Working Group 4

Focus: *Post-event Management Plans that Minimize the Socio-economic Impacts of Natural Disasters*

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Achieving Situation Awareness

OBJECTIVES

- To capture, access, and present a comprehensive, trusted picture of a MCMD, including current information on damage, death and injury, assets, evacuations, and response and recovery efforts
- To achieve resilience in communications, computing, and user interfaces
- To build an archive of solutions that can be used for research, training, and education

RESEARCH CHALLENGES

- Develop appropriate technologies and institutional arrangements to address issues of data security, privacy, and proprietary ownership of distributed data
- Address issues of data syntax, semantics, user interface design, lack of metadata, and georeferencing that currently impede interoperability
- Engage a full range of data acquisition technologies and data sources, including sensors and social media, and address related data quality issues
- Develop standards to support discovery, accessibility, and archiving of services in an open service-oriented architecture
- Research technologies that can assure resilience of communications and computing networks during emergencies
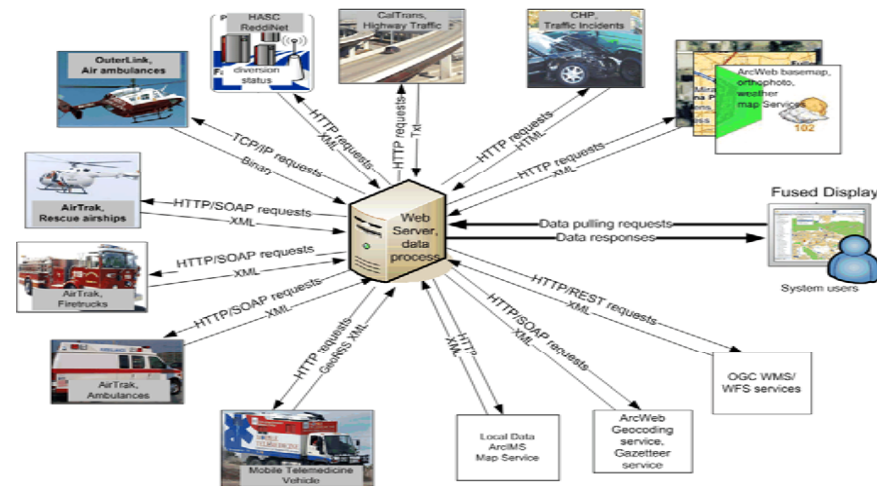
BROADER IMPACTS

- The proposed research will address many of the issues that currently impede the development of a common operating picture
- A resilient information and communication technology will address many of the problems experienced during recent disasters, and build trust among the user community
- By engaging all available data acquisition technologies, the research will take full advantage of recent technological and societal trends
- The research will result in a significant improvement in society's ability to monitor and reduce the impact of disasters

Achieving Situation Awareness

Summary: The fundamental challenge is to address the problems that currently impede the development of situation awareness during response to an MCMD. It is impossible to anticipate the range of agencies and governments that will be involved in any MCMD, and therefore to arrange in advance for the timely acquisition, sharing, and dissemination of data. Moreover today's range of technologies lack the necessary interoperability to achieve rapid sharing. Service-oriented architectures distribute functionality across the Internet and avoid the transmission of raw data. Research is needed to develop firewalls that can protect privacy and respect proprietary ownership, while allowing sufficient access to achieve situation awareness. Research is also needed to develop standards of function description (metadata for services) that can support discovery and use of distributed granular services and address the deficiencies of current standards. Research is needed on issues of data quality, especially for crowdsourced data….

Smart Sensor Web for Situation Awareness

OBJECTIVES

- Provide a real-time situation awareness from a smart sensor web using programmable sensors in self-organizing wireless networks operable in dense urban environments
- Robust, capable of **self-organization** and **adaptation** for sensing, filtering, and transmission of data
- Interoperable and compatible with **smart wireless devices** for **distributed, real-time situation awareness**

TECHNOLOGICAL CHALLENGES

- Development of programmable, self-organizing sensor networks for structural health monitoring in order to provide immediate post-event status of critical infrastructure such as hospitals, bridges, schools, etc.
- Develop devices with capability to:
    - Determine the status the physical infrastructure based on observed/monitored response
    - Allow self-organization and maintain operational capability accounting for potential loss of network nodes
    - Allow on demand and self-initiated reporting for events exceeding threshold limit
    - Low cost and field deployable in an ad-hoc environment

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- New paradigm for coordination and management of emergency responders to provide situation awareness
- Transformative effect on structural health and structural performance monitoring
- Directly applicable to other natural and man-made disasters
- Broadly applicable to a large range of applications requiring monitoring in challenging environments
- Broad opportunities for international and multidisciplinary collaboration
- Significant improvement in directing resource allocation and response

Smart Sensor Web for Situation Awareness

Summary: Smart Sensor Web is a network of distributed, programmable, low cost, wireless sensors embedded in major structures and other critical infrastructure elements to provide real time information. The networks are highly scalable, embedded or deployable on demand. When configured with a GPS they can be also used for real time tracking applications. The range of applications includes structural health monitoring, tracking of hazardous plumes, and real time performance monitoring. Ultimately, the goal is to be able to remotely assess the status of critical infrastructure or the movement of hazardous plumes in order to provide rapid, real time situation assessment for response planning and coordination, and resource allocation.

