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Managing Risk in Real Time: Integrating Information Technology into Disaster Risk Reduction and Response

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Introduction

Emergency managers in Pennsylvania face an extraordinarily complex set of tasks in reducing risk to communities that vary widely in size from the metropolitan regions of Philadelphia and Pittsburgh to the small towns of rural Pennsylvania. These communities, with different degrees of density in population and interdependence of infrastructure, are exposed to a wide range of weather conditions, transportation accidents, hazardous materials spills, technical failures, and potential security threats. Emergency managers are responsible for identifying potential threats to the Commonwealth, alerting multiple agencies that are responsible for different functions to reduce such threats, and mobilizing an effective inter-organizational system to respond to rapidly evolving emergency events. Recent events, such as the severe ice storm of February 14, 2007, illustrate the risks, costs, and losses that occur in such emergencies on a region-wide basis.

Increasingly, emergency managers are turning to decision support systems to provide real-time information for the complex tasks of anticipating, communicating, and responding to emergencies. While various software programs such as EIS, E-Team, and WebEOC have been designed, developed, and adopted by emergency response agencies, none has been particularly successful in providing the type of dynamic, yet focused information that emergency managers need to mobilize coordinated action on a regional scale. Emergency managers, operating at different locations and carrying out different functions simultaneously, require timely, valid information that can be updated quickly as conditions change. The challenge is to create a “common operating picture" for the set of emergency managers working at different levels of responsibility and exposed to different degrees of risk to enable them to take more informed, effective action in a coordinated response for the region.

Creating this "common operating picture" is complicated by the heterogeneity of disciplines, organizations, and jurisdictions that are involved in the mobilization of an effective response system to an extreme event. For example, the response system that evolved following Hurricane Katrina included 535 organizations from city, parish, sub-region, state, federal, and international jurisdictions, identified in news reports from the *Times Picayune* published in New Orleans, Louisiana (Comfort and Haase 2006). The distribution of organizations crossed jurisdictional lines, as 76, or 23.9%, were from the municipal level of operations, while 93, or 29.2%, were federal organizations. In hindsight, it is clear that few personnel from these two levels of operations had worked together previously, or had developed a common understanding of what actions needed to be taken by which agencies at what time to reduce the threat to the region.

The initial step in disaster reduction lies in recognizing risk, and in developing a common definition of risk that is shared among the participating actors. Under these conditions, risk is the probability of danger, not the hazard itself. It can be defined as the dynamic interaction of the exposure to hazard, less the capacity of the community to act to reduce that hazard (Johnson 2005). Many theorists have sought to define risk, but it is difficult to capture the dynamic characteristics of risk as it changes both over time and in reference to specific geographic, technical, organizational, social, economic, and political conditions. Omar Cardona (2003), an international engineer who has examined risk from multiple perspectives, refers to risk as the potential loss to the exposed subject or system, resulting from the convolution of hazard and vulnerability.

Cardona recognizes, importantly, that the degree of risk to which a community is exposed may be modified by actions taken to reduce vulnerability to hazards in the community. Further, he specifies that vulnerability is increased or decreased by the interaction among technical, organizational, social, economic, political, and cultural conditions as the community acts in reference to the hazards to which it is exposed. That is, if a community acknowledges its exposure to hurricanes and allocates resources and training to emergency response agencies to prepare for such extreme events, its vulnerability to hurricanes will decrease. For example, the state of Florida, based on its significant experience, has increased its capacity to reduce the likely consequences of hurricanes for its communities, and has notably decreased its vulnerability to this hazard, although hurricanes will surely recur in Florida. Conversely, if a community acknowledges the threat of severe weather, but takes no action to mitigate the likely consequences for its population and infrastructure, its vulnerability to severe weather will increase. Risk is the status of the community at a particular time, given its exposure to a specific hazard and the actions that it has taken to reduce that hazard.

