

Inter-Organizational Design for Disaster Management: Cognition, Communication, Coordination, and Control

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ABSTRACT: *The recurring pattern of failed governmental actions in response to major disasters compels a re-examination of the traditional organizational framework of command-and-control that has served as the basis for disaster planning and response actions in most nations of the world. The contrast between the top-down hierarchical control that is presumed in national emergency plans and the need for flexibility required in effective operations in rapidly changing disaster environments requires a fresh approach to emergency planning and action. This article focuses on the role of cognition of risk as the triggering action that leads to effective communication, coordination, and emerging collective control as a community learns to manage risk more effectively in collaboration with other organizations and wider jurisdictional authorities.*

Keywords: Disaster Management; Cognition; Communication; Management; Coordination; Control

1. Introduction

Learning from the actual experience of disaster is an extraordinarily difficult task. Too often, the official records retained after a disaster are used to justify the actions taken, whether they were constructive or not. The dead are memorialized; the fallen emergency responders are transformed into heroes; the mournful sound of bagpipes, at least in the U.S. context, becomes synonymous with honor and sacrifice for the larger public good. Yet, those symbolic efforts to mask the horror and destruction of disaster contribute little to a rigorous inquiry into the inevitable set of human errors that led to a catastrophic disaster. Rather, learning from disaster means analyzing the preparedness, response, and recovery operations as they actually occurred in contrast to what had been expected or ignored. It means separating the reality of action from the myths of planning and learned ignorance, and recognizing that the basis for building effective crisis management lies in the human ability to recognize and correct mistakes

The contrast between planning and practice has long been a gap that theorists in emergency management have sought to close. In the last decades, theorists in public policy and emergency management

have increasingly recognized that the dynamic, complex environment of rapidly evolving emergency events requires a different approach than the traditional hierarchical administrative framework that assumes stable operating conditions [3, 5, 6, 11, 12]. A second major problem with current planning practice has been the persistent effort to develop an "all hazards approach" to emergency management. That is, threats to civilian populations are considered to have similar characteristics, and to require common actions in response. While this assumption may be largely valid for response actions after a catastrophic event has occurred, the processes for cognition and detection of potential risk differ substantially among hazards. Monitoring seismic movement requires different instruments, a different scientific knowledge base, and different methods of analyzing and interpreting the risk from monitoring the risk of hurricanes, fires, or floods. Each hazard poses a threat to the community that requires an informed response designed to minimize that danger. Hurricanes may require evacuation of whole cities; fires may require collective action to build fire breaks to prevent a fire from spreading; floods may require inter-organizational

collaboration to monitor rising waters and inform community residents of timely alternatives for safely coping with the danger. The critical step for each hazard is recognizing the degree of risk it poses to the community, the actions required to reduce that risk, and the consequences for the community if action is taken---or not taken. Anticipating risk is a global problem, affecting every nation and region of the world.

The risk of earthquakes-sudden, urgent events that have regional effects-represents a global hazard that requires both planning and action. The catastrophic losses recorded in recent earthquakes-Hanshin, Japan, 1995, Marmara, Turkey, 1999; Gujarat, India, 2001; Bam, Iran, 2003; Sumatran Earthquake and Tsunami, 2004; Northern Pakistan, 2005; Pisco, Peru, 2007-count the number of dead in thousands, tens of thousands, and for the Sumatran Earthquake and Tsunami, hundreds of thousands. Economic losses escalate into the billions of dollars. A response system evolved after each earthquake, but the question is whether insights gained from that specific event are implemented in public practice to reduce losses from the next. Could innovative approaches to disaster mitigation and response be designed to enable communities to manage continuing seismic risk more effectively?

The grief and losses generated by a large disaster compel each nation to re-examine its policies and practices after the fact. Yet, the effectiveness of such inquiry depends on the basic characterization of disaster. Is it a random event that disrupts otherwise well designed and well managed communities, or is it an event that reveals the basic flaws in the affected community's socio-economic-legal-technical system? If the event is perceived as originating from sources external to the system, the policy makers are unlikely to change their basic approach, often reinforcing earlier mistakes. If the event is perceived as originating in conditions internal to the system, genuine change may result. How the event is interpreted and communicated to the citizenry inevitably creates the basis for either effective management or escalation of destruction in the next disaster.

