DESIGNING RESILIENCE FOR COMMUNITIES AT RISK: BUILDING CAPACITY FOR COLLECTIVE ACTION

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RISK AND RESILIENCE

The recurring failure of communities to assess, monitor and respond effectively to threats from dynamic environments represents a continuing problem in human and social dynamics. Recent examples of devastation to the city of New Orleans following Hurricane Katrina and the ensuing flood in 2005, and the nearly complete destruction of the city of Banda Aceh, Indonesia following the 2004 Sumatran Earthquake and Tsunami, illustrate the discrepancy between current forms of organizational planning and the actual capacity of individuals and organizations to act collectively in the face of extreme danger. In both instances, scientific information about the potential threat was well documented among scientists, but the representation of the threat and the timely transmission of that information to the wider community failed to initiate appropriate action as the communities confronted the actual events.

While response to the 2004 and 2005 events listed above appears to validate the argument by Mancur Olsen (1965) that organizing collective action for large groups is very difficult, even with the shared goal of reducing extreme danger, we explore a different set of cognitive processes that link information to action. Instead of searching for a 'logic of collective action' (Olsen, 1965), we explore the emergence of a "common operating picture," a term used by emergency managers (EMs) to describe the collective recognition of danger that enables the simultaneous activation of different types of action at different levels of responsibility by distinct actors and organizations. This collective recognition of risk is even more difficult when an entire community is exposed to risk, as there is significant heterogeneity among the individuals, households, groups and organizations, all of whom share the risk, but each has different degrees of knowledge, experience, resources, training, and capacity for action. Many of these diverse actors do not interact with others in the community on a regular basis. Yet, the degree to which an entire community can take informed, timely action in response to urgent threats depends upon its capacity for collective recognition of risk. Developing collective cognition would constitute a primary means for reducing risk and loss from disaster, and serve as a major component of building that community's resilience to recurring risk. We explore the relation between cognition and action for communities exposed to recurring risk, and the possibilities for designing collective cognition that leads to community-wide action to reduce risk.

COLLECTIVE COGNITION IN RISK ENVIRONMENTS

The process of perceiving risk, recognizing danger, and translating that knowledge into action has been studied by psychologists (Weick, 1995; Weick and Roberts, 1993; Klein et al., 1993; Flin, 1995), but those findings have most often focused on individual actors or leaders. Klein and his colleagues have developed a model of "recognition-primed decisionmaking" (RPD) which captures the process of perceiving risk, identifying plausible actions in a constrained environment, and formulating a workable strategy of action. This model has been recognized by emergency response personnel and military officers as an insightful representation of the decision making process they follow in urgent environments (Killion, 2000). The focus of the RPD model, however, remains on the individual decision maker, not on collective cognition.

The High Reliability theorists (LaPorte and Consolini, 1993; Rochlin et al., 1987; Roberts, 1993) come closest to studying collective cognition by examining the processes of perception, training, and action that characterize organizations that operate under risky conditions. The primary feature of these organizations is common training, common knowledge, and shared responsibility for executing the mission. While this model has been demonstrated effectively on aircraft carriers and, nuclear plants, the focus is on a set of well-defined tasks executed by a single organization.

Instances of collective cognition in communities have been observed and reported. A vivid instance that documents this phenomenon was reported in the accounts of actions taken by the inhabitants of Simeulue Island, just off the tip of Northern Sumatra following the 2004 Sumatran Earthquake and Tsunami.[1] The island is located about forty miles from the epicenter of the Magnitude 9.0 Richter scale earthquake. Although the ensuing tsunami wave struck the island with dangerous force within 30 minutes of the earthquake, there was little loss of life from the tsunami, unlike the coastal communities of other nations around the Indian Ocean Basin. Only 7 of the 75,000 inhabitants of Simeulue Island died due to the tsunami. As the first wave of the sea pulled back, the islanders recognized that the returning wave would engulf everything in its path and ran to high ground. Their spontaneous life-saving actions were triggered by a common recognition of the indicators of a tsunami wave, information handed down from generation to generation. This shared knowledge base created a "common operating picture" when the tsunami struck, and enabled the islanders to form a coherent, timely, collective response to the threat. The communities on Simuelue Island were simple, without sophisticated telecommunications or trained emergency response personnel. Yet, this incident illustrates the power of creating a common knowledge base for a community exposed to recurring risk.