Cardona (2003) proposes that the degree of risk for any community may be expressed in mathematical terms as “the probability of surpassing a determined level of economic, social, or environmental consequence at a certain site and during a certain period of time.” This proposition suggests a practical means of assessing risk from known hazards for specific communities, and using this information as a basis for informed decision making to reduce risk from hazards. Determining the degree of risk for a given community requires the design and development of a knowledge base and decision support system for the region that characterizes the economic, social, technical, organizational, and geophysical characteristics of the region in order to identify accurately the thresholds of performance that enable a community to manage the consequences of the hazard and still continue its basic operations. Current information technologies provide the potential for addressing the assessment of risk in real time, and providing timely, accurate decision support to practicing emergency managers in the dynamic environment of disaster risk reduction and response.

Risk Assessment and Response at a Regional Level

Managing risk for a given region involves measuring the rate of change between two interacting components in real time: 1) the degree of exposure to a specific hazard for the region, and conversely, 2) the capacity of the region to act to reduce the likely consequences of that hazard when it occurs. The dynamic is reciprocal. As the degree of exposure to a given hazard increases and the region deploys its existing capacity to reduce the likely consequences of that hazard, the vulnerability of the community to danger will increase, unless capacity is augmented. The ratio of the probability of occurrence of the hazard to the capacity of the region to mitigate that hazard will vary over time. Achieving the appropriate balance between timely, accurate assessment of the probability of hazards and allocation of resources and effort to minimize the potential consequences can be enhanced with the use of innovative information technologies.[1] Designing decision support systems to enable emergency managers to make more informed, timely decisions in managing risk represents an innovative approach to the reduction of recurring risk in metropolitan regions.

A community's capacity for response to hazards can be considered 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. It is at these four transition points of escalating requirements for action that human cognitive, communicative, and coordinating skills frequently fail. Five propositions present a conceptual framework for building resilience in communities exposed to recurring risk.

Detection of Risk

In detection of risk, measurement of hazards is conducted by a network of scientists that review and validate the current status of the hazard and then forward this information to decision makers in public, private, and nonprofit organizations. For example, on August 23, 2005, the meteorologists at the National Hurricane Center (NHC) in Florida identified a tropical depression forming over the Bahamas. On August 24, they upgraded it to Tropical Storm Katrina. On August 25, the staff at the NHC tracked the storm as it made landfall in south Florida as a Category 1 hurricane. On August 26, the storm moved into the Gulf of Mexico and intensified to become a Category 2 hurricane and the NHC

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[1]The Interactive, Intelligent, Spatial Information System (IISIS) Laboratory at the University of Pittsburgh has focused on the degree to which the capacity of a region to respond to shared risk can be enhanced by the appropriate use of innovative information technologies. For more information, please see http://www.iisis.pitt.edu.

projected landfall in Louisiana and Mississippi. At each step of the evolving state of the storm, scientists at the NHC notified the public officials and news media regarding its changing strength and direction. On August 27, as the storm strengthened over the Gulf of Mexico, the NHC upgraded it to a Category 3 hurricane; the next day, August 28, the storm intensified to a Category 4, and then Category 5 storm, with winds over 175 miles per hour. On Monday morning, August 29, Hurricane Katrina made landfall just east of New Orleans as a Category 4 storm. The scientists monitoring the hazard – the evolving hurricane – provided timely, accurate information to both decision makers and the public. Ironically, this scientific information did not lead to sufficiently informed action by the policymakers and emergency managers.

While the validation of weather data is an important stage in this process, monitoring performance across a wider range of critical conditions for the community would provide more accurate and timely detection of emerging danger than separate assessments for particular conditions. The process of risk detection is vulnerable to the fragilities of human organization and performance. Responsible decision makers may be watching separate conditions for indications of vulnerability, but miss the interaction among these conditions that may intensify the potentially destructive impact of the hazard on the whole community. The design of appropriate means to assess the status of a core set of interacting conditions and operational systems critical to the community would augment the early detection and validation of risk. These assessments, reported as thresholds of risk across a set of critical conditions and functions for the community, would provide a more integrated and timely assessment of risk to human decision makers responsible for risk reduction.

