DHS/FEMA

Modeling and Data Working Group

Phase I Report

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Executive Summary

The Modeling and Data Working Group (MDWG) was established in August of 2012 by the Emergency Support Function Leadership Group (ESFLG) to identify and assess the data and modeling resources that are used across the interagency during emergency management. The membership was chosen by the ESFLG and is chaired by the Director of FEMA's Planning Division, Response Directorate. The working group is supported by Gryphon Scientific, whose role is to collect and analyze the information required to identify the data and modeling resources available and determine when and how those resources are used in the context of emergency management. This information has been and will continue to be gathered during extensive interviews with the MDWG members and the subject matter experts they recommend. The scenarios addressed by the MDWG during the first iteration of the project are limited to earthquakes and hurricanes with additional scenarios to be addressed by exception during future iterations of the project.

This project is divided into four phases as follows:

- **Phase I:** determine what decisions are made using data and models during emergency management, with a focus on the questions data and modeling are used to answer;
- **Phase II:** determine what data inform those decisions;
- **Phase III:** identify and characterize the models and data processing tools required to produce operationally-relevant decision-support information;
- **Phase IV:** identify what resources are the most empirically useful based on the known user communities and produce an interactive library of available models and decision-support tools accessed via a GUI that will facilitate an understanding of the flow of information during emergency management. This product will identify both the producers and consumers of these models/tools.

In this report, we describe the findings from phase I of the project. We describe the framework that we have built to reflect how data and modeling resources are used to produce information to support decision-making—from the scientific models that forecast the weather to the calculations that drive hiring decisions for surge personnel who provide support to survivors after the event. We have mapped this framework onto the timeline of an event to provide context for the temporal aspects of the flow of information during a disaster. The primary findings of this phase of the project include:

- Data and/or modeling are used across the interagency and by those involved at all levels of emergency management.
- Producing operationally-relevant information requires iterative steps of data collection and processing.

- The information required to support operational decision-making are phase-specific and diverge by mission areas as the event progresses.

An initial gap analysis identified the questions for which decision-makers do not currently have the information they need, as described in the conclusions.

A set of bullet points outlining the primary findings can be found in the blue boxes at the beginning of each section of the document.

Introduction

Phase I Introduction

- The amount of information available to emergency managers has dramatically increased in recent years as data resources and modeling tools have become increasingly available.
- The Modeling and Data Working Group (MDWG) was established in August of 2012 to engage interagency stakeholders to collaborate more effectively on issues related to data and modeling.
- The MDWG will identify and catalogue the authoritative data and modeling resources required to support operationally-relevant decision making.

Informed decision-making is key to successful emergency management. New data resources and modeling tools, as well as ready access to these resources, have led to a rapid expansion in the amount of information available to decision-makers across the interagency during emergency management. However, the information produced is not always available to those who need it when they need it, is often not in a form that best facilitates operational decision-making, or has not been sufficiently verified and validated to inspire the confidence of decision-makers. Furthermore, a lack of coordination of efforts has led to situations in which conflicting results have been presented and in which the available data or information could not be effectively leveraged to support effective decision-making.

In August of 2012, the Emergency Support Function Leadership Group (ESFLG) established the Modeling and Data Working Group (MDWG) to identify and catalog the authoritative data and modeling resources required to support high-level, operationally-relevant decision making, particularly during the time-sensitive response period, but across all phases of emergency management from preparedness and planning, to response, recovery, and mitigation. The working group was designed to engage stakeholders from across the interagency to collaborate more effectively on issues related to the data and modeling resources being used to support all phases of emergency management by identifying and characterizing existing resources based on their utility. The goal of the working group, as defined by the charter, is to establish an authoritative list of the most useful and effective resources available to support decision makers across the interagency during emergency management.

The charter and project plan can be found in Appendices 1 and 2.

Project Overview

Overview

- Through interviews with high-level decision makers, program managers, and subject matter experts, the MDWG will identify the data and modeling currently being used to support emergency management.
- The project will characterize not only which data and modeling resources that are in use, but also when, how, and by whom those resources are accessed, and what questions they are used to address.
- The project has four phases, the descriptions of which can be found in Figure 1.

The project has been divided into four phases (see Figure 1). In phase I, we have identified how, when, and for what data and modeling are used during planning and operational decision-making during emergency management, with a focus on the questions those resources are used to address. In phase II, we will identify the information required to support this decision-making and begin to identify the data resources required to provide that information. In phase III, we will identify, characterize, and evaluate the existing data processing tools, including predictive models and assessment tools, that are used to process data collected prior to and during an emergency and produce the required decision-support information. During phase IV, we will complete the analytical framework and build an interactive catalogue of the data and modeling resources identified and characterized during earlier phases of the project. Based on the resources catalogued, we will perform a gap analysis and recommend a series of Courses of Action to address the gaps identified, build an interactive library providing access to and information about the resources identified, and outline paths forward to best leverage the strengths, collaborations, and resources already in place across the interagency. A more detailed description of the final product is included in the next section.

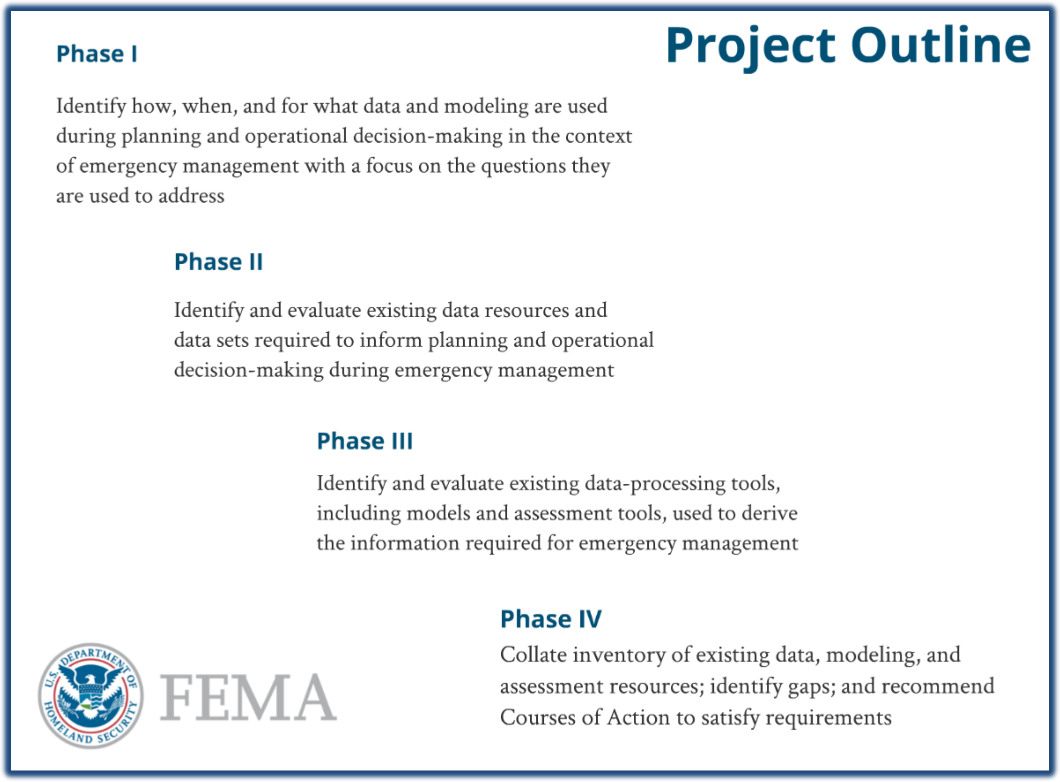

Figure 1. Project overview with a brief description of each phase.

Description of the Final Product

Overview Description of the Final Product

- The final product of the project will be an interactive library of the data resources, models, and decision-support tools currently in use across the interagency.
- This effort will produce a database, accessed via a user-interface, that will facilitate an understanding of the flow of information during emergency management and identify the producers and consumers of those resources.

The MDWG has been tasked with identifying and characterizing the authoritative data and models used to support operational decision-making during emergency management across the interagency. The resulting information will be collated into an interactive library of the models and decision-support tools available accessed via a user-interface that will facilitate an understanding of the flow of information during emergency management and identify the producers and consumers of those models/tools. This product will provide a description of each resource and its operationally-relevant characteristics. The database component will be exportable for use during planning activities and to provide a comprehensive list of available resources. In order to make this database accessible and useful during an event, a user-interface will be designed that will facilitate user inputs, and run queries to identify the resources available relevant to the question, mission, or organization requiring the information. The details of this product will be defined and refined over the course of this project to ensure that the information collected will be available in a useable format, specifically designed to support operational decision-making.

Importantly, the final product of this effort will be specifically designed for use and maintenance by the user community, as is expected to be defined over the course of this project.

The contact information associated with each resource will include that of the owner or producer of the resource who can address questions relevant outside of an event and the contact information for the person or group responsible for providing access to the resource or its outputs during an event. In some cases, these contacts will overlap; in others, they will diverge. The contact information for each resource will be verified with those contacts before the final product is released.

Use Cases: Hurricanes and Earthquakes

Overview of Use Cases: Hurricanes and Earthquakes

- The MDWG chose to focus initially on hurricane and earthquake disaster scenarios, as they are well-practiced and relatively well-understood.
- The use of these scenarios will allow us to develop a comprehensive framework that can be used to consider additional scenarios in the future.

The need for a comprehensive understanding of the data and modeling requirements for planning and operational-decision making is consistent across all emergency scenarios, including the national planning scenarios, wildland fire, and cyber threat scenarios. The MDWG chose to focus on the large-scale hurricane and earthquake natural disaster scenarios typified by Hurricane Ono and the New Madrid Earthquake scenarios, which were used as the basis for recent national level exercises. While many efforts have previously focused on these types of scenarios, they provide a useful starting point to assess the data and modeling requirements, develop methodology, build a framework, and define authoritative resources for decision-making based on the utility of the resources identified. Precisely because the requirements for these scenarios are relatively well-understood and the necessary resources are generally available, the project effort can be focused on organizing these resources so they can be more efficiently and effectively shared, enhancing collaboration and resource-sharing across the interagency. Because these scenarios are well-understood and often practiced, decision-makers are able to articulate their information requirements and clearly define their needs. As we build a framework that describes the flow of information and the time-dependent aspects that define the utility of this information, the analysis can be verified because the users of the tools can ensure that all the resources available can be captured within the framework. This understanding will allow us to build a comprehensive inventory that captures all requirements and their corresponding resources. Furthermore, because the gaps are likely to be limited, they can be clearly defined, and the courses of action developed to fill those gaps are more likely to be of a scope that can be readily addressed. The resulting framework will then be in place and tested as we move into additional, less frequent types of event, for which there are likely to be larger gaps and increased uncertainty. Analysis of these additional scenarios will benefit from an already-established framework that can be used to identify and characterize the gaps in the data and modeling resources available for management of those scenarios. The use of a pre-defined framework will also increase the efficiency with which the necessary information about those new scenarios can be collected and analyzed.