For example, the extensive reorganization of the emergency management system in the U.S. following the terrorist attacks of September 11, 2001 reinforced the traditional model of command and control. The separation of the key functions of crisis management and consequence management and their allocation to separate federal departments in the Interagency

Domestic Terrorism Concept of Operations Plan [20] initiated the decline of mitigation as a primary focus of emergency management. This decline was accelerated with the establishment of the new Department of Homeland Security (*DHS*) in 2003 [16]. Under this reorganization of emergency functions, the Federal Emergency Management Agency was formally subsumed under the authority of the new *DHS* as one of twenty-two federal agencies with responsibilities related to security. Formal plans to reorganize emergency management functions that were produced and introduced into practice under the authority of *DHS* further widened the gap with actual practice. These plans specified a detailed, hierarchical structure of command and control in the National Response Plan [8] and the National Incident Management System [9] that largely ignored the complexity and uncertainty inherent in actual disaster environments. Like generals fighting the last war in their planning processes, the *DHS* policy makers in the U.S. focused almost exclusively on the threat of terrorist attacks after 9/11, neglecting the very real threats of hurricanes, floods, tornadoes, and fires that recur every year.

The obvious collapse of the U.S. intergovernmental system in emergency management under the strain of the catastrophic events initiated by Hurricane Katrina provides an unquestioned demonstration of the failure of hierarchical control in the dynamic context of actual disaster. The question becomes how to reframe the organizational issues endemic in emergency management practice in ways that policy makers can understand and implement. This task requires rethinking the terms of communication and coordination to dispel the myth of hierarchical control and redefining these terms in ways that fit the reality of practice in extreme events.

2. Science vs. Policy: A Continuing Tension in Emergency Management

"What worked?" and "what went wrong?" are classic questions asked in any after-action review.

While after-action reviews are basic forms of inquiry following any hazard, the recent case of Hurricane Katrina in the U.S. revealed the startling differences between science and policy in building resilience for a community exposed to serious risk. In the events leading up to Hurricane Katrina, the scientists were acutely aware and remarkably accurate in their assessment of the size, direction,

severity, and likely impact of the developing storm. Current Doppler radar systems had identified the formation of Tropical Depression Twelve in the Caribbean on August 23, 2005. Meteorologists at the National Hurricane Center in Miami upgraded the depression to Tropical Storm Katrina in the morning of August 24, classified the storm as a Category One hurricane as it made landfall in south Florida on August 25, upgraded the hurricane to Category Two as it moved into the Gulf of Mexico on August 26, and projected landfall as a Category Three hurricane in Louisiana and Mississippi on August 27 [7]. The scientists provided clear, timely, professional warnings regarding the severity, intensity, and direction of Hurricane Katrina to public information sources.

The failure was not lack of communication, as the information regarding the impending storm was transmitted to policy makers and public news agencies in time to mobilize action [14]. Rather, the issue was cognition of the risk posed by the storm. Although key policy makers at federal, state, parish/county, and municipal levels had received warnings via direct telephone calls from Max Mayfield, director of the National Weather Service, they failed to comprehend the risk and potential destruction of a Category Four or Category Five hurricane for the City of New Orleans and other vulnerable Gulf Coast communities. Without clear recognition of the severity of the threat and its likely consequences, decision makers at all four levels of jurisdictional responsibility in emergency management failed to communicate the urgency of the danger to their respective agencies. Without authoritative communication to activate appropriate response operations, coordination of actions among the levels of jurisdictions in the emergency response system largely failed.

In contrast, some organizations and groups did heed the storm warnings and take appropriate action to reduce risk. The clearest example is that approximately 80% of the population of New Orleans followed the voluntary evacuation order issued by Mayor Ray Nagin on Saturday evening, August 27, and left the city before the storm struck. The limits of this action were painfully clear in the economic and racial differences among those who could leave and those who had no means to do so on their own. As the television monitors showed silently, the approximately 100,000 people who remained in the city as the storm struck were largely poor and African-American. Other examples of partial efforts include

the decision of the airlines to suspend flights from Louis Armstrong Airport in New Orleans on Sunday morning, August 27. In protecting their own operations, the airlines ironically cancelled the possibility of others to leave the city before the storm. These examples illustrate the uneven results of separate actions taken without an overarching framework for collective action for the region at risk.

Innovative efforts to cope with the flood in New Orleans and the aftermath of the storm in other areas were documented in multiple ways by individuals, public, private and nonprofit organizations. Coast Guard helicopter crews scanned the abandoned city of New Orleans for survivors and airlifted injured persons to safety and medical care when there were no operable communications or transportation in the city. Local emergency personnel worked long hours to help others despite their own losses, demonstrating professional commitment and personal responsibility. Individual residents took their own power saws to clear roads of downed trees, clearing vital transportation routes in outlying areas. National business organizations sent assistance to their local affiliates in the storm-affected region, increasing local capacity to manage the damage and destruction to their business operations. Citizens across the nation responded with voluntary contributions totaling more than \$2.3 billion to assist those in need. There were extraordinary acts of courage and generosity by individuals and groups in this massive event, but the capacity to harness those individual actions into a coherent process of response and recovery was missing. In retrospect, the policy framework to facilitate self organizing actions in response to valid scientific information was largely absent. Instead, individuals and organizations volunteering to provide assistance to those in need were often turned away for lack of proper forms or until some distant authority could approve the action under existing procedural controls [2].

