu, 2006).

6. Findings

The structures of planned and actual intermunicipal emergency management networks are graphed and compared. Figures 1 and 2 depict the planned network involving all the municipalities that had formally set up agreements to collaborate during emergency events and the actual intermunicipal network that emerged in the context of the coronavirus pandemic.

To evaluate the network effectiveness, we compared the formalized intermunicipal network with the actual network formed in response to the pandemic. Network analysis was used to identify and compare the measures of density, centralization and fragmentation of both networks, which are presented in Table 1.

According to Table 1, the actual network is denser than the planned one ($D_ACTUAL = 0.07$ versus $D_PLANNED = 0.04$), indicating that the emergent network is more cohesive than that previously agreed upon by the municipalities. The planned network comprises 106 potential links that were available for activation by the municipalities in order to organize their response to the coronavirus pandemic. However, only 15% of those links were effectively activated. Despite this weak activation of previous agreements, the actual network response comprises a larger number of

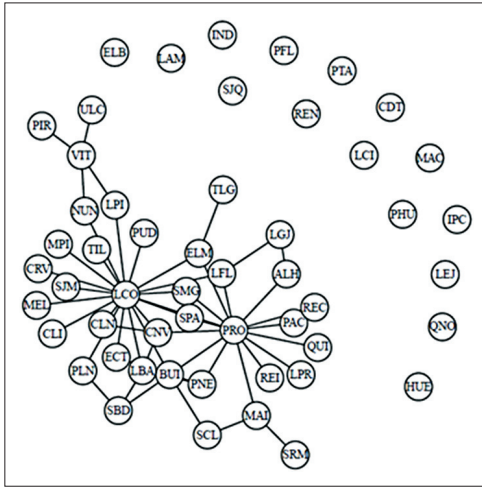


Figure 1: Planned Network

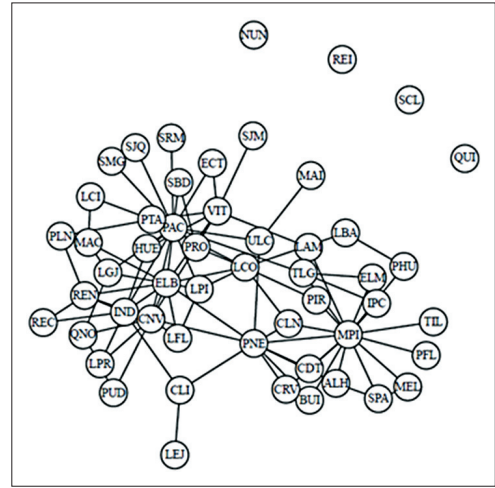


Figure 2: Actual Network

Source: Authors' own calculations

Table 1: Measures of whole networks

	Planned Network	Actual Network
Interactions (links)	106	182
Components	16	5
Density	0.04	0.069
Centralization	0.352	0.245
Fragmentation	0.498	0.149

Source: Authors' own calculations

intermunicipal relationships (182 links) of which 166 are informal and emergent interactions.

On the other hand, the measures of centralization indicate that the planned network is more centralized than the actual one ($C_{\text{PLANNED}} = 0.37$ versus $C_{\text{ACTUAL}} = 0.25$). In the planned network, cohesion is organized around a few municipalities while, in the emergent network, the power of the individual actors varies widely across the network, indicating a loosely coupled network. The planned network has two central actors, Las Condes (LCO) and Providencia (PRO), whereas the actual network has five: Maria Pinto (MPI), Pedro Aguirre Cerda (PAC), El Bosque (ELB), Cerro Navia (CNV) and Paine (PNE).

Table 2 presents the measures for degree and betweenness centrality for each of the top 11 municipalities with higher scores in the planned and actual networks.