Membership

Overview of MDWG Membership

- The MDWG membership was appointed by the Emergency Support Function Leadership Group (ESFLG) and includes both subject matter experts and program managers.
- Each of the federal Emergency Support Functions is represented by members who sit on the MDWG.

The membership of the working group was chosen by the ESFLG and includes a wide range of emergency managers and subject matter experts from across the interagency, including members from each of the federal Emergency Support Functions, as identified by PPD-8. Both primary and secondary points of contact were identified for each division or agency represented; membership is continually expanded upon request by current ESFLG or MDWG members. Current membership and the agency each member represents can be found in Appendix 3.

Methods

Phase I Methods

- Information was collected through interviews with high-level decision makers, program managers, and users of data and modeling outputs.
- Interviewees included those with a wide range of roles during emergency management, from model developers to high-level decision makers.
- Select state and local emergency managers were interviewed upon recommendation from MDWG members to ensure that the project adequately reflects their resources, needs, and limitations.

The information required for this analysis of the data and modeling resources used to support planning and operational decision-making has been collected through a series of in-person and phone interviews. In most cases, the MDWG members are interviewed initially. Interviews with additional subject matter experts or leadership are scheduled upon recommendation to provide further breadth or depth of information depending on the size of the agency or division represented and the expertise of each interviewee. In phase I, there was an emphasis on interviews with the high-level decision-makers, program managers, and users of the data and modeling outputs. The emphasis during phases II and III will shift toward the subject matter experts, data collectors, and developers of the tools to ensure an understanding of the technical characteristics of each resource. During phase IV, interviews will be, again, focused on the users of the analytical framework and interactive library, with follow-up interviews with subject matter experts to ensure accuracy.

In addition to federal officials, a number of state and local emergency managers were interviewed to assess their use of data and models in their respective agencies. Directors of state emergency management departments and other key personnel in their departments were interviewed following the recommendation of MDWG members. The presidents of major associations of emergency managers (IAEM and NEMA) were also interviewed. Interview questions for state and local entities were similar to those for federal officials, with added emphasis on interaction with federal agencies.

Interviews are opened with an introduction to the project. A questionnaire (see Appendix 4) outlines the topics to be addressed during the interviews for each phase and is used as a general guide for the discussions. In this phase of the project, the conversations have focused on the role of each group during each phase of emergency management and the questions they use data and modeling to address during that work. Interviewees have included those who are primarily providers of data or are tool engineers; those who are primarily analysts of those data and users of the tools who in turn provide the results to decision-makers; those whose primary role is to make operationally-relevant decisions based on the information provided; and those who have roles that include a combination of tool-development, analysis, and decision-making. Interviews are designed to capture an overview of the roles and responsibilities of each group and the ways in which data and data processing tools, including modeling, support those roles. The flow of the conversation varies widely based on the expertise of the interviewee and attempts to capture both the general and specific information requirements from each interviewee across the spectrum of emergency management missions and the phases of an emergency.

In phase I, 62 interviews were completed with 116 people representing 38 divisions or agencies. In addition, nine interviews were completed with fourteen individuals representing six states (with additional interviews still forthcoming). A comprehensive list of the interviews completed during phase I can be found in Appendix 5.

Results

Phase I Results Overview

- Data and data processing tools are widely used across the interagency to support decision making during all phases of emergency management.
- Information requirements vary over the course of an emergency; the questions asked by decision-makers change over time.
- The use of data and modeling in disaster management is an iterative process, and there is no single resource or tool that can be used to address all questions or requirements.

Data and data processing tools (including predictive models) have been used to support operational decision making during emergency management for many years. However, with the advent of readily accessible and mobile computing capacity in the last decade, data and models have become increasingly available to support decision making in real-time and in the field. The data and modeling resources available have expanded accordingly, but effectively coordinating these resources and using the information they produce is still a challenge. This challenge is evidenced by widespread interest in Big Data, and has been addressed by a wide variety of efforts across the interagency, including the GeoCONOPS effort and other work specifically focused on improving access to operationally relevant information during emergency management.

The Modeling and Data Working Group (MDWG) was initiated not to supplant these previous efforts, but to incorporate and expand upon them. The strength of this effort lies in the breadth of the membership and the inclusion of all phases of emergency management. In addition, while there are many efforts that have compiled lists of all available resources, the goal of this effort is to identify the authoritative resources, as defined by their interagency utility, and to build an interactive library of these tools that can be used as a resource during an emergency regardless of the level of sophistication of the user—or the level of detail they need.

This project is divided into four phases, the first of which is covered in this report. The interviews and analysis in phase I have addressed how data and modeling are used to support operational decision making during emergency management, specifically in hurricane and earthquake scenarios; the primary focus has been on the questions asked by decision makers throughout all phases of disaster management, and how those questions are supported by available data and modeling resources. The results are based on the information gathered during interviews with the MDWG members and subject matter experts they have recommended. The analysis of the phase I results is described below.

Phase-specific Questions

Phase-specific Questions Summary

- Information requirements change and develop over the course of an emergency.
- There is significant overlap between the questions addressed in the course of work associated with a wide range of mission-areas, particularly during the planning and response periods of emergency management. .
- The phases of an emergency and the information required during those phases can overlap, particularly for some missions.

While the specific questions that data and modeling are used to address during large-scale emergencies caused by hurricanes and earthquakes vary by mission, the types of questions are more heavily determined by the phase of the emergency, rather than by the user's specific mission area. The event timeline generally consists of five phases: preparedness, planning, response, recovery, and mitigation. Each phase is not strictly temporally distinct, but they are instead divided to help provide context for the division of labor. For example, recovery often begins simultaneously with response, but typically continues for much longer; mitigation is generally considered to have a distinct role during all phases of emergency management. The questions asked during each of these phases are specific and unique. Preparedness is defined by the activities that help emergency managers and those agencies involved position themselves to be more effective during an emergency. During this phase, the questions that will need to be addressed during future events are defined, and the data and modeling resources required are identified. During planning, data and models identified during preparedness are used to address questions about a specific, impending threat. During response, these questions become continually more specific and refined, addressing mission-specific, actionable requirements. During the transitional period between response and recovery, accurate situational awareness data become increasingly important, preferably at the highest resolution available. Mitigation, then, provides an opportunity to reflect on lessons-learned, as well as a chance to use assessment data in the model verification and validation process.

An overview of the phase-specific questions that data and models are used to address across the interagency during emergency management are shown below. These questions are presented to serve as examples and are not intended to provide a comprehensive outline of every question asked at the federal level during emergency management. However, by considering specific questions and their relationship with the timeline of emergency response, it is possible to develop a more holistic understanding of the ways that information requirements change and develop over the course of a emergency.

Preparedness

- How can we best allocate resources to minimize risk?
- How can we most effectively develop systems, programs, and infrastructure to support all phases of emergency management?

Planning

- What is the current threat and how severe will the threatening event be?
- When and where will the event occur?
- Who and what will be affected by the event and at what time?

Response

- What needs to be done?
- What and who were *actually* impacted, and how severely?
- What resources are available for response?
- How should we allocate existing resources and set priorities for response?

Recovery

- What resources are still needed to allow those impacted to recover from the event?
- When is our mission complete and withdrawal appropriate?

Mitigation

- What went well?
- What could have been improved?
- How can we improve our existing systems, programs, and infrastructure to address future emergencies?

Of note, similar questions and concerns can, and often do, arise throughout all phases of emergency management. Although certain types of questions and critical information requirements are associated with specific periods of an emergency, these questions often remain relevant throughout the event. The information required during response and recovery has some of the greatest overlap, as the decision-making responsibilities associated with recovery can begin well before the response period is complete. For example, it is not uncommon for toxic environmental releases to occur during or after natural disaster events such as hurricanes or earthquakes. In these instances, the EPA's extended environmental recovery phase begins concurrently with the response phase and is often defined by similar information requirements. In these instances, the EPA's extended environmental recovery phase begins concurrently with the response phase and is often defined by similar information requirements. There is often no definite distinction between response and recovery; in fact, the intentional overlap between the two phases highlights the fact that response and recovery are inherently interdependent.

Similarly, preparedness is uniquely situated in a position to address multiple phases of emergency management. From this position, advanced planners have the opportunity to strengthen the information infrastructure in a way that is meaningful to preparedness, response, recovery, and mitigation. Through the use of exercises and risk assessments to identify and plan for threat-specific challenges, the preparedness mission area is able to develop and improve systems, programs, and infrastructure.

Flow of Information

Flow of Information Summary

- The use of data and modeling in disaster management is an iterative process.
- Types of datasets include ground-truth data, situational awareness data, decision support information, and mission-specific requirements.
- Types of models and tools include event characterization models, consequence models, and decision support tools.
- Event characterization and consequence models are shared widely across the interagency, while decision support tools and mission-specific requirements changed based on an agency's specific mission.

Data and models are used extensively in emergency management across the interagency and throughout each phase of the event. Notably, these data and models are not monolithic, and there is a cascade of information that flows through iterative steps of data collection and data processing. At each step, raw observational data and outputs from earlier iterations of modeling are aggregated. These data are then processed using tools of varying sophistication, ranging from computationally intensive predictive weather forecast models, to simple, computationally conservative tools that produce the information required to inform more narrowly-defined mission-specific decisions. A broad overview of this framework is shown in Figure 2.