3. Cognition, Communication, Coordination, and Control

Three critical terms in emergency management - communication, coordination, and control - imply an interdependent, evolving process of organizational management. This process is illustrated by the record of disaster operations both before and after Hurricane Katrina made landfall, noted above. The record demonstrates the importance of a prior term - cognition - that is essential to activating the process of

response. Serious efforts to revise and strengthen a national capacity for emergency management begin with recognition of the need to create a common knowledge base for collective action in extreme events. This need is well recognized by practicing emergency managers.

In the language of practice, building a “common operating picture” is essential for clear communication and coordination of actions among emergency response organizations. This means achieving a sufficient level of shared information among the different organizations and jurisdictions participating in disaster operations at different locations, so all actors readily understand the constraints on each and the possible combinations of collaboration and support among them under a given set of conditions. This task is usually accomplished through common training, years of shared experience, and professional interaction among individual emergency response personnel. The task becomes more difficult as the size, scope, and severity of an impending disaster increase. It becomes a major challenge when the requirements of disaster operations include a range of heterogeneous organizations from the nonprofit and private sectors, as well as individual households and neighborhood groups.

While the role of cognition has been recognized by theorists of decision making under conditions of uncertainty [1, 21, 22] and is widely acknowledged in practice, it has not been formally included in the organizational framework of the National Response Plan. Recognition-primed decision-making [13, 22] is now incorporated in many training programs for emergency personnel. Klein’s concept of recognition-primed decision making acknowledges that, under threat, the process of reasoning through a linear set of instructions or rules was far too slow for human managers to avoid danger. Rather, he observed that experienced leaders drew upon a repertoire of previous actions in similar conditions and created workable strategies to fit the existing context for action more appropriately. The limits of this approach lie in the maxim of Simon [17], “we can only create what we already understand”. If actors under threat confronted a situation that was so completely different from their experience, they found little meaning that could serve as a basis for action. Essentially, it means that decision makers operating under conditions of urgent stress formulate strategies of action based on their prior experience or training.

The importance of cognition is critical to understanding the collapse of the intergovernmental emergency management system in disaster operations in response to Hurricane Katrina. Only the scientists had a clear understanding of the potential threat of this powerful storm, which crossed the jurisdictional boundaries of at least nine states, three federal regions, and international borders within the Caribbean, and with Mexico and Canada. Without a clear understanding of the severity of this emerging threat, the policy makers did not engage effectively in the kinds of system-wide communication that would have led to stronger coordination of preparedness and response operations and improved control over the wide scale of activities required to mitigate, respond, and recover from the consequent destruction. The dependence of effective communication upon cognition, and equally, the dependence of effective coordination upon communication illustrate the nonlinear structure of disaster management operations. Control in disaster operations cannot be achieved through hierarchical measures alone. Rather, it develops through a process of rapid assessment of risk, integration of information from multiple sources, capacity to formulate strategic plans of action, identification and correction of error, and a continual monitoring and feedback process. This process cannot function effectively on a wide scale under the rigid constraints imposed by the current organizational design and procedural requirements of the National Response Plan and the National Incident Management System.

4. Reframing Intergovernmental Crisis Management

The challenge, of course, is to rethink the process of cognition, communication, coordination and control to achieve a more effective operational system in crisis management. Three major problems characterize intergovernmental response in large-scale, catastrophic events. These problems -heterogeneity among the participating groups, asymmetric information processes, and asynchronous dissemination of information --limit the timely mobilization of collective response and are independent of the type of hazard. Two recent cases, the Sumatran Earthquake and Tsunami, 2004 in Indonesia and Hurricane Katrina, 2005 in the United States, demonstrate the importance of cognition as the trigger for action in disaster response operations in complex disaster environments.

