

**HOW TO EFFECTIVELY OVERCOME REGIONAL COLLABORATION  
DILEMMAS: LESSON FROM INTER-LOCAL COLLABORATIVE MECHANISM  
IN KOREA**

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**ABSTRACT**

The purpose of this research is to test interdependent and independent risk hypotheses that explain the formation of interorganizational ties using the network evolution approach. The main objective is to uncover the dynamic structure of interorganizational emergency management network after a disaster. Based on the datasets collected before and after the 2012 Korean typhoons, the results of the stochastic actor-based models found support for the interdependent risk hypothesis suggesting the interorganizational collaboration tends to be based on the notion of shared risk. The findings also suggest that organizations, located on the coastline and participated in the joint full-sized exercise, tend to forge interorganizational ties with others after a disaster. Taken together, the findings imply that an organization experiencing prefer to collaborate with other organizations in order to minimize risk resulted from disasters

**Keywords:** Emergency Management, Interorganizational Collaboration, Resilience, Social Network Analysis, Korea Typhoons.

**Introduction**

Building organizational resilience is a complex and dynamic process playing out over multiple scales of public, private, and nonprofit organizations. While much of growing

research has highlighted the importance of interorganizational emergency management networks (Waugh, 2003; Waugh and Streib, 2006; Kapucu, 2006; Choi and Brower, 2006; Andrew and Carr, 2012), few research has identified how patterns of social relations established by diverse local organizations is modified by a disaster. The transformation of interorganizational ties in order to enhance organizational resilience is timely and an important topic for the fields of emergency management (Kapucu et al., 2012). Given the limitations of resource and fragmented regional governance, previous literature has argued that emergency networks encompassing federal, state, and local governments played an important role in promoting successful adaptation to adversity (Kapucu et al., 2010; Andrew, 2009; 2010). Helping to build organizational resilience – characterized by a community's ability and capacity to respond and recover damages from disasters – has also received much attention by regional, state, and national policymakers (Norris et al., 2008; Chandra et al., 2010; Sherrieb et al., 2010).

This research is intentionally designed to test two general hypotheses: interdependent and independent risk hypothesis. While the former illustrates the importance of trust and information redundancy to coordinate and align emergency preparedness and response, the latter captures the tendency for local actors to seek dominant partners in order to bridge crucial information across the region (see Andrew, 2009; 2010; Andrew and Carr, 2012). The relationship between interorganizational ties and organizational resilience is timely and an important topic for the fields of urban and emergency management (Kapucu et al., 2012). Given the limitations of resource and fragmented regional governance, scholars have argued that emergency networks encompassing national, regional, and local governments as well as private and non-governmental organizations play an important role in promoting adaptation to adversity and establishing meaningful emergency planning processes (Kapucu et al., 2010; Andrew, 2009; 2010).

The main objective is to determine the patterns of interorganizational relations and how planned joint coordination efforts are modified to meet unexpected local demands and thus contributing to organizational resilience. The term organizational resilience is generally conceptualized as the capability of an organization to bounce- back from an adverse situation (National Research Council, 2010; Cox and Perry, 2011; Andrew et al., Forthcoming). The concept has gained wide interest after the adoption of the Hyogo Framework for Action 2005-2015, calling for the need of national and organizational resilience to disasters (Manyena, 2006). Organizational resilience is operationalized as the capability of interconnected networks of organizations to foster the following resilience dimensions: robustness, rapidity, resourcefulness, and redundancy.

Moreover, in the realm of emergency management, whether planned or not, during disasters self-organizing governance will emerge in one form or another (Dynes, Quarantelli,

and Kreps, 1972; Kreps, 1991; Dynes, 1994). Although this stream of work provides insights into the different types of emergence groups during disasters, it tends to focus on the normative issues rather than investigating factors explaining the process of interorganizational coordination. This research overcomes this gap by collecting data at the organization level. This is an innovative approach in that it focuses our attention on how a diverse set of organizations are transforming their resources and devising alternative means to overcome unexpected challenges, thereby building organizational resilience.

### **Institutional Collective Action Framework**

The Institutional Collective Action (ICA) framework posits that transaction costs of collaboration can prevent organizations from working together to achieve better outcomes. The relative advantage analysis of transaction costs (e.g. information costs, negotiation costs, agency costs, and enforcement costs) provides insights on obstacles preventing collective decisions to be realized (Inman and Rubinfeld, 1997; 2000; Feiock, 2007). The dilemmas also arise from a system of fragmented authority (i.e. vertical, horizontal, and functional fragmentation), which become barriers to mutually beneficial action because they generate transaction costs when organizations consider agreements for joint activities. The ICA perspective extends the collective action theory that is concerned with individuals' behaviors and identifies problems associated with sub-optimal outcomes at the organizational level. The framework has also been utilized to study organizational behaviors using contract and transaction cost theories (Feiock, 2009; Feiock and Scholz, 2010).

In the context of emergency management, the ICA framework has been applied to study interorganizational collaboration as interactions or interorganizational ties (Andrew and Carr 2012; Andrew et al. forthcoming; Andrew, Jung, and Li, forthcoming). Such interactions can improve the level of emergency response as they offer informal mechanisms for actors to reduce the cost of coordination and cooperation (Andrew et al., Forthcoming). A beneficial exchange is realized when actors received crucial resources from multiple actors. For instance, bonding strategy stresses the importance of social cohesion leading to the ability of organizations to pool their resources together (Andrew et al., Forthcoming), but bridging facilitates connection to those organizations that otherwise would not be connected in order to coordinate human and capital resources (Burt, 1992).