The challenge of building capacity for collective cognition on a community-wide scale lies in balancing the heterogeneity of individuals, organizations, groups, and information systems that make up even small communities with a common focus for the welfare of the community and a bias for action. For example, the Simuelue islanders constituted a small, homogeneous community with shared experience of earthquakes and tsunamis that threaten the island in recurring patterns. All members of the community shared a common history that includes recognition of tsunami risk, and a common goal of survival. In moving to a more complex community, the degree of heterogeneity increases with the size, number, and range of differences in knowledge, tasks, and resources held by the agents[2] in the community. The task of creating a "common operating picture" increases with the degree of complexity that characterizes the operational components of the community as a system, and the interactions among those components. Further, if the interactions among the component groups are supported by multiple information processes, any member of the community is likely to be exposed to different, and often conflicting, information sources than other members. The risk is that the complexity of factors involved in the communications process stifles action, as individuals, groups, and organizations lose their focus in an effort to juggle conflicting priorities. Collective cognition is not a trivial task, particularly in an environment of shifting conditions, urgent time constraints, limited resources, and changing perspectives on action.

[1] http://www.usatoday.com/news/world/2005-02-28-tsunami-island_x.htm

[2] All participating actors in the community will be termed 'agents' in the subsequent discussion.

Building collective cognition of risk in a community undergoing rapid change requires an ongoing process of updating strategies of action based on incoming information, and revising or eliminating prior assumptions based on outdated information. This requirement is difficult for human managers operating under urgent stress, as it requires them to rethink their original assumptions and formulate new ones that are more consistent with current information. In Argyrian terms, it represents "double loop learning" (Argyris 1985) as human managers rethink the assumptions that serve as the rationale for their actions (or inactions). This type of learning rarely occurs under stressful conditions, as it requires reflection and reasoning that most often occur over time.

COLLECTIVE COGNITION OF RISK

The critical problem in building collective cognition of risk in rapidly changing environments lies in updating shared knowledge of risk with current information regarding imminent threats. This may mean revising existing beliefs based on outdated information, as well as reformulating strategies of action based on valid, current information. This task is difficult on an individual basis, but in environments exposed to shared risk, such as the Gulf Coast states in the U.S., or the coastal nations of the Indian Ocean Basin, the task becomes magnified by the size of the area, the number of entities likely to be affected, the heterogeneity of the entities in terms of differences in language, law, and culture.

Two primary approaches have been proposed as a means of building collective cognition. The first is to develop a 'culture of prevention' in the region exposed to risk. (Puente, 2006; Briceño, 2007). Such a culture may develop over generations, as was shown in the Simuelue case. It is based on the assumption that beliefs about risk adopted at an earlier time remain valid across generations. Actions, based on these beliefs, are confirmed by recurring experience. As experience is shared, beliefs are reinforced throughout the community. There is anecdotal evidence that this cultural perspective has developed in areas that experience frequent hazards, as in Erzincan, Turkey that is exposed to frequent seismic risk (Comfort and Sungu, 2001) or in the island nations of the Caribbean Region that are exposed to recurring hurricanes (Huggins, 2007). Yet, no systematic model or approach has been developed for characterizing the collective belief structures – or mental model – of a region exposed to recurring risk. The question is whether the earlier beliefs continue to fit the conditions of risk in a changing environment.

The second approach has been proposed by computer scientists. It is based upon using networks of technical sensors to measure and transmit information on changing conditions that reveal risk to the community under time-sensitive conditions. This approach is based on developing a capacity for collective reasoning on a regional scale. It proposes using the technical capacity of sensors, computers, and telecommunications to monitor, update, revise, and disseminate information about risk to responsible agencies that base their actions on current, valid information regarding changing conditions in a region exposed to recurring risk.. An early proponent of this approach, Jon Doyle (1979) termed his proposed model a "truth maintenance system." The system was based upon systematic monitoring of conditions of risk, and timely updating of information regarding the vulnerability of the region (Doyle, 1979). While Doyle has since renamed this concept as a reason maintenance system, the basic concept is the same. It relies on the processing of incoming information regarding risk, presenting this information to key decision makers responsible for coordinating action in disaster environments, and engaging their reasoning processes, as opposed to cultural values, in the decision making regarding an uncertain situation. What distinguishes Doyle's concept from other work on collective reasoning processes is that he acknowledges the importance of updating obsolete information, correcting errors in assumptions, and revising strategies of action based on more accurate, valid, and complete information. Doyle's approach is decidedly rational, and he uses the systematic power of computation to update, validate, and revise underlying assumptions that inform action in environments exposed to risk. He acknowledges the importance of beliefs as the basis for action, but also that beliefs may change over time in response to new information.