In order to achieve such a distributed system of data detection and analysis, an effective decision support system would require a number of monitoring systems that would measure change in critical conditions for maintaining continuity of operations. For example, measuring the capacity of the levee system to withstand the added pressure of a storm surge from the Gulf of Mexico moving into the City of New Orleans through the Mississippi River Gulf Outlet would be a key factor in determining the vulnerability of the city’s population to the storm. Other factors, such as monitoring the state of readiness to implement the evacuation plan for all sectors of the city’s population, or the current status of alternate communications facilities, are essential measures to calculate the degree of risk for the entire metropolitan region. These monitoring systems would not only provide redundancy in incident detection, but also allow measurement of the rate of change in key factors over time, which is critical to understanding the probable impact of the hurricane on the community under study. When more details are needed on a particular event, the set of monitors should be able to deliver this information in as much detail as the emergency managers require. Only the needed information should be shown to the emergency managers during the daily operation of the system.

> **Proposition 1**: Human capacity to perceive risk increases with the timeliness, accuracy, and validity of information transmitted in reference to a core set of thresholds of risk to conditions critical for community resilience.

Recognition and Interpretation of Risk

Prior research has found that an individual's capacity for problem solving drops under stress (LaPorte 1975, Miller 1967, Simon 1981). This drop in capacity is the result of the increased number of risk factors, the degree of unfamiliarity with new information, and the degree of uncertainty that characterizes extreme events. In these contexts, appropriate uses of information technology offer a means of extending human problem solving capacity in uncertain conditions. A key question for investigation is the extent to which a socio-technical information infrastructure, designed to detect and transmit risk information quickly and accurately, can facilitate the rapid recognition of risk within a community and lead to more informed, timely action.

With a well-designed socio-technical system, the emergency managers will receive only the information they select to view. The usual way of doing this is to centralize all information into a single server, use database technology to extract relevant views from the database, and transmit it to the consoles of the emergency managers. This approach often creates a bottleneck, since data must be collected into a single server and extracted from the single server under tight timing constraints (in real-time) to be useful. Most systems that use this method slow down the information distribution among emergency managers who operate at different jurisdictional levels of responsibility.

> **Proposition 2**: Human capacity to recognize risk conditions can be increased by focusing risk data through "views" that are

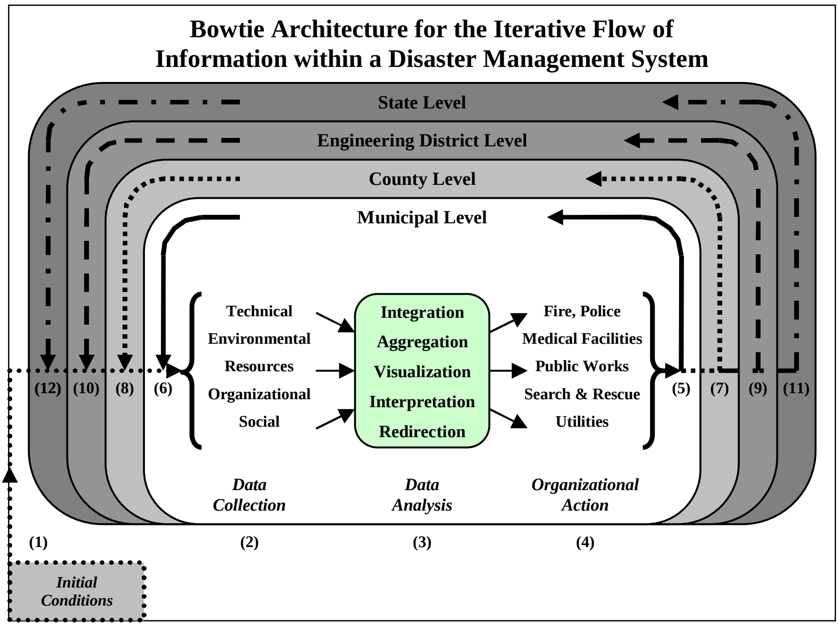
directly relevant to the responsibilities of each major decision maker in the system, thus reducing the overload of less relevant information and time required for information processing and facilitating rapid absorption of threatening information by individual decision makers.