Table 2: Centrality measures of both networks

Planned Network				Actual Network			
Nº	M	Degree	Betweenness	Nº	M	Degree	Betweenness
1	LCO	20	840.667	1	MPI	16	616.28
2	PRO	15	551.433	2	PAC	14	640.045
3	BUI	6	112.1	3	ELB	11	405.766
4	CNV	4	17.3	4	CNV	10	332.623
5	LBA	4	26.833	5	PNE	10	531.908
6	VIT	4	139	6	IND	8	184.981
7	ELM	3	70	7	LCO	7	196.823
8	LFL	3	53.8	8	VIT	7	209.413
9	MAI	3	81.8	9	REN	5	66.234
10	PNE	3	7.333	10	LGJ	4	30.617
11	SBD	3	5.133	11	LPI	4	32.484
12	ALH	2	14.2	12	LPR	4	8.667
13	CLN	2	0	13	MAC	4	33.939
14	ECT	2	0	14	PRO	4	51.395
15	LGJ	2	1	15	TLG	4	192.074

Source: Authors' own calculations

According to Table 2, Las Condes (LCO) has the largest number of ties with other municipalities in the planned network (DEGREE_LCO = 20), followed by Providencia (PRO) (DEGREE_PRO = 15). These are the network's central actors. At the same time, these municipalities have the greatest betweenness centrality (BETW_LCO = 840 and BETW_PRO = 551), followed by Vitacura (VIT) (BETW_VIT = 139) and Buin (BUI) (BETW_BUI = 112). In other words, these municipalities act as bridges with other municipalities that would otherwise be isolated from the network. LCO and PRO are located in the central urban area and are among the wealthier municipalities, not only in the Santiago Metropolitan Region but also the country as a whole. From a resource dependence perspective (Pfeffer and Salancik, 1978), we can suggest that municipalities with fewer resources and less agency capacity may be more interested in formalized collaborative agreements with wealthier municipalities as a way of ensuring resources in the context of an emergency.

In the actual network, on the other hand, Maria Pinto (MPI) has the largest number of ties with other municipalities in the network (DEGREE_MPI = 16), followed by Pedro Aguirre Cerda (PAC) (DEGREE_PAC = 14), El Bosque (ELB) (DEGREE_ELB = 11), Cerro Navia (CNV) (DEGREE_CNV = 10) and Paine (PNE) (DEGREE_PNE = 10). These municipalities also have the greatest betweenness centrality, permitting brokerage among municipalities into the network (BETW_PAC = 640, BETW_MPI = 616; BETW_PNE = 531; BETW_ELB = 405, BETW_CNV = 332). These five municipalities are either among the poorest in the Santiago Metropolitan Region or are located in rural areas, which means they deal with deeper social vulnerabilities. Additionally,

these municipalities share a history of collaboration with similar partners (poorest and rural ones) in the form of municipal associations. According to these findings, we suggest that municipalities' contingent collaborative response in emergency events may follow a more social criterion based on trust developed among those with a shared history of collaboration and vulnerabilities.

Finally, the fragmentation measure indicates whether the network is broken into unconnected nodes, dyads and cliques. Table 1 shows that the planned network is much more fragmented than the actual one ($FG_PLANNED = 0.498$ versus $FG_ACTUAL = 0.149$). The planned network has more municipalities that are themselves unconnected to the main component of the network in which none of them interacts with others because they are undertaking specific tasks independently. Figure 1 reveals the 15 municipalities that remain isolated from the planned network. On the other hand, Figure 2 shows that only four municipalities do not participate in actual emergency network interactions in the Santiago Metropolitan Region. The actual response network is more complex because it has more active participants and relationships.

7. Discussion and conclusion

The results presented indicate that the planned emergency management network established among Chilean municipalities was not effective in responding to the coronavirus pandemic. Only a few of the formal emergency management agreements were activated to coordinate the municipalities' response to the emergency. Actual interactions went beyond the pre-planned agreements, incorporating non-planned actors and interactions among pairs of actors outside the scheduled procedures. This situation reveals a waste of the local agency's resources. The municipalities dedicated a significant amount of time and resources to establishing and maintaining formal relationships ahead of an emergency but these agreements did not function properly when one occurred. Consequently, a problem of network effectiveness was evident in the case studied.

The actual intermunicipal network that emerged to respond to the coronavirus pandemic comprises mainly new and informal relationships. As a whole, this network is denser, less centralized and less fragmented than the planned ones, which means that it contains more relationships, power is more distributed among the actors and only a few actors remain isolated. Therefore, the actual network reflects a more complex emergency response.

These results are consistent with previous studies that have demonstrated an important gap between planned and actual emergency networks (Choi and Brower, 2006; Choi and Kim, 2007; Kapucu and Demiroz, 2011; Hu *et al.*, 2014). In the uncertain, stressful and chaotic environment of a disaster, unlike normal circumstances, participants may not follow expected behaviors (Robinson *et al.*, 2013; Abbasi, 2014). This leads to an actual response network structure that is significantly different from the scheduled one (Abbasi and Kapucu, 2016; Song, 2018).

