# Brokerage roles in disaster response: organisational mediation in the wake of Hurricane Katrina


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**Abstract:** When one organisation serves as an intermediary for two other organisations which are not in direct contact, that organisation is said to engage in brokerage behaviour. Using the case of the Hurricane Katrina disaster, this study demonstrates the use of formal brokerage measures to study communication among the responding organisations. We apply the brokerage role typology put forth by Gould and Fernandez (1989) to communication

networks among the responding organisations in two communities: Saint Bernard Parish, Louisiana and Bay Saint Louis, Mississippi. We find that relatively few organisations perform most of the brokerage; primarily, these brokering organisations were locally based. The implications for predisaster planning are discussed.

**Keywords:** social network analysis; brokerage; bridging; Hurricane Katrina; disaster response; emergent multiorganisational networks; organisational response; resource allocation; communication; centrality.

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## 1 Introduction

The impact of Hurricane Katrina in late August 2005 scourged both the physical and social landscape of the Gulf coast region. The storm claimed between 1319 (Bourque *et al*., 2006, p.139) and 1833 (Knabb *et al*., 2005, p.11) lives, displaced more than 270 000 evacuees who sought refuge in various shelters (Gabe *et al*., 2005, p.19), and left roughly 2500 victims reported missing (Bourque *et al*., 2006, p.139). Wind damage

and flooding forced the closure of most businesses and blocked many of the region's roads; many people slept without electricity, water, or shelter for days following the initial landfall. In terms of financial loss, studies estimate the storm cost a total of $81 billion (Knabb *et al*., 2005, p.12), with a $500 million daily loss due to business closures in the area (Banipal, 2006, p.485) and a 0.5%–1.0% slowdown in economic growth in the second half of 2005 (Cashell and Labonte, 2005). In terms of telecommunications, Bay Saint Louis, Mississippi went without land line telephone service for at least a month, and did not have access to wireless communications for at least five days (Banipal, 2006, p.488). In addition to impacting the general public, this situation reduced responding organisations' ability to communicate with each other – ultimately imposing difficulties for relief efforts (Independent Panel Reviewing the Impact of Hurricane Katrina on Communications Networks, 2006). This lack of communication infrastructure prevented many disaster responders from coordinating with each other and introduced barriers between the Katrina recovery efforts in neighbouring communities.

This task of community response following a disaster of Hurricane Katrina's scale requires coordination among a diverse array of organisational and public actors, a feat which often proves difficult to accomplish in of itself (Comfort and Kapucu, 2006; Stephenson, 2005). Despite a common interest in providing relief, many individual and organisational actors are frequently unable to communicate directly with other actors – a common problem during disasters identified by Kapucu (2006). In such cases, contact among actors may be dependent upon the ability of third parties to *broker* or mediate communications between them (Marsden, 1982). Brokerage is thus central in facilitating coordination within settings featuring substantial disruption to physical and social communication infrastructure, such as the Katrina response. While it is perhaps unsurprising that participation in brokerage activity varies across actors, it is also important to note the presence of variation within brokerage activities themselves. Indeed, the same organisational diversity which makes brokerage so critical for coordination also creates the opportunity for diversity in the nature of the brokerage which results. As Gould and Fernandez (1989) discuss, distinct *brokerage roles* frequently arise, in which actors from particular groups mediate contacts among specified sets of alters. Using network analytic methods, it is possible to directly quantify the incidence of specific brokerage roles within emergent interorganisational networks such as those formed by response organisations during disasters. Here, we illustrate the utility of these methods for disaster research by examining brokerage roles among response organisations within two Gulf coast communities in the immediate aftermath of Hurricane Katrina. Our substantive focus will be on the question of which organisations do (and do not) wind up in particular roles, and of whether this is suggestive of a broader pattern which may be replicated in other communities. In addition to understanding the historically significant context of Hurricane Katrina response itself, we argue that an understanding of organisational brokerage in disaster settings has important implications for effective response.

To assess organisational brokerage in the Hurricane Katrina response, we examine the emergent communication networks formed by emergency response organisations in Bay Saint Louis of Hancock County, Mississippi and Saint Bernard Parish, Louisiana using structured interviews with organisational informants (Tirado, 2006). These networks are examples of *emergent multiorganisational networks*, or 'EMONs', which result

from coordination efforts in the aftermath of disasters and crisis situations (see Drabek *et al*., 1981; Topper and Carley, 1999). While EMONs emerge in many settings which require novel organisational responses (Dynes, 1970; 2003; Drabek and McEntire, 2002) or which pose problems of task interdependence (Thompson, 1967; Perrow, 1970), they assume particular importance in contexts where coordination demands are high and conventional communication infrastructure has been heavily degraded. In the case of Katrina, the disaster resulted in severe property damage as well as the dissolution of conventional communication channels for both Gulf Coast communities. Given the dire need for an effective network of contacts among responding organisations under circumstances that inhibit regular communication, EMONs played a particularly important role in the early phases of the Katrina response process. Our study focuses on this critical period, analysing reported organisational interaction within each community during the first 30 days following landfall of Hurricane Katrina in Louisiana. Comparing these two communities following the same disaster offers several advantages. First, we control for the effect of the *type of disaster*, and how it may influence organised response. This heeds the suggestion of Kreps (1983, p.457), who implies that the type of disaster may affect patterns of response, whereby responders develop different organisational forms depending upon the disaster. Second, despite being struck by the same hurricane, Bay Saint Louis and Saint Bernard Parish had quite different experiences in terms of realised damages. Following Quarantelli (1997) and Comfort *et al.* (2004), who claim that the type of disaster matters less than its severity, we explore the possibility of whether the experienced severity of Katrina lead to differences in response between the two communities.

To account for emergent brokerage activity, we identify the number of times that responding organisational actors ('egos') fulfil each of the brokerage roles defined by Gould and Fernandez (1989) by mediating between two other organisational actors ('alters') of a given type.[1] Following these calculations, we seek to explain why certain response organisations broker more relationships than others. This methodology provides a new way to understand communication patterns following a disaster, especially one which interrupts conventional forms of communication that consequently interferes with interorganisational coordination. Additionally, we consider the question of whether organisations included within their communities' respective Emergency Operations Plans (EOPs) broker more relationships than those excluded from such plans. We pose this query because typically the organisations included within the EOP will have a greater institutional advantage in obtaining resources during a disaster than those outside of the EOP's scope. Such inequality may be justified by policy makers via the argument that organisations within the EOP will respond more effectively than others. If this assumption is correct, we expect to see that organisations within the scope of the EOP broker significantly more often than other organisations. The presence or absence of such a difference has considerable practical import for assessing plan effectiveness, as well as significance for the ongoing theoretical debate regarding the relative importance of planned versus emergent behaviour in disasters (Comfort, 2005; Dynes, 1970).