In this process, the technical skills of computation enhance the intuitive skills of human reasoning, and provide a more systematic check against personal bias or error. The intent is to enhance the reasoning skills of human managers by providing technical support to the often subjective and unsystematic process of reasoning from known facts to probable actions in an uncertain environment. Doyle's approach links information to action in a systematic, timely way. More important, he acknowledges that not correcting errors in assumptions underlying actions in complex, interdependent environments creates new risk from faulty human reasoning that can escalate danger across sociotechnical systems.

THE CHALLENGE FOR ACTION

The challenge, of course, is to design a workable model that can support the complex task of building collective cognition of risk in a multi-organizational, multi-sectoral, interdependent community. Current information technology makes it plausible to consider methods of identifying core assumptions underlying existing public policies, checking the validity of those assumptions against current scientific knowledge or incoming data in a changing environment, identifying quickly which assumptions are no longer accurate, updating the status of valid knowledge; and making the current status of the community accessible to key decision makers in response organizations to inform their actions in response to changing conditions. More difficult is the process of engaging individual processes of cognition and extending those processes to create a collective mental model of risk for the community.

Obstacles to collective cognition and learning

Chris Argyris recognized that difficulties in bridging individual and organizational learning arose from faulty assumptions embedded in belief structures that went unquestioned despite obvious evidence to the contrary (Argyris, 1993). Termed 'defensive routines,' these beliefs were not based in fact, but rather reinforced core concepts of self in relation to others that focused individual action narrowly on a predefined set of values, triggering action almost automatically (Argyris et al. 1985; Argyris and Schõn, 1996). In Argyrian terms, individuals were not acting on the basis of information, but rather on 'mental models' constructed from previously defined categories that emerged from their experience and social context. If individuals were not exposed to other concepts or experiences, they found it easier to function with an existing view of the world that did not challenge their basic beliefs. This process becomes more complex in a community with a wide range of organizations that have different degrees of knowledge, experience, and training in reference to risk reduction and response. Consequently, a first step in building a model of collective action in risk environments is to examine the basic assumptions that characterize a community's approach to managing risk.

A sociotechnical strategy for building collective action for risk reduction

To examine the process of collective action in managing recurring risk, we undertook a trial demonstration project in twenty-eight communities in the Pittsburgh Metropolitan Region that are exposed to recurring risk of flooding. This set of communities, all but one, borders the Monongahela River .Most have experienced repeated flooding in their two hundred year history, and all have been affected by the damage and losses incurred by neighboring communities. Previous practice has been for each municipality to look to Allegheny County for assistance, mop up the flood waters, comfort the victims, and hope the sun will return. But the risk recurs, the losses continue, and the communities are now willing to explore alternative strategies for managing flooding risk. One important strategy is to examine the potential for reducing risk through adopting new information technologies and training for emergency services personnel.

The Interactive, Intelligent, Spatial Information System (IISIS) Laboratory of the University of Pittsburgh designed a one-year trial demonstration project to explore the role of information technology in increasing the capacity of these twenty-eight communities to manage the risk of flooding and other hazardous incidents in a more timely, efficient way. The proposal gained the support of three local Pittsburgh foundations and the Mon Valley Project was initiated on October 1, 2006. The project also received corollary support from a shelter program conducted in these same communities by the Southwestern Pennsylvania Chapter of the American Red Cross and funded by the U.S. Steel Corporation, once the primary employer of the residents of these river communities. The goal of the project is to design and implement a prototype interactive, intelligent, spatial information system that the twenty-eight communities could use to manage the recurring risk of flooding more efficiently and effectively.