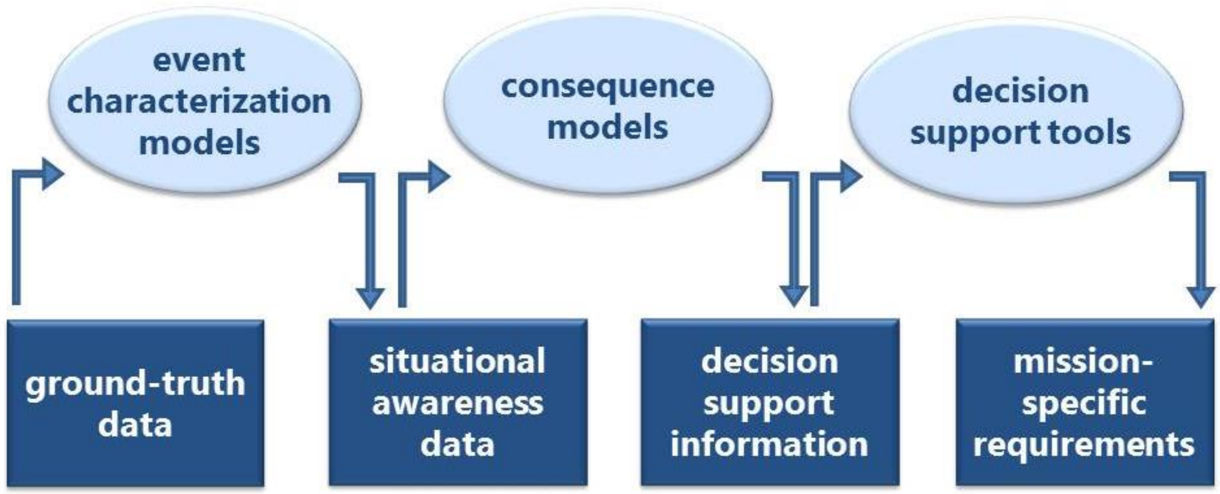

Figure 2. Framework describing the flow of information through iterative rounds of data and modeling. Data sources are shown in dark blue; models and data processing tools are in light blue. Arrows indicate the flow of information. Note: Additional resources provide data and are incorporated into each step but are not shown for simplicity. Examples are described in the text.

In brief, ground truth data describe the current state of the world: the real-time weather, the location of fault lines, or the amount of seismic activity. These data feed event characterization models, predictive models that characterize the size and scope of the event (e.g. weather forecasts, flood predictions, identifying when and where an earthquake has occurred). These models produce situational awareness data that characterize the location, timing, and severity of the threat (e.g. when a hurricane will make landfall or which regions were affected by an earthquake). Situational awareness data then feed consequence models, which are used to estimate impacts and help to characterize the effected population and infrastructure. These consequence models, such as HAZUS, are used across the interagency to estimate economic impacts, health effects, and infrastructure damage. The outputs of these models are, in turn, used as inputs for mission-specific decision-support models, such as those used to drive decisions about the timing of evacuation, purchase and allocation of disaster relief supplies, or optimal locations at which to deploy search and rescue teams. The resulting mission-specific information can also be used to define hiring or staffing requirements, or to provide information about patient flow in the context of the public health response.

Importantly, this flow of information is not unidirectional. In some cases, and often optimally, as information about the event is collected in real time, these data can be fed back into the predictive models to refine the outputs and improve the fidelity of the results. This process can be particularly important for those models whose outputs are continually used to feed mission-specific tools that define response requirements. For example, as information about actual high water marks or surge data are collected during a hurricane, the inundation models can be re-run with these inputs, and the resulting outputs can be used to guide evacuation decisions further up the coast.

Neither is the flow of information a closed loop. Steady state data describing infrastructure or road maintenance do not inform event-characterization models, but are important data feeds underlying many of the consequence and mission-specific decision-support tools. These data, though not shown in the overview image in Figure 2, are incorporated from additional sources at each iterative step of modeling. These sources of data are described in more detail below.

This framework is delineated in more detail below with examples specific to the use cases on which this iteration of the project is focused. These examples are not intended to be all inclusive, and are used here for the purpose of illustration. A comprehensive set of the data and modeling resources available will be collected over the course of phases II and III.

Ground Truth Data

While the uses of data and models differ by mission and the specific needs of each user, the majority of the modeling performed for the purposes of emergency management relies heavily on ground truth data produced by a small number of specialized agencies. Ground truth data are defined here as those data that define the physical characteristics of a specific hazard or steady-state data that characterize the environment prior to and during an event. A few examples of ground truth data are listed in Table 1. It is worth noting that many of these data sources are useful beyond their most obvious applications. For example, precipitation data are important not only for predicting the path of a hurricane, but also for estimating the severity of an earthquake, as the degree of ground saturation changes ground shaking dynamics. Additionally, temperature is critical for informing the response to any emergency in which homes are lost or survivors require housing: housing requirements vary dramatically if temperatures are expected to be near freezing or to fluctuate significantly between daytime and nighttime.

Table 1. Ground Truth Data. Examples specific to hurricane and earthquake scenarios.		
Data Class	**Type of Data**	**Resource Provider**
Geography	sea height (surge data)	NOAA, USGS
	fault line mapping	USGS
	seismic data	USGS
Weather	precipitation	NOAA
	wind speed	NOAA
	Temperature, pressure	NOAA
Population	special populations	HHS
	demographics	Census; HHS
	population size	Census
Infrastructure	power grid	DHS IP; DOE
	hospitals	HHS, DHS IP
	roads	DOT, DHS IP

Event Characterization Models

Event characterization models are those models that predict the location, time, and severity of an event. These models are used to consider specific characteristics of potential or impending hazards. The major questions underlying emergency response rely on the outputs of these models, as they define which regions are impacted, in what specific locations, and to what degree. These data drive high-level decisions: whether or not an event requires an emergency response; as well as concrete decisions: which patients in which hospitals will need to be relocated because the power is down and the generators flooded. Event characterization models include weather forecast models such as those produced by NOAA, but also include models such as SLOSH, which incorporates observational weather data to estimate which areas are going to be inundated with flood waters, when, and with how much water. These forecasts are required to guide the vast majority of downstream decisions, regardless of the specific mission.

Table 2. Event Characterization Models. Examples specific to hurricane and earthquake scenarios.		
Model	**Application**	**Resource Provider**
GFS	Atmospheric Forecast	NOAA
NAM	Atmospheric Forecast	NOAA
SLOSH	Inundation Prediction	NOAA
ShakeMap	Ground Shaking	USGS

Situational Awareness Data

Situational awareness data are those used during or after an event to characterize the impacts of an event as it is occurring. These data can be collected either by instrumentation or can be the outputs of event characterization models. For example, both the weather forecast and inundation maps that show predictions of the location and scope of flooding ahead of a hurricane would be considered situational awareness data. For events without advance notice such as earthquakes, these data would include information about the size of an earthquake, as collected by seismometers and by social media tools such as "Did You Feel It?", a tool developed by USGS to provide additional data from which to estimate the size and scope of an earthquake, particularly in regions where seismometers are far apart. Notably, these data can also be modeled using ground-shaking models that use seismometer data inputs to calculate the likely magnitude of the event in the intervening regions. Such models would be defined as event characterization models, producing these same types of situational awareness data.

Table 3. Situational Awareness Data. Examples specific to hurricane and earthquake scenarios.		
Data Class	**Type of Data**	**Resource Provider**
Geography	event magnitude	NOAA, USGS
	impacted areas	NOAA, USGS
	storm surge	NOAA, USGS
	ground shaking	USGS
Weather	forecasts	NOAA
	regions affected	NOAA
Population	population density	Census, LandScan program
	spatial distribution	Census, LandScan program
	demographics	Census
Infrastructure	flooding	FEMA, agency-specific assets
	infrastructure stability	FEMA, DHS IP, agency-specific assets

Consequence Models

Consequence models are those used to predict the impacts of a potential or impending hazard, including, but not limited to, economic consequences, infrastructure damage, health effects, or impacts to the supply chain. These models, such as HAZUS, make estimates regarding economic loss and infrastructure damage and help characterize the affected populations. These models are scenario-specific, though some include predictions for multiple hazards. HAZUS, Hazards US, for example, is a loss estimation tool that provides economic consequence estimates for earthquakes, floods, and hurricanes. The US Army Corps of Engineer's SimSuite similarly provides planning support for earthquakes, floods, and hurricanes, with the goal of expanding to a wide array of terror scenarios. By contrast, PAGER, a USGS product, is specific to earthquakes. Both HAZUS and SimSuite are designed to be flexible platforms that accept a wide variety of data feeds to be incorporated into a single resource.

In the course of the phase I interviews, it has become clear that consequence models are often used much more widely and broadly than their producers originally intended. For example, HAZUS, the loss estimate tool produced by the Mitigation division of FEMA, was originally designed to provide first-pass damage estimates for the purposes of gauging the scope of the financial burden of a specific event. However, HAZUS is being used throughout the interagency as a tool to estimate general event impacts for those with a wide array of mission areas. Its outputs, either without further analysis, or after processing by downstream tools, are used to guide estimates of the volume of temporary housing resources that will be required, the populations affected, and even the number of loan officers required to field the applications that are expected to be filed with the Small Business Administration. Understanding this expansion in utility is important, as it suggests that the product serves as an important backbone for operational decision-making during emergency management, increasing the value of keeping the product updated, maintained, and, potentially, suggesting that its original intended audience should not be the only drivers of its future expansions. These findings may, in fact, support the formation of an interagency process by which to support products of such broad utility.

Table 4. Consequence Models. Examples specific to hurricane and earthquake scenarios.

Model	Application	Resource Provider
HAZUS	Economic; General	FEMA
PAGER	Economic; Health Effects	USGS
CNIMS	General	DTRA
SimSuite	General	USACE

Decision Support Information

Decision support information is the data that defines what needs to be done. The information can be predictive, as from outputs from consequence models, or can be derived from assessment data collected by those on the ground (or in the air) immediately following the event. These data directly inform the response and recovery phases of an emergency. Decision support information is used broadly in support of nearly all mission-areas, and can range from the identification of the states most likely to request federal assistance, the regions most likely to be out of power based on critical infrastructure impacts, the cities specifically impacted, or the cascading effects of greatest concern (e.g. nuclear power plants most likely to have sustained damage from an earthquake). Each agency, and often each division, may collect, process, and use these data differently. While many of those interviewed described success in having access to the outputs of predictive consequence modeling and many appear to use these data streams effectively, assessment data was a point of concern for many individuals across the interagency.

Assessment data are those data that define the actual impacts of an event and, by definition, can only be collected during or after the event. In the best case scenario, these data should be made immediately available to those making response and recovery decisions: to verify the outputs of the predictive modeling and continually re-assess response and recovery activities as the event continues. These data can include neighborhoods or individuals in distress as identified by local emergency responders, schools on high ground that can be used as temporary shelters, or aerial imagery data upon which rescue operations can be planned for those stranded by flood waters. Critically, these data must be processed, formatted, and presented in ways that facilitate analysis and subsequent decision making. Based on the interview results, reporting delays, a lack of standard operating systems for data collection, or a lack of analysis (for example, of geocoding or time stamping of aerial photographs) have previously prevented the use of these data. In other examples, some assessment data such as real-time surge data can be collected only if the equipment necessary to collect the information is pre-deployed in anticipation of the event. Such data collection requires pre-event funding and coordination efforts that do not yet appear to be fully in place.

Table 5. Decision Support Information. Examples specific to hurricane and earthquake scenarios.