## 2 Literature review

### *2.1 A word on social networks*

'Brokerage' is a fundamentally structural concept, and as such it must be studied using the methods of structural analysis. In particular, we study brokerage roles as realised within the context of emergent social networks. By 'social network' we mean a "set of actors and the ties among them" (Wasserman and Faust, 1994, p.9). 'Actors', in this sense, could potentially include people, firms, animals, inanimate objects, locations, *etc.*; in the case of the Hurricane Katrina EMONs, however, our focus will be limited to organisational actors. Likewise, the concept of 'ties', or relations, can include advice, friendship, transfers or exchanges, rivalry, dominance, and so forth. Conceptually, ties can be either directed (as is the case where one gives advice to another) or undirected (such as mutual communication with another). In some cases, ties may have a quantitative value attached to them, such as communication frequency or volume of trade. In other cases, relationships or ties maybe treated as either present or absent (*i.e.*, dichotomous); for example, two districts either have some mutual aid agreement, or they do not. For this study, we use reported communication as our tie between organisations. Such communication ties are allowed to be directed (reflecting a one-way relationship), but will be treated as dichotomous (present or absent) due to the difficulty of obtaining precise quantitative information on communication events from human informants (Bernard *et al.*, 1984). As we will see, this information is nevertheless adequate to reveal much about the structure of communication during the Katrina response.

To summarise, then, our study centres on two emergent multiorganisational communication networks. Each network consists of a set of organisational actors, along with the communication ties among them. A tie extends from organisation $i$ to organisation $j$ if $i$ sent information to $j$ during the Katrina response; in this case, $i$ is said to be *adjacent* to $j$ in the communication network. The relationship between two organisations is said to be *mutual* if communication was bidirectional (*i.e.*, $i$ sends a tie to $j$ and $j$ sends a tie to $i$), or *asymmetric* if communication was unilateral (*i.e.*, $i$ sends a tie to $j$, but $j$ does not send a tie to $i$). By analysing the pattern of ties among the entire set of organisations, we can determine which organisations played particular roles in the emergent communication structure. It is to this problem that we now turn.

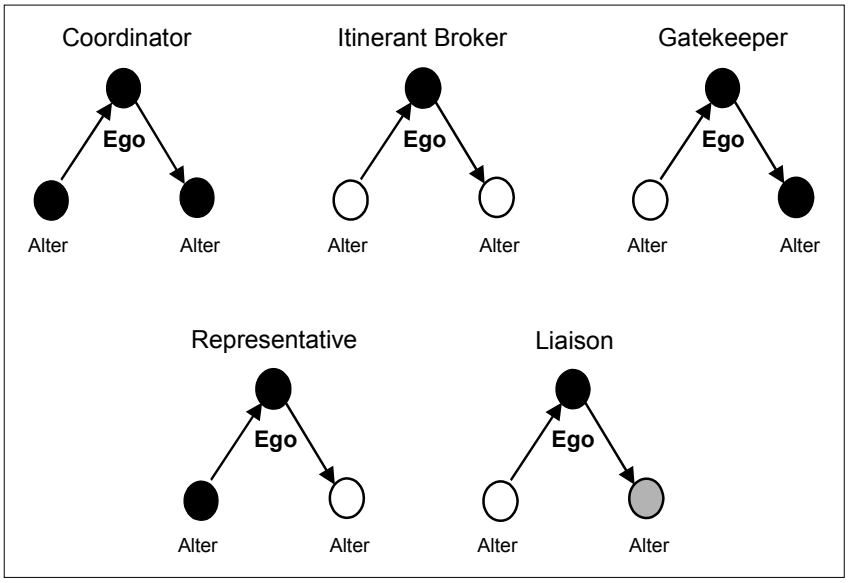
### *2.2 Brokerage*

Intuitively, 'brokerage' is a condition in which one party acts as an intermediary between two others. Cross *et al*. (2001) liken this condition to the phenomenon of bridging within a social network (see Granovetter, 1973; Freeman, 1979; Burt, 1992). All brokerage relationships therefore require three actors, two of whom cannot be directly tied to each other and a third who bridges a connection to the other two. This third actor, the *broker*, mediates exchange between those who cannot or do not directly exchange with each other. The substantive content of this exchange may represent a transfer of some form, such as money, trust, or (as is the case for this study) information. Brokers thus have special status as "intermediary actors [who] facilitate transactions between other parties lacking access to or trust in one another" (Marsden, 1982, p.202). By using methods to identify brokers, disaster researchers and practitioners can potentially understand why certain actors or organisations emerge as critical responders following a disaster.

But, while the incidence of brokerage itself is significant, it is of particular importance where network members belong to distinct subgroups. In this case, the implications of one's status as a broker may depend upon the groups to which one and one's partners belong.[2]

By *subgroups* (or *affiliations*), we refer here to any set of exogenously defined classes, such that each actor belongs to exactly one class. (For instance, a community EOP implicitly divides organisations into two classes: those who are explicitly included, and those which are not.) Depending upon the affiliations of the broker and her/his alters, a number of qualitatively distinct types of *brokerage roles* may emerge. Gould and Fernandez (1989) outline five distinct types of brokers emerging from such affiliations: coordinators; itinerant brokers; gatekeepers; representatives; and liaisons.[3] These five brokerage roles are illustrated schematically in Figure 1; we also briefly summarise each role below.

**Figure 1** Illustration of each brokerage type




Notes: Each point represents an actor in a social network and the lines between them signify their ties. The middle points, labelled 'Ego', are the brokers. Differences in shading designate distinct subgroups or affiliations.

In the simplest brokerage scenario, all three actors belong to the same subgroup. In such instances, the *coordinator* broker serves as a go-between for two actors sharing the same affiliation. This type of broker is a peer to those who do not communicate directly. To illustrate the concept of coordinator brokerage, one might imagine a scenario of three siblings, two of which do not speak due to a past feud, but indirectly communicate with the third who sympathises with both. One feuding sibling may convey regret over the dispute to the sympathetic brother or sister, who in turn delivers that message to the third. Similarly, in the context of disaster response, consider an instance in which two federal agencies have overlapping jurisdictions, but no direct lines of communication through which to resolve potential conflicts. A third federal agency with ties to both (*e.g.*, a parent agency) may then step in to broker contacts among the other two.

In the slightly more complex case of *itinerant brokerage*, the brokered actors belong to the same group and the broker belongs to another. Theoretically, the broker is an outsider relative to the others. Returning to our two federal agencies, an alternative to mediation by a federal entity would be for a state or local agency to broker communications between them. Such a scenario might be especially likely if the overlap in the federal agencies' jurisdictions directly involved the state or local entity in question; while this common ground could facilitate contact, the fact that the broker is drawn from a different level of government distinguishes it from the case of coordinative brokerage.

The third and fourth brokerage roles are referred to as *gatekeepers* and *representatives*. Gatekeepers are brokers who do not belong to the subgroup of the sending actor, but instead belong to the subgroup of the actor receiving the exchange; they are thus in a position to manage (and possibly block) incoming resources or communications. Corra and Willer (2002, p.180) introduce the notion of gatekeeping by discussing how "in the past, access to the king was controlled by the chamberlain who was originally the servant caring for the king's personal rooms. By gatekeeping for the king, those serving as chamberlain had opportunities to become wealthy from client 'fees'."[4] These clients would attempt to influence a monarch's political stance through the chamberlain, but unlike the king and the chamberlain, however, the chamberlain's clients were clearly outsiders to the royal court. Representatives, on the other hand, are brokers who share an affiliation with the sending actor and do not share an affiliation with the receiving actor. This gives representatives particular influence over information or other resources exiting their group. Friedman and Podolny (1992) analyse the flow of trust in the context of a faculty labour dispute at 'Midwestern University'. All of the actors in this situation were faculty labour negotiators who were sided either with the union's bargaining team or the administration's bargaining team. A representative (in the Gould and Fernandez (1989) sense) on the union's side receives trust from another union negotiator *and* this same representative would also, in turn, indicate that he or she trusts a negotiator on the administration's behalf.