Disasters can overwhelm the capacity of any single sector or community, making the inclusion of different actors in emergency response activities a necessity (Robinson, 2012; Comfort, 1994; Kapucu, 2006; 2007). Since collaboration between different functional organizations and levels of government often generates coordination problems, creating a

“hub” or a bridge that spans across multiple actors can facilitate access to new information and novel resources (Burt, 2005). The bridging strategy can also broaden the range of participants. The participants then spread the risk with adjacent communities, and they respond quickly and appropriately. These mechanisms integrate decision-making, create mutually binding agreements, delegate authority, and impose authority through networks (Feiock, 2013). Each mechanism resolves a collective action dilemma differently. Social network studies suggest that various coordination strategies are adopted to minimize transaction costs of collaboration and risks associated with potential default (Berardo and Scholz, 2010).

In the underlying ICA framework, collaboration risks reflect incoordination (inaction), division (division of costs), and defection (agreement violation) (Feiock, 2013). Defection risks are especially high in disaster situations because if even one participant does not conform to the agreement, others will probably fail to respond effectively to the disaster. Each disaster has different frequency and intensity in general. This might change the action of each organization relying on their internal condition or capacity. For better response, the collaborative networks have been already established at the preparedness stage, but rational actors might consider the benefit and cost when they face disasters regardless of agreement. High risk deriving from high uncertainty increases transaction cost.

### **What Explains the Evolutionary Structure of Interorganizational Ties?**

Organizational ties that build an effective interorganizational collaboration change after a catastrophic event. The unpredictable and chaotic features of catastrophic events overwhelms the capacity of any single organization and thus, motivating organizations to include and/or exclude certain actors in emergency response activities (Comfort, 1994; Perry and Lindell, 2003; Waugh and Streib, 2006; Robinson, 2012). From the resource dependency perspective, Pfeffer and Salancik (1978) assert that if an organization is not self-sufficient, it will adapt to its environment in order to survive. Since the need for acquiring crucial resources suggests that an organization is dependent on other organizations (Scott, 1987, p. 111), the formation of interorganizational ties is determined by both internal and external factors. During a period of adversity, for instance, resilient organizations are more likely to establish efficient measures for securing tangible resources, which can improve response operations. On the other hand, some organizations may have limited sources to exchange indispensable resources, and thus may not be able to manage disaster situations without depending on outside assistance (Sutcliffe and Vogues, 2003).

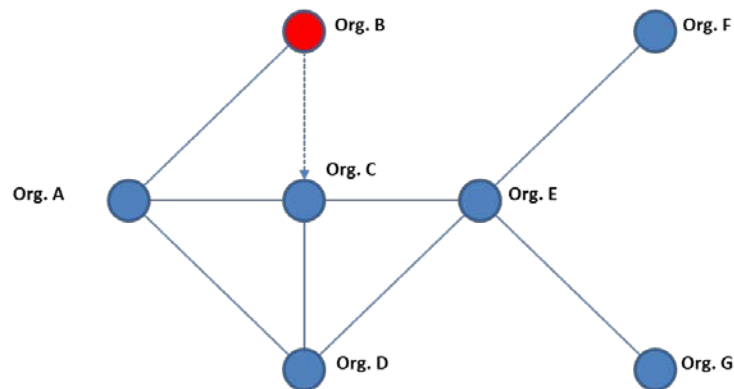
However, collaboration may not materialized in the presence of uncertainty. Despite

the emphasis on the importance of coordination and communication between diverse actors (Kettl, 2003, McEntire and Dawson, 2007), strategies for mitigating risks may not work in emergency contexts (Andrew and Carr, 2013). Unlike an effort on achieving the goal of collaborative relations in the area of mitigation, the cost of establishing and sustaining interorganizational networks can be high and the enforcement mechanism might be absent. Commitment that local government should follow in planning documents can be unrealistic if key elements required to implement the planning activities are not tested. Moreover, the change in collaboration also are affected by changing environmental conditions such as natural and technical disasters (Dynes and Drabek, 1994). Such changes can be explained by two general hypotheses: “interdependent risk” and “independent risk” (Berardo and Scholz, 2010). The next section explains the causal mechanisms explaining strategies to minimize collaborative risk in the presence of disasters.

### **Interdependent Risk Hypothesis**

The interdependent risk hypothesis suggests that organizations have a strong preference to forge ties with those that are connected closely together in order to share risks and cope with disasters. In other words, an organization closely connected to other organizations may be more resilient than another organization because of the following reasons: (1) Andrew (2010) highlights that forging a direct tie can broaden the range of collaborators leading to risk-sharing with adjacent communities and enables people to respond quickly; (2) Burt (2005) suggests, when applies to emergency management, holding a close-knit structure provides informal structural power to directly access and mobilize indispensable resources that an organization urgently needs during a disaster; (3) Choi and Kim (2006) and Vasavada (2013) highlight the importance of associational benefits resulting from close-knitted structures, implying that locally clustered organizations mobilize themselves to share resources through formal and informal arrangements after a disaster.