Type of Data	Resource Provider
event severity and scale	NOAA, USGS, FEMA
time-specific impacts	NOAA, USGS
location-specific impacts	NOAA, USGS, FEMA, DHS IP, DoE, EPA
population-specific impacts	FEMA, HHS, EPA

Decision Support Tools

Decision support tools are models and data processing tools which are typically mission-specific, and developed by divisions or agencies with comparatively narrowly defined scopes. Most often, these tools use decision support or assessment data to determine specific actions required during response and/or recovery. For example, HURREVAC, a decision-support tool developed through a partnership between FEMA, NOAA, and USACE, calculates when specific regions will need to be evacuated based on a forecast of the storm path, severity, and time of arrival. In addition, the Army Corps of Engineers has developed a tool that predicts the amount of debris likely to be left in public roadways in regions impacted by flooding; this tool additionally helps calculate the number of dump trucks and other equipment required to remove that debris.

While some of these decision support tools are related to a mission that is relatively agency-specific (such as the maritime search and rescue model, SAROPS, developed and used by the US Coast Guard), others provide information that is critical to a broad range of missions and agencies. EAGLE-I, for example, is a recently developed Department of Energy tool that addresses a need identified by a wide range of interagency partners. The tool identifies and reports known electric power outages in real time based on an aggregation of data reported by private electric companies, and provides information about natural gas and petroleum networks. While some missions may require these data at a higher resolution than is provided (county or zip code resolution), these data can provide direct decision support for emergency managers involved in many facets of decision-making, ranging from generator placement, to hospital closures, or to evacuation recommendations.

It is of note that the incorporation of assessment data into iterative model runs is particularly critical for the verification, validation, and continuous use of event characterization and consequence models. For example, SLOSH is an excellent flood inundation model, but a combination of high water marks or, better, surge gauge data must be incorporated after each event to improve the fidelity of the model with each storm. Similarly, earthquake damage assessment data should be used to validate the outputs from models such as PAGER, providing robust and data-driven verification and validation of modeling outputs to ensure that the tools improve with each new event and the availability of new data.

The use of assessment data is challenging, partially due to difficulties in defining standardized methods for data collection, centralization, and organization to facilitate data mining or analysis. This lack of standardization and the subsequent lack of effective use of assessment data prevents the incorporation and adjustment of response or recovery activities based on those data and also prevents effective verification and validation of the models.

Table 6. Decision-Support Tools. Examples specific to hurricane and earthquake scenarios.

Tool	Application	Resource Provider
Debris-Estimating Model	Debris	USACE
EAGLE-I	Energy	DoE
HURREVAC	Evacuation	FEMA
ShakeCast	Infrastructure	USGS, agency-specific infrastructure data

Mission-Specific Requirements

As indicated by the name, mission-specific requirements are just that: mission-specific. Each interviewee we spoke with described some aspects of their work or questions they use data or models to address that are specific to their agency, their division, and/or their role. Most often, mission-specific tools incorporate data collected during post-event assessments or from outputs of predictive models and use these data to inform specific decisions. These data quantify the impact of an event and inform specific agencies about the resources required to support each mission, from personnel, to equipment or to temporary housing or shelter.

Notably, most state and local use of data and modeling outputs falls in this category. As discussed in more detail below, the primary role of state and local governments during emergencies, whether small or catastrophic, is to directly provide the resources necessary to protect their affected population. Their information requirements are primarily focused on region-specific and population-specific impacts, and what concrete resources are required to restore normalcy for their constituents.

Table 7. Mission-Specific Requirements. Examples specific to hurricane and earthquake scenarios.	
Type of Data	**Resource User**
critical infrastructure impacts	FEMA, DHS IP, HHS, DoE
equipment requirements	FEMA, USACE, HHS, Red Cross
personnel requirements	FEMA, USACE, SBA
prioritizing response	FEMA, USACE, USCG, HHS, DoE, EPA, USFS

Phase-specific Flow of Information

Summary of Phase-specific Flow of Information

- The use of the iterative steps of data and modeling described in previous sections can be mapped to an event timeline.
- There are few differences between advance notice events (e.g. hurricanes), and no-notice events (e.g. earthquakes), with the exception that advance notice events allow for a period of event-specific planning before the event occurs.
- While emergency management during hurricanes and earthquakes require the use of unique event characterization and consequence models, the same decision support and mission-specific information and tools support the majority of the response and recovery efforts for both types of natural disaster events.

The flow of information during emergency management can be mapped onto the timeline of an event to highlight the way in which information requirements change over the course of an event. While the phases of emergency management are often shown in a circle, we have linearized the timeline to simplify the correlation of data and model use to each phase, as shown in Figure 3. The event shown is an advance notice event, such as a hurricane, during which there is a period pre-event of about 96 hours during which event-specific planning is focused. During a no-notice event such as an earthquake, the only difference is the lack of an event-specific planning period; this same effort is completed in the first hours following the event.

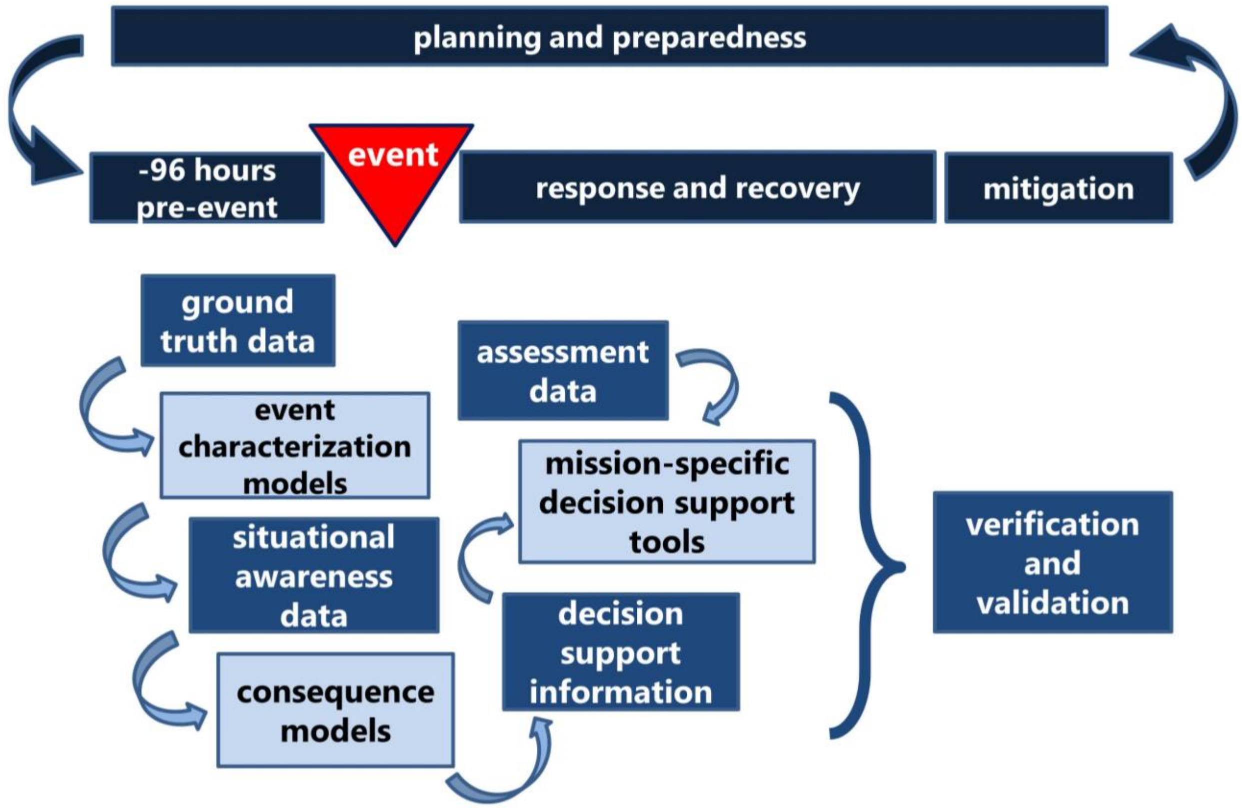

Figure 3. Flow of information required during emergency management organized along the timeline of an event. Data sources and phases of the event are shown in dark blue; models and data processing tools are in light blue. Arrows indicate the flow of information. No-notice natural disaster events would not include the -96 hours of preparedness.

Hurricanes

With the approach of a hurricane, planning relies heavily on the ground truth weather data collected by NOAA and processed by their weather models to produce accurate forecasts of the storm track, size, forward speed, and intensity. The outputs from these models are used to predict the scope of the event using SLOSH and other inundation models. These outputs are used to directly inform specific decisions that have to be made pre-event, such as pre-deployment of resources, as informed by consequence models such as HAZUS, or pre-landfall evacuation decisions informed by tools such as HURREVAC, which are based directly on the outputs of SLOSH combined with pre-calculated evacuation clearance times. During the event itself and during the early response, ground truth data are rapidly gathered to provide real-time situational awareness. The consequence models are re-run based on this information and the incoming assessment data is used as inputs for each decision-support and mission-specific tool that informs the actions necessary for the response and recovery efforts that are initiated immediately. These efforts continue during the response and early recovery phases. (Some recovery activities begin immediately post-event and much of early recovery is concurrent with response.) During recovery, resource allocation tools are used extensively, informed by a combination of the information produced by consequence models, but more often informed by those on the ground who are involved in the response. Assessment data that provide information about the ongoing status of the response and recovery, such as data about power outages and fuel availability, are continually collected and analyzed. Some of this data analysis is performed with the aid of data analysis tools; much of it is performed by the emergency managers and disaster relief effort specialists who are leading the response and recovery efforts themselves.

During response and recovery, the methods by which data are collected, analyzed, and presented to decision-makers vary widely. In some cases, data are input directly into fillable PDF documents or uploaded directly to websites that are housed and curated by the agency (e.g. the Environmental Protection Agency.) In others, data are transmitted to the Emergency Operations Center, NRCC, JFO, or other coordinating facility by phone call. Information sharing platforms such as WebEOC, are used by many at the state and local level, though these systems do not tend to be integrated with the systems of their counterparts in the federal government. Although there appear to be a number of these types of systems available, only a few of the interviewees described using them during recent storms.