Following the above, the gatekeeper *receives* a transaction on the behalf of his/her subgroup, whereas the representative *sends* a transaction on behalf of his/her subgroup. As a consequence of this property, when the transaction flows both to and from the mediator for the same pair of non-adjacent alters, these roles are indistinguishable. They are still distinct from the other brokerage roles, however, in that both involve a configuration in which the broker bridges one ingroup member and one outgroup member. In the analyses conducted here, we will merge gatekeeper and representative roles when dealing with the community of Saint Bernard Parish – as all relations in this community are symmetric or 'two-way' – while keeping these roles distinct for Bay Saint Louis.

The fifth form of brokerage is that of *liaison*. In this case, each of the three parties belongs to different subgroups. This brokerage role conveys the idea of two unaffiliated parties who are bridged by a third from a different background.[5] In their study of technological innovation, Hargadon and Sutton (1997) attribute the success of their case firm to its ability to 'cross-pollinate' diverse ideas and backgrounds through brokering. When developing a new product, they found the firm most productive when grouping engineers from radically different pasts and interests. Such results have suggested the

possibility that liaison brokerage may play a particularly important role in contexts involving creativity and improvisation, two factors of particular interest in disaster response (Dynes, 1970; Mendonça and Wallace, 2004).

Lastly, Gould and Fernandez (1989) consider the cumulative effect of brokerage as *total brokerage*. Unlike the five distinct forms mentioned earlier, total brokerage does not make use of subgroup affiliation. It simply consists of the total number of cases in which a given actor serves as intermediary to two other actors (from any subgroup) who cannot directly interact.[6] As such, the total brokerage of a given actor is equal to the sum of the number of times that actor occupies each of the five specific brokerage roles (*i.e.*, the cumulation of all coordinator, itinerant brokerage, representative, gatekeeper, and liaison roles). In some cases, it may be total brokerage (rather than brokerage of a specific type) which is of particular interest. For example, Padgett and Ansell (1993) credit the rise of the Medici family of Florence in the early 15th century to their ability to form business and marriage ties with families who were otherwise unrelated.[7] Similarly, Morselli (2001) argues that a renowned cannabis smuggler of the 1970s and 1980s made a successful career by way of his ability to work with other smugglers who remained oblivious to the others working the same venture.

## 3 Bay Saint Louis, Mississippi and Saint Bernard Parish, Louisiana

As described above, our study focuses upon the application of formal brokerage analysis to communication in the aftermath of Hurricane Katrina within the communities of Bay Saint Louis, Mississippi and Saint Bernard Parish, Louisiana. The two cases provide an interesting comparison and contrast in light of the particular circumstances of the disaster. Both communities are similar in having suffered immense damage from Katrina, lost conventional forms of modern communication infrastructure including telephones and cable television (Independent Panel Reviewing the Impact of Hurricane Katrina on Communications Networks, 2006), and having had populations smaller than 70 000. In contrast, Bay Saint Louis is more of a rural location characterised by racial and socioeconomic heterogeneity, while Saint Bernard Parish lies closer to the urban hub of New Orleans and has a substantial population hailing from the Canary Islands. The two communities also differ in terms of the damage caused by the hurricane. Because the eye of Katrina crossed Hancock County, wind damage and structural damage were more serious concerns in Bay Saint Louis than Saint Bernard Parish (Gabe *et al*., 2005). And although flooding occurred in both locations, its effects were more severe in Saint Bernard Parish due to levee failure, where approximately 97% of residents experienced its effects (Gabe *et al*., 2005). Whereas the flooding drained in a relatively rapid manner at Bay Saint Louis, the water remained stagnant in Saint Bernard Parish. As a result, communication failure persisted longer in Saint Bernard Parish than Bay Saint Louis. We would expect, therefore, a greater need for brokers in Saint Bernard Parish resulting from more severe communication constraints.

## 4 Data

The data used for this study was collected through face-to-face interviews following the first 30 days of the disaster, with informants from public and private organisations involved in the Hurricane Katrina response (Tirado, 2006). The research team, lead

by Tirado, used a modified snowball sampling design to arrive at the list of responding organisations. At each site, the sampling procedure began with the Emergency Operations Centers (EOC) and other organisations cited within the Emergency Operations Plan.[8] These organisations cited other organisations with whom they communicated (bilaterally or otherwise). Any organisation mentioned by two or more other organisations was subsequently surveyed, and its communication ties elicited. This process was continued until there were no remaining organisations cited as communicating with two or more organisations in the sample.[9]

Snowball sampling is an example of a broader family of designs (called *link-trace designs*) which are usable in cases like the Katrina response where the sampling frame is unknown (see, *e.g.*, Marsden, 2005). Because there does not exist a complete roster of responding organisations in these two communities, Tirado (2006) was unable to use sampling methods requiring a known sampling frame (*e.g.*, a complete network census). In the absence of a well-validated roster, link-trace methods such as that employed by Tirado avoid the pitfall of limiting attention to well-known organisations (*e.g.*, large government agencies) to the exclusion of organisations whose roles are less likely to be known in advance (*e.g.*, smaller, non-governmental organisations not contained in the EOP). The presence of the latter type of organisations in our sample, along with traditional response organisations suggests that such bias might indeed have resulted from relying exclusively on a predetermined frame, had this been done; tracing ties from initially identified organisations to others active in the response allows us to speak to the role played by organisations whose participation was not anticipated by the existing planning process.

Given the above sampling scheme, face-to-face interviews were conducted with informants from sampled organisations which were involved in the first thirty days of the response operations. This interview-based data presents us with a unique view into the immediate on-the-ground workings of response activities within these two communities, and offers a relatively rare opportunity to study EMONs without depending upon archival sources (though see Drabek *et al*., 1981).

Network data for this study was specifically obtained via a structured survey item which elicited interorganisational communication ties. In particular, informants were asked, "During the month following Hurricane Katrina, who (individuals, organisations, agencies, institutions) did you communicate with to share information in regards to the allocation of resources?"[10] The one month time window includes the entire initial response period, as well as the extensive stabilisation efforts which were required before recovery could commence. This window also served as a salient unit for purposes of recall. Interviews were conducted immediately following the recall window to minimise errors due to forgetting; it should be noted, moreover, that the data should be seen as representing overall patterns of communication during the period, as opposed to specific events. General patterns over an extended period are more accurately recalled than particular events (Bernard *et al*., 1984; Freeman *et al*., 1987; Sudman *et al*., 1996), and the data are hence expected to contain less error than would be observed by eliciting interaction over a narrow interval. After all other organisations with which his or her organisation communicated were elicited, each informant was then asked to indicate if any of those relationships were 'one-way', as well as the direction of the communication in this case. Communication relationships not identified as unidirectional were treated as bidirectional. The resulting lists of one-way and two-way communication from this were

aggregated to generate a directed communication network. In combining data across informants, it is important to note that reports regarding each relationship are elicited from both of the organisations involved: both *i* and *j* have the opportunity to indicate communication from *i* to *j*, from *j* to *i*, or both. Here, we estimate the underlying communication structure using the union-rule locally aggregated structure of Krackhardt (1987), in which a tie from *i* to *j* is assumed to exist if such a tie is mentioned by either *i* or *j*. We choose this estimator due to its superior performance on data for which errors of omission exceed overreporting errors, a phenomenon generally observed for informant reports of this kind (Bernard *et al*., 1984; Butts, 2003; Freeman *et al*., 1987; Sudman *et al*., 1996). It should be emphasised that this process preserves directional structure in the tie reports: if *i* and/or *j* indicate an asymmetric tie from *i* to *j*, and neither claims that this communication is reciprocal, then we estimate the relationship to in fact be one-way. For an in-depth treatment of issues relating to substantive asymmetry and asymmetric reports see Carley and Krackhardt (1996).