Assumptions underlying the Mon Valley Project

The design of the Mon Valley Project was informed by a set of assumptions drawn largely from prior observation and research regarding change processes in dynamic environments. This design represents an adaptation of Doyle's "reason maintenance system" to a set of communities that share the common threat of flooding, but that have operated as independent municipalities throughout their history.

These assumptions are:

1. A community's capacity for response is viewed as a dynamic inter-organizational system of interacting organizations, groups, and individuals that mobilize action to reduce risk
2. This system is characterized by four primary decision points:
    a. detection of risk;
    b. recognition and interpretation of risk for the immediate context;
    c. communication of risk to multiple organizations in a wider region; and
    d. self organization and mobilization of a collective, community response system to reduce risk and respond to danger
3. Information serves as the driving force for change in the system; conversely, lack of information serves as a potential source of failure
4. The rate of change in capacity for risk reduction increases as communities invest time and resources in building an information infrastructure to support inter-organizational learning

A TRIAL DEMONSTRATION PROJECT IN THE MONONGAHELA VALLEY

The Mon Valley Project, conducted in 28 adjacent communities, had four main phases: 1) data collection; 2) construction of the knowledge base; 3) continuing development and implementation of an interactive prototype decision support system; and 4) training sessions for emergency services personnel to evaluate the prototype decision support system. The project conducted a final session for emergency services personnel to demonstrate the functions incorporated from feedback from the emergency managers.

First, an initial survey was done of the emergency services personnel in each of the twenty-eight municipalities to do a baseline assessment of what hazards constitute the primary threats to their respective communities, what are their existing practices in terms of planning and preparedness for response, what types of technical equipment and information technology they are currently using, and what are their current patterns of interaction both among emergency services within each municipality and among municipalities. Second, the data collected by the survey was incorporated into a common knowledge base for all twenty-eight municipalities, and a Geographic Information System (GIS) for the sub-county region was developed. Third, the technical development of a dynamic decision support system proceeded throughout the year, and was used in the set of training sessions that was conducted in June, July, August, and September, 2007. These training sessions were designed to demonstrate the prototype decision support system to local emergency managers and also to invite their comments, suggestions, and feedback regarding the performance of the system for the needs of their communities. The training sessions were also intended to provide opportunities for information exchange and interaction among emergency managers in the study region.

The analysis of findings from this project is still in process, but we present preliminary findings on the characterization of the communities and their existing pattern of actions in regard to risk and response. Data from the initial survey of emergency personnel from all 28 communities, conducted at the beginning of the study, portray a set of communities with a relatively high exposure to risk, but a limited degree of preparedness and collective action in response to emergencies. On the next page, Table 1 presents the.frequency distribution of the types of incidents to which emergency services agencies responded in the last five years. The data show the significant risk of flooding to the region, with nearly half, 46.3%. of the response actions taken in reference to flooding. Table 1 also shows the dominant role of the fire services in emergency response actions in these small Mon Valley communities, with 59.1% of the response actions reported by fire personnel. This fact underscores both the vulnerability and the commitment of these valley communities, as 27 of the 28 communities rely on volunteer fire departments. In the distribution of emergency services provided by agency, fire personnel provide half of all services, or 50.4% of all services reported. Within the fire departments, two thirds, or 66.7%, of their response actions involve fire and rescue services.

Table 1: Frequency Distribution by Types of Incidents by Agency*

	Fire		Police		EMS		Total	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Flooding	420	41.1	168	43.6	213	66.2	801	46.3
Windstorm	198	13.4	59	15.3	30	9.3	287	16.6
Hazmat Incident	142	13.9	28	7.3	15	4.6	185	10.7
Utility Disruption	83	8.1	35	9.1	20	6.2	138	8.0
Building Collapse	70	6.8	10	2.5	10	3.1	90	5.2
Mass Transit Accident	19	1.8	37	9.6	18	5.6	74	4.3
Aviation Accident	21	2.1	3	0.8	6	1.9	30	1.7
Landslide	57	5.6	45	11.7	10	3.1	112	6.5
Other	12	1.2	0	0	0	0	12	0.7
Total	**1022**	**59.1**	**385**	**22.3**	**322**	**18.6**	**1729**	**100.0**
Number of Cases = 60 Number of Observations = 1729								

* Multiple responses were accepted.