Communication of Risk to Wider Arenas of Response Organizations and Resources

The prevailing method of communicating risk relies largely on command and control processes through a carefully defined hierarchical order. For example, during Hurricane Katrina, the official policies included the National Response Plan (FEMA 2004) and the National Incident Management System (FEMA 2005) that were adopted by the Federal Emergency Management Agency and the Department of Homeland Security. These policies follow a serial format for communication of risk and requests for assistance from lower to upper jurisdictional levels. These plans have recently been replaced by the National Response Framework (January 2008), which includes minor adjustments, but still follows the prevailing pattern of established hierarchical control. A sobering analysis of communication patterns among emergency response agencies in the hours and days leading up to and following Hurricane Katrina illustrates vividly the breakdown of this formal design in practice (Comfort 2005, 2006). Building the awareness of risk to support collective action is a cumulative process. If the first two steps of risk detection and communication have not been carried out successfully, the effort to engage organizations from a wider arena into the emergency response system is likely to flounder or fail.

Our model for achieving this task of communicating critical information to focused audiences is the “bowtie” architecture for decision support (Csete and Doyle 2004, Comfort 2005). This architecture offers a method of presenting relevant views to different emergency managers, while preserving not only the meaning of the incoming data, but also preserving the integrity of the collected data. As shown in Figure 1 on the following page, a “bowtie” design identifies key sources of data that “fan in” simultaneously to a central processing unit (or “knot”) where the data are integrated, analyzed and interpreted from the perspective and performance of the entire system. New information is then “fanned out” to relevant actors or operating units that use the information to make adjustments in their specific operations informed by the global perspective.

Figure 1



This design fits well with an Emergency Operations Center (EOC). In an EOC, status reports from multiple agencies are transmitted to the service chiefs who collectively integrate, analyze and interpret the data in reference to the performance of the whole response system. They then transmit the relevant information to the respective agency personnel, who adjust the performance of their units informed by the operations perspective for the entire system. The capacity for reciprocal adjustment of performance among multiple organizations based on timely, valid information represents self organization in emergency response, guided by the shared goal of protecting lives, property and maintaining continuity of operations for the whole community (Comfort 1994, Axelrod and Cohen 1999).

This theoretical framework acknowledges the importance of both design and self organizing action in guiding coordinated action in a complex, dynamic environment. It can be modeled as a set of networks that facilitate the exchange of incoming and outgoing information through a series of analytical activities that support systemic decision making. The information flow is multi-way, but gains efficiency through integrated analysis and coordinated action toward a clearly articulated goal for the whole system. It operates by identifying the key sources of information, the key processes of analysis and interpretation for the whole system, and the key routes of transmission. It maintains self organizing functions in that personnel, with informed knowledge, adjust their own performance to achieve the best performance for the whole system. Design, self organization, and feedback are central to effective performance of distinct organizational units within the global system.

The system will use multicasting networks to support the simultaneous transmission of information to multiple actors under conditions of escalating risk. Because such conditions require the aggregation of information at successive levels of responsibility, the proposed network will provide such aggregation functions within the network itself, guided by the views that emergency managers specify. Further, the presentation of fused and selected information (readily understandable to personnel with different levels of training and experience) will be done to avoid information overload. Lastly, the views requested by emergency managers may (and will) change based on temporal conditions and event information. For example, in the early stages, vague, scattered, incoherent indicators of risk will necessitate little information and aggregation, allowing the network to self-organize. Then, during emerging risk, clear indicators trending toward significant danger will require more information to be provided, while still avoiding information overload. During rescue and recovery, data will be distributed in the reverse direction and transformed into action to protect lives and property.

> **Proposition 3**: 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.

Self Organization and Mobilization of Collective Action to Reduce Risk

The collective capacity of a community to take informed, coherent action in the face of danger is a measure of that community's resilience. This capacity depends upon the cumulative set of cognitive, communicative, and adaptive processes outlined above. If any one of the preceding steps fails, the capacity of the community for collective action is weakened. If all of the preceding steps are performed effectively, the capacity for collective action is strengthened. Further, instances of negative feedback can have the reverse effect of weakening the whole system's performance in response to danger.

Disaster management involves multiple governmental, nonprofit, and private entities with different structures and organizational models. The interest of each organization in gathering information and data regarding exposure to hazards derives directly from its own mission. In current disaster management systems, these organizations are much more vulnerable to information overload caused by the transmission of a large amount of irrelevant information. As the number and variety of sources of information and sensors continue to grow, so does the volume of data generated by these socio-technical sources of information.