The investigators (Tirado, 2006) also coded the type of operations for each organisation, identifying local, state, federal, and non-governmental organisations, as well as whether they were included in their community's EOP. The high level of detail on interorganisational communication provided by these interviews, coupled with descriptive information regarding the organisations themselves, allows us to apply formal brokerage analysis (Gould and Fernandez, 1989) to the EMON in each community. For this paper, we employ organisation type (local government, state government, federal and non-governmental) as the salient subgroup status for purposes of defining brokerage roles.

## 5 Analysis

### *5.1 Descriptives*

Tables 1 and 2 provide a general description of the organisations in this study. Twenty-two actors were included in the Bay Saint Louis sample and 13 in Saint Bernard Parish. The two cases include a diverse array of responders, such as the Federal Emergency Management Agency (FEMA), the Bay Saint Louis Mayor's Office, and a Scientology church. For Bay Saint Louis, eight (~37%) were included in the EOP, while ten (~77%) were part of the EOP in Saint Bernard Parish. In terms of the type of organisations included in the Bay Saint Louis Study, the sample incorporates 11 local government organisations, three state government agencies, and two federal agencies, as well as six non-governmental organisations. Like Bay Saint Louis, most of the organisations in Saint Bernard Parish were local (nine), although state agencies are absent in the Saint Bernard Parish. In both cases, we see that all responding state and federal agencies were included in the EOP, whereas the non-governmental organisations were excluded from the EOP.

**Table 1** Bay Saint Louis, MS organisation descriptions

| *EOP standing* | *Federal* | *State* | *Local* | *NGO* | *Total* |
|---|---|---|---|---|---|
| Not in EOP | 0 | 0 | 8 | 6 | 14 |
| In EOP | 2 | 3 | 3 | 0 | 8 |
| *Total* | 2 | 3 | 11 | 6 | 22 |

**Table 2** Saint Bernard Parish, LA organisation descriptions

| *EOP standing* | *Federal* | *State* | *Local* | *NGO* | *Total* |
|---|---|---|---|---|---|
| Not in EOP | 0 | 0 | 1 | 2 | 3 |
| In EOP | 2 | 0 | 8 | 0 | 10 |
| *Total* | 2 | 0 | 9 | 2 | 13 |

On the basis of social network indicators, the two networks appear somewhat similar. On average, organisations in Bay Saint Louis have a total of 13.727 communication ties that they both receive and transmit to other organisations. In Saint Bernard Parish, this figure is comparable at 10.769. In terms of network density – the faction of possible ties which are actually observed (Wasserman and Faust, 1994, p.164) – the Bay Saint Louis network shows that 0.327 of possible communication ties transpired, whereas in Saint Bernard Parish this proportion equals 0.449. These densities are large compared to many social networks, although contained within the range of densities (0.175 to 0.456) of the seven search and rescue EMON networks studied by Drabek *et al*. (1981). (Note that while density can vary from 0, indicating no ties, to 1, indicating all possible ties present, it is rare for networks of any appreciable size to have densities in excess of 0.5. See Mayhew and Levinger (1976) for a discussion of the causes and consequences of this phenomenon.) Although organisations in Bay Saint Louis, on average, communicated with more organisations than those in Saint Bernard Parish, a larger fraction of possible ties is observed in the Saint Bernard Parish network ($p = 0.008$, chi-squared test of proportions). This difference between the average number of ties and the fraction of observed ties arises from the fact that Bay Saint Louis has more organisations responding – thus, each organisation in the Bay Saint Louis EMON would (on average) have had to maintain nearly 19 incoming and outgoing ties (combined) for this network to have the same density as that observed in Saint Bernard Parish. While organisations in Bay Saint Louis do, in fact, sustain more communication ties than those in Saint Bernard Parish, this quantity appears to have grown less quickly than the number of responding organisations (perhaps pointing to a limit in organisational capacity for interaction). Also of interest, in Saint Bernard Parish all ties between organisations are reciprocated. This means that none of the communication links was 'one-way'. This differs slightly from Bay Saint Louis, where the fraction of ties reciprocated equals 0.900; in this community only 10% of communication between organisations are one-way.[11] These findings contrast with an earlier study on organisational response to Katrina which suggests a tendency towards asymmetry among responding organisations (Comfort and Haase, 2006, p.339). This earlier study conceptualises asymmetry as a lack of communication between organisations operating at different jurisdictional levels, as exemplified by federal organisations who do not work with local organisations. This conceptualisation differs from our treatment and earlier discussion of asymmetric ties (Holland and Leinhardt, 1970; Wasserman and Faust, 1994).

As we see from Figures 2 and 3, the communication networks reflect these similarities. In Bay Saint Louis we see local organisations playing a central role in this network, with state-level organisations more on the outskirts. In Saint Bernard Parish we also notice that the more central organisations are local in their operations and primarily within the scope of the EOP. In both cases, the non-governmental organisations tend to be on the periphery of these networks.

**Figure 2** Bay Saint Louis communication network

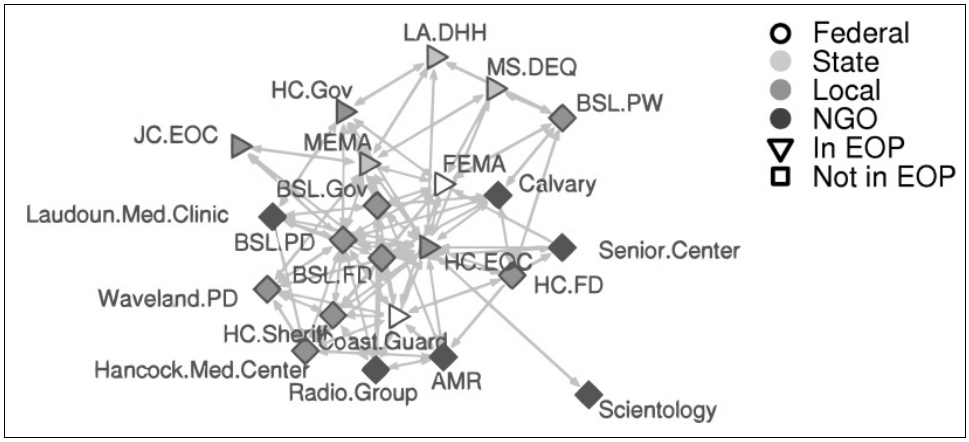
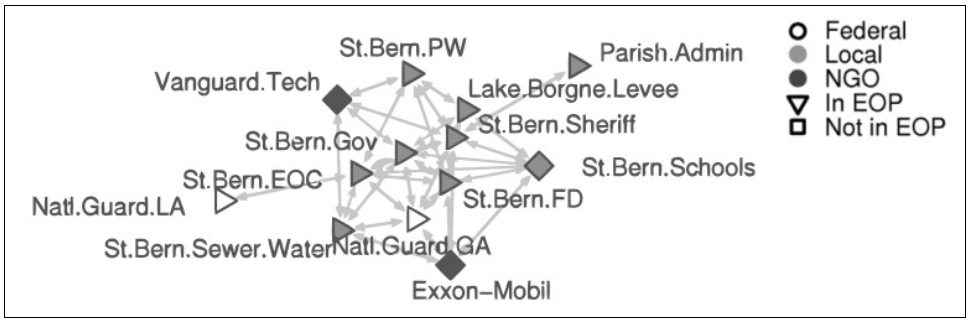