4.1. Heterogeneity Among Participating Organizations

There was an extraordinarily high degree of heterogeneity in size, experience, knowledge, and capacity among the participating groups, organizations, and jurisdictions involved in response operations to both disasters, 2004 Sumatran Earthquake and Tsunami and 2005 Hurricane Katrina. Although governmental organizations have the legal responsibility for managing extreme events, the scale of operations required to respond to both the Sumatran Earthquake and Tsunami and Hurricane Katrina exceeded the capacity of the emergency response organizations at the local jurisdictional levels: municipal, district/parish/county, and province/state. As the public emergency response organizations at the local jurisdictional levels were overwhelmed, emergency organizations from other regional, national/federal, and international jurisdictions responded to needs in the heavily damaged communities. Private and nonprofit organizations initiated their own activities in an effort to lend assistance. This situation led to an even greater diversity in knowledge, training, facilities, and capacity to act in seriously eroded conditions. The “operating picture” was anything but common, and errors, misjudgments, frustrations, and abuse characterized disaster operations instead. The useful lesson from these sets of conditions is that the common operating picture must be established before the disaster.

4.2. Asymmetric Information Processes

Without a “common operating picture”, emergency response operations tend to revert back to hierarchy as a means of control. This condition creates asymmetry in the information processes that are used as the basis for communication and action. For example, jurisdictions and organizations with higher levels of responsibility and authority transmit orders to lower levels without requesting or listening to feedback from field operations personnel or from organizations outside the formal chain of command. Instead of building a shared perspective on priorities for disaster operations, asymmetric information processes deny managers the operational feedback essential to identify and correct errors. Instead, information may be skewed to support largely political priorities, and the basic functions of disaster response, design and delivery of assistance to families that have lost their homes tend to go badly off track. Instances

of failed judgment, corruption, and mismatch of resources and needs are exacerbated by communication processes that are unidirectional. Without clear, timely feedback, organizations lose the possibility of correcting mistakes and adapting their performance to changing conditions.

4.3. Asynchronous Dissemination of Critical Information

The two factors - heterogeneity among actors and asymmetric information processes - combine to produce a third dysfunction, asynchronous dissemination of critical information to participating groups. That is, different groups received critical information at different times and initiated their own actions without awareness of its impact on other organizations or groups. For example, in the 2004 Sumatran Earthquake and Tsunami, residents of Banda Aceh felt the severe earthquake. When the shaking stopped, many went into the streets to assess the damage to their buildings. When they saw the ocean waves pulling back out to sea, they did not recognize the risk of a tsunami. Instead of running away from the ocean and certain danger, some residents ran toward the beach to pick up the fish that were left behind. Without a clear understanding of the indicators of a tsunami, they were engulfed in the powerful returning wave. No tsunami warning alerted them to the danger in time.

Table (1) shows the heterogeneity among the 554 organizations that were identified in the Jakarta Post newspaper as participating in Indonesian disaster response organizations following the tsunami. The striking facts in this table are that the largest number of participating organizations, 230 or 41.5%, is international; the second largest, 172 or 31%, is national. The 90 local organizations, in contrast, represent 16.2% of the total number. Of the 554 organizations, 337 or 60.8% are public organizations from all jurisdictional levels, while the private and nonprofit organizations are nearly equally divided at close to 20% respectively. This set of participating organizations represents a very high degree of heterogeneity, with different levels of skills, experience, and capacity to act within the response system.

Table (2) shows the smaller set of organizations that interacted with other organizations in the actual conduct of disaster operations. The breakdown among jurisdictions and between sectors is similar, showing again a strong degree of heterogeneity within

Table 1. Organizational distribution, full Indonesian response system, 2004 Sumatran earthquake and tsunami.

The Distribution of Organizations within the Full Indonesian Tsunami Response System										
	Source of Funding									
	Public		Private		Non-Profit		Special Interest		Totals	
Level of Jurisdiction	N	%	N	%	N	%	N	%	N	%
International	151	27.3%	37	6.7%	40	7.2%	2	0.4%	230	41.5%
National	84	15.2%	48	8.7%	36	6.5%	4	0.7%	172	31.0%
Provincial	18	3.2%	1	0.2%	4	0.7%	1	0.2%	24	4.3%
Special Region	19	3.4%	1	0.2%	6	1.1%	0	0.0%	26	4.7%
Regency	9	1.6%	0	0.0%	2	0.4%	0	0.0%	11	2.0%
Sub-District	1	0.2%	0	0.0%	0	0.0%	0	0.0%	1	0.2%
Local	55	9.9%	23	4.2%	12	2.2%	0	0.0%	90	16.2%
Totals	337	60.8%	110	19.9%	100	18.1%	7	1.3%	554	100.0%

Source: Jakarta Post, Jakarta, Indonesia, December 27, 2004 - January 16, 2005.

Table 2. Frequency distribution of interacting organizations, Indonesian response system, 2004 Sumatran earthquake and tsunami.