Figure 1. Interdependent Risk Hypothesis



According to the interdependent risk hypothesis (*see* Figure 2), organization B has a motivation to collaborate with organization C in order to maintain response operations (Dooley, 1997; Comfort *et al.*, 2001). Given the hypothesized network, solid lines indicate existing interorganizational ties and the dotted line represents the choice made by organization B after a disaster. When deciding whether to collaborate with either organization C, E, F, or G, organization B would rather forge a tie with organization C at time 2. This is because a close-knitted triadic structure not only can facilitate mutual reciprocity but also ensures organizations within the network commit to their agreement to cooperate (Andrew, 2010). Since a single organization cannot effectively cope with a disaster (Katz and Kahn, 1966; Donaldson, 1996), a group of organizations may prefer to share risks by forging ties with those that are socially positioned in a highly clustered network. Therefore, this research hypothesizes that:

Hypothesis 1: After a disaster, organizations have a strong preference to forge ties with those that are closely connected with each other in order to share risks and cope with the aftermath of the disaster.

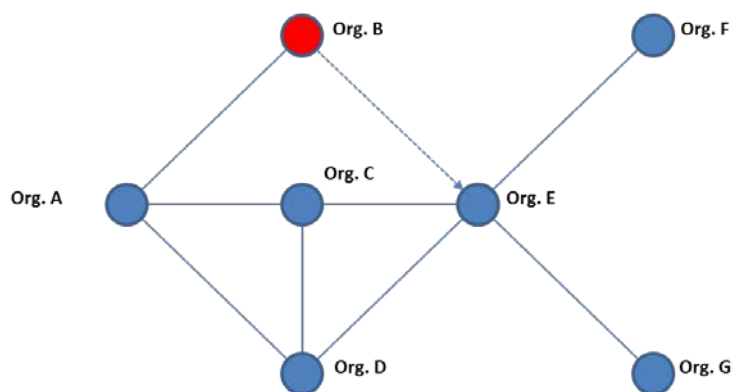
### Independent Risk Hypothesis

Alternatively, the independent risk hypothesis posits that an organization will spread risks by establishing ties with those outside their close-knitted circle. The hypothesis highlights the importance of entrepreneurial behaviors of organizations to spread risks. The independent risk-spreading strategy is important for organizations to minimize potential losses from the disaster (Kreimer, Arnold, and Carlin, 2003). The reasons motivating organizations to spread risks and establish ties with a central organization are that by

establishing organizational ties with a central actor, the organization can reduce additional costs of coordination (Andrew 2010).

According to Kapucu (2006), organizations in the peripheral of a network prefer to directly link to core actors because they cannot bear the costs of crafting and monitoring other collaborators independently. For instance, organizations with a limited number of skilled personnel and budget constraints may be motivated to seek exclusive exchange partners who can provide an opportunity for additional resources. They also spread risks after a disaster if the organization has preference to enhance organizational capacity. Such a strategy is important if the region has a low probability of disaster occurrence, especially in megacities located in East Asian (Hochrainer and Mechler, 2011).

Figure 2. Independent Risk Hypothesis



According to the independent risk hypothesis (*see* Figure 3), organization B would rather establish a tie with organization E than organization C, F, or G at time 2. This is because organization E does not have any commitment with organization A. In this situation, organization B can secure exclusive access to organization F and G. In other words, organization B could better spread its risks by establishing tie with organization E (Andrew, 2010). The decision is consistent with the entrepreneurial behavior of an organization aiming to secure the most influential actor within its network in order to cope with internal constraints (Kreimer, Arnold, and Carlin, 2003). Thus, this research hypothesizes that:

Hypothesis 2: After a disaster, an organization has a preference to forge ties with those that are centrally connected to orders in order to spread risks and cope with the aftermath of the disaster.

## **Homophily Hypothesis**

In the field of emergency management, the homophily hypothesis allows us to investigate the similarity of organizational attributes. The hypothesis suggests that similarities of actors will predispose the actors to have comparable policy preferences and strategic behaviors to reduce transaction costs (Goodreau *et al.*, 2009). Lubell (2007) argues that intrinsic similarities among organizations are crucial for selecting potential collaborative partners. This is important because it helps reduce transaction costs (Feiock and Scholz, 2010) and/or minimize risks derived from collaboration (Gulati and Gargiulo, 1999).

According to the homophily hypothesis, an organization has a strong preference to forge a tie with another organization if both have similar organizational attributes (i.e., level of government and type of emergency tasks). In the emergency management literature, collaboration among similar organizations can reduce collaborative risks because previously shared authority can enhance trust and working relationships between them after a disaster occurs (Moynihan, 2009). In addition, Comfort (2007) indicates that interorganizational cohesion between similar organizations reinforces trust building by sharing operational cognition. That is, because network diversity derived from inter-sector collaboration may hinder effective resource mobilization during a disaster as the heterogeneity of backgrounds, beliefs, and interests of organizations, which creates “a greater coordination burden than faced by small homogenous networks” (Provan and Milward, 2001, p. 41; Moynihan, 2009). Therefore, this research hypothesizes that:

Hypothesis 3: After a disaster, organizations with similar organizational attributes have a strong preference to forge ties.

## **Research Design and Methods**

### **Scope of Study and Site Selection**

This research focuses on the role of interorganizational coordination in the recovery phase of the Southeastern region, which consists of Busan Metropolitan City, Ulsan Metropolitan City, and South Kyeongsang Province. The region was affected by three major typhoons. On 28 August 2012, Typhoon Bolaven devastated the Korean peninsula, resulting in 25 deaths and causing severe destruction in infrastructure and livelihood. The economic lost was estimated at \$374.3 million in South Jeonna and South Kyeongsang provinces. Unlikely previous years, between August 28 and September 18, 2012, the recent disaster was caused by three successive typhoons: Bolaven, Tembin, and Sanva, (see Table 1). The National Emergency Management Agency (NEMA) (2012) reported that, the region



experienced maximum wind speed of 130 and 175 mph, which led to overflows of water along the southern coastlines and a heavy runoff from the Nakdong river basins. Over 1.9 million households in the southwestern provinces experienced total blackout for more than a week. Approximately 20,000 hectares of agricultural lands were damaged. Samsung, Hyundai, and Kia factories located in the Southeastern regions were also affected, especially in Ulsan Metropolitan area. With an estimated \$730 million in economic losses, the Korean national government officially designated 45 cities as “special disaster zones”.