**Column % calculated against column total, but the cumulative total is calculated against total number of responses, 1729.

According to the state and county emergency plans, each community is expected to complete an analysis of the hazards to which their community is exposed. One measure of preparedness is the extent to which these hazard analyses have been completed. Table 2 reports that less than 30% of the respondents report completing a formal hazard analysis, while nearly one-quarter, or 24.1%, report completing an informal hazard analysis. More than one-third, or 37.9%, report no knowledge of a hazard analysis and 8.6% report that none has been conducted.

Table 2: Frequency Distribution of Degree of Completion of Hazard Analyses*

Q.: "Has your agency completed a hazard analysis for your jurisdiction specific to the services your organization provides?"

		Fire		Police		EMS		Total	
	Value	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Formal	4	14	43.8	2	10.5	1	14.3	17	29.3
informal	3	8	25.0	3	15.8	3	42.9	14	24.1
not to my knowledge	2	7	21.9	12	63.2	3	42.9	22	37.9
none	1	3	9.4	2	10.5	0	0.0	5	8.6
Total		**32**	**55.2**	**19**	**32.8**	**7**	**12.1**	**58**	**100.0**
Number of Cases = 58 Number of Responses = 58 Mean = 2.74; Median = 3.00; Std. Deviation = 0.98									

*Column % calculated against column total; the cumulative total is calculated against total number of responses, 58.

These findings show a limited degree of preparedness that compounds the dependence of these communities on volunteer fire departments. This finding is corroborated by the responses to planning practice. Table 3 reports the degree to which planning measures have been developed and put into practice. Nearly half of the 57 respondents report that their municipality has formal written operational plans, while a large percentage, 40.4%, report that they operate on past practice without plans, and a small percentage, 5.3%, report that they have no plan or past practice.

Table 3: Planning Measures in Place by Degree of Practice*

		Fire		**Police**		**EMS**		**Total**	
	Value	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Formal written flood plans	4	1	3.2	2	10.5	0	0	3	5.3
Formal written operational plans	3	14	45.2	9	47.4	5	71.4	28	49.1
Past practice w/o plans	2	14	45.2	7	36.8	2	28.6	23	40.4
No plan or past practice	1	2	6.5	1	5.3	0	0	3	5.3
Total		**31**	**54.3**	**19**	**33.3**	**7**	**12.3**	**57**	**100.0**

Number of cases = 57
Number of responses = 57
Mean = 2.54
Median = 3.00
Std. Deviation = 0.68

*Column % calculated against column total; the cumulative total is calculated against total number of responses, 57.

Given the exposure to risk and the limited preparedness and planning practice, one means of securing assistance in event of disaster is the development of mutual aid agreements among municipalities. Mutual aid means that one community agrees to provide resources to a neighboring community, if that community is struck by an extreme event. The difficulty with mutual aid agreements is that in region-wide events such as flooding, the neighboring community may also be damaged and thus unable to provide assistance, if asked.

Table 4: Frequency Distribution of Types of Mutual Aid Agreements Among Emergency Services*

	Fire		**Police**		**EMS**		**Total**	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Written into preplans & exercised	21	40.4	8	29.6	2	22.2	31	35.2
Written agreements but not preplaned/explained	8	15.4	6	22.2	5	55.6	19	21.6
informal agreement/history of working together	18	34.6	11	40.7	2	22.2	31	35.2
none, we will call when needed	4	7.7	2	7.4	0	0.0	6	6.8
none, mutual aid not permitted	1	1.9	0	0.0	0	0.0	1	1.1
Total	**52**	**59.0**	**27**	**30.6**	**9**	**10.2**	**88**	**100.0**

N of cases = 60
N of responses = 88

* Multiple responses were accepted.
** Column % calculated against responses by agency, cumulative total calculated against total number of responses, 88.

Table 4 above shows the distribution of types of mutual aid agreements that are currently in place among the 28 communities in the study. Slightly more that one-third, or 35.2%, of the 60 emergency personnel responding to this question reported that mutual aid agreements were written into their preplans and exercised. A comparable number, 35.2%, reported that they relied on informal agreements and a history of working together, while 21.6% replied that they had written agreements, but the agreements were not preplanned or explained. A small number reported that they had no mutual aid agreements, but would call when they needed assistance.