**Figure 3** Saint Bernard Parish communication network




In light of these descriptions, we now to turn to the issue of brokerage within and across organisation types. For the analyses that follow, we seek to identify which organisations fulfilled particular brokerage roles at significantly high levels. Using the statistical tests of Gould and Fernandez (1989, pp.102–115), observed brokerage scores are compared to those arising from a null model in which ties are randomly placed. This null distribution maintains the same average number of ties as our networks for Bay Saint Louis and Saint Bernard Parish, as well as the same number of actors in each organisational type for each network. Significance is then assessed by identifying brokerage scores which are substantially larger (or smaller) than would be expected under the null model; significant scores indicate brokerage levels which cannot be easily explained in terms of the number of actors or communication volume in each respective graph, and which hence suggest the presence of additional social mechanisms. Using null models allows disaster researchers to simulate an array of alternative and unrealised response scenarios for purposes of statistical comparison. Given this, the analyses which follow will highlight the organisations who broker significantly more, or potentially fewer, relationships during the Katrina response than we would expect from chance alone.

### *5.2 Bay Saint Louis, MS Brokerage*

Which organisations broker communicative relationships following a disaster that degrades existing channels of communication? Table 3 illustrates the answer to this question for Bay Saint Louis. In keeping with what we would expect from standard response systems such as the Incident Command System or National Incident Management System, the Hancock County Emergency Operations Center (HC.EOC) exhibits relatively high levels of brokerage across all forms. The Bay Saint Louis Police Department (BSL.PD) likewise brokers at significantly high rates among all brokerage types except itinerant brokerage. This means that the local police department generally mediates contact between organisations who did not, and likely could not, interact directly, excluding non-local pairs of organisations which both belong to the same type of organisation (*e.g.*, FEMA and the Coast Guard, the Scientology Church and Calvary or Mississippi Department of Environmental Quality [MS.DEQ] and the Mississippi Emergency Management Administration [MEMA]). In fact, aside from the HC.EOC, the only organisation performing significantly high levels of itinerant brokerage is the Bay Saint Louis Fire Department (BSL.FD). MEMA also mediates a number of relationships at significantly high levels, although their mediation is restricted to communications to and from only two organisations: MS.DEQ and the Louisiana Department of Health and Hospitals (LA.DHH).

In general, we see that most of the brokerage in Bay Saint Louis is performed by local organisations, while none of the non-governmental organisations broker significantly more pairs of actors than would be expected by chance. As suggested by the findings in Table 3, responders in Bay Saint Louis do not seem to broker any more or less if they are included within the EOP. In terms of total brokerage, when all five brokerage scores are aggregated, only BSL.PD and HC.EOC reach significantly high levels. Figure 4 illustrates this finding, along with the relationships between all organisations in this network. In this diagram, we have scaled the size of each organisation's vertex in proportion to its total brokerage score.

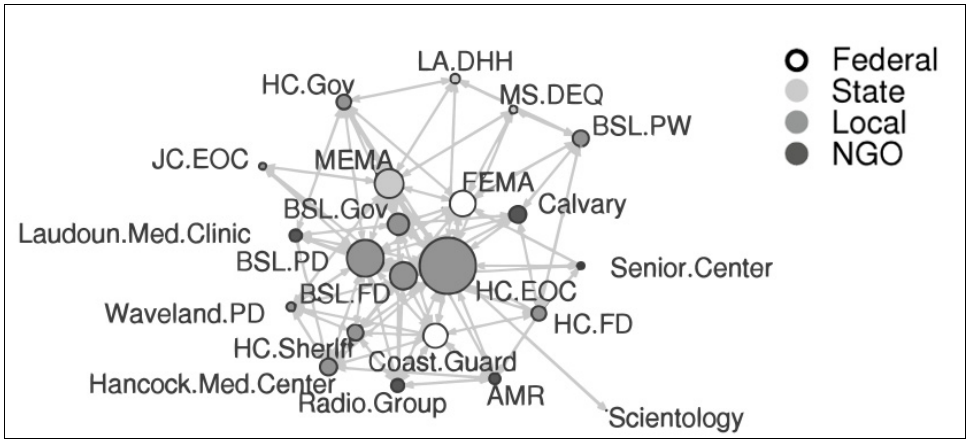
As stated earlier, previous scholars have equated brokerage to other bridging phenomena (Cross *et al.*, 2001). We examine this idea for Bay Saint Louis in Table 4 by comparing total brokerage to three centrality measures – namely, indegree, outdegree, and betweenness (Freeman, 1979). We see that the organisations with the highest total brokerage, the Bay Saint Louis Police Department and the Hancock County EOC, are also the most central in the response network. Indeed, total brokerage correlates very highly ($p \leq .001$) with all three using a one-tailed, Spearman's rank correlation test.

**Table 3** Bay Saint Louis, MS brokerage scores

| *Organisation* | *In EOP?* | *OrgType* | *Coordinator* | *Itinerant* | *Gatekeeper* | *Representative* | *Liaison* | *Total* |
|---|---|---|---|---|---|---|---|---|
| Coast.Guard | Yes | Federal | 0 | 16 | 5 | 4 | 14 | 39 |
| FEMA | Yes | Federal | 0 | 20 | 3 | 6* | 15 | 44 |
| BSL.PD | No | Local | 27*** | 4 | 21* | 23** | 16** | 91*** |
| BSL.PW | No | Local | 0 | 2 | 3 | 3 | 9 | 17 |
| BSL.FD | No | Local | 6 | 9** | 10 | 15 | 9 | 49 |
| BSL.Gov | No | Local | 0 | 6 | 3 | 3 | 18*** | 30 |
| Hancock.Med.Center | No | Local | 4 | 1 | 7 | 6 | 1 | 19 |
| HC.FD | No | Local | 3 | 2 | 5 | 1 | 3 | 14 |
| HC.Sheriff | No | Local | 4 | 0 | 7 | 4 | 2 | 17 |
| Waveland.PD | No | Local | 0 | 0 | 2 | 2 | 1 | 5 |
| HC.Gov | Yes | Local | 2 | 0 | 2 | 2 | 8 | 14 |
| JC.EOC | Yes | Local | 2 | 0 | 1 | 0 | 0 | 3 |
| HC.EOC | Yes | Local | 28*** | 25*** | 55*** | 46*** | 58*** | 212*** |
| AMR | No | NGO | 0 | 1 | 2 | 2 | 3 | 8 |
| Scientology | No | NGO | 0 | 0 | 0 | 0 | 0 | 0 |
| Calvary | No | NGO | 0 | 19 | 0 | 0 | 0 | 19 |
| Senior.Center | No | NGO | 0 | 1 | 0 | 0 | 2 | 3 |
| Laudoun.Med.Clinic | No | NGO | 0 | 10 | 0 | 0 | 0 | 10 |
| Radio.Group | No | NGO | 0 | 4 | 4 | 2 | 1 | 11 |
| MS.DEQ | Yes | State | 0 | 2 | 1 | 1 | 0 | 4 |
| LA.DHH | Yes | State | 0 | 4 | 1 | 1 | 0 | 6 |
| MEMA | Yes | State | 2*** | 18 | 12** | 13** | 11 | 56 |
| *Total* | | | 78 | 144 | 144 | 134 | 171 | 671 |

Notes: *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.