Earthquakes

The data and modeling used to support operational decision making during planning and operational decision making following a large-scale earthquake are incorporated in the same basic framework that describes the flow of information for hurricane scenarios. The greatest differences in specific data and modeling resources are in the ground truth data, data collection, and event characterization models. These data sets and models reside almost entirely with the US Geological Survey (USGS), which, like NOAA, makes all their data publicly accessible on open source websites with open access. The ground truth data, much like those collected by both NOAA and USGS that supports hurricane preparedness, are collected ahead of time: mapping of fault lines, analysis of historical earthquakes to anticipate scope and magnitude of future events, and mapping of building codes associated with infrastructure across the US and abroad to help model the potential impacts of events. Seismometers collect the real-time earth shaking data that determine when an earthquake has occurred and a series of models calculates the magnitude and scope of the event based on those real-time data. This information about magnitude and scope are incorporated as inputs for a number of earthquake-specific consequence models, including PAGER (USGS) and HAZUS (FEMA). Once the consequences of the event have been calculated, the vast majority of decision support and mission-specific information and tools are the same as those upon which decision-makers rely for hurricanes or any other large-scale natural disaster. The focus of the response and recovery efforts is on ensuring that lifelines are secured for those affected, that critical infrastructure is secured to prevent or limit the scope of cascading effects (e.g. preventing chemical releases from industrial sites or securing nuclear reactors in the affected area), or that debris is cleared from the roadways, electricity restored, and transportation infrastructure repaired. The data and modeling required to support these missions is as similar as the missions themselves.

Information Requirements: State and Local Governments

Summary of Information Requirements for State and Local Governments

- The flow of information and phases of disaster management affecting state and local emergency managers correspond to those at the federal level.
- Efficient allocation of resources is a primary concern for state and local emergency management.
- State and local emergency managers often require a higher resolution of information than what is currently available for the federal level, specific to their region.

While the interviews of the federal members of the MDWG have spanned a wide variety of agencies, we are limited to a much smaller number of interviews at the state and local levels; these interviews have focused on conversations with the state emergency managers and a small number of additional contacts who have provided an overview of how data and modeling are used to support decision making during emergencies at the state and local level. Table 8 lists those interviewed thus far.

Importantly, because each state has its own emergency management structure, the findings may not capture the entirety of the methods used by each state and likely oversimplify the differences between states and localities. The adage that "every emergency is a local emergency" applies, and the ways in which emergencies are managed differ widely. For example, this analysis compiles information collected from states with either centralized or home-rule emergency management and with widely varied emergency management capabilities. Furthermore, these interviews are on-going; this discussion serves solely as an initial assessment and generalization of the ways in which data and modeling resources are used and how state and local governments fit into the larger framework of national-level emergency management.

Based on the phase I interviews, the mission of greatest concern to those at the state and local levels involved in emergency management is to efficiently and effectively allocate resources during response and recovery. These groups focus their efforts on collecting information regarding what assistance is needed and what resources are available. Some of this information may be collected in the planning phase, when outputs from federal models are used to predict the level and type of resources likely to be needed. Often states have developed their own tools to analyze the model outputs and provide these estimates. Once the event occurs, however, the majority of data-related efforts from the state and local agencies are in collecting assessment data to monitor and direct response activities.

The progression of emergency management activities for state and local emergency managers includes planning and preparedness, response, recovery, and mitigation, as it does at the federal level. Likewise, the flow of information, from ground-truth data through mission-specific requirements, remains the same. The primary difference is in whether the state and local entities are performing as consumers or generators of information. The upstream data, including outputs from event characterization models and consequence models, primarily come from the federal agencies that produce them. These data are provided by the lead federal agency for the information that produces and publishes official model outputs, from which the state and local consumers of the information either pull the data themselves or receive it, “pushed,” from the federal agency. In this way, states are operating off of the exact same information that the federal government is. For example, states typically rely on the National Hurricane Center’s forecasts for location and severity of a hurricane at landfall to inform planning activities. Likewise, when a state relies on consequence outputs from HAZUS, it uses the runs performed and published by FEMA.

Table 8. State and Local Officials Interviewed.		
Name	**Organization**	**Title**
John Madden	National Emergency Managers Association; Alaska Division of Homeland Security and Emergency Management	President, NEMA; Director, Alaska DHS&EM
Jeff Walker	International Assoc. of Emergency Managers; Licking County, OH, Emergency Management Agency	President, IAEM; Director, Licking County EMA
Mark Ghilarducci	California Emergency Management Agency	Secretary
Kathy McKeever	California Emergency Management Agency	Director of Infrastructure Protection
Matthew Hawkins	California Emergency Management Agency	Deputy Commander of the State Threat Assessment Center
Kim Zagaris	State of California Governor's Office of Emergency Services	State Fire and Rescue Chief
James E. Turner III	Delaware Emergency Management Agency	Director
Bryan Koon	Florida Division of Emergency Management	Director
Michael Whitehead	Florida Division of Emergency Management	Florida State Mass Care Coordinator
Richard Butgereit	Florida Division of Emergency Management	Information Management Section Head
John Wilson	Lee County, FL, Emergency Management Agency	Director (retired)
Ken Mallette	Maryland Emergency Management Agency	Executive Director
Jordan Nelms	Maryland Emergency Management Agency	Director of Planning
Michael Fischer	Maryland Emergency Management Agency	Director of Administration

State emergency managers rely heavily on the data and model outputs produced by the federal government, and these data are generally shared effectively and in a timely fashion. However, a number of interviewees indicated that while the available data are at sufficient resolution for planning at the federal level, the requirements for accuracy and resolution are much higher for state and local planning and response departments, and those needs are not currently met by the resources provided by the federal government. Specific examples included suggestions that the grid cell sizes from SLOSH could be reduced for higher resolution and that the accuracy of the critical infrastructure data made available through the Homeland Security Infrastructure Program (HSIP) could be improved. Some states have begun addressing this latter gap by compiling more detailed and locally-relevant critical infrastructure data sets of their own, but others are hopeful that this issue can be addressed at the federal level.

As the information needed progresses toward the mission-specific, state and local entities contribute more of the information. The primary responsibility of states and localities during response to an emergency is allocation of resources, especially police, fire, and rescue crews. Tracking of the availability of these resources by necessity happens at the local level. In order to support these missions, real-time assessment data such as the status of critical infrastructure elements, power availability, and traffic flow are crucial. However, access to these types of data is consistently lacking for states and localities; in some cases, this information is not available (not collected), and in others, it is collected by a number of entities and not shared effectively, if at all, with emergency officials. These data sets are critical to managing an effective response, but most states are not in a position to use them to their full potential. Structured management systems such as WebEOC generally have not been found useful to state emergency managers. While efforts are beginning at the federal level to aggregate some of these data (e.g. the Department of Energy's EAGLE-I), it remains a gap, and one that will need cooperation with states, localities, and the private sector to be sufficiently addressed.

Initial Gap Assessment

Initial Gap Assessment Summary

- Additional storm surge data are necessary to more accurately predict the extent of flooding due to hurricanes.
- Though a great deal of assessment data is collected, it is often not fully incorporated into consequence models and decision-support tools.
- Very few supply chain models are in use at the federal level. Although there are efforts underway to develop this type of resource, they are not yet operational.

This assessment is an initial analysis of the questions that the currently available data and modeling resources do not sufficiently address, as described by the interviewees. This analysis will be expanded and will serve, in future phases, as a place for additional research and assessments of the tools currently available, if not currently in use.

The gaps identified during the phase I interviews fell into three main categories: gaps in the data available to better model the events, gaps in the assessment data following an event, and gaps in specific types of modeling products required to address a specific subset of operationally-relevant questions. Each of these gaps were mentioned multiple times by a variety of uses, so aims to identify those gaps that would address the needs of the greater emergency management community most broadly if filled.

Gaps in Ground Truth Data

The first gap is characterized by a concern about the inability of current surge models to accurately predict the scope of flooding or inundation ahead of a hurricane or tropical storm. Both Hurricane Isaac and Tropical Storm Debby from the 2012 hurricane season highlight this gap: in both storms, storm surge caused extensive flooding at times and in locations that could not be predicted by the strength of the winds. Because current surge models rely almost entirely on wind speed to identify when and what strength at storm will hit, these models fail to capture rises in sea level either ahead of these winds or in the absence of strong winds, despite other factors such as rainfall. These factors have combined in several cases to prevent decision makers from having access to accurate information predicting the extent of flooding and hinder the ability of emergency managers to make the accurate evacuation decisions necessary to protect the affected population.

Gaps in Assessment Data

While a great deal of assessment data is collected in the aftermath of an event, many agencies and groups have significant challenges collating, analyzing, and using those data to refine their response and recovery activities accordingly. Situation reports tend to describe a small subset of static data and, while useful for those for whom they are intended, this user group is relatively small; these reports often does not fill the needs of those on the ground. The best systems available were described as incorporating mobile applications for the ready input of assessment collected by those on the ground in the affected regions, pulled into a centralized database, from which the data must then be analyzed and provided back to those making operationally-relevant decisions. The entirety of this process is only successfully completed by a minority of those with whom we spoke.

Modeling Gaps

The primary gaps in the models and data processing tools available, as described to us during interviews, were those focused on predicting, characterizing, and quantifying the effect of supply chain dynamics and the associated cascading effects associated with disruptions in the supply chain. We have found no comprehensive, widely-available tools that link, for example, power outages to critical infrastructure to transportation routes. It is in this area that there is likely to be the greatest benefit of significantly greater interagency coordination and information sharing. By collating the data sets that provide this information into a single resource, a systems model could then be used to assess the connections between these data sets. There are efforts underway to develop this type of resource, though they are not yet operational. These efforts will be one area of further analysis during later stages of this project.

Conclusions

Phase I Conclusions

- Data and/or modeling are used across the interagency and by those involved at all levels of emergency management.
- Producing operationally-relevant information requires iterative steps of data collection and processing.
- The information required to support operational decision-making are phase-specific and diverge by mission areas as the event progresses.

What is modeling?

When asked about what data and modeling they use, many people initially responded that they do not use models for operational decision-making during emergency management. However, nearly all use data, and the vast majority have some type of data processing tool that helps to perform mission-specific analysis of data collected over the course of their work prior to or during an emergency. While agencies such as NOAA and USGS require and use computationally intensive, highly complex models to produce the information they are tasked with providing, the majority of the tools used by the federal government to perform data analysis in support of response and recovery missions require, by necessity, only limited computing power and limited training. This difference suggests that the tools available are, at least in most cases, tailored to the needs of the users.

The Questions

The focus of phase I was on the types of questions that those involved in emergency management across the interagency use data and modeling to address. Despite the breadth of the emergency management community, the questions that data and modeling are used to address during large-scale hurricanes and earthquakes differ more by phase than by mission. The similarity of the questions asked is most marked during the early phases of the emergency when everyone simply needs to know what is going to happen, when, and where. These questions are, for the most part, answered by the work of a few agencies that specialize in event characterization. Similarly, consequence tools that incorporate the situational awareness data produced by the event characterization models are used widely. However, it is of note that these tools are often not used for their intended purpose. Most notably, while HAZUS is a model designed to calculate economic impact, it is used much more broadly; it is used by the vast majority of groups with whom we spoke, and its outputs serve as inputs for a wide array of assessment tools in support of widely varied missions.