Information is critical to activating emergency response, and the types of information to which the emergency response personnel have access shapes their capacity in both local and regional events. Table 5 presents the distribution of responses regarding types of information that are perceived as critical to emergency response. Not surprising, weather forecasts/warnings are identified by the largest number, 23.4%, of responses, while other types of information such as utility information and resources are also identified as critical.

Table 5: Frequency Distribution of Types of Information Perceived as Critical to Emergency Response*

	Fire		Police		EMS		Total	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**
weather forecasts/warnings	32	22.4	14	25.4	5	25.0	51	23.4
Utility company info	22	15.4	11	15.4	4	20.0	37	17.0
resources from your dept	26	18.1	9	16.3	2	10.0	37	17.0
resources from other depts	25	17.5	12	21.8	5	25.0	42	19.3
specific building info	21	14.7	6	10.9	1	5.0	28	12.8
hazard info	17	11.9	3	5.5	3	15.0	23	10.6
Total	**143**	**65.6**	**55**	**25.2**	**20**	**9.2**	**218**	**100.0**
N of cases = 60 N of responses = 218								

* Multiple responses were accepted.

**Column % calculated against responses by agency, but the cumulative total is calculated against total number of responses, 218.

Sources of information are also critical to effective emergency response. On the next page, Table 6 presents the data regarding the different sources of information that are identified as critical by emergency response personnel in the study area. Community dispatch represented 25.9% of the responses, while direct observation represented 20.8%. Preplanning represented only 13%, and was nearly matched by the internet as a source, at 12.5% of the responses. Combined with 8.3% of the responses for the in-station computer, this finding indicates an emerging reliance on information technology among the emergency responders.

Nonetheless, communications problems remain a persistent difficulty in emergency response, and can inhibit the capacity for a community or regional response. Table 7 reports the data on types of difficulty that are most frequent in communications during emergency events. Interestingly, incomplete information and inaccurate information represent a significant proportion of the problems reported, at 37.9%, as well as the inability to access other organizations, at 17.4%. Equipment and technical difficulties also were identified as a source of difficulty in emergency communications.

Table 6: Frequency Distribution of Sources of Information Perceived as Critical to Emergency Response*

	Fire		Police		EMS		Total	
	N	%	N	%	N	%	N	%
Dispatch	31	25.4	19	30.6	6	18.8	56	25.9
Observation	25	20.5	14	22.6	6	18.8	45	20.8
Preplan	19	15.6	5	8.1	4	12.5	28	13.0
resource manuals	9	7.4	4	6.5	5	15.6	18	8.3
field computer	3	0.5	2	3.2	1	3.1	6	2.8
in-station computer	9	7.4	5	8.1	4	12.5	18	8.3
Internet	13	10.7	8	12.9	6	18.8	27	12.5
other agency	13	10.7	5	8.1	0	0	18	8.3
Total	**122**	**56.5**	**62**	**28.7**	**32**	**14.8**	**216**	**100.0**
N of cases = 60 N of responses = 216								

* Multiple responses were accepted.
**Column % calculated against responses by agency, but the cumulative total is calculated against total number of responses, 216.

Table 7: Frequency Distribution of Types of Perceived Communication Problems in Emergency Response Operations*

	Fire		Police		EMS		Total	
	N	%	N	%	N	%	N	%
Incomplete info	21	22.6	8	18.2	5	20.8	34	21.1
inaccurate info	14	15.0	8	18.2	5	20.8	27	16.8
unable to access other orgs/units	13	14.0	11	25.0	4	16.7	28	17.4
required info was unavailable	7	7.5	1	2.3	4	16.7	12	7.5
info overload	6	6.5	2	4.5	1	4.2	9	5.5
Tech/equipment difficulties	16	17.2	9	20.5	2	8.3	27	16.8
interoperability problem	12	12.9	5	11.4	3	12.5	20	12.4
Other	4	4.3	0	0.0	0	0.0	4	2.5
Total	**93**	**57.8**	**44**	**27.3**	**24**	**14.9**	**161**	**100.0**
N of cases = 60 N of responses = 161								

* Multiple responses were accepted.
**Column % calculated against responses by agency, but the cumulative total is calculated against total number of responses, 161
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The findings presented above characterize the capacity for the emergency services to respond to hazards in their communities. Table 8 presents their reported interactions with outside agencies. Interestingly, fire services interact most frequently with outside agencies, at approximately twice the rate as their counterparts in the police and EMS services. Not surprisingly, fire services interact most frequently with other fire agencies; police services interact most frequently with other police services. While the data clearly show patterns of interaction with other agencies, 97 out of a total of 337 responses, or 28.8%, reported that they rarely interacted.