**Figure 4** Bay Saint Louis communication network




Note: Actors scaled by total brokerage.

**Table 4** Bay Saint Louis, MS centrality

| *Organisation* | *Total brokerage* | *Indegree* | *Outdegree* | *Betweenness* |
|---|---|---|---|---|
| BSL.PD | 91 | 13 | 12 | 41.075 |
| BSL.PW | 17 | 5 | 5 | 8.210 |
| BSL.FD | 49 | 11 | 7 | 31.139 |
| HC.Gov | 14 | 7 | 7 | 4.311 |
| MS.DEQ | 4 | 3 | 4 | 2.866 |
| BSL.Gov | 30 | 8 | 8 | 9.288 |
| JC.EOC | 3 | 3 | 3 | 0.778 |
| AMR | 8 | 5 | 5 | 2.162 |
| Scientology | 0 | 1 | 1 | 0.000 |
| LA.DHH | 6 | 4 | 4 | 4.021 |
| Hancock.Med.Center | 19 | 8 | 7 | 6.363 |
| Calvary | 19 | 6 | 6 | 10.914 |
| Coast.Guard | 39 | 8 | 11 | 14.291 |
| Senior.Center | 3 | 2 | 3 | 0.783 |
| Laudoun.Med.Clinic | 10 | 5 | 6 | 2.750 |
| HC.FD | 14 | 4 | 7 | 10.586 |
| HC.EOC | 212 | 19 | 17 | 127.224 |
| MEMA | 56 | 10 | 10 | 28.352 |
| FEMA | 44 | 10 | 9 | 22.353 |
| Radio.Group | 11 | 5 | 7 | 2.896 |
| HC.Sheriff | 17 | 8 | 7 | 5.523 |
| Waveland.PD | 5 | 6 | 5 | 1.117 |
| Spearman's rank correlation with total brokerage | NA | 0.932 | 0.917 | 0.963 |

### 5.3 Saint Bernard Parish, LA Brokerage

With respect to organisational mediation, the response to Hurricane Katrina in Saint Bernard Parish differs noticeably from that in Bay Saint Louis (see Table 5). The only organisations which broker significantly more pairs of actors than expected are local organisations included in the EOP. Referring to Table 2, this finding may reflect the nature of the participants more than the organisations' communication patterns *per se*, in the sense that the majority of responders in Saint Bernard Parish are local organisations in the EOP (8 out of 13). Despite this possibility, we see that in Table 5 the federal and non-governmental organisations did not perform *any* of the gatekeeping/representative brokerage roles in this case.[12] Due to their smaller presence in the data, these federal and non-governmental organisations cannot perform coordinator brokerage,[13] however this constraint would not prevent gatekeeper or representative brokerage. Further, none of the organisations in the Saint Bernard Parish case exhibit significantly high amounts of liaison brokerage.

**Table 5** Saint Bernard Parish, LA brokerage scores

| *Organisation* | *In EOP?* | *OrgType* | *Coordinator* | *Itinerant* | *Gatekeeper/ Representative* | *Liaison* | *Total* |
|---|---|---|---|---|---|---|---|
| Natl.Guard.GA | Yes | Federal | 0 | 12 | 0 | 6 | 18 |
| Natl.Guard.LA | Yes | Federal | 0 | 0 | 0 | 0 | 0 |
| St.Bern.Schools | No | Local | 6 | 0 | 3 | 0 | 12 |
| Parish.Admin | Yes | Local | 0 | 0 | 0 | 0 | 0 |
| St.Bern.FD | Yes | Local | 4 | 0 | 5 | 0 | 14 |
| St.Bern.Sheriff | Yes | Local | 14* | 2* | 11** | 2 | 40*** |
| St.Bern.EOC | Yes | Local | 12 | 2* | 8 | 0 | 30* |
| St.Bern.PW | Yes | Local | 6 | 0 | 3 | 0 | 12 |
| Lake.Borgne.Levee | Yes | Local | 4 | 0 | 2 | 0 | 8 |
| St.Bern.Sewer.Water | Yes | Local | 0 | 2* | 3 | 2 | 10 |
| St.Bern.Gov | Yes | Local | 14* | 0 | 5 | 2 | 26 |
| Vanguard.Tech | No | NGO | 0 | 6 | 0 | 0 | 6 |
| Exxon-Mobil | No | NGO | 0 | 6 | 0 | 2 | 8 |
| *Total* | | | 60 | 30 | 40 | 14 | 184 |

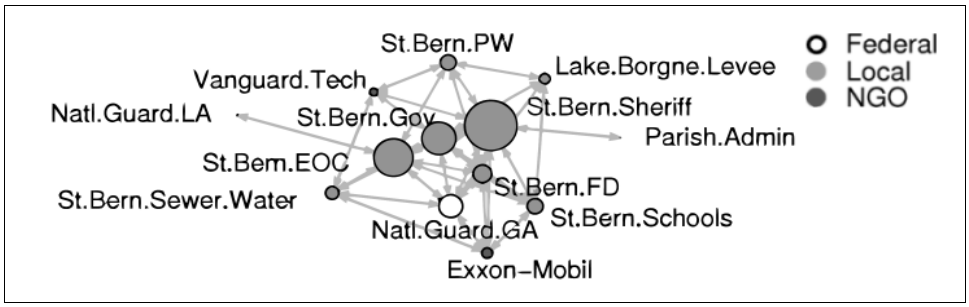
Notes: *p ≤ 0.05.
**p ≤ 0.01.
***p ≤ 0.001.

Figure 5 displays the total brokerage in Saint Bernard Parish alongside the relationships between responding organisations. In this case, the Saint Bernard Parish Sheriff mediates the most relationships, both in terms of generally significantly high levels of brokerage relative to expectations and in terms of the absolute number of brokered relationships. During the interview with this organisation, the informant expressed the view that the Sheriff's office played the most pivotal role in this community, beyond even the Saint Bernard Parish Emergency Operations Center. However, we see that the Saint Bernard Parish Emergency Operations Center also generally brokers a significantly large number of relationships in this network, both in terms of total brokerage and itinerant brokerage.

In an account paralleling the Sheriff's office, the informant from the Emergency Operations Center claimed the EOC as the most essential organisation in the emergency response network. Informants from both organisations were correct in accounting for their individual importance, yet neither recognised the value of the other as equal to their own. Such relational myopia has been noted in studies of individual-level networks (Bernard *et al.*, 1984; Krackhardt, 1987), as well as in practitioner accounts of the so-called 'Robinson Crusoe Effect' (Auf der Heide, 1989). Knowledge of one's local network has been linked to increased efficacy in organisational settings (Krackhardt, 1990), suggesting that responders in Saint Bernard Parish could have benefited from a broader view of the relational context in which they were embedded.

As with Bay Saint Louis, total brokerage in Saint Bernard Parish also bears a strong resemblance to other bridging concepts (see Table 6).[14] We see that the Parish EOC and Sheriff, who perform the most brokering in this network, are also two of the most central actors in the network. Like Bay Saint Louis, total brokerage correlates strongly with these measures of centrality ($p \leq .001$).