Table 1. Characteristics and Impacts of Three Typhoons in South Korea, 2012

	Bolaven	Tembin	Sanva
Category (SSHS*)	Category 4 typhoon	Category 4 typhoon	Category 5 super typhoon
Maximum winds	145 mph	130mph	175 mph
Date of impacts	28 - 30 August 2012	31 August -2 September 2012	16 - 18 September 2012
Fatality	25	2	2
Total damage	USD 374.3 million	USD 8.25 million	USD 347.5 million

\*The Saffir–Simpson Hurricane Scale (SSHS) is the classification of hurricanes from 1 to 5 categories distinguished by the intensities of continual winds. A typhoon with maximum sustained winds of at least 74 mph is classified as Category 1. The highest classification in the scale, Category 5, is earmarked for the typhoon with winds exceeding 156 mph (National Hurricane Center 2012).

\*\* Source: The National Typhoon Center in South Korea (2012)

## Data Collection and Survey Instruments

The data collection involves a two steps process. First, before the typhoons, on 16-28 July 2012, I collected data in the region related to emergency planning. The unit of analysis is at the organization level (e.g., local and provincial agencies, fire and police stations, and non-governmental organizations). A semi-structured interview technique was employed where I interviewed 30 key informants who had direct responsibility for processing and/or providing services on behalf of their organizations in the region. The semi-structured interview guideline was developed around the following research questions:

1. With whom local organizations/agencies coordinate their efforts to provide emergency services in the affected areas?

2. What are the key issues surrounding their coordination planning and the modification they made in order to meet local demand for services during the response?
3. Given the nature of the disaster, what types of resources being deployed and utilized to ensure local community are able to bounce back from the disasters?

The second stage, after the typhoons, I administered another survey<sup>1</sup> on 7-12 January 2013. The objective was to determine whether interorganizational networks changed during the transitional stage of the disaster. However, only a total of 159 organizations were contacted in the region, and 112 organizations agreed to complete the surveys (i.e., 70.4 percent respond rate). The organizations responded to the phone survey included senior public officials from municipal governments, assistant chief of fire and police stations, and non-governmental organizations.

Table 2. Responded and Cited Respondents by Types of Organizations

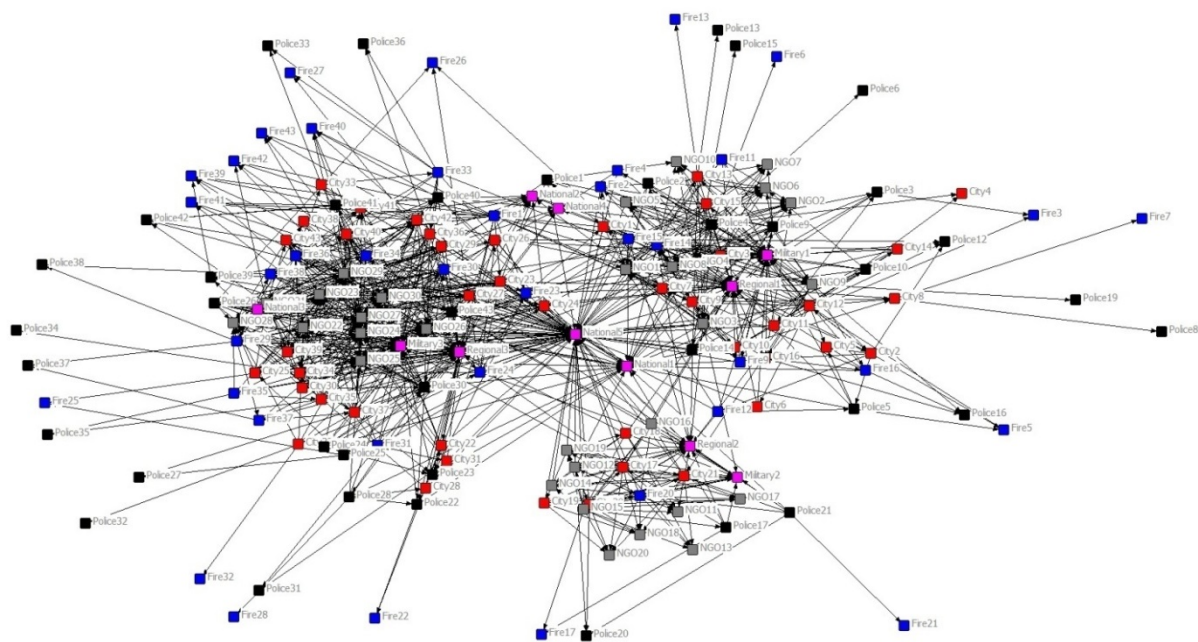
Organizational Type	Before the typhoons		After the typhoons	
	Frequency	Others cited	Frequency	Others cited
National agencies	-	5	-	5
Regional agencies	-	6	-	6
Local governments	43	-	43	-
Fire stations	34	9	24	19
Police stations	28	15	20	23
Nongovernmental organizations	25	5	25	5
Total	130	40	112	58

Table 2 provides the distribution of the responded organizations in both July 2012 and January 2013, indicating that 43 local governments and 25 nongovernmental organizations responded both surveys while only 24 fire and 20 police stations less than the first survey answered the second survey.