Table 8: Frequency Distribution of Reported Interactions with Outside Agencies*

	FIRE						**POLICE**					
	frequently		**occasionally**		**rarely**		**frequently**		**occasionally**		**rarely**	
Value	3		2		1		3		2		1	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Fire	26	41.3	1	22.2	3	5.6	12	20.3	8	18.6	0	0.0
rescue	5	7.9	13	28.9	8	15.1	6	10.2	10	23.3	3	9.7
EMS	6	9.5	6	13.3	9	17.0	15	25.4	5	11.6	0	0.0
police	10	15.9	4	8.9	7	13.2	17	28.8	1	2.3	0	0.0
emerg. mgmt	9	14.3	6	13.3	7	13.2	5	8.5	6	14.0	7	22.6
Hazmat	4	6.3	5	11.1	12	22.6	1	1.7	6	14.0	12	38.7
Red Cross	3	4.8	10	22.2	7	13.2	3	5.1	7	16.3	9	29.0
Column Total	**63**	**44.7**	**45**	**44.6**	**53**	**54.6**	**59**	**41.8**	**43**	**42.6**	**31**	**32.0**

	EMS						**TOTAL EMERGENCY SERVICES**					
	frequently		**occasionally**		**rarely**		**frequently**		**occasionally**		**rarely**	
Value	3		2		1		3		2		1	
	N	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
Fire	4	21.1	2	15.4	1	7.7	42	29.8	11	10.9	4	4.1
rescue	2	10.5	2	15.4	2	15.4	13	9.2	25	24.8	13	13.4
EMS	7	36.8	0	0.0	0	0.0	28	19.9	11	10.9	9	9.3
police	5	26.3	1	7.7	1	7.7	32	22.7	6	5.9	8	8.3
emerg. mgmt	0	0.0	3	23.1	3	23.1	14	9.9	15	14.9	17	17.5
Hazmat	0	0.0	2	15.4	4	30.8	5	3.5	13	12.9	28	28.9
Red Cross	1	5.3	3	23.1	2	15.4	7	5.0	20	19.8	18	4.1
Column Total	**19**	**13.5**	**13**	**12.9**	**13**	**13.4**	**141**	**100**	**101**	**100.0**	**97**	**100**

Number of cases = 57
Number of responses = 218

* Multiple responses were accepted.
**Column % calculated against responses by agency, but the cumulative total is calculated against total number of responses, "frequently" = 141, "occasionally" = 101, and "rarely" = 97.

CONCLUSION

Returning to the set of assumptions stated earlier, it is clear that building capacity for collective response on a regional scale is not an easy task. The 28 communities in the Mon Valley study area had significant exposure to risk, but limited investment in personnel, equipment, and training. There is a beginning pattern of use of information sources and planning to improve emergency response, but still a significant reliance on informal means and historical practice.

This indicates that there is growing interest in improving performance, but still a significant set of traditions and practice to overcome. These findings characterize the Mon Valley communities at the beginning of the study. Even in this sub-region of the County, the findings document a significant degree of heterogeneity in exposure to risk, access to information, and investment in training and equipment

The critical question will be whether the interactions among the emergency services within municipalities will increase with the use of the regional decision support system, and especially whether the interactions among the municipalities will increase. It is clear that lack of information inhibits interaction, and problems in communication limit interaction among agencies within a jurisdiction, and also among jurisdictions. If information serves as the driving force for change; then lack of information serves as a potential source of failure. The Mon Valley Project marks a beginning effort to increase the rate of change in capacity for risk reduction. As communities invest time and resources in building an information infrastructure to support inter-organizational learning, this investment will likely return major benefits to the set of communities and the region. Well designed information technology that allows a set of municipalities to check the state of their communities against valid information and to correct faulty information and assumptions more quickly holds promise as an updated version of a 'reason maintenance system.'

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