In contrast to most current research into network effectiveness using comparisons of planned and actual networks, this paper examines horizontal self-organized networks. Previous research has focused on hierarchical networks in which a single participant or group of key participants is mandated to serve as the coordinator of emergency response (Abbasi, 2014). Our research reveals a gap between the expected position of coordinated authorities in the planned versus the actual network, showing that NGOs or other private organizations can also play a coordinating role (Choi and Brower, 2006; Kapucu *et al.*, 2009).

Since horizontal self-organized networks stress autonomy and the voluntary nature of agreements, there is not a hierarchical expectation around a coordinator, and the gap between planned and actual networks can vary in unexpected ways. In the present study, the gap between the planned and actual networks reflects differences in the type of central actors. In the planned network, the key municipalities are those with more resources and higher status, suggesting an instrumental logic underlying the establishment of formal agreements: actors with fewer resources and less capacity seek wealthier partners to ensure resources in the face of an emergency. By contrast, in the actual network, the central actors are those that have actively participated in municipal associations and, thus, share a history of intermunicipal collaboration, suggesting an embeddedness logic underlying the actual patterns of interactions.

Given that few formal agreements were activated during the coronavirus event, this study concludes that, in the Chilean case, the embeddedness logic, rather than the instrumental logic, is more helpful in understanding intermunicipal emergency management. According to these findings, the effectiveness of intermunicipal self-organized networks can be improved if these informal relationships are sustained through more permanent, stable and formalized intermunicipal collaboration. Some studies have demonstrated that an emergency management network that is sustainable over time produces the most effective results (Weber, 2003; Kapucu *et al.*, 2013) since, when a catastrophe strikes again, all the network participants will be prepared and ready to collaborate.

In the case studied here, stable collaboration is reflected in the work of municipal associations. Although these associations do not consider emergency management as part of their collaborative endeavors, the central actors from the emergent network are members of the municipal associations with the longest trajectory in the Santiago Metropolitan Region and they act as bridges for their partners' incorporation into the actual network. This suggests that a history of collaboration and the consequent trust are able to sustain the relationships in times of emergency. These results can be used by policymakers and public managers to incorporate municipal associations as key actors in the emergency management system and, in this way, improve the phase of disaster preparedness and its effectiveness.

From a scholarly standpoint, the article contributes to intermunicipal research by suggesting some conceptual revisions. Firstly, it develops a conceptual approach to the operationalization of planned emergency management networks on the basis

of horizontal self-organized networks. Local governments establish voluntary agreements to jointly resolve collective problems imposed by institutional fragmentation. Particularly in the emergency management context, policy problems and underlying resource systems become increasingly interconnected so that the decisions of one local government inevitably affect outcomes of concern to the other units. To measure effectiveness, identification of the sets of voluntary agreements on emergency management served as an innovative way of capturing the planned network structure for comparison against the actual network.

Finally, the Chilean case shows that, in the emergency management field, formal relationships established before an emergency may not be activated when required. An important line of research on intermunicipal cooperation rests exclusively on formal agreements to define the collaborative phenomenon and explain its causes and consequences. According to the findings of this paper, future research should examine whether formal agreements are an appropriate proxy of effective collaborative action.

References:

1. Abbasi, A. and Kapucu, N., 'A Longitudinal Study of Evolving Networks in Response to Natural Disaster', 2016, *Computational and Mathematical Organization Theory*, vol. 22, pp. 47–70.
2. Abbasi, A., 'Link Formation Pattern during Emergency Response Network Dynamics', 2014, *Natural Hazards*, vol. 71, no. 3, pp. 1957–1969.
3. Agranoff, R. and McGuire, M., 'Big Questions in Public Network Management Research', 2001, *Journal of Public Administration Research and Theory*, vol. 11, no. 3, pp. 295–326.
4. Agranoff, R. and McGuire, M., *Collaborative Public Management: New Strategies for Local Governments*, Washington, D.C.: Georgetown University Press, 2003.
5. Agranoff, R., *Managing within Networks: Adding Value to Public Organizations*, Washington, D.C.: Georgetown University Press, 2007.
6. Andrew, S.A. and Hawkins, C.V., 'Regional Cooperation and Multilateral Agreements in the Provision of Public Safety', 2013, *The American Review of Public Administration*, vol. 43, no. 4, pp. 460–475.
7. Arias Yurisch, K. and Garrido-Vergara, L., 'What Propels Municipal Governments to Collaborate? The Case of Thematic Environmental Association in Chile', 2019, *Lex Localis*, vol. 17, no. 1, pp. 139–157.
8. Arias Yurisch, K., Retamal Soto, K. and Ramos Fuenzalida, C., 'Inter-municipal Cooperation in Latin America: Current Situation and Future Research Challenges', 2019, *Revista de Administração Pública*, vol. 53, no. 3, pp. 575–591.
9. Bowman, A.O.M. and Parsons, B.M., 'Vulnerability and Resilience in Local Government: Assessing the Strength of Performance Regimes', 2009, *State & Local Government Review*, vol. 41, no. 1, pp. 13–24.
10. Brudney, J.L. and Gazley, B., 'Planning to Be Prepared: An Empirical Examination of the Role of Voluntary Organizations in County Government Emergency Planning', 2009, *Public Performance & Management Review*, vol. 32, no. 3, pp. 372–399.

11. Caruson, K. and MacManus, S.A., 'Mandates and Management Challenges in the Trenches: An Intergovernmental Perspective on Homeland Security', 2006, *Public Administration Review*, vol. 66, no. 4, pp. 522–536.
12. Choi, S.O. and Brower, R.S., 'When Practice Matters More than Government Plans: A Network Analysis of Local Emergency Management', 2006, *Administration and Society*, vol. 37, no. 6, pp. 651–678.
13. Choi, S.O. and Kim, B.T., 'Power and Cognitive Accuracy in Local Emergency Management Networks', 2007, *Public Administration Review*, vol. 67, no. s1, pp. 198–209.
14. Cigler, B.A., 'The 'Big Questions' of Katrina and the 2005 Great Flood of New Orleans', 2007, *Public Administration Review*, vol. 67, no. s1, pp. 64–76.
15. Comfort, L.K. and Haase, T.W., 'Communication, Coherence, and Collective Action: The Impact of Hurricane Katrina on Communications Infrastructure', 2006, *Public Works Management and Policy*, vol. 10, no. 4, pp. 328–343.
16. Comfort, L.K. and Zhang, H., 'Operational Networks: Adaptation to Extreme Events in China', 2020, *Risk Analysis*, vol. 40, no. 5, pp. 981–1000.
17. Comfort, L.K., Waugh, W.L. and Cigler, B.A., 'Emergency Management Research and Practice in Public Administration: Emergence, Evolution, Expansion, and Future Directions', 2012, *Public Administration Review*, vol. 72, no. 4, pp. 539–547.
18. Coronavirus Resource Center, John Hopkins University [Online] available at <https://coronavirus.jhu.edu/map.html>, accessed on July 22, 2020.
19. Drabek, T.E. and McEntire, D.A., 'Emergent Phenomena and the Sociology of Disaster: Lessons, Trends and Opportunities from the Research Literature', 2003, *Disaster Prevention and Management: An International Journal*, vol. 12, no. 2, pp. 97–112.
20. Drabek, T.E., Tamminga, H.L., Kilijanek, T.S. and Adams, C.R., *Managing Multi-organizational Emergency Responses: Emergent Search and Rescue Networks in Natural Disaster and Remote Area Settings*, Denver, Colorado: University Institute of Behavioral Science, 1981.
21. Du, L., Feng, Y., Tang, L.Y., Kang, W. and Lu, W., 'Networks in Disaster Emergency Management: A Systematic Review', 2020, *Natural Hazards*, vol. 103, no. 1, pp. 1–27.
22. Dzigbede, K., Gehl, S.B. and Willoughby, K., 'Disaster Resiliency of US Local Governments: Insights to Strengthen Local Response and Recovery from the COVID-19 Pandemic', 2020, *Public Administration Review*, vol. 80, no. 4, pp. 634–642.
23. Feiock, R.C. and Scholz, J.T., *Self-organizing Federalism: Collaborative Mechanisms to Mitigate Institutional Collective Action Dilemmas*, New York: Cambridge University Press, 2009.
24. Freeman, L.C., 'Centrality in Social Networks Conceptual Clarification', 1978, *Social Networks*, vol. 1, no. 3, pp. 215–239.
25. French, P.E. and Raymond, E.S., 'Pandemic Influenza Planning: An Extraordinary Ethical Dilemma for Local Government Officials', 2009, *Public Administration Review*, vol. 69, no. 5, pp. 823–830.
26. French, P.E., 'Enhancing the Legitimacy of Local Government Pandemic Influenza Planning through Transparency and Public Engagement', 2011, *Public Administration Review*, vol. 71, no. 2, pp. 253–264.