<sup>1</sup> Appendix A: Human Subject Application No. 12567 approved by Institutional Review Board in University of North Texas

The interorganizational emergency management (EM) networks consist of 170 (responded organizations and those cited by the organizations). The sociograms are presented in Figures 2 and 3. The figures illustrate interorganizational networks of all organizations interacting in before and after natural disasters, and isolators in both EM networks decreased from 8 (4 fire and 4 police stations) to 5 organizations (4 police stations and 1 nongovernmental organization). There are apparent patterns that national agencies (i.e., NEMA and Ministry of Public Administration and Safety) and metropolitan and provincial governments play a significant role in coordinating emergency management resources. In addition, noteworthy from the networks is that local governments are placed in a central position of local emergency management compared to other types of organizations. On the contrary, fire and police stations are not well represented in both networks. Lastly, non-governmental organizations shown in the networks are evidence for different interaction patterns in accordance with their status such as regionalized and localized branches.

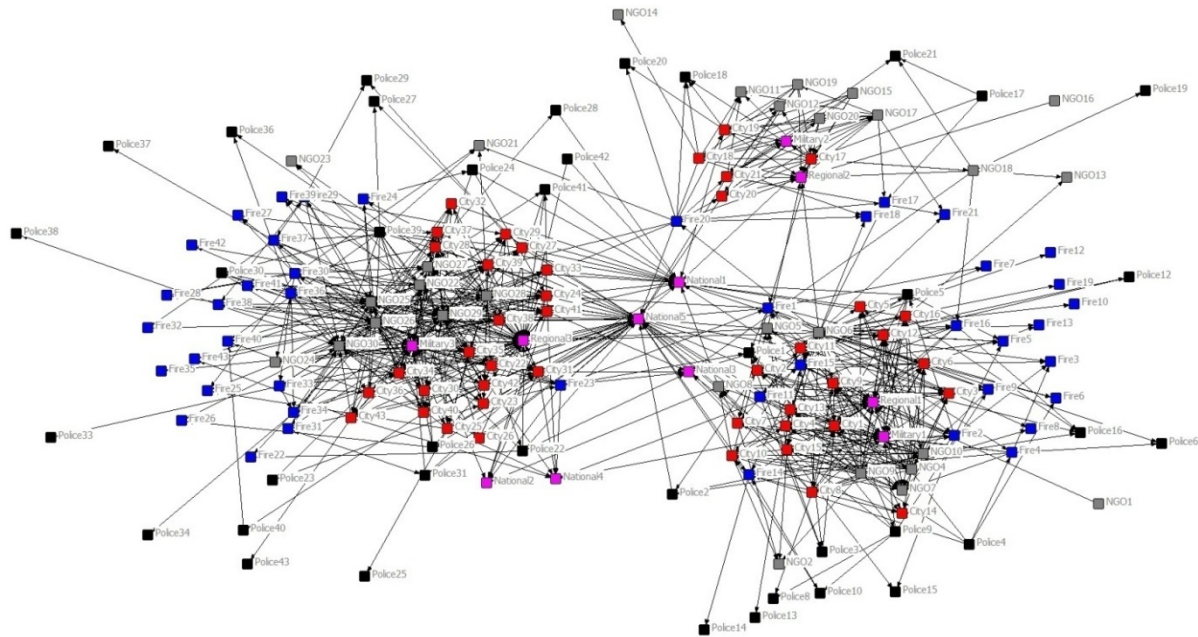
Figure 3. Interorganizational Emergency Management Networks before the typhoons



Note: Red nodes are local governments; blue nodes are fire stations; black nodes are police stations, gray nodes are nongovernmental organizations; and purple nodes are national and provincial agencies.

[Figure 4 is here]

Figure 4. Interorganizational Emergency Management Networks after the typhoons



## Descriptive Statistics

The descriptive analysis in Table 4 presents specific network statistics of two interorganizational EM networks. In the overall networks, mutual dyads increased from 54 to 68 while asymmetric dyads decreased from 1,159 to 832. As a result of that, the network density decreased from 0.039 to 0.028. In columns 2 through 6 of Table 4, I categorize the samples into five groups by a type of organizations. In terms of the relationships among same organizational type (i.e., local government, fire and police stations, and organizations in the nongovernmental sector), the network density of the nongovernmental sector (.054) is only greater than the overall density (.039) in the network before the typhoon while there is no group that is greater than the overall density (.028) in the network after the typhoon. Despite that, the density of the fire station group increased from .012 to .014 through the disaster. Although the density of relationships across sectors decreased from .038 to .029, moreover, its density in the network after the typhoon is greater than any other types of organizations, indicating that approximate 89.7 percent of mutual and 91.9 percent of asymmetric dyads are established by relationships across sectors.