One method of facilitating the timely exchange of valid information to multiple managers simultaneously is the design of an "executive dashboard," in which data from different sources are represented visually to provide a "common operating picture" of the status of the region at risk. This design translates the concept of the "bowtie" architecture for information processes into a working decision support system for emergency managers operating at graduated levels of responsibility and authority. The capacity for multiple managers at different levels of responsibility to view the relevant information for their specific arenas of action simultaneously enhances their ability to adapt and adjust their performance to the emerging threat more quickly, efficiently, and effectively.

Setting the thresholds of risk for participating agencies that have different levels of resources but are exposed to threats of different degrees of severity requires the judgment of experienced emergency managers as well as timely, valid information. In planning sessions for simulated operations exercises, selected practicing emergency managers would be invited to participate in the definition of thresholds that are relevant to their specific responsibilities. The model of an executive dashboard offers a mechanism for building a "common operating picture" among responsible actors in a complex disaster management system for a community at risk.

> **Proposition 4**. The collective capacity of a community to act in coherent ways to reduce risk can be increased through information search, exchange, focused views, 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.

Vulnerability to Systemic Failure in Communities Exposed to Risk

At each of the four decision points identified above, human capacity for informed action is enhanced by access to appropriately designed and functioning information technology. The interaction between organizational performance in coordinating action and the availability and access to a functioning information infrastructure has a fundamental effect upon a community's capacity to manage the risk to which it is exposed. Without access to such a technical information infrastructure, the organizational capacity to mobilize collective action in a region will likely fail. The collapse of the emergency response system in New Orleans after the city lost its communications illustrates this argument vividly.

> **Proposition 5**: Without a well-defined, functioning information infrastructure supported by appropriate technology, the collective response of a community exposed to serious threat will fail.

The five propositions, taken together, constitute a conceptual framework regarding the evolution of capacity for collective action in communities exposed to recurring risk. The basic argument is that human capacity to act collectively and constructively in risky, uncertain environments can be significantly enhanced through appropriate uses of information technology.

The Mon Valley Project

In order to test the conceptual framework of the "bowtie" architecture for decision support, the IISIS Laboratory research team engaged in a trial demonstration project that involved 27 Pennsylvania municipalities[2] that border the Monongahela River. Pittsburgh's signature three rivers create a recurring risk of flooding for the metropolitan region. Within the last 23 years, seven damaging floods have ravaged riverfront communities, each causing substantial loss of property, disruption of community economic activity, and significant hardship for families, businesses, and communities. These floods include the following events:

1985: Monongahela Flood, Pittsburgh, November 14.

1986: North Hills Flash Flood, May 31. Eight dead.

1996: River Floods, January, Pittsburgh area.

2001: Southern West Virginia Floods, June-July.

2004: Tropical Storm Ivan, September 17.

2005: January Floods, Allegheny River.

2007: July Floods, Allegheny River.

Given past experience, exposure to flooding is a known hazard for the Pittsburgh metropolitan region which compels the communities to seek more effective means of managing this risk. The reconstruction of the storm water drainage systems is, of course, an overriding need, but as shown by recent studies sponsored by the Allegheny Conference, the price tag for these infrastructural improvements runs well into the billions of dollars. New methods for analyzing risk to human life and property from natural disasters can help public managers, businesses, and households take preventive action in a timely fashion and at manageable cost. Several of these methods have been incorporated into an innovative decision support system under development at the University of Pittsburgh.

The Interactive, Intelligent, Spatial Information System (IISIS) Laboratory of the University of Pittsburgh has developed a prototype decision support system (DSS) to enable communities to make decisions regarding the vulnerability of existing infrastructure, the threat to local

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[2]Braddock, Braddock Hills, Chalfont, Churchill, Dravosburg, Duquesne, East McKeesport, East Pittsburgh, Edgewood, Forest Hills, Homestead, McKeesport, Munhall, North Braddock, North Versailles, Rankin, South Versailles, Swissvale, Turtle Creek, Versailles, Wall, West Mifflin, Whitaker, White Oak, Wilkins, Wilkinsburg, and Wilmerding.

populations, and the capacity of local resources to respond effectively to flooding in the Pittsburgh metro region. This prototype is currently being tested in a real world setting. The Allegheny County Emergency Management Agency and 27 municipalities along the Monongahela River are collaborating with the IISIS Laboratory to test the model.