The questions that data and modeling are used to address once the event is characterized and the general sense of scope understood are more divergent. However, the data required between missions differ more in resolution than in source. For example, given a single high-rise apartment building, one group may need to know if it has power, another if it has a roof or is structurally sound, and another needs to know the special populations who live there. These data interact closely; even if these data are not available from the same source, sharing of the information between agencies is critical.

Iterative analysis

Data collection and analysis are iterative. There is a flow of information between each step of data collection and analysis as the analysis becomes less abstract and more operationally relevant. As the modeling or data analysis becomes more operationally relevant, it becomes less computationally intensive. This progressive simplification and reduction is what allows those in the field to call up mission-specific data analysis tools or input assessment data directly via their mobile devices and is also what limits the complexity of each single piece of information so that it can be processed by those who are responsible for tremendous breadth (e.g. the Federal Coordinating Officers and state and local emergency managers) as opposed to those responsible for tremendous depth (e.g. the meteorological scientists at NOAA).

This iteration of data collection and analysis has important implications for the tools themselves. While there was originally a perception that there are many overlapping tools, these results suggest that, just as there are critical roles for both the meteorological scientists and the FCOs in emergency management, so too are there for data collection and analysis tools tailored for each. The key is that information can flow directly from one into the other, that everyone who needs information at the same level of resolution or detail is able to share information with each other, and that when any one person needs access to information at a different level of resolution, that they know where to find that information.

Notably, this framework applies to state and locals as well as those in the federal government. Upstream data are very often the same feeds that the federal government is producing. The states' major contribution is in providing decision-support information—in the form of real-time assessment data—and mission specific requirements. Information from all sources (federal, state, and local) is shared in the same data stream. The extent to which the data come from the federal agencies versus the state and local entities will vary by state. No matter the information balance, though, the key element in this relationship is the ability to easily share data in both directions. A standard, consistent mechanism to facilitate the sharing of information resources at the federal level would allow states to design their own systems that would integrate with that system.

Next Steps

The next two phases of this project are focused on identifying and characterizing (1) the information requirements and data sources that supply that information and (2) the models or data processing tools that provide the data analysis that transforms the data collected into information upon which operationally relevant decisions can be made. The goal of the project is to produce an interactive library of the models and decision-support tools available accessed via a user-interface that will facilitate user inputs, run queries, to identify the data sets and the tools used as well as the producers and consumers of those resources. The final product will be built in phase IV of the project and will serve to identify the resources that are used most widely or are foundational to other decision-support tools and identify the gaps in the currently available resources. Ultimately, the goal of the project is to ensure that those involved in emergency management across the interagency have access to the information they need when they need it to more effectively accomplish their missions.

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Appendix 1: The ESFLG Modeling and Data Working Group (MDWG) CHARTER

August 6, 2012

1.0 PURPOSE

This charter provides the framework for the establishment and structure of the Modeling and Data Working Group (MDWG). The MDWG is comprised of Emergency Support Function Leadership Group (ESFLG) members or designees and chaired by the Director of FEMA's Planning Division, Response Directorate. The MDWG will:

- Analyze the catastrophic scenarios to be addressed and prioritized;
- Define and assess information requirements for response planning and operational decision-making;
- Evaluate existing modeling resources to support the range of scenarios and determine modeling input and output requirements;
- Identify gaps and recommend solutions to meet the modeling input and output requirements.

2.0 MISSION

The MDWG mission is to identify consistent, reliable, authoritative models and data sets for response planning and operational decision making for catastrophic events.

3.0 BACKGROUND

Scientific based models and empirical information products and programs are increasingly used to predict the effects of and inform response planning and operations, particularly when faced with complex, cascading "maximum of maximums" threats and incidents. These models and programs enable decision makers with enhanced situational awareness and heightened visualization of the operational environment to prepare and assess the response to catastrophic events. For example, the benefits of prompt and accurate modeling include improved incident warning, reduction of public anxiety through effective risk communications, and delineation of hazard areas. Both real world events and exercises alike have highlighted a need to standardize these processes and products. However, currently no central mechanism exists to address the doctrine, organizational, training, materiel and leadership requirements necessary to exploit the effective use and coordination of such models and products.

The lack of a formal and standardized approach to integrating scientific modeling and coordinating related technical programs is a challenge to information sharing as well as to the development of effective preparedness plans and responses. The need to develop a standardized framework of modeling across the Emergency Support Function Leadership Group (ESFLG) structure is essential to closing core capability gaps, and improving the overall effectiveness of models for both planning and operations. The MDWG will address modeling and analysis requirements and the most effective ways to exploit emerging data generation products, to include scientific modeling and data sets to meet those requirements.

4.0 MEMBERSHIP

The Modeling and Data Working Group (MDWG) members were nominated by the Emergency Support Function Leadership Group (ESFLG) and will meet on a monthly basis. A list of the voting organizations of the MDWG is attached. The MDWG will address the most effective ways to exploit emerging data generation products, to include scientific modeling and data sets. The working group will determine the most effective programs to incorporate into the ESFLG structure as well as to evaluate implementation success.

5.0 ROLES AND RESPONSIBILITIES

- The MDWG voting members will provide primary and alternate representatives to contribute throughout the process.
- Each primary organization of the MDWG will have a voting responsibility when dealing with modeling and data issues that affect the interagency working group.
- The MDWG gathers and assesses modeling and information requirements for catastrophic scenarios and will provide regular updates to the ESFLG for evaluation.
- The ESFLG will then use the information compiled to work with the Office of Science and Technology Policy (OSTP) and the National Security Staff (NSS) to develop and formalize interagency modeling capability governance and coordination.

6.0 DELIVERABLES

The working group will provide an update status to the ESFLG on a monthly basis.

The working group will provide the following deliverables:

1. Identify and analyze the catastrophic scenarios to be addressed and prioritized;
2. Define and assess information requirements for response planning and operational decision-making;
3. Define information requirements for response planning and operational decision making.
4. Develop criteria to evaluate and determine modeling and data source that support requirements
5. Evaluate authoritative modeling and data sources to support catastrophic scenarios; and
6. Identify gaps and recommend solutions to solve the identified modeling and information requirements.
7. Utilize the results from each scenario to inform subsequent scenarios.

7.0 RESOLUTION OF ISSUES AT MDWG MEETINGS

- The working group will utilize the ESFLG structure to resolve interagency coordination issues.
- Any interagency issues that cannot be resolved at the ESFLG level will consult the National Security Staff (NSS) and the Office of Science and Technology Policy (OSTP) for resolution of policy issues.
- Finalize resolution of policy issues will be handled by the Domestic Readiness Group (DRG).

8.0 ESFLG WORKING GROUPS

The MDWG is an ESFLG working group, in accordance with the ESFLG Charter. ESFLG working groups will include appropriate expertise and representation to guide the development of the requisite procedures for response and recovery activities under the National Response Framework (NRF) and National Disaster Recovery Framework (NDRF), as well as Federal Interagency and National planning efforts. Representation on working groups will be open to selected departments and agencies and FEMA Regions as appropriate.

The working group's purpose is to:

- Convene on an ad-hoc basis as designated for specific issues, and disband upon completion of the specific assigned task;
- Address issues that require appropriate department/agency participation for researching and developing procedures to operationalize and execute policy decisions;
- Identify and suggest process improvements to the ESFLG for approval;
- Provide input from subject matter experts; and
- Provide expertise to the Federal response community to address tasks including the research and development of potential options/courses of action and drafting of documents, recommendations, and procedures to improve Federal interagency coordination, integration, and incident response.

9.0 MDWG Primary Voting Organizations

Department of Agriculture

Department of Agriculture/Forest Service

Department of Commerce

National Oceanic and Atmospheric Administration

Department of Defense (OSD, Joint Staff)

Department of Defense/U.S. Army Corps of Engineers

Department of Energy

Department of Energy/National Nuclear Security Administration

Department of Health and Human Services

Department of Homeland Security

Federal Emergency Management Agency
U.S. Coast Guard
Transportation Security Administration
Immigration and Customs Enforcement
Customs and Border Protection
United States Secret Service
Office of Science & Technology
United States Citizenship & Immigration Services

Department of Housing and Urban Development
Department of the Interior
Department of the Interior/National Park Service
Department of Justice
Department of Transportation
Environmental Protection Agency
Small Business Administration

Appendix 2: The ESFLG Modeling and Data Working Group Project Plan

DHS/FEMA

The ESFLG Modeling and Data Working Group (MDWG)

Project Plan

RD-Planning/ESFLG/MDWG/MDWG Project Plan.doc/svc
8/6/2012

Introduction

In July of 2012, both the Department of Homeland Security (DHS) and Federal Emergency Management Agency (FEMA) agreed that FEMA would coordinate the creation and implementation of an interagency Modeling and Scientific Workgroup (MDWG), with the full support and involvement of the Emergency Support Function Leadership Group (ESFLG). At the July 19, 2012 ESFLG meeting, there was concurrence by the ESFLG to form the Modeling and Data Working Group (MDWG) and designate a representative from their department/agency to participate on the MDWG. On July 31, 2012, the MDWG was formed from ESFLG nominations and the August 6th kickoff meeting was announced. The MDWG will assess the current state of modeling systems used, including their owners, requirements, consumers, production processes and means of public messaging. The working group will utilize the ESFLG structure to resolve routine interagency coordination issues. The working group will consult the National Security Staff (NSS) for resolution of policy issues. The purpose of the MDWG will be information gathering – regular updates will be provided to the ESFLG. The ESFLG will then use the information compiled to work with the NSS to develop and formalize interagency modeling capability governance and coordination.

Background

Scientific based models and data generation products and programs are increasingly used to predict the effects of and inform response planning and operations, particularly when faced with complex, cascading “maximum of maximums” threats and incidents. These models and programs enable decision makers with enhanced situational awareness and heightened visualization of the operational environment to prepare and assess the response to catastrophic events. For example, the benefits of prompt and accurate modeling include improved incident warning, reduction of public anxiety through effective risk communications, and delineation of hazard areas. Both real world events and exercises alike have highlighted a need to standardize these products, programs, and processes. A need exists to understand the strengths and constraints of each scientific model and related technical program; enabling the closing of core capability gaps, however, currently no central mechanism exists to address the doctrine, organizational, training, materiel and leadership requirements necessary to exploit the effective use and coordination of such models and products.

The lack of a formal and standardized approach to integrating scientific modeling and coordinating related technical programs is a challenge to information sharing as well as to the development of effective preparedness plans and responses. The need to develop a standardized framework of modeling across the Emergency Support Function Leadership Group (ESFLG) structure is essential to closing core capability gaps, and improving the overall effectiveness of their use in both planning and operations.