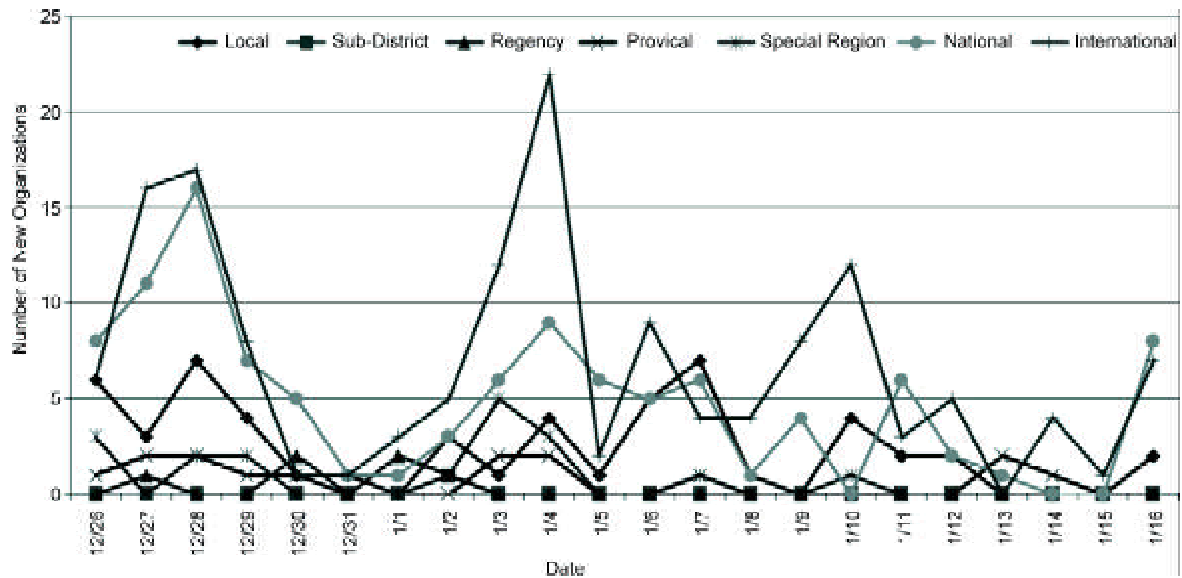
	Source of Funding									
	Public		Private		Non-Profit		Special Interest		Totals	
Level of Jurisdiction	N	%	N	%	N	%	N	%	N	%
International	99	28.3%	23	6.6%	26	7.4%	2	0.6%	150	42.9%
National	57	16.3%	28	8.0%	19	5.4%	2	0.6%	106	30.3%
Provincial	10	2.9%	1	0.3%	3	0.9%	1	0.3%	15	4.3%
Special Region	13	3.7%	0	0.0%	5	1.4%	0	0.0%	18	5.1%
Regency	4	1.1%	0	0.0%	2	0.6%	0	0.0%	6	1.7%
Sub-District	1	0.3%	0	0.0%	0	0.0%	0	0.0%	1	0.3%
Local	32	9.1%	15	4.3%	7	2.0%	0	0.0%	54	15.4%
Totals	216	61.7%	67	19.1%	62	17.7%	5	1.4%	350	100.0%

Source: Jakarta Post, Jakarta, Indonesia, 27 December 2004 - 16 January 2005.

the interacting system. The largest number, 150, or 42.9% of the 350 interacting organizations in the Indonesian response system are international, while the next largest number, 106, or 30.3%, are national. These figures document the extraordinary losses sustained by the local public, private, and nonprofit organizations which represented 54, or 15.4% of the total number of organizations actively engaged in disaster response operations.

Figure (1) shows the daily entry of new organizations into the Indonesian response system. The pattern reveals an early influx of organizations on days two and three, followed by a sharp drop on day four. The entry of new organizations continues to fall on days five and six, and only on January 4, after the New Year 2005, does the number increase again. This increase likely indicates the influx of international nonprofit organizations that played a significant role in the delivery of disaster relief materials to the badly damaged communities of Aceh Province. The jagged pattern of entry of organizations into response operations documents the difficulty in establishing a coordinated response system.

Similarly, a dysfunctional information process in the response to Hurricane Katrina led to a regrettable stand-off between the evacuees from New Orleans and the public officials in Gretna, LA on August 30, the day after the hurricane struck. The evacuees, largely poor minorities displaced from their homes in the flooded city, were told to walk across the Crescent City Convention Bridge to relative safety in the middle-class suburb of Gretna, LA. They were stopped at gunpoint by the Jefferson Parish sheriff and his deputies to prevent them from entering their community [18]. Exhausted, without food and water in sweltering heat, many of them camped on the bridge, waiting for assistance that took hours to come. Federal agencies had still not fully mobilized response operations; the New Orleans emergency service organizations were overwhelmed trying to maintain order in the Superdome; and hundreds of residents of the city of New Orleans were stranded without support or access to safety. Neither the evacuees nor the Jefferson Parish Sheriff's Office had received timely information about alternative strategies for shelter and sources of potential support.