This research will fundamentally transform the sensing and communications infrastructure for emergency response management during major earthquakes, as well as other natural and man-made disasters.

Scalable Evacuation and Sheltering
for MCMD Emergency Response

OBJECTIVES

- Investigate new generation of scalable evacuation route planning algorithms using contra-flow, phased evacuation, and multi-modal transportation systems incorporating behaviorally based information.
- Probe into novel sheltering concepts to accommodate community diversity including gender, ethnicity, age-groups and pets

RESEARCH CHALLENGES

- MCMD-scalable heuristics and algorithms to:
  - Identify most promising multi-modal evacuation routes
  - Recommend contra-flow options w/ resource constraints
  - Evaluate phased evacuation schedules
  - Incorporate real-time information (e.g. traffic)
  - Forecast demand-map for food, water, fuel, shelter
- MCMD datasets (e.g. population, transportation network capacities) needed for evacuation n shelter planning.
- Ground truth datasets from real evacuations and exercises to evaluate routes and shelter plans
- Understand evacuee behavior to increase compliance
- Combine technology and humanity concerns to improve current practices in community evacuation, sheltering and resettlement.
- Improve space design of shelters for disadvantaged members

BROADER IMPACTS

- Minimize exposure to vulnerable populations via new generation of evacuation route planning techniques
- Enhance community (e.g. trust, social fabric, neighborly interaction, …) aspect of interim housing.
- Multidisciplinary environment for student education and training
- Applicable to other natural and man-made disasters
- Broad opportunities for international collaboration
- Significant improvement in first responders ability to handle disasters and save the lives of individuals.

Scalable Evacuation and Sheltering for MCMD Emergency Response

Summary: Effective evacuation and shelter planning is currently an issue of major importance due to the increasing risks from natural disasters. Evacuations are by nature disruptive and expensive, and they can become politically sensitive issues. The costs of hurricane evacuations, for example, can exceed US$1 million per mile of coastline from losses in tourism, commerce, and general productivity. It is intended that this research will combine technology and humanity concern to improve current practices in community evacuation, sheltering and resettlement. Therefore a new generation of technology will be developed based on scaleable heuristics and algorithms to (a) identify most promising multi-modal evacuation routes, (b) recommend contra-flow options w/ resource constraints, (c) evaluate phased evacuation schedules and (d) forecast demand-map for food, water, fuel, shelter. As a result of this research work we can minimize exposure to vulnerable populations via new generation of evacuation route planning techniques and enhance shelter hospitality and increase community (e.g. trust, social fabric, neighborly interaction, …) coherence at the interim housing stage.

This research will fundamentally transform the evacuation and sheltering methods and infrastructure for emergency response management during major natural and man-made disasters.
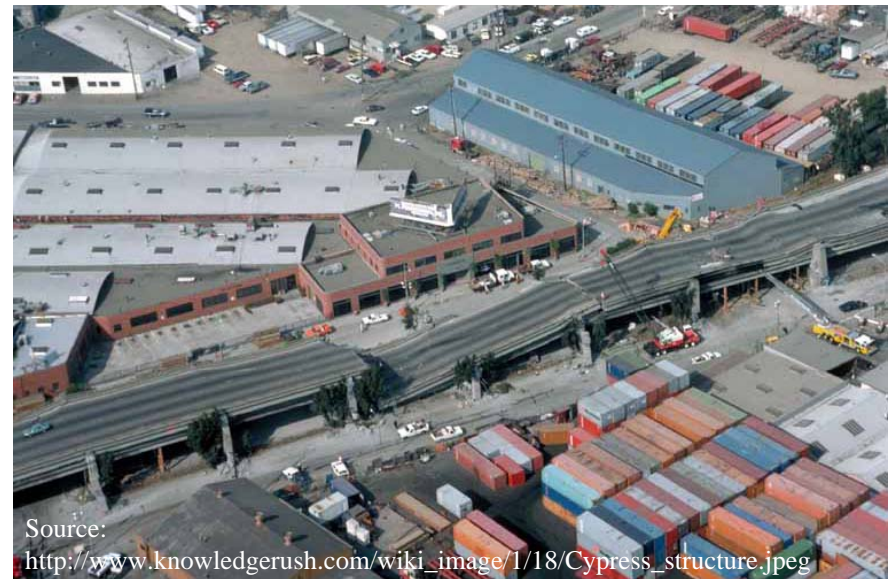
Social Impacts of Mega-City after Mega-Disaster

OBJECTIVES

- Resource acquirement, integration, and distribution of mega-city after mega-disaster
- Post-mega disaster function of emergency response system in mega city: within the city; coordination and collaboration among jurisdictions
- Resilience building of mega-city on social function, infrastructure, and public services
- Strengthening and mobilization of social capital, networking of NPOs and enterprises
- Information and communication: How to facilitate reliable information dissemination

Source: http://www.knowledgerush.com/wiki_image/1/18/Cypress_structure.jpeg

RESEARCH CHALLENGES

- Research on trust building related to resource allocation (under the chaos of mega-disaster)
- Research on human response to "mega-disaster" (the current research mainly focus on smaller scale disasters).
- Study on resilience building processes after mega-disaster when the urban function failed and social networking breakdown
- Study on organizational conflicts among government agencies and NPOs in order to find possible solution models.
- Study on collaboration mechanism among NPOs.
- Study on adoptive social behavior after mega-disaster.