Project Plan

The MDWG will address the most effective ways to exploit emerging data generation products, to include scientific modeling, data requirements, and geospatial analysis for catastrophic scenarios. The working group will determine the most effective modeling and data products to incorporate into the

ESFLG structure as well as to evaluate implementation success. Further, Presidential Policy Directive #8 (PPD-8), and specifically the response core capabilities, will inform this process and support this effort.

The MDWG will:

- Analyze catastrophic scenarios to be addressed;
- Assess data requirements for response planning and operational decision-making;
- Evaluate existing resources to support scenarios and address data requirements;
- Identify gaps and recommend solutions to solve the data requirements.

Roles/Responsibilities

- The MDWG voting members will provide primary and alternate representatives to contribute throughout the process.
- Each primary organization of the MDWG will have a voting responsibility when dealing with modeling and data issues that affect the interagency.
- The MDWG gathers and assesses modeling and data requirements for catastrophic scenarios and will provide regular updates to the ESFLG for evaluation.
- The ESFLG will then use the information compiled to work with the OSTP and NSS to develop and formalize interagency modeling capability governance and coordination.

Project Management

1. The membership group will establish a charter.
2. The membership group will establish a work plan.
3. The MDWG will meet monthly to discuss working issues.
4. The MDWG Chair will provide an update to the ESFLG on a monthly basis.
5. The MDWG will provide a formal status update to the ESFLG annually.
6. The MDWG voting members will provide primary and alternate representatives to contribute throughout the process.

Deliverables

The MDWG will provide an update status to the ESFLG on a monthly basis.

The MDWG will provide the following deliverables:

1. Identify and analyze the catastrophic scenarios to be addressed and prioritized
    a. Review the 15 National Planning Scenarios
    b. Review other catastrophic scenarios (i.e. flooding, tsunami, solar storms)
    c. Prioritize scenarios and choose pilot scenarios
    d. Establish process and rating scheme for prioritizing scenarios
2. Define and assess data requirements for response planning and operational decision-making
    a. Map the data requirements for the pilot scenarios

   b. Identify the response organizations for each pilot scenario
   c. Collect input from the response organizations on their current modeling and data requirements supporting these pilot scenarios
3. Evaluate authoritative modeling and data sources to support pilot catastrophic scenarios
   a. Review the modeling and data requirements of each response organization
   b. Define the lead agency responsible for the modeling and data products
   c. Identify the consumers of each modeling and data product
4. Identify gaps and recommend solutions to meet the identified modeling and data requirements
   a. Determine if the existing modeling and data products are meeting the needs of the response organizations and stakeholder groups (e.g. White House, Public, etc.) in assisting them to make informed decisions.
   b. Develop a matrix to determine gaps in modeling and data requirements for each pilot scenario
   c. The MDWG will vote upon solution sets for each gap identified and recommend these solutions to the ESFLG for review and approval
5. Utilize the results from the pilot scenarios to inform subsequent catastrophic scenarios
6. Provide a formal briefing to the ESFLG annually on work accomplished during the fiscal year.

Appendix 3: MDWG Points of Contact

NAME Last, First	AGENCY
Aeschelman, Jeremiah	DTRA
Alt, Rich (A)	DHS NPPD/IP (HITRAC)
Anderson, Debra	DHS S&T
Applegate, David (P)	US Geological Survey
Artz, Richard	NOAA
Ballado, William	DHS IMAAC
Barrett, Todd	USDA Emergency Programs Division
Basiaga, Dariusz	Defense Threat Reduction Agency (DTRA)
Bausch, Doug	FEMA
Bennett, Gerilee	FEMA Recovery
Berman, Eric	FEMA (Mitigation)
Blumenthal, Daniel (P)	DOE NNSA
Blunt, Kenyetta	FEMA Recovery
Bonifas, Michelle	FEMA IA
Boyce, Carla	FEMA NIC
Briggs, Kevin	NCS
Brown, Cliff	FEMA IA
Canturk, Kaan	NPPID/IP
Chacko, Betsie (A)	DHS IMAAC
Chatfield, Catherine	DHS HITRAC
Christine Cunningham	NPPD/IP
Crawford, Sean	FEMA CBRNE
Daigler, Donald	FEMA Planning
Decker, KC	NESC, SUMMIT
Demorat, David "Mo"	FEMA NPAD

Dial, Patrick (P)	SBA
Diaz, Steve	USACE
Dickinson, Tamara, Ph.D.	OSTP
DiMego, Jeff	NOAA NWS (EMC)
Dozor, Joshua	FEMA Planning
Draxler, Roland	NOAA ARL
Ewing, Melvin	FEMA
Flick, Darrin	DTRA
Franco, Crystal	DHS S&T: Chem Bio
Gilmore, Lance	FEMA US&R
Gleason, Joseph J CAPT (A)	USCG
Gorman, Chad	FEMA
Griffith, David	FEMA NHP
Gunning, Jason	USCG
Hammond, Steve (A)	USGS
Harned, Rebecca	FEMA NIC
Hernandez, Patrick	FEMA
Hill, Laura	USFS
Hinkson, Tasha	FEMA IA
Hodge, Craig	FEMA Public Health Service
Holtermann, Keith	FEMA
Hunt, Michael	USCG
Irwin, William	USACE
Jackson, Mike	NORAD-USNORTHCOM
King, Steve	DHS
Knabb, Richard	NOAA
Landry, Mary (P)	USCG
Lant, Tim, Dr.	HHS BARDA
Legary, Justin	FEMA | PNP | NPD | NTEED
Leong, Timothy CIV (P)	DTRA

Lippert, Alice	DOE
Longenecker, Gene	FEMA
Lowenstein, Eric	DITRA
Lumpkins, Donald	FEMA, National Exercise Division
Lundgren, Scott	USCG
Magnuson, Matthew (P)	EPA
Mahrous, Karim	FEMA
Mapar, Jalal	DHS S&T Resiliance Systems
Maycock, Brett	FEMA/Medical Liaison
McDonald, Blair	FEMA IA (Housing)
McGlynn, Matt	USCG
McQueen, Jeff	NOAA NWS (EMC)
Moe, Matthew	DHS S&T: Chem Bio
Monarez, Susan Coller	DHS S&T: Threat Characterization and Attribution
Mongeon, Albert	NOAA
Montañez, José M. Gil	FEMA
Moore, Brian	USCG
Morgan, D'arcy	DHS S&T
Mueller, Lora	NOAA
Murray, Michelle	DOS
Norman, Michael	DHS
Nye, William	USACE
O'Neill, Ed	State
Olsen, Jennifer	HHS
Perry, Sue	USGS Hazards Science
Rabin, John	FEMA NPAD
Reeves, Toimu (Troy)	NORTHCOM
Remick, Alan (A)	DOE/NNSA
Rhome, Jamie	NOAA
Roberts, Nikki	FEMA

Roohr, Peter (P)	NOAA
Rozelle, Jessee	FEMA
Sanderson, Bill	FEMA
Schargorodski, Spencer	USACE
Schilling, David (P)	DOT
Schumann, Jean	EPA
Scott, Margaret (P)	DOE
Shephard, Dave	DHS S&T: Chem Bio
Snead, Kathryn (A)	EPA Emergency Operations
Sokich, John (A)	NOAA
Springstein, Thomas	FEMA
Stanfill, Derek	FEMA
Tippie, Tammy, Dr.	HHS
Tribble, Ahsha, Ph.D	NSS White House
Tune, Greg	Red Cross
Underwood, Patricia, PHD (P)	DHS NPPD HITRAC
ValentineDavis, Victor (P)	DHS IMAAC
Valliere, John (A)	SBA
Vaughan, Chris	FEMA
Villoch, Deborah (P)	NPPD/IP
Wiacek, Chris (A)	DOT
Wiedlea, Andrew CIV (A)	DTRA
Woodhams, Katrina	FEMA
Zuzak, Casey	FEMA

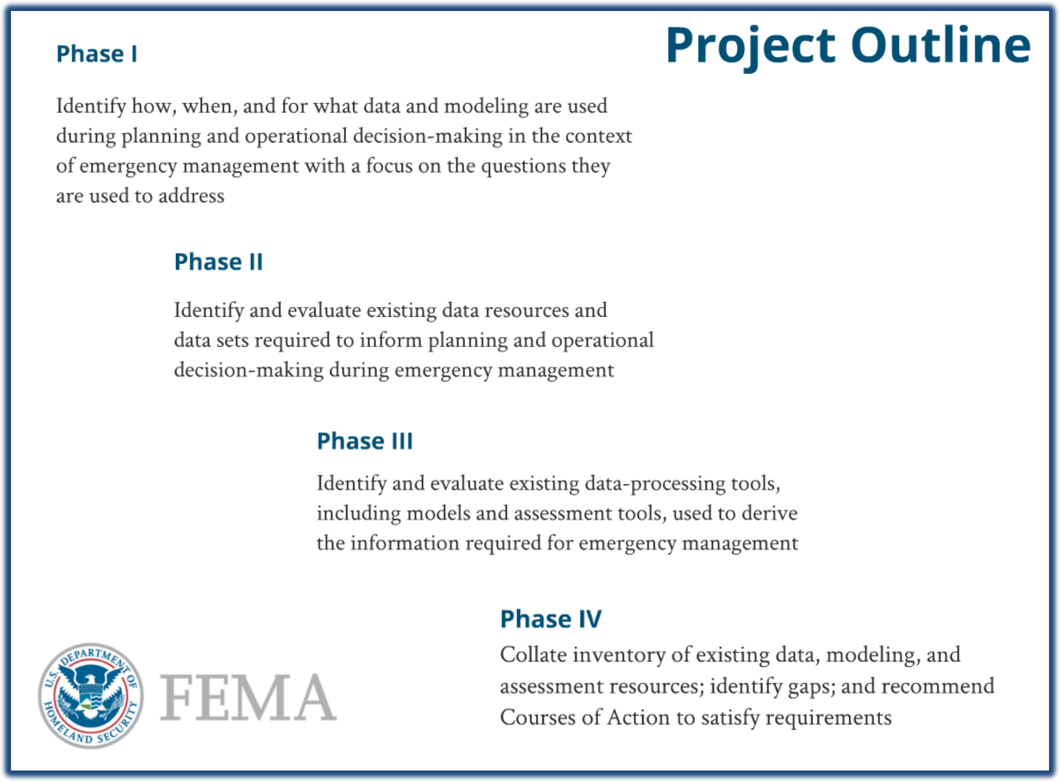
Appendix 4: Phase I Questionnaire

ESFLG Modeling and Data Working Group Phase I Questionnaire

The MDWG Charter recognizes the need to "develop a standardized framework of modeling across the… [ESF] structure…" Informed by national preparedness goals and the associated core capabilities, this effort will produce an expansive list of modeling and data resources used during all stages of emergency activities. Based on the list generated through informed interviews with experts in each department, the MDWG will ultimately determine the most effective modeling and data products to incorporate into the ESFLG structure and evaluate implementation success. In addition to unifying modeling and data resources in use, this process will identify gaps in currently available modeling and data resources.
The MDWG will:

- **Analyze catastrophic scenarios to be addressed;**
- **Assess data requirements for emergency planning and operational decision-making;**
- **Evaluate existing resources to support scenarios and address data requirements;**
- **Identify gaps and recommend solutions to satisfy the data requirements.**

The project will be separated into three phases. This questionnaire is phase I of the MDWG requirements analysis, designed to elicit both general and specific data requirements to inform phases II and III. It is intended for high-level Emergency Managers and Interagency Policy/Planners (Current MDWG group). This questionnaire focuses on two notional "use cases", the Hurricane Ono scenario and the New Madrid Earthquake scenario; other scenarios will be added by exception. Collection of this information is focused on all hazards; notional disasters are used to elicit specific information where appropriate. Phases II and III will involve additional detail and levels of complexity by engaging SMEs with the goal of assessing the volume, velocity, and variety of modeling and data efforts for disaster preparedness, response, recovery, and mitigation. Data will be collated and provided in a report at the conclusion of each phase.