Source: Jakarta Post, Jakarta, Indonesia, 27 December 2004 - 16 January 2005 [19].

Figure 1. Daily entry of new organizations into the Indonesian response system, 2004 Sumatran earthquake and tsunami.

Table (3) reveals the substantial heterogeneity among the 535 organizations reported in the Times Picayune as participating in disaster response operations following Hurricane Katrina.

The data document the high number of federal/national organizations engaged in disaster response, followed by the late entry of these organizations into the disaster response system, as shown in Figure (2). While local organizations from the city and parish levels took some actions before the storm, it was only on September 1, four days after landfall, that a sizeable infusion of support arrived from federal agencies.

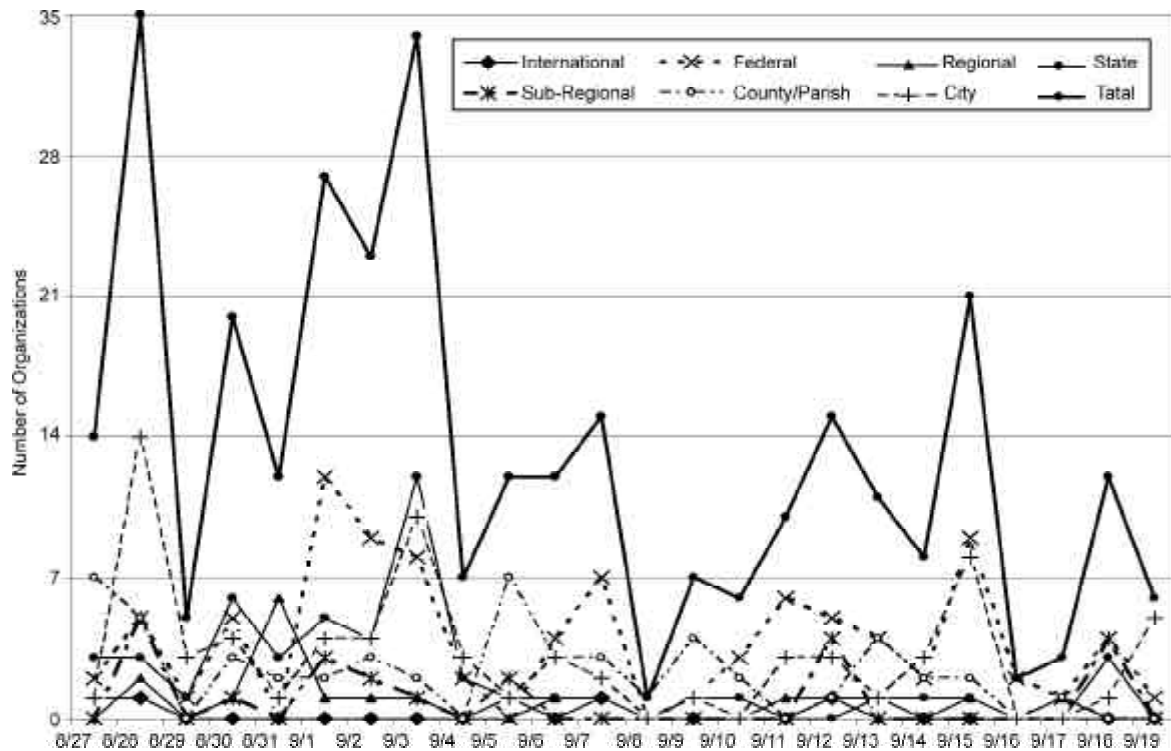
The record of operations from these two catastrophic events, the Sumatran Earthquake and Tsunami and Hurricane Katrina, compels a redefinition of the organizational framework and standard terms

of emergency management. Effective intergovernmental performance requires both structure and flexibility. The difficulty lies in achieving the balance between the two, and recognizing that the appropriate balance will vary with the size, scope, and severity of the event and the initial conditions of the communities in which disaster occurs. The conceptual framework for an emergency management system necessarily must accommodate change and uncertainty. The national disaster plan established by the Indonesian Government proved largely unworkable in Aceh Province that had been wracked by civil conflict before the 2004 earthquake and tsunami. The disaster decimated an already weakened local government and left it with little capacity to cope with the extreme event. In the U.S., the rigid, rule-bound structure

Table 3. Frequency distribution of organizational response system by sector and distribution, Hurricane Katrina, August 26 - September 19, 2005.