Table 3. Networks Statistics

	Overall Network	Among Governments Gov ↔ Gov	Among Fire Stations FS ↔ FS	Among Police Stations PS ↔ PS	Among Nongovernmental Organizations NGO ↔ NGO	Across Sector
<b>Before the typhoons</b>						
Mutual	54	4	2	2	1	45
Asymmetric	1159	22	19	15	45	1058
Null	16352	879	882	886	389	13316
Density	.039	.014	.012	.009	.054	.038
Average Degree	6.351	.605	.488	.395	1.567	6.937
<b>After the typhoons</b>						
Mutual	68	1	2	1	3	61
Asymmetric	832	24	21	8	14	765
Null	19753	878	880	894	418	16683
Density	.028	.014	.014	.005	.023	.029
Average Degree	4.741	.605	.581	.209	.667	5.194

Table 4 shows tie changes between subsequent observations. The changes of ties indicate that through the catastrophic event, organizations participating in the EM network maintained 1,183 ties while established 487 new ties and terminated 696 previous ties. While Andrew (2009) and Steglich et al. (2006) argue that the changes of ties may not examine dynamics of the network evolution due to limited methods of data collection based on documents and contents, this research proposes that at least the changes of ties show dynamic impacts of the catastrophic event when the data collection procedures based on the peer-to-peer survey covered a full range of organizations in both networks. Again, the changes of ties between networks before and after the typhoon would account for the notion that those organizations may maintain existing ties, establish new ties, or terminate previous

ties by learning the significance of certain interorganizational collaboration from natural disaster.

Table 4. Tie Changes between Subsequent EM Networks

	No Tie	New Tie	Broken Tie	Maintained Tie
	0 → 0	0 → 1	1 → 0	1 → 1
$t_1 - t_2$	27,228	487	696	1,183

### Model Specification

The dynamic of interorganizational ties is estimated by including the endogenous and exogenous effects in a model that is performed using the Stochastic Actor-based Models for network evolution (*see* Snijders, 2005; Snijders *et al.*, 2010). The endogenous effects include a set of network effects as specified in SIENA (i.e., reciprocity, distance-2, betweenness, transitive triplets, and 3-cycles effects). The exogenous factors include social and environmental vulnerability indicators, and a dyadic covariate indicating joint full-sized exercises that encompass professional training and comprehensive education.

In Stochastic Actor-based Models, the model specification estimates the rate parameter, network effects, and organizational attributes simultaneously (Snijders *et al.*, 2010). In order to capture the probability that organizations decide to change their ties, the rate parameter estimates the change before and after the 2012 Korean typhoons. The parameter estimates the average number of changes in bridging and bonding strategies, which are the endogenous factors in my model. The first endogenous effect is the reciprocity effect (*see* Figure 5), which captures the propensity of organizations to establish a mutual tie with those who had a one-way relationship with them during the period under a catastrophic event. A positive value for the reciprocity parameter indicates that organizations have a strong tendency to forge reciprocal relations, while a negative value suggests these organizations tend not to do so. It is formally defined by:

$$\text{Reciprocity, } s_{il}^{net}(x) = \sum_j x_{ij} x_{ji}$$

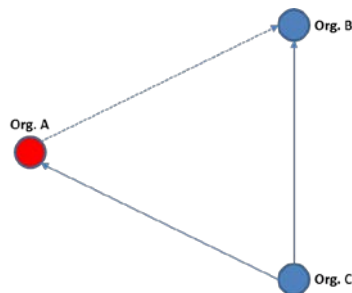
Figure 5. Reciprocity



The interdependent risk hypothesis is tested by identifying the transitive triplets and 3-cycles effects (*see* Figures 6 and 7). These effects explore the behaviors of organizations that prefer to share risks by building a close-knit network structure. A positive parameter value for the transitive triplet and 3-cycle effect indicate that in order to establish a highly clustered network at time  $t_2$ , an organization forges direct ties with another organization that was indirectly connected at time  $t_1$ . A negative value associated with these effects suggests the interdependent risk effect is not probable. The transitive triplets and 3-cycles effect are defined respectively as:

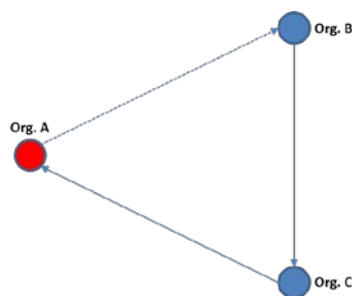
$$\text{Transitive triplets, } s_{i4}^{net}(x) = \sum x_{ij}x_{ih}x_{jh}$$

Figure 6. Transitive Triplets



$$\text{3-cycles, } s_{i5}^{net}(x) = \sum_{j,k} x_{ij}x_{jh}x_{hi}$$

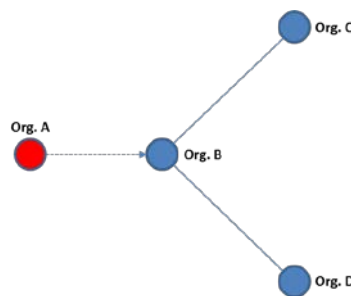
Figure 7. 3-Cycles



The number of actors at distance-2 and betweenness effects uncovers the independent risk hypothesis of how an organization spreads risks by seeking a bridging organization or playing an entrepreneurial role in bridging between two other organizations after a disaster. A positive value suggests organizations without the bridging organization or role at time  $t_1$  tend to at least forge a tie with it or two other organizations at time  $t_2$ . A negative value suggests organizations have a tendency to not utilize the independent risk strategy due to the higher collaboration risk and uncertainty after a catastrophic event (Jung, 2013). The numbers of actors at distance-2 and betweenness effects (see Figures 8 and 9) are defined respectively by:

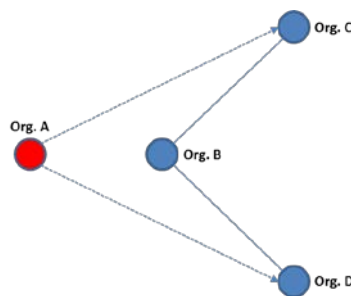
The number of actors at distance-2,  $s_{i2}^{net}(x) = \#\{j | x_{ij} = 0, \max_h (x_{ih} x_{hj}) > 0\}$

Figure 8. Number of Actors at Distance-2



Betweenness,  $s_{i3}^{net}(x) = \sum_{j,k} x_{hi} x_{ij} (1 - x_{hj})$

Figure 9 Betweenness Effect



This research also tests for the homophily effect, which examines whether or not an organization is likely to establish ties with similar organizations. For the homophily effect, a positive parameter implies that actors prefer ties to others with similar preferences, while a negative parameter suggests the actors' preferences for similar actors are less likely to drive



actors to establish ties with them. The organization of interest is the local governments (i.e., whether local governments are likely to establish interorganizational ties among themselves before and after a disaster). The indicator function is coded 1, if an organization is local government, otherwise 0.

Following Snijders *et al.* (2010), the exogenous effects such as social and environmental vulnerability and the joint full-sized exercise are included in the rate function effect. It captures “the average frequency at which an actor gets the opportunity to change their outgoing ties” (Snijders *et al.*, 2010, 53). For instance, organizations with environmental vulnerability may change their network ties more frequently than others that are not located in the coastal line. Depending on such actors’ attributes, the stochastic actor-based model allows us to test whether the exogenous factors have an effect on the rate function (*see* Snijders, 1996; Snijders *et al.*, 2008). A positive parameter value for the exogenous effects suggests that organizations with one of the attributes tend to change their network ties.

The forward model selection strategy is employed as proposed by Snijders *et al.* (2010). The approach first considers only endogenous effects followed by the inclusion of the exogenous effects. The model convergence is also performed to determine the model fit. This is performed in the following ways: Based on a continuous-time Markov chain Monte Carlo (MCMC) simulation--where the algorithm computes the maximum likelihood estimates SIENA employs a three-phase stochastic approximation algorithm to estimate the pattern of relationships (Snijders *et al.*, 2010). Through these methods, the SIENA conducts a test of convergence of each variable. If the convergence diagnostic statistics for the algorithm is less than 0.2 in absolute value, the parameter estimate is considered to have good convergence and excellent when they are less than 0.1 (Snijders *et al.*, 2010). The convergence diagnostic, covariance, and derivative matrices were based on 1,000 iterations, and the t-value provides a significance test of the estimated parameters.

## Results and Discussion

The parameter for reciprocity is positive and statistically significant in the two models. The parameter indicates that organizations tend to establish mutual relationships after a disaster. Two organizations establish a mutual relationship, even though collaboration creates complexity and uncertainty. This implies that when organizations change their ties, they collaborate reciprocally rather than asymmetrically. These norm/information-sharing relationships in dense networks are more likely to be firm (e.g. Granovetter, 1985; Coleman, 1990). Further, as Burt (2005) argues, the level of trust can be more critical where brokerage is more valuable.

The parameters for the interdependent risk hypothesis, i.e., the effect of transitive triplets and 3-cycles are positive and statistically significant. It indicates that organizations tend to have not only reciprocity in an exchange but they also interpret the hierarchy of the network differently (Snijders et al., 2010). For example, through the 2012 Korean typhoons, local interorganizational networks that organize themselves within the administrative boundary of each city may have switched from hierarchical to non-hierarchical emergency management structures. Because disasters require a comprehensive response from different organizations, research has focused on networks that collaborate functionally and interact at the same level organizationally, even though national organizations, such as NEMA and MPAS, help coordinate local efforts. During a disaster, the government may not be able to do everything, but diverse organizations can collaborate to help local governments responding effectively.

The parameters for the independent risk hypothesis i.e., the number of actors at distance two and the betweenness are negative and statistically significant. They indicate that organizations are not inclined to spread the risk during a disaster. From the perspective of the ICA framework (Feiock, 2013), the results show that collaboration risks generated by the 2012 Korean typhoons may have encouraged organizations to directly collaborate with other organizations that had critical resources and information rather than rely on national and regional agencies. The findings imply that spreading risk through other organizations may not function effectively during a disaster response (Comfort and Haase, 2007). In addition, the homophily effect of local government is positive and significant ( $E = 0.548$ ;  $p < .01$ ), indicating the propensity that interorganizational ties are more likely to be established among local governments. The finding is consistent with the argument of Andrew (2009), indicating that in order to reduce the administrative costs, local governments tend to establish ties with other local governments under regional EM coordination enforced by metropolitan and provincial governments.

The exogenous effects on rate function are included in model 2. The model 2 tests the probability that organizations under certain social and environmental conditions such as social and environmental and the joint full-sized exercise are more likely to collaborate with other organizations after a disaster. The results report that organizations that are located on the coastline ( $E = .461$ ;  $p < .01$ ) and have had the joint full-sized exercise ( $E = .293$ ;  $p < .01$ ) are more likely to create interorganizational ties after the typhoons. Both results may support the notion that organizations collaborating with other organizations are influenced by environmental vulnerability (Villa & McLeod, 2002). It also implies that by enhancing joint exercise activities for hazard mitigation before a disaster, organizations actively secure critical resources and information under an unexpected condition (Randolph, 2012). The final results are presented in Table 5.