Project Outline
Phase I
Identify how, when, and for what data and modeling are used during planning and operational decision-making in the context of emergency management with a focus on the questions they are used to address
Phase II
Identify and evaluate existing data resources and data sets required to inform planning and operational decision-making during emergency management
Phase III
Identify and evaluate existing data-processing tools, including models and assessment tools, used to derive the information required for emergency management
Phase IV
Collate inventory of existing data, modeling, and assessment resources; identify gaps; and recommend Courses of Action to satisfy requirements
FEMA

SECTION 1: PARTICIPANT AND AGENCY PROFILE

Last Name:

First Name:

Phone Number (primary):

Phone Number (alternate):

Fax:

Email Address:

Work Address:

Home Organization:

Department, Division or Office Name:

Position Title:

1. **Are you considered a program manager, SME or both?**
2. **For which of the following Emergency Support Functions (ESF) does your division support and what is your role (Coordinator, Primary, Secondary)? Select all that apply**

___ ESF #1 – Transportation ___C ___ P ___ S

___ ESF #2 – Communications ___C ___ P ___ S

___ ESF #3 – Public Works and Engineering ___C ___ P ___ S

___ ESF #4 – Firefighting ___C ___ P ___ S

___ ESF #5 – Emergency Management ___C ___ P ___ S

___ ESF #6 – Mass Care, Housing and Human Services ___C ___ P ___ S

___ ESF #7 – Resource Support ___C ___ P ___ S

___ ESF #8 – Public Health and Medical Services ___C ___ P ___ S

___ ESF #9 – Urban Search and Rescue ___C ___ P ___ S

___ ESF #10 – Oil and Hazardous Materials Response ___C ___ P ___ S

___ ESF #11 – Agriculture and Natural Resources ___C ___ P ___ S

___ ESF #12 – Energy ___C ___ P ___ S

___ ESF #13 – Public Safety and Security ___C ___ P ___ S

___ ESF #14 – Long-term Community Recovery and Mitigation ___C ___ P ___ S

___ ESF #15 – External Affairs ___C ___ P ___ S

3. **For which of the following Recovery Support Functions (RSF) does your division support and what is your role (<u>C</u>oordinator, <u>P</u>rimary, <u>S</u>econdary)? Select all that apply.**

___ Community Planning and Capacity Building ___C ___ P ___ S

___ Economic ___C ___ P ___ S

___ Health and Social Services ___C ___ P ___ S

___ Housing ___C ___ P ___ S

___ Infrastructure Systems ___C ___ P ___ S

___ Natural and Cultural Resources ___C ___ P ___ S

4. **For which of the following Mitigation Core Capabilities does your division support? Select all that apply.**

___ Threats and Hazard Identification

___ Long-term Vulnerability Assessment

___ Risk and Disaster Resilience Assessment

___ Community Resilience

5. **Please provide contact information for the lead modeling point of contact for your function so we can follow-up with them.**

6. **How does the use of modeling and empirical data add to your division's mission?**

7. **How does your division generally use modeling and the associated data sets required to support pre- and post-emergency activities?**

   a) **event preparedness?** *(e.g. risk assessments and threat hazard identification; estimating available capabilities and determining required capabilities)*

   b) **event mitigation?** *(e.g. identifying characteristics and potential consequences of hazards; identifying the benefit of risk reduction efforts)*

   c) **event response?** *(e.g. improving Situational Awareness; establishing response priorities)*

   d) **event recovery?** *(e.g. determining resource requirements; guiding restoration efforts)*

SECTION 2 - DATA REQUIREMENTS

1. In a scenario such as Hurricane Ono:

a) What data sets do you use to support your modeling efforts? On what types of data are your modeling parameters typically based?

b) From what sources do you obtain the information and data required to support your division's responsibilities? Check all that apply

___ Commercial database provider

___ Public Internet

___ Informal social network

___ In-house library/archive

___ Local Government (SPECIFY):

___ State Government (SPECIFY):

___ National Agency (SPECIFY):

___ Other (SPECIFY):

c) With whom do you collaborate in defining your data requirements and/or sources?

2. In a scenario such as the New Madrid Earthquake:

a) What data sets do you use to support your modeling efforts? On what types of data are your modeling parameters typically based?

b) From what sources do you obtain the information and data required to support your division's responsibilities? Check all that apply

___ Commercial database provider

___ Public Internet

___ Informal social network

___ In-house library/archive

___ Local Government (SPECIFY):

___ State Government (SPECIFY):

___ National Agency (SPECIFY):

___ Other (SPECIFY):

c) With whom do you collaborate in defining your data requirements and/or sources?

SECTION 3 – MODELING APPLICATIONS

1. **How would modeling be used within your division specifically to support pre- and post-emergency activities in the event of a scenario such as Hurricane Ono?** *(e.g. aid in making pre-landfall evacuation decisions; determining required core capabilities and supporting resources)*

    a) **What specific models would you use?**

    b) **Which questions would these models be used to address?**

    c) **Is there an alternate model available that could be used to address these same questions?**

2. **How would modeling be used within your division to specifically to support pre- and post-emergency activities in the event of a scenario such the New Madrid earthquake?** *(e.g. aid in making post-event evacuation decisions; determining required core capabilities and supporting resources)*

    a) **What specific models would you use?**

    b) **Which questions would these models be used to address?**

    c) **Is there an alternate model available that could be used to address these same questions?**

Appendix 5: Phase I Interview Participants

NAME Last, First	AGENCY
Ballado, William	DHS IMAAC
Chacko, Betsie	DHS IMAAC
ValentineDavis, Victor	DHS IMAAC
Chatfield, Catherine	DHS IP
Norman, Mike	DHS IP
Danielson, Glenn	DHS IP
Mapar, Jalal	DHS S&T
Franco, Crystal	DHS S&T
Moe, Matthew	DHS S&T
Shephard, Dave	DHS S&T
Monarez, Susan Coller	DHS S&T
Cedres, Stewart	DoE
Clark, Jamie	DoE
Lucas, Anthony	DoE
Rollison, Eric	DoE
Lippert, Alice	DoE
Scott, Margaret	DoE
Blumenthal, Daniel	DoE NNSA
Greenberg, Jeremy	DoT
Landry, Mary	DoT
Schilling, David	DoT
Vanness, Jeffrey	DoT
Wiacek, Chris	DoT
Aeschelman, Jeremiah	DTRA
Basiaga, Dariusz	DTRA
Leong, Timothy	DTRA

Lowenstein, Eric	DTRA
Magnuson, Matthew	EPA
Snead, Kathryn	EPA
Irizarry, Gilberto "Tito"	EPA
Anderson, Lindsey	FEMA
Bausch, Doug	FEMA
Berman, Eric	FEMA
Decker, KC	FEMA
Gorman, Chad	FEMA
Hewgley, Carter	FEMA
Juskie, John	FEMA
Mahrous, Karim	FEMA
Roberts, Nikki	FEMA
Rozelle, Jessee	FEMA
Sanderson, Bill	FEMA
Stanfill, Derek	FEMA
Vaughan, Chris	FEMA
Zuzak, Casey	FEMA
Hall, Mike	FEMA
Ingram, Deborah	FEMA
Daigler, Donald	FEMA
Longenecker, Gene	FEMA
Brown, Cliff	FEMA
Hinkson, Tasha	FEMA
McDonald, Blair	FEMA
Woodhams, Katrina	FEMA
Lumpkins, Donald	FEMA
Griffith, David	FEMA
Boyce, Carla	FEMA
Harned, Rebecca	FEMA

Demorat, David "Mo"	FEMA
Rabin, John	FEMA
Legary, Justin	FEMA
Hodge, Craig	FEMA
Gilmore, Lance	FEMA
Byrne, Mike	FEMA
Rogers, James	FEMA
Faison, Kendrick	FEMA
Almonor, Niclaos	FEMA
Macintyre, Anthony	FEMA/ DHS Medical Liaison
Maycock, Brett	FEMA/ DHS Medical Liaison
Imbriale, Samuel	HHS
Lurie, Nicole	HHS
Olsen, Jennifer	HHS
Gabriel, Ed	HHS
Nguyen, Ann	HHS
Lant, Tim	HHS
Briggs, Kevin	NCS
Artz, Richard	NOAA
Mongeon, Albert	NOAA
Roohr, Peter	NOAA
Sokich, John	NOAA
DiMego, Jeff	NOAA
McQueen, Jeff	NOAA
Tune, Greg	Red Cross
Dial, Patrick	SBA
Valliere, John	SBA
O'Neill, Ed	State
Diaz, Steve	USACE
Harris, Dewey	USACE

Hendricks, Joel	USACE
Irwin, Bill	USACE
Keown, Patrick	USACE
Markin, Chad	USACE
Nye, William	USACE
Schargorodski, Spencer	USACE
Town, Patrick	USACE
Gleason, Joseph J	USCG
Gunning, Jason	USCG
Hunt, Michael	USCG
Lundgren, Scott	USCG
McGlynn, Matt	USCG
Moore, Brian	USCG
Hill, Laura	USFS
Applegate, David	USGS
Hammond, Steve	USGS
Baron, Tom	USNORTHCOM
Jackson, Mike	USNORTHCOM