

Technology-Aided Situation Awareness: A Key to Organizational and Community Resilience in Disaster Management

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Presentation Overview

- Resilience – goal for disaster management
- Importance of technology enhanced situational awareness to support decision makers and managers
- Need for intra and inter- organizational awareness to achieve community resilience.
- Observations about need for a socio-technical systems approach to the design of situation awareness based decision support systems

Recent Large Scale Natural Disasters

- Focused attention on
 - Shortcomings of current institutional approaches to major disasters
 - Complexity of the decision making environment
 - Need to facilitate decision maker's access to data and knowledge critical to effective disaster response and recovery
 - Understanding community resilience

Example - Hurricane Katrina

- Demonstrated
 - Complexity exceeded cognitive and psychological capacities of decision makers at all levels
 - Shortcomings of current approaches to managing major disaster situations
 - Need for development of decision support system capacity to ensure resilience to natural disasters – especially
 - Measurement systems
 - Decision support technology
 - Simulation methods
 - Communication and collaboration networks
 - Situation awareness as key to management decision making

Resilience

- Different meaning to different people
- Usually associated with ecological systems - resilience considered by many a measure of system recovery rate - rate of return to functionality and delivery of services following a disaster event - simply defined as engineering reliability or “engineering resilience” – Mostly Response driven
- More recently understood from a socio-economic systems perspective – decision making involves organization mission, assessment of risk tolerance, strategic policy - rather than being solely a technical or operations activity – Mostly Recovery driven

Managing Resiliency is Managing Risk

- Resiliency management is a continuous process improvement activity in managing risk
- Encourages structured approach to establishing resiliency objectives related to organization's core mission
- Measuring performance
- Directing effort and resources to areas where they create most benefit – i.e., eliminating threats, reducing vulnerabilities, and improving organization's and community's ability to cope with the disruption

Resiliency

- Is not the result of one single decision or improvement – it is a result of doing a large number of things well
- Resiliency approach helps organizations
 - identify capabilities that contribute to sustainability
 - guides efforts to develop and improve them

Enhancing Resilience

- Depends on ability of organization's ability to make sense of
 - significance of events as they unfold
 - decisions made by those responsible for related resources
- Acceptance that basic information technologies and pre-structured decision models are limited where setting is dynamic and characterized by
 - ill-structured problems
 - incomplete, ambiguous, or changing information
 - time caused stress

Community Resilience

- Communities are more than sum of buildings and infrastructure – they are concentration of culture and socio-economic systems
- Physical property damage remains a loss – losses in flows of social and economic goods and services can be reduced by
 - organization's decision makers
 - implementation of strategic policy
- Reduction of social and economic consequences requires timely and effective decision making, conservation, reallocation, outsourcing, rescheduling lost production to later
- Business interruption losses often equal or exceed physical property damage, making response management decisions critical

Situation Awareness

- Enables organization's decision makers to assess
 - Actual and probable physical damage to structures
 - Social and economic impacts (e.g., injuries, deaths, production losses, and other economic displacements)
 - How multiple parties in an organization relate to each other
- Fundamental to disaster management
 - Must integrate with organization's existing systems
 - Be easily accessible and useable by decision makers
 - Facilitate “what-if analysis” in response and recovery decision making

Organizational Awareness

- Units within organizations are not always aware of others responsibilities, decisions and actions - result is poor communication and collaboration and ultimately decisions
- Organizational awareness requires
 - Shared vision of disaster situation to make strategic, tactical and operational decisions
 - Knowledge of interaction of organizational units and responsibility for actions
- Process includes three phases
 - Collecting data on interactions between subparts of the organization
 - Analyzing the resulting processes
 - Visualizing organizational processes in a dynamic organizational chart in analogy with a situation map

Community Awareness

- Understanding how organizations relate to each other is fundamental to achieving community resilience
- Community awareness - requires
 - collection of data about the interactions between public and private organizations and agencies
 - assessment of the degree of collaboration within the community network
 - understanding, at the community level the inter-organizational relationships necessary to ensure community resilience.

Disaster Management Decision Making

- Requires
 - Choosing between alternative courses of action in response to non-trivial demands on organizations and community systems
 - Timely quality data, information and knowledge about the disaster situation
 - Communication and collaboration in decision making in response to the situation