**Figure 5** Saint Bernard Parish communication network




Note: Actors scaled by total brokerage.

**Table 6** Saint Bernard Parish, LA centrality

| *Organisation* | *Total brokerage* | *Indegree* | *Outdegree* | *Betweenness* |
|---|---|---|---|---|
| Parish.Admin | 0 | 1 | 1 | 0.000 |
| St.Bern.FD | 14 | 7 | 7 | 3.933 |
| Vanguard.Tech | 6 | 4 | 4 | 2.200 |
| St.Bern.Sheriff | 40 | 9 | 9 | 30.267 |
| Natl.Guard.GA | 18 | 7 | 7 | 7.000 |
| St.Bern.EOC | 30 | 8 | 8 | 26.700 |
| St.Bern.PW | 12 | 5 | 5 | 5.167 |
| Lake.Borgne.Levee | 8 | 4 | 4 | 1.733 |
| St.Bern.Sewer.Water | 10 | 5 | 5 | 3.867 |
| St.Bern.Schools | 12 | 6 | 6 | 4.700 |
| Natl.Guard.LA | 0 | 1 | 1 | 0.000 |
| Exxon-Mobil | 8 | 5 | 5 | 2.300 |
| St.Bern.Gov | 26 | 8 | 8 | 10.133 |
| Spearman's rank correlation with total brokerage | NA | 0.981 | 0.981 | 0.972 |

### 5.4 Summary of findings

Table 7 summarises our main findings. The *coordinator* role was epitomised by the Bay Saint Louis Police Department, the Hancock County EOC, the Saint Bernard Parish Sheriff's office, and Saint Bernard Parish Government. Thanks to their strong relationships with peer groups of local officials – or state officials, in the case of MEMA – they were able to link together groups which often were not able to physically communicate with each other following the disaster. The Hancock County Emergency Operation Center, the Bay Saint Louis Fire Department, the Saint Bernard Parish Emergency Operations Center, the Parish Sheriff, and Saint Bernard Parish Sewer and Water displayed the traits of *itinerant brokers*. These local organisations were able to pass communication between two or more federal-level, state-level, or non-governmental organisations while responding to the disaster.

**Table 7** Summary of results

| *Characteristics* | *Bay Saint Louis* | *Saint Bernard Parish* |
|---|---|---|
| Community type | Rural | Near urban New Orleans |
| Damage | Wind and Structural | Flooding |
| Number of responding organisations | 22 | 13 |
| Density | High (0.327) | High (0.449) |
| Reciprocity | High (0.900) | High (1.000) |
| *Leading brokers* | | |
| Coordinator | Bay St. Louis Police Depart., Hancock County EOC, MEMA | St. Bernard Parish Sheriff and St. Bernard Parish Government |
| Itinerant | Hancock County EOC, Bay St. Louis Fire Dept. | St. Bernard Parish Sheriff, St. Bernard Parish EOC, St. Bernard Parish Sewer and Water |
| Gatekeeper | Bay St. Louis Police Depart., Hancock County EOC, MEMA | St. Bernard Parish Sheriff |
| Representative | Bay St. Louis Police Depart., Hancock County EOC, MEMA, FEMA | St. Bernard Parish Sheriff |
| Liaison | Bay St. Louis Police Depart., Hancock County EOC, Bay St. Louis Government | NA |
| Total brokerage | Bay St. Louis Police Depart., Hancock County EOC | St. Bernard Parish Sheriff, St. Bernard Parish EOC |

The *gatekeeper* and *representative brokers* were epitomised by the behaviour of the Bay Saint Louis Police Department, the Hancock County EOC, and MEMA, as well as the Saint Bernard Parish Sheriff's office. The latter, despite its exclusion from the Emergency Operations Plan, established a communications network among key stakeholders paralleling that of the Parish EOC's communications network. We also see that in Bay Saint Louis, the Federal Emergency Management Agency fulfilled a representative brokerage role at a rate twice that of its gatekeeping. This means that FEMA received information on resources from the US Coast Guard and later

communicated to local and state-level organisations. Finally, although we do not observe considerable levels of *liaison brokerage* in Saint Bernard Parish, in Bay Saint Louis we see that the Police Department, the local government, and the Hancock County EOC epitomised the liaison broker role – all local organisations responding to the disaster.

## 6 Discussion

This study offers insights into the emergent brokerage of interorganisational communication following a major disaster. In addition to illustrating a new way to analyse communication during disaster response, by using the case of Hurricane Katrina response in two communities – Hancock County, Mississippi and Saint Bernard Parish, Louisiana – we have identified which organisations displayed significantly high levels of brokerage. These same organisations also show a propensity towards engaging in other bridging activities in their communities. Although interesting in their own right, these findings raise a number of other important issues. We briefly discuss several of these issues here, along with suggestions for further research.

The present study clearly indicates substantial differences in brokerage behaviour across organisations, which motivates the question of the benefits or liabilities which may accrue to brokers (and those they broker). At present, little research has been done on the consequences of these communication roles in the event of a disaster (though see Comfort and Haase, 2006; Comfort *et al*., 2005; Kapucu, 2006 for recent studies of other structural features). Bridging theorists often suggest that networks prone towards brokering produce more efficient and effective results than those characterised by redundant ties (Bavelas and Barrett, 1951; Burt, 1992; Granovetter, 1973). While this may sensibly be true, what of scenarios in which relatively few actors contribute the majority of ties brokered? In both Bay Saint Louis and Saint Bernard Parish, only two organisations in each community surpass expected levels of *total brokerage*. Additionally, these organisations tend to dominate all other forms of brokerage as well. Do cases characterised by few but influential brokers hasten or hinder a community's recovery? The answer would undoubtedly prove illuminating for practitioners and structural theorists alike.[15] Partially, the answer depends upon the ascribed legitimacy of the lead brokering organisations. For instance, organisations outside of the Emergency Operations Plan's scope, who lack the tangible resources to provide relief but mediate between numerous relations (like the Bay Saint Louis Police Department or the Saint Bernard Parish Sheriff), may prove less effective in disaster response than organisations included in the EOP who receive such resources. The presence (or absence) of such legitimacy could potentially help (or hinder) how effectively an organisation can respond to a disaster (Comfort *et al.*, 2004).

On another note, the existence of prior ties among organisations may also influence observed brokerage roles following a disaster (as suggested by practitioner accounts such as Auf der Heide, 1989). In the cases studied here, these prior communication lines tended to cluster among the local organisations. We see that in the weeks following the hurricane only one non-local agency in the Hancock County case, MEMA, assumed multiple brokerage roles in the county's response and none of the non-local organisations in Saint Bernard Parish tended to broker at high rates among any of the brokerage indicators. Supporting this point, comments made by FEMA representatives during the

interviews acknowledged that their organisation had failed to establish any significant contact with local officials prior to the disaster. In the hours leading up to the hurricane making landfall in LA, this organisation had sought to persuade local officials to relocate the local Emergency Operations Center in Bay Saint Louis. However, the local officials refused, citing a lack of mutual trust. In contrast, the Bay Saint Louis Police Department was able to play a pivotal role in brokering communications in the surrounding communities, thanks to its previously established relationships with other local officials and community leaders. This finding is consistent with an observation found in an earlier study of the Bay Saint Louis, following Hurricane Camille. As cited in Mendonça and Wallace (2004), the Bay Saint Louis Police Department played a pivotal role in the wake of the 1969 hurricane. These findings suggest important limits to the type of 'swift trust' that can form during a disaster, and suggest the potential utility of pre-disaster network surveys as a mechanism for identifying and rectifying problematic structural holes (Burt, 1992) as part of communities' ongoing mitigation and preparedness efforts.