27. Gerber, B.J. and Robinson, S.E., 'Local Government Performance and the Challenges of Regional Preparedness for Disasters', 2009, *Public Performance & Management Review*, vol. 32, no. 3, pp. 345–371.
28. Guo, X. and Kapucu, N., 'Examining Collaborative Disaster Response in China: Network Perspectives', 2015, *Natural Hazards*, vol. 79, no. 3, pp. 1773–1789.
29. Hu, Q., Knox, C.C. and Kapucu, N., 'What Have We Learned since September 11, 2001? A Network Study of the Boston Marathon Bombings Response', 2014, *Public Administration Review*, vol. 74, no. 6, pp. 698–712.
30. Jung, K. and Song, M., 'Linking Emergency Management Networks to Disaster Resilience: Bonding and Bridging Strategy in Hierarchical or Horizontal Collaboration Networks', 2015, *Quality and Quantity*, vol. 49, no. 4, pp. 1465–1483.
31. Kapucu, N. and Demiroz, F., 'Measuring Performance for Collaborative Public Management Using Network Analysis Methods and Tools', 2011, *Public Performance & Management Review*, vol. 34, no. 4, pp. 549–579.
32. Kapucu, N. and Garayev, V., 'Structure and Network Performance: Horizontal and Vertical Networks in Emergency Management', 2016, *Administration and Society*, vol. 48, no. 8, pp. 931–961.
33. Kapucu, N., 'Interagency Communication Networks during Emergencies: Boundary Spanners in Multi-agency Coordination', 2006, *The American Review of Public Administration*, vol. 36, no. 2, pp. 207–225.
34. Kapucu, N., Augustin, M.E. and Garayev, V., 'Interstate Partnerships in Emergency Management: Emergency Management Assistance Compact in Response to Catastrophic Disasters', 2009, *Public Administration Review*, vol. 69, no. 2, pp. 297–313.
35. Kapucu, N., Garayev, V. and Wang, X., 'Sustaining Networks in Emergency Management: A Study of Counties in the United States', 2013, *Public Performance & Management Review*, vol. 37, no. 1, pp. 104–133.
36. Lutz, L.D. and Lindell, M.K., 'Incident Command System as A Response Model within Emergency Operation Centers during Hurricane Rita', 2008, *Journal of Contingencies Crisis Management*, vol. 16, no. 3, pp. 122–134.
37. McEntire, D.A. and Dawson, G., 'The Intergovernmental Context', in Waugh, W.L. and Tierney, K.J. (ed.), *Emergency Management: Principles and Practice for Local Government*, ICMA Press, 2007, pp. 57–70.
38. McGuire, M. and Silvia, C., 'The Effect of Problem Severity, Managerial and Organizational Capacity, and Agency Structure on Intergovernmental Collaboration: Evidence from Local Emergency Management', 2010, *Public Administration Review*, vol. 70, no. 2, pp. 279–288.
39. McGuire, M., 'Managing Networks: Propositions on What Managers Do and Why They Do It', 2002, *Public Administration Review*, vol. 62, no. 5, pp. 599–609.
40. Milgrim, M., 'Vaccine Prioritization during an Influenza Pandemic', Fairfax, VA: George Mason University Law School, Critical Infrastructure Protection Plan, 2007.
41. MINSAL (Ministry of Health), Official Data on COVID-19, [Online] available at <https://www.gob.cl/coronavirus/cifrasoficiales/>, accessed on July 22, 2020.
42. Petak, W.J., 'Emergency Management: A Challenge for Public Administration', 1985, *Public Administration Review*, vol. 45, Special Issue, pp. 3–7.