Disaster Management Issues

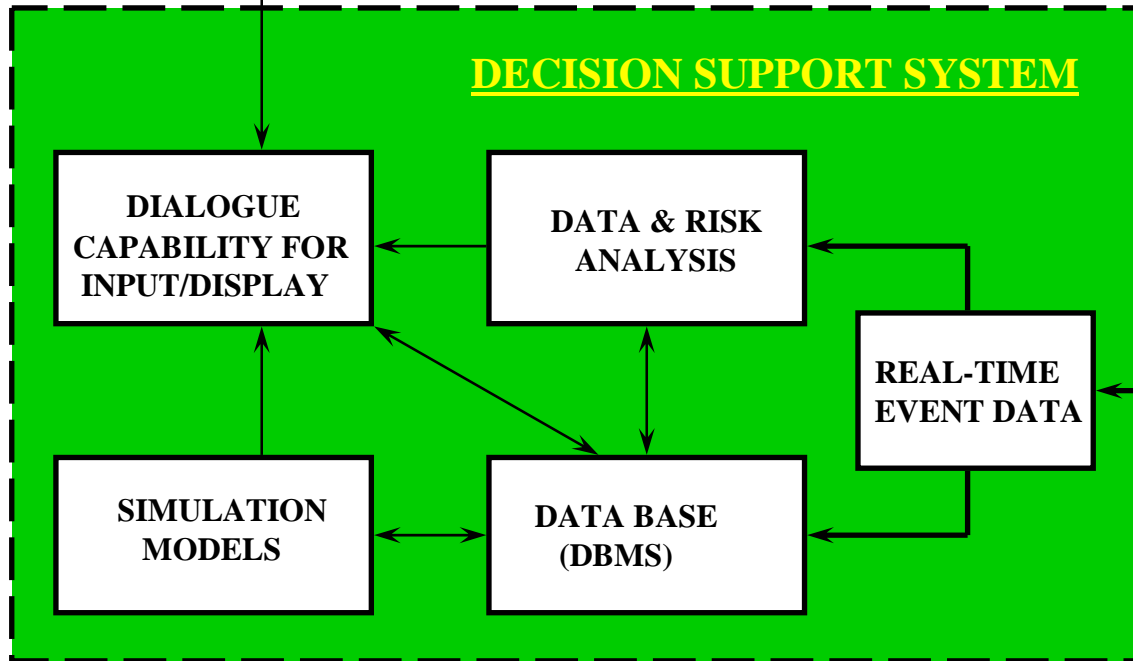
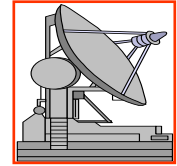
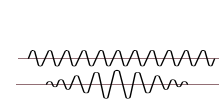
- Tasks defined in advance of a disaster are likely to be inadequate for the actual situation due to lack of situational information and knowledge
- Decision support systems for management of disaster processes must be integrated with best technology available to address major factors affecting situation awareness, i.e., perception, comprehension and projection of the disaster event and its consequences.

Decision Aiding Technology

- Intended to reduce ambiguity and uncertainty to improve perception and comprehension of current situation
- Real problems are limited capacity of people, poor communication, and insufficient data - information
- Data alone is not sufficient - consists of bits, signals, and images
- Information is data with an interpretive context
- Knowledge is information with a purpose for its use
- Understanding is knowledge applied to specific contexts
- Needed is information more than data, knowledge more than information, and understanding most of all

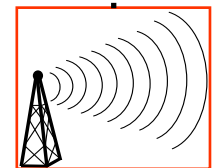
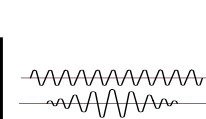
**DISASTER RISK MANAGEMENT
DECISION MAKING**

**FIELD
INSTRUMENTS**



**DISASTER SITUATION ASSESSMENT
DATA
INFORMATION
KNOWLEDGE
UNDERSTANDING**

**FIELD
INSTRUMENTS**



Situation Awareness

- Establishes the context for risk management decision making based on knowledge and understanding about surrounding situation or environment
- Provides disaster managers and organizational team members dynamic data, information and knowledge needed to support global and local decisions to meet resilience goals and objectives
- Local awareness is required for decision making and actions to meet immediate response demands
- Global knowledge and understanding is required for working effectively and collaboratively with other jurisdictions or organizations

Situation Awareness

- Is the perception of the environment within a volume of time and space, the comprehension of meaning, and the projection of status in near future
 - perception of information about status, attributes and dynamics of various entities in an environment
 - comprehension involves integration and interpretation of data and information to explain what is happening
 - projection of the situation involves prediction of a future state of affairs given a continuation of the situation
- Continuous assessment about what is happening and what is likely to happen next are major factors in deciding course of action

Situation Awareness Model

- The model illustrates the factors that influence the relationship between
 - disaster response tasks and system factors (e.g., workload, complexity, stress, etc.)