The primary objectives of this project are:

1. To implement an innovative decision support system (JIISIS)[3] for assessing the vulnerability to flooding in 27 municipalities exposed to risk in the Monongahela Valley.
2. To collect and validate the data needed to establish a regional knowledge base for the 27 participating communities.
3. To evaluate the performance of the JIISIS prototype in a demonstration exercise with practicing emergency managers.
4. To communicate the results of the exercise to the partner agencies that supported the project: Allegheny County Emergency Management Agency, Southwestern Pennsylvania Chapter of the American Red Cross, the 27 municipalities, the Pittsburgh Foundation, the Buhl Foundation, and an anonymous local foundation.

Interactive, Intelligent, Spatial Information System (IISIS)

The JIISIS is a computational decision support system that integrates data from key sources into a visual framework to assist managers in making an effective assessment of risk to their communities. It helps managers to interpret this information through color-coded graphics that indicate varying levels of risk as the conditions change. While initially developed for flooding incidents, the basic techniques are applicable to any type of hazard. The JIISIS includes three principal components, all of which are integrated into a dynamic information processing system that provides updates on the status of key functions in real time. The components include four types of components: 1) a dynamic bridge to the local 911 system in which incidents are reported in real time, along with the current availability of emergency response units and personnel;

[3]The prototype Interactive, Intelligent, Spatial Information System (IISIS) has now been converted into JAVA, hence the acronym, JIISIS.

2) a GIS system with data stored on physical characteristics, engineered infrastructure, and social and economic characteristics of the region; 3) a Documents Library that stores current policies, procedures, emergency plans for participating jurisdictions in a regional response system, and professional assessments of risk; and 4) a series of computational modules that estimate the vulnerability/capacity of communities to manage their own risk.

911 Bridge

A major challenge for emergency managers is to keep abreast of the status of a dynamically evolving emergency situation. The JIISIS prototype has developed a bridge that transmits data directly from the local 911 system to the central IISIS processing server in real time to provide a continually updated profile of incidents as they occur. This feature includes dynamically tracked data on resources so that emergency managers know what resources are available at any given time and which have already been committed to action.

Incident Action Plans

As required to be compliant with the National Incident Response System, emergency managers now must file a series of Incident Action Plans. The forms for these plans have been replicated in electronic format, with the identifying information for each form carrying over to subsequent forms. This format facilitates the required recordkeeping tasks for emergency managers, saving time and focusing their attention on the critical information required for coordinated action.

Active Geographic Information System

A key feature of the JIISIS is its capacity to generate GIS thumbnail maps as part of the information that is registered for a particular incident. That is, as an incident is reported, with location, type of hazard, and severity, this information generates a small GIS map that locates the incident in the region. This function has the advantage of building a geographic profile of incidents in the region, and emergency managers can refer to this larger pattern of incidents in making decisions regarding the routing of emergency units and allocation of resources.

Documents Library

The Documents Library stores policies, procedures, plans, and other relevant information for easy reference by emergency managers as complex incidents unfold. These documents are especially useful in inter-jurisdictional events with multiple agencies from many jurisdictions involved in response operations.

Dynamic Assessment Module (DAM)

This module represents a decision-support tool that measures change in a set of significant parameters in infrastructure, threat level, changing environmental conditions, and availability of the emergency response units and personnel. It indicates the vulnerability, or its inverse – capacity – of a particular community or region to respond to disaster. As incidents occur and response assets are assigned, their availability for subsequent incidents lowers the resiliency of the community, and other communities to whom they provide mutual aid. The inverse of the response organization capability is the changing vulnerability of the community based on varying states of infrastructure, environment, and weather conditions.

The equations upon which the model is built include 36 different variables to determine initial vulnerability. These variables are combined into three components of vulnerability: geophysical attributes, engineered structures, and social environments. A total of 10 variables are used to determine the response capacity of public safety and emergency management officials. One variable is used to measure the resiliency of public safety response organizations.