BROADER IMPACTS

- Shortening the duration of social dysfunction of mega-city after mega-disaster
- Increasing sense of security, hope, and collective efficacy

Social Impacts of Mega-City after Mega-Disaster

Summary: The fundamental challenge is the knowledge gap of how our society react to the chaos after mega-disaster in mega-city. The main focuses include post-disaster resource, emergency operation system, social function, social engagement, and information/communication. The following research topics are recommended to fill the current gaps:

1. Research on trust building related to resource allocation (under the chaos of mega-disaster)
2. Research on human response to "mega-disaster" (the current research mainly focus on smaller scale disasters).
3. Study on resilience building processes after mega-disaster when the urban function failed and social networking breakdown
4. Study on organizational conflicts among government agencies and NPOs in order to find possible solution models.
5. Study on collaboration mechanism among NPOs.
6. Study on adoptive social behavior after mega-disaster.

The research will help emergency managers and citizens of mega-city not only shortening the duration of social dysfunction of mega-city after mega-disaster, but also increasing sense of security, hope, and collective efficacy

Changing the Recipe for Disaster:
Predictive Modeling of the Human Costs

OBJECTIVE

- **Enable the prediction of requirements for life-saving/sustaining goods and services following a major catastrophic event to facilitate post-event recovery.**

- **Provide baseline characterization of disaster risk and societal impacts.**

- **Model likely economic impacts—primary, secondary, tertiary and cascading, to provide guidance for post-event recovery and restoration of, livelihoods—locally, nationally, globally.**

- **Ascertaining the differential impacts of the event based on social and disaster risk vulnerabilities, for the efficient and equitable allocation of resources**

RESEARCH CHALLENGES

- Data availability—granularity and timeliness
- Baseline inventories of existing pre-event conditions (demographics, property values, economic activity, local knowledge) are not standardized or spatially specific
- Lack of integration between natural science models of disaster risk and social models
- Lack data and methods for linking multi-level vulnerability assessments of people (households, community) and places (geographic units)
- Documentation of disadvantaged populations
- Translation of the research into practice (shortening the time frame)
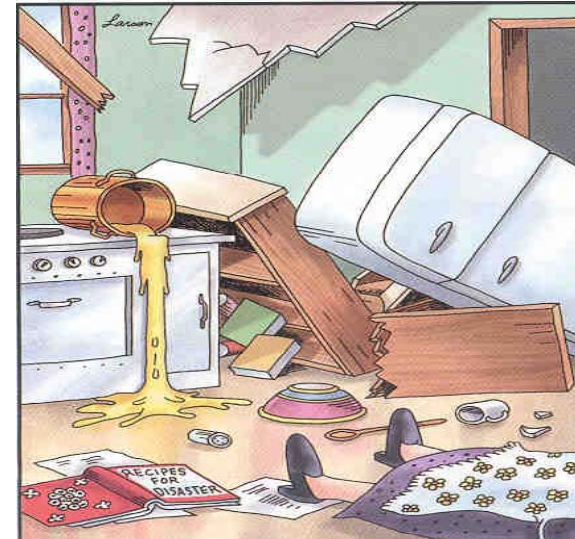
BROADER IMPACTS

- Assist in realistic and timely response to catastrophic events

- Identify long-term economic vulnerabilities to develop mitigation alternatives for reducing worst case impacts.

- Address the disparities and inequalities in the social impacts of disasters, through better understanding of pre-event conditions, and informed decision making at federal, state, and local levels

- Provide evidence-based research in support of public policy objectives and needs for disaster risk reduction

Changing the Recipe for Disaster:
Predictive Modeling of the Human Costs

Summary: One of the fundamental challenges facing emergency managers is the ability to predict with greater precision and certainty the likely impacts of disasters on local people and places. Such knowledge will enhance planning, policies, and resourcing for short-term and long-term recovery, which at the present, are not well articulated in theory or in practice. Forecasting long-term recovery needs requires analytical and integrated methods and models that are currently in their infancy, and data that are not readily available. Such integrated science requires multi-disciplinary expertise to model disaster risk as well as social models that include economic and demographic trends, political realities and constraints, governance structures, community engagement in the recovery process, and local knowledge.

This research has the potential to reduce the human costs of disasters and foster disaster resilient communities.