	Public		Nonprofit		Private		Special Interest		Total N of all Organizations	
	N	%	N	%	N	%	N	%	N	%
International	11	2.1%	3	0.6%	6	1.1%	0	0.0%	20	3.7%
Federal/Nat'l	69	12.9%	23	4.3%	75	14.0%	1	0.2%	168	31.4%
Regional	1	0.2%	7	1.3%	25	4.7%	0	0.0%	33	6.2%
State	78	14.6%	7	1.3%	4	0.7%	2	0.4%	91	17.0%
Sub-Regional	11	2.1%	12	2.2%	10	1.9%	0	0.0%	33	6.2%
Parish/County	69	12.9%	3	0.6%	1	0.2%	0	0.0%	73	13.6%
City	66	12.3%	29	5.4%	22	4.1%	0	0.0%	117	21.9%
Totals	305	57.0%	84	15.7%	143	26.7%	3	0.6%	535	100.0%

Source: Times Picayune, New Orleans, Louisiana, August 26 - September 19, 2005.



Source: Times Picayune, New Orleans, Louisiana, August 26 - September 19, 2005.

Figure 2. Entry of Actors into Katrina interaction system by date and jurisdiction.

of the National Response Plan with its focus on terrorism and the specific requirements of the National Incident Management System failed to function in the severely damaged context of New Orleans with its vulnerable physical environment, civil infrastructure, and population, as well as in surrounding regions before and after the storm.

If the operational capacity for intergovernmental crisis management is conceived as an evolving, complex system with multiple components that form and reform in response to changing conditions [6], the emerging structure more closely resembles a networked organization than a hierarchical structure with precisely defined allocations of responsibility and authority. In actual events, personnel with assigned responsibilities may not be available, or their capacity to act is reduced by damaged infrastructure, or their resources and experience are inadequate for the conditions they face. The capacity for adaptation to a suddenly altered or rapidly changing environment is critical for effective performance. This capacity still depends on the critical functions of cognition, communication, coordination, and control, but need to be understood in a new way. The requirements of cognition, discussed above, provide the initial content and activating link to the subsequent processes of

communication, coordination, and control. Each process, however, can be redefined in ways that support the capacity for adaptation and change in extreme events.

4.3.1. Communication

Communication in emergency management practice has focused on the interoperability of mechanical devices, such as radios, hand-held data devices, cell phones, landline and satellite telephone networks. In practice, communication necessarily involves the capacity to create shared meanings among individuals, organizations, and groups. Luhmann [15], in his book, *Ecological Communication*, refers to communication as the process of activating the creative spark, or autopoiesis, in self and others. By this, he means the capacity for innovation or finding new ways to solve immediate problems. This capacity generates a larger concept of resonance between an organization and its environment. That is, if the organization articulates its goals and mission in ways that have meaning for others, individuals and organizations in the wider society will respond with resources and support to achieve that goal. Creating and sustaining resonance between the organization and its wider environment are central to achieving effective action in crisis

management.

Luhmann identifies a third factor in the evolution of systems as the capacity to create a unity from the differences among the components, or a new system that is created by mutual recognition and respect for the differences among them. The intent of communication, then, is to reframe the differences among the component elements in ways that allow the components to focus on the characteristics that unify, rather than differentiate, them from one another. For example, if the local emergency managers in the coastal cities and towns of Aceh Province had informed the residents of the risk of tsunami following earthquakes, would the people have escaped to safety on high ground? Or, if the Sheriff of New Orleans Parish, Louisiana had articulated the common goal of regional safety and security to the Sheriff of Jefferson Parish, would the evacuees from New Orleans have been welcomed into Gretna instead of driven back to their drowning city? These are not easy goals to achieve, but the concept of communication clearly includes the creation of shared meanings among different members of an interacting system.

4.3.2. Coordination

Coordination means aligning one's actions with those of other relevant actors and organizations to achieve a shared goal. Again, the capacity for coordination depends upon effective communication. If the communication processes do not elicit sufficient shared understanding among the parties to align their priorities for action, the likelihood of achieving a common action framework among multiple actors is seriously diminished. Coordination has a further characteristic. The term assumes that the participating actors align their activities voluntarily. If this does not occur, managers are left with only two options. They can either coerce the recalcitrant actors into changing their performance (at which point the process can no longer be called coordination), or they can ignore the fact that some actors are not participating fully and essentially become "free riders" on the energy and talents of other members of the group. Such discrepancies breed discontent in any group, and lead, sooner or later, to discontent, frustration, and ineffective performance. Voluntary coordination depends upon effective communication and reinforces the capacity for adaptive performance in dynamic conditions.