The capability of the public safety response organizations is subtracted from the initial vulnerability of the region to show the change in risk conditions as local resources are deployed to bring the threat under control. This adjusted vulnerability varies as response assets fluctuate between available and assigned. The results have been translated into color-coded graphics that allow the emergency managers to gauge the community's present status at a glance. In practice, a connection to a live 911 data stream would allow managers to assess real-time information on the status of their community and provide additional warning time to minimize the hazard to a community. This unique decision support tool gives emergency managers the technological edge necessary to gain insight into how disasters evolve and to alert them to potential problems in time to intervene and minimize the damaging impact to their communities.

Risk Assessment Analytical Tools

Several tools for identifying hazardous materials or locating existing quantities in storage are also available, as well as a module for Patient Tracking. Other modules for Traffic Monitoring and Routing are in the early planning stages. These modules represent continuing development by the IISIS Lab research team, with informed guidance and review by practicing managers and interdisciplinary experts.

Risks and Risk Management Strategies

Introducing new concepts and strategies for action into any set of communities poses the risk of rejection by existing managers in favor of maintaining a more familiar status quo. In the case of flooding risk, recent events have increased the awareness of these riverfront communities to the dangers they face and the economic and physical losses they are likely to sustain. Introducing a new approach to managing well-known flooding risk is likely to be clearly understood and well-received by the communities that have recently experienced losses from Hurricane Ivan and watched the devastation created by the flooding of New Orleans in Hurricane Katrina. The timing for introducing a method of computational modeling of flooding risk is appropriate, given the heightened level of public awareness of risk. The trial demonstration project for communities in the Mon Valley included meetings with local communities to explain the need for data collection, the methods, and benefits of the project's operation. Project staff worked directly with emergency service personnel in each community to ensure that they understand the workings of the prototype and would be able to implement it in their respective communities.

Current Status

The one-year pilot project to implement the JIISIS decision support tool with the collaboration of 27 riverfront communities that are most at-risk from flooding was the first demonstration project designed primarily for a study region of municipalities in Allegheny County. These communities also participated in a companion project, the Monongahela River Community Shelter Project that is being conducted by the Southwestern Pennsylvania Chapter of the American Red Cross. The Community Shelter Project, supported by a grant from the U.S. Steel

Foundation, is both strengthened by, and complementary to, the University of Pittsburgh project to assess vulnerability to flooding in the Mon Valley.

These two related projects integrated existing databases as well as added new data to create a regional model for managing risk in the Mon Valley. IISIS staff members are working to develop the partnerships essential for continuing this project on a regular basis. Organizations central to the coalition include Allegheny County Emergency Management Agency, Southwestern Pennsylvania Chapter of the American Red Cross, and the 27 municipalities participating in the Community Shelter Project. Additional organizations may be included as the effort builds a region-wide coalition of informed organizations committed to reduce the risk and losses from flooding.

The Mon Valley Project began on October 1, 2006, and formally concluded on October 8, 2007, with a demonstration of the working design for the selected communities in Allegheny County that are exposed to flooding risk. The prototype is currently being checked and validated for use by the municipalities, and a trial version was released to the participant communities in Fall 2008 for continued testing and feedback. This demonstration served as the major method of evaluating the performance of the project and the efficacy of using information technologies to support decision processes in managing recurring risk. Practicing emergency managers from the 27 municipalities were invited to assess the performance of the prototype and its contribution to increasing the regional capacity to reduce damage and losses from flooding.

Conclusions

The Mon Valley trial demonstration project offered a means of testing a decision support system based on the "bowtie" architecture prior to making a major investment in hardware and software in the Pittsburgh Metropolitan Region. Experience to date demonstrates that information technology facilitates information search and exchange processes among organizations participating in disaster risk reduction and response, but that demonstration and training are essential to encourage adoption and use. Unless such processes are recognized and accepted as part of continuing operations in communities, they are not likely to produce the desired results. If information technologies are introduced as part of a sociotechnical system that enables human managers to make more accurate, timely decisions under stress, they are more likely to be incorporated quickly into daily operations as a means to improve performance within and among organizations.

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