Table 5. Parameter Estimates and Standard Errors

		Model 1		Model 2	
		Estimates	Std. Err.	Estimates	Std. Err.
Rate Parameter (rho) $t_{1-2}$		13.907***	.358	13.059***	.317
Endogenous Effects	Reciprocity	2.048***	.231	2.051***	.274
	Transitive Triplets	.239***	.05	.285***	.058
	3-Cycles	.945***	.256	1.354***	.302
	The Number of Actors at distance 2	-1.112***	.287	-1.354***	.302
	Betweenness	-.164***	.042	-.148***	.023
Homophily Effects	Local Government	.544***	.075	.548***	.082
Exogenous Effects on Rate Function	Social Vulnerability	-	-	-.048	.070
	Environmental Vulnerability	-	-	.461***	.078
	Joint Full-Scale Exercise	-	-	.293***	.082

Note: All coefficients are resulted from the SIENA (3.12) with directed network matrixes; All statistics converged with a t-statistic <0.1 with a minimum of 1,000 iterations; \*\*\* $p < .01$ ; \*\* $p < .05$ ; \* $p < .1$

[Table 5 is here]

## Conclusion

Interorganizational collaboration for building resilient community comes in many forms, and thus it is critical to understand the change of its formation before and after a catastrophic event. Given uncertainty and complexity of building organizational resilience (National Research Council 2010), the dilemmas of local organizations are: (1) the decision whether to

forge a tie as interorganizational collaboration or not and (2) the choice with whom to create collaborative ties. Through much trial and error in the dilemmas, interorganizational EM networks have evolved over the years (Feiock and Scholz, 2010; Kapucu et al., 2012). The network evolution in terms of natural disasters is predicted on the success of previous collaboration, the significance of current partners, and the expectation of subsequent collaboration that ultimately enhance organizational resilience. By perceiving, experiencing, and learning the significance of collaborative ties through the disaster, consequently, organizations optimize the costs to establish new ties, terminate previous ties, and maintain existing ties as procedures of the network evolution.

The findings in this chapter provide two implications to understand the dynamics of interorganizational EM networks. First, interorganizational collaboration for enhancing organizational resilience proposes the importance of mutual aids rather than unilateral. Since interdependency offers the potential benefits to reduce conflicts among local organizations as well as across the sector (Feiock and Scholz, 2010), self-organizing EM networks are more likely to consist of reciprocal collaboration that enhance organizational resilience. In terms of the importance of bilateral aids, particularly, the interview results highlight that the three typhoons hold up a true mirror to the existing limit of the unilateral aids provided by other organizations. According to the principal administrator in the City of Changnyeong, Kwon Heeduck, the requests for emergency aids relying on the unilateral agreement was easily overlooked during the disaster. The director of regional fire administration headquarter in the South Kyeongsang province, Jung Dongcheol, also pointed out that successive catastrophic events such as continuative three typhoons shelved almost of the unilateral requests and aids until at least passing the typhoons while a committed bilateral aids between organizations intensified the resource mobilization during the disaster in order to support those who are located on the affected area.

Second, the interdependent risk hypothesis highlighting direct collaborative ties with other organizations generate structural benefits derived from close-knit EM networks. Formulating a clustered structure in efforts to enhance organizational resilience not only provides associational benefits such as reputation, knowledge, and institutional norms. Also, a highly dense network structure provides practical advantages such as sharing technical resources and coordinating joint activities based on consensus reflecting organizational preferences (Randolph, 2012). For example, local governments and agencies located on the riverbank (i.e., Nakdong River across the Southeastern Economic Region) established the committee for hazard mitigation planning and implementation in 2011 and have developed the resource mobilization framework that activates during the disaster. Given the institutional committee, local organizations can enhance organizational resilience through formal and informal communication and availability of shared resources (Andrew,

2009; Kapucu et al., 2012). The principal manager of Fire Station in the City of Changwon, Park Changho, emphasized the importance of a close-knit EM network in the local level, arguing that direct collaborative ties forging a dense network structure allow local organizations to secure their own communication channel to increase organizational resilience. Those findings imply that separate communication channels of organizations such as local governments, police, and fire stations have impeded effective information and resource mobilization in emergency responsiveness as well as recovery procedures.

While scholars in the field of emergency management have speculated for years on the importance of networks, they have fallen short in predicting the change of structures that are likely to emerge after natural disaster (Waugh and Streib, 2006; Kapucu, 2006; Kapucu et al., 2010; 2012; Andrew and Kendra, 2011). This research aims to test two hypotheses i.e., interdependent and independent risk, and draw implications about the formation of interorganizational EM collaboration that can enhance a particular configuration of ties, and thus, organizational resilience. The findings in this chapter are considerably consistent with the argument provided by the assistant director of National Urban Disaster Management Research Center, Dr. Lee Byoungjae. In the interview, he strongly underlined that because current interorganizational collaboration tends to heavily rely on emergency planning and paper-based system, a sparse network based on one-way relationships are more likely to fail to secure resources and critical information that local organizations need during a catastrophic disaster. Given the nature of natural disaster and organizational resilience, this report provides strong evidence that local organizations related to emergency management transform from the unilateral into bilateral relationships as well as from indirect into direct collaboration with other organizations through natural disaster.

Despite these significant findings, this research has two limitations. First, an entire network relies on egocentric measures. As Scott (2000) points out, unreported ties may influence the different network measures. Second, this study only examined a case in the Seoul metropolitan area, South Korea. It may not be generalized to other regions and states. Future research could examine other metropolitan areas and identify key actors at the local, regional, and national level. Also, in-depth interviews with local officials could prove the validity of future research.

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