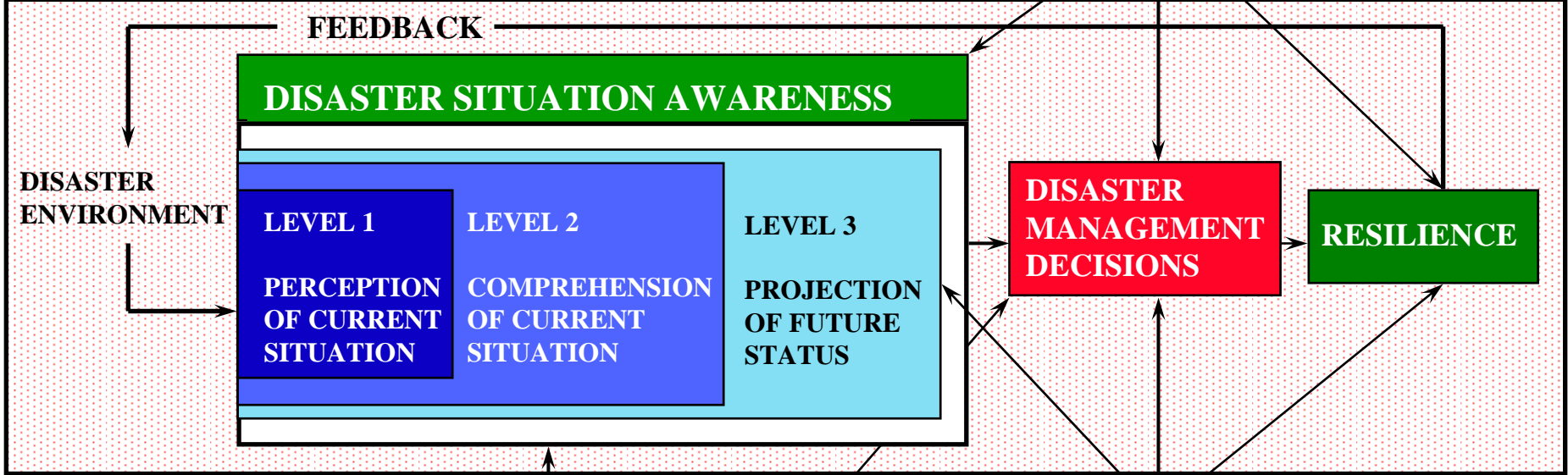
and

- individual manager / decision maker factors (e.g., perception, attention, allocation, individual abilities, etc.)

**REAL-TIME
DECISION SUPPORT SYSTEM**

- SYSTEM CAPACITY
- COMPLEXITY
- INTERFACE DESIGN
- AUTOMATION
- STRESS AND WORKLOAD

DISASTER SYSTEM FACTORS



INDIVIDUAL FACTORS

- GOALS AND OBJECTIVES
- PRECONCEPTIONS
- EXPECTATIONS

- INFORMATION PROCESSING MECHANISMS
- LONG TERM MEMORY
- AUTOMATICITY

- ABILITIES
- EXPERIENCE
- TRAINING

Disaster Decision Making

- Decisions are typically made under time pressure, involve high stakes (e.g. lives at risk), and are made without adequate information
- Differs from other situations - requires decisions based on frequent discrete information updates rather than the continuous process changes that typify many dynamic environments
- Disasters present real-time dynamic, time constrained, and uncertain situations where consequences of poor or wrong decisions are significant to the decision maker, the organization and the community
- Coordination of decisions is essential under such circumstances

Important Considerations

- Routine tasks continue during crisis with routine behavior is impacted with incidents that demand much higher levels of attention
- Decision makers have differing levels of responsibility and situation awareness needs based on for different demands
- Maintaining local and global awareness of the disaster situation is important for effective organizational and community response – recovery and sustaining resilience
- Collaboration is critical to effectively managing a disaster situation

Collaboration Framework

- Collaboration is necessary to understand and coordinate interactions required
- High level of collaboration among organizations is necessary to meet challenges of a rapidly changing situation
- Decision maker roles, responsibilities, associated tasks in the network and level of interaction are to be clarified
- Differing needs and communication methods to support management processes must be understood by all
- Expectations - predictability of collaboration (scheduled vs. unscheduled times), and places for collaboration (co-located decision makers vs. disbursed decision makers) need to be clarified
- Decision processes need to be clarified as part of data, information and communication systems design

Socio-Technical System Requirements

- **Functionality** - technical specification must cover system functions and performance to support required range of organizational tasks
- **Usability** - users will be able to master and exploit the system without undue strain on their capacities and skills
- **User Acceptability** - system must not be perceived as threatening to aspects of users work they consider important
- **Organizational Acceptability** - system must not only serve immediate tasks and needs but must support organization's goals, policies, and structures and not impede other aspects of organizational functioning

Summary Observations

- *Successful introduction of situation awareness based decision support systems for disaster management depends upon the ability and willingness of decision maker's to use the systems in responding to a disaster situation*
- *System designers must not view their system as an end unto itself, but must use a socio-technical approach that meets the needs of the users*

Summary Observations

- *Implementation requires a program of planned change designed to meet the needs of the individuals responsible for using the system in a disaster situation.*
- *Success in implementation at the level of an organization, and effectiveness at the community level, will depend upon the participation of relevant intra and inter-organizational stakeholders in the design process*

Summary Observations

- *Success in program implementation will be a function of meeting individual and collective organizational goals by providing means and opportunities for improvement in the system design.*
- *System specifications must include consideration of factors affecting the organization's operating environment where people work and collaborate.*

Summary Observations

- *A system must serve the functional needs of individuals and organizational units responsible for decisions affecting the organization's resilience.*
- *Application of a new system requires organizational and individual learning*
- *New approaches to decision making must be complimentary to existing procedures and organization practices*