43. Pfeffer, J. and Salancik, G.R., *The External Control of Organizations: A Resource Dependence Perspective*, New York: Harper & Row, 1978.
44. Provan, K.G. and Lemaire, R.H., 'Core Concepts and Key Ideas for Understanding Public Sector Organizational Networks: Using Research to Inform Scholarship and Practice', 2012, *Public Administration Review*, vol. 72, no. 5, pp. 638–648.
45. Provan, K.G. and Milward, H.B., 'A Preliminary Theory of Interorganizational Network Effectiveness: A Comparative Study of Four Community Mental Health Systems', 1995, *Administrative Science Quarterly*, vol. 40, no. 1, pp. 1–33.
46. Provan, K.G. and Milward, H.B., 'Do Networks Really Work? A Framework for Evaluating Public-sector Organizational Networks', 2001, *Public Administration Review*, vol. 61, no. 4, pp. 414–423.
47. Provan, K.G. and Sebastian, J.G., 'Networks within Networks: Service Link Overlap, Organizational Cliques, and Network Effectiveness', 1998, *Academy of Management Journal*, vol. 41, no. 4, pp. 453–463.
48. Provan, K.G., Fish, A. and Sydow, J., 'Interorganizational Networks at the Network Level: A Review of the Empirical Literature on Whole Networks', 2007, *Journal of Management*, vol. 33, no. 3, pp. 479–516.
49. Robinson, S.E., Eller, W.S., Gall, M. and Gerber, B.J., 'The Core and Periphery of Emergency Management Networks', 2013, *Public Management Review*, vol. 15, no. 3, pp. 344–362.
50. Savitch, H.V., 'Does 9-11 Portend a New Paradigm for Cities?', 2003, *Urban Affairs Review*, vol. 39, no. 1, pp. 103–127.
51. Schneider, S.K., *Flirting with Disaster: Public Management in Crisis Situations*, Armonk, N.Y.: M.E. Sharpe, 1995.
52. Somers, S. and Svara, J.H., 'Assessing and Managing Environmental Risk: Connecting Local Government Management with Emergency Management', 2009, *Public Administration Review*, vol. 69, no. 2, pp. 181–193.
53. Song, M., 'Does Having a Strong Commitment Matter in Building Sustainable Networks?', 2018, *Quality and Quantity*, vol. 52, no. 2, pp. 551–564.
54. Spicer, Z., 'Regionalism, Municipal Organization, and Interlocal Cooperation in Canada', 2015, *Canadian Public Policy*, vol. 41, no. 2, pp. 137–150.
55. Swianiewicz, P. and Teles, F., 'The Institutionalization of Inter-Municipal Arrangements in Europe: Findings from the Unusual Suspect', 2019, *Transylvanian Review of Administrative Sciences*, no. 57E, pp. 119–136.
56. Teles, F., *Local Governance and Intermunicipal Cooperation*, New York: Palgrave MacMillan, 2016.
57. Wachhaus, A., 'Bootstrapping Disaster: The Challenge of Growing and Maintaining a Cross-sector Collaborative Network', 2016, *Journal of Emergency Management*, vol. 14, no. 6, pp. 397–411.
58. Wasserman, S. and Faust, K., *Social Network Analysis: Methods and Applications*, Cambridge: Cambridge University Press, 1994.
59. Waugh, W.L. and Streib, G., 'Collaboration and Leadership for Effective Emergency Management', 2006, *Public Administration Review*, vol. 66, no. s1, pp. 131–140.
60. Waugh, W.L., 'Regionalizing Emergency Management: Counties as State and Local Government', 1994, *Public Administration Review*, vol. 54, no. 3, pp. 253–258.

61. Weber, E.P. and Khademian, A.M., 'Wicked Problems, Knowledge Challenges, and Collaborative Capacity Builders in Network Settings', 2008, *Public Administration Review*, vol. 68, no. 2, pp. 334–349.
62. Weber, E.P., *Bringing Society Back In: Grassroots Ecosystem Management, Accountability, and Sustainable Communities*, Cambridge, M.A.: Massachusetts Institute of Technology Press, 2003.
63. Weible, C.M., Nohrstedt, D., Cairney, P., Carter, D.P., Crow, D.A., Durnova, A.P., Heikkila, T., Ingold, K., McConnell, A. and Stone, D., 'COVID-19 and the Policy Sciences: Initial Reactions and Perspectives', 2020, *Policy Sciences*, vol. 53, pp. 225–241.