4.3.3. Control

Too often the concept of control is misused as the exercise of power over members of an organization by a small group of privileged managers. In the dynamic, uncertain environment of disaster operations, control means, rather, the capacity to keep actions focused on the shared goal of protecting lives, property, and maintaining continuity of operations. Control in this sense is maintained through shared knowledge, commonly acquired skills, and reciprocal adjustment of actions to fit the requirements of the evolving situation. In disaster environments, control means the capacity to focus on the critical tasks that will bring the incident to a nondestructive, non-escalating state. It is self imposed, and in its effective use, sets the example for others to follow in adapting their performance to a changed environment. This concept of control is similar to that articulated in military environments for 'third generation warfare' that characterizes the capacity of military personnel to frame strategies of action to achieve the goal outlined by their commander [10], but based on their own orientation, observation, decision, and action [4].

Individual instances of control were common in disaster response operations following Hurricane Katrina, but in the overall performance of disaster operations, emergency response agencies largely lost control of their capacity to act in the days immediately after landfall. In Aceh Province, the Indonesian military had the legal responsibility to provide relief to the victims of disaster, but after decades of civil war, the citizens bore deep distrust toward the army. Only when the distribution of disaster relief was placed under the agency of the United Nations did the citizens willingly accept assistance. Similarly, in New Orleans, the fact that FEMA employees were told to leave the damaged city until federal reinforcements arrived on September 1 regrettably illustrated the loss of control within the Superdome, the sorry refuge for those who were left behind.

In summary, intergovernmental crisis management can be reframed as a complex, adaptive system that adjusts and adapts its performance to find the best fit to the demands of an ever-changing physical, engineered, and social environment. This capacity depends upon a well-designed information infrastructure that can facilitate the processes of cognition, communication, coordination and control among participating actors and organizations.

5. Conclusions and Recommendations for Change

Reflecting on the costs and opportunities that have been created by the public dialogue following Hurricane Katrina and the Sumatran Earthquake and Tsunami, it is possible to reframe intergovernmental crisis management as an auto-adaptive system [6]. Such a system can be conceived as a dynamic inter-organizational system that is characterized by four primary decision points:

- (1) detection of risk;
- (2) recognition and interpretation of risk for the immediate context;
- (3) communication of risk to multiple organizations in a wider region; and
- (4) self organization and mobilization of a collective, community response system to reduce risk and respond to danger.

The decision points move from individual to organizational to system levels of aggregation and communication of information that are used as a basis for creating a “common knowledge base” to support collective action to reduce risk. In practice, it is at these four transition points of escalating requirements for action that human cognitive, communicative, and coordinating skills frequently fail. When they do, the organizations inevitably lose control of the situation.

A major requirement for improving intergovernmental crisis management is investment in the technical information infrastructure to support the interdependent tasks of cognition, communication, coordination, and control requisite for collective response to an extreme event. This financial investment, most appropriate at the federal or national level, is essential to creating and sustaining the individual and organizational learning processes characteristic of successful auto-adaptive systems. Five propositions regarding constructive change for the intergovernmental crisis response system serve as an initial justification for investment in a regional information infrastructure that would facilitate the development of a “common operating picture” in extreme events. Such an investment would build on the human capacity to learn, and use information technology to monitor performance, facilitate detection and correction of error, and enhance capacity for creative problem solving and responsible performance. The propositions include:

- ❖ Human capacity to perceive risk increases with the timeliness, accuracy, and validity of data

transmitted in reference to a core set of thresholds of risk to conditions critical for community resilience.

- ❖ Human capacity to recognize risk conditions can be increased by focusing risk data in formats that are directly relevant to the responsibilities of each major decision maker in the system, thus reducing the overload of less relevant information and time required for information processing and facilitating rapid absorption of threatening information by individual decision makers.
- ❖ The capacity of a set of organizational managers, each with specific responsibilities and operating at different locations, to coordinate their actions can be increased by the simultaneous transmission of relevant risk information to each manager, creating a “common operating picture” of risk to the region for all managers.
- ❖ The collective capacity of a community to act in coherent ways to reduce risk can be increased through information search, exchange, focused formats for specific tasks or responsibilities, and feedback processes to create an inter-organizational learning system that adapts its behavior to fit available resources to changing conditions of risk more appropriately.
- ❖ Without a well-defined, functioning information infrastructure supported by appropriate technology, the collective response of a community exposed to serious threat will fail.

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