Lastly, despite the differences in damage caused by Hurricane Katrina, the two communities displayed very similar response patters. Although on average organisations in Bay Saint Louis communicated with more organisations than Saint Bernard Parish, when examined by a t-test (not shown) this difference is negligible.[16] In both communities, local organisations were the most central, while non-governmental organisations were the least. Additionally, at each site the vast majority of communication between organisations were reported as mutual. Although this was not the case in Bay Saint Louis or Saint Bernard Parish, it is important to consider that if the organisations reported more asymmetric ties, we would observe fewer brokers. In terms of brokerage, both cases had relatively few organisations performing most of the brokering and these organisations were locally based. We find that the only discernible difference between the cases is the number of organisations responding to the disaster, whereby fewer organisations responded in the flooded Saint Bernard Parish than in Bay Saint Louis. With regard to claims that the realised severity of a disaster affects response patterns (Quarantelli, 1997; Comfort *et al.*, 2004), from our two case comparison we see the severity as impacting only the sheer number of responders, but not their communication patterns. This comes as a surprise to us, given the lasting telecommunication interruption in Saint Bernard Parish and suggests innovative forms of correspondence in this community.

Although our analysis has illustrated the potential for formal brokerage analysis to provide insight into response EMONs, extensions and improvements are always possible. In particular, the value of the methods demonstrated here can be greatly leveraged by improving the quality and scope of available data. Data collected in parallel samples using equivalent methods, for instance, would permit much stronger conclusions regarding the extent to which brokerage patterns in particular communities reflect general trends, versus local idiosyncrasy; while our study benefits from the ability to compare two such cases, access to a larger number of communities would obviously permit stronger and more refined conclusions. Similarly, collecting dynamic network data (*e.g.*, snapshots of the organisational networks at multiple points in time) would allow researchers to asses the emergence and disappearance of brokers. Particularly valuable would be improved baseline data on interactions among response organisations during routine circumstances; unfortunately, the unpredictable nature of disasters makes such data difficult to obtain without an ongoing programme of systematic community baseline studies. Finally, the reliability of EMON studies can be enhanced by the use of 'cognitive

social structure' designs (Krackhardt, 1987) during data collection. This data collection method asks informants to report not only on their own (or their organisation's) tie, but also on the presence or absence of ties among other pairs of actors or organisations. In addition to yielding informants' mental models of the overall social system (a potentially useful resource in its own right), information of this kind can be statistically aggregated to form accurate estimates of network structure even in the presence of missing data and measurement error (Butts, 2003). Related methods could potentially be employed to incorporate data from additional sources, such as newspaper articles, transcripts of radio or television broadcasts, and situation reports.

Although we have taken an 'after action' perspective in this paper, we also note the potential for brokerage analysis to be conducted in the midst of an ongoing response. By employing pre-fabricated 'instrument packs' with surveys of the kind employed here, together with automated data analysis tools, it is possible for response organisations to obtain a view of the broader interorganisational network within a period of a few hours. Given analysis by trained response personnel and/or specialist consultants, this data can identify key players and their roles in the emergent organisational network, which in turn can be used to identify opportunities for improved communication among response organisations.

In sum, this study demonstrates the use of brokerage analysis to identify the roles performed by organisational actors in response to disaster. We have used this approach to assess the extent to which various officials and their organisations performed as communication brokers following the Katrina disaster – a situation characterised by the absence of traditional, working communications channels, and a reliance on emergent multiorganisational communication networks. In this light, it is interesting to note that only 23% of the organisations surveyed considered the communications they brokered as 'innovative'. The remainder thought of their behaviour as following standardised communication functions prescribed by established communication protocols. Despite this perception, observations in the field clearly underscored the fact that Katrina disrupted formal communications channels in both communities, and therefore precluded the organisations from actually performing their respectively prescribed functions. Innovation was thus required, resulting in the diverse brokerage roles described above. This disconnect between perception and performance – strongly reminiscent of the limits on network participants' knowledge found previously by Killworth and Bernard (1976; 1979), Bernard and Killworth (1977), Krackhardt (1987), and others – suggests that local emergency preparedness planners could benefit from a greater understanding of the role of social networks and the diverse brokering functions formal officials and informal community leaders perform following a disaster.

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## Notes

1 Following common practice in social network analysis (Wasserman and Faust, 1994), we refer to a given focal actor (individual organisational) as 'ego', with actors to whom ego is tied being referred to as 'alters'.

2 This distinction is not readily available for other methods of measuring bridging phenomena.

3 To the knowledge of the authors, Fernandez and Gould (1994) is the only published work that utilises all five distinct brokerage roles.

4 Although Corra and Willer (2002) theorise that gatekeeping always entails extracting fees, other scholars of brokerage claim that interests and financial gain hinder a broker's potential influence (Fernandez and Gould, 1994; Gould, 1989).

5 Intrinsically, this form of brokerage exists only in situations involving three or more affiliation groups.

6 Marsden (2002, pp.417–418) has noted that this form of brokerage is equivalent to egocentric betweenness.

7 Corra and Willer (2002) mention this argument as suggestive of the Medicis as gatekeeper, however they fail to make an argument that differentiates gatekeeping from other forms of brokerage.

8 It is natural to consider whether this process exaggerated the apparent brokerage of the EOP members (*vis-à-vis* other organisations). If this were true, we would expect the average brokerage of EOP members to substantially exceed that of other organisations in our study. To test this possibility we performed a permutation test of the difference in means between organisations included and excluded from the EOP (not shown). Such an effect is not observed here (one-tailed p-values 0.14 and 0.23).

9 While requiring a two-citation threshold could have understated the role of hubs (*i.e.*, an organisation that communicates with many organisations who do not communicate amongst themselves), this is not supported by the data: only three organisations were found to have ties to a single informing organisation (and hence to be at risk for being unrecognised hubs).

10 All respondents in this study were instructed to answer in terms of their organisations, rather than their own activities as individuals. While no single informant can speak on behalf of *all* activities of an organisation, proxy reports have been shown to provide valuable information on behaviour (Mingay *et al.*, 1994; Sudman *et al.*, 1996) and on interorganisational interaction in particular (Calloway *et al.*, 1993). All analyses were conducted using organisation-level data.

11 It is important to note that the high levels of reciprocity do not result from sampling or survey design. Every organisation surveyed had an opportunity to indicate the presence of asymmetric communications. If more organisations responded that their ties were 'one-way', the reciprocity scores would be much lower.

12 The Saint Bernard Parish communication network is entirely reciprocal. In cases like this, as mentioned earlier, gatekeeper brokerage and representative brokerage are indistinguishable.

13 For an organisation to be a coordinator they need to belong to a subgroup with three or more members. In the Saint Bernard Parish, the non-governmental and federal organisation subgroups only have two organisations each.

14 In Table 6, indegree and outdegree centrality are identical. This is due to the fact that all ties in the network are reciprocal.

15 Additionally, one may speculate as to influence of organisational size on brokerage and disaster response. Although we do not have the data to speak to this issue, it would be of interest for future studies.

16 The observed difference in densities between the two networks can thus be understood as stemming from the effect of size given approximately constant mean degree.