Modeling and Data Working Group

Role of Data and Models in Supporting Planning and Response to an Improvised Nuclear Device (IND) Detonation

Phase II: How Data and Modeling are Used in Emergency Management

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Executive Summary

Effective emergency management relies on senior level decision-makers, first responders, and the public having access to the information they need when they need it. Ready access to critical information directly supports resiliency, informing the decisions that can prevent an emergency from becoming a disaster. Data and modeling resources can play a key role in informing these decisions, whether at a high-level or on-the-ground. Only if those involved in emergency management have ready access to and have experience using these data and modeling resources will the information be successfully leveraged during an event. As such, it is important that these resources be identified, characterized, and made readily accessible to support their incorporation into interagency emergency management plans and Concept of Operations (CONOPS).

In recognition that informed decision-making is key to successful emergency management, the Emergency Support Function Leadership Group (ESFLG) established the Modeling and Data Working Group (MDWG) to identify and categorize the data and modeling resources used to support the work of federal decision-makers during all phases of emergency management. In support of the MDWG, and on behalf of Lawrence Livermore National Laboratory, the methods, ontology, and previously-identified data and modeling resources available to inform decision making during emergency management in the context of hurricane and earthquake scenarios has been applied and expanded to nuclear detonation, or improvised nuclear device (IND) scenarios.

The report below outlines the questions and associated critical information requirements that correspond to the response timeline outlined in the Task 1 report. These questions and the types of information available to address them are organized into a framework that describes the flow of information through iterative steps of data collection and processing. The information produced can then be used to support a wide range of missions across all phases of emergency management during an event such as an IND detonation. Much of the data and modeling that is expected to be used by the federal interagency in the early stages emergency management of a nuclear detonation are well-defined. Specifically, interagency coordination efforts have been codified that clearly outline the role of various data collection and modeling efforts to characterize the event. However, the translation of the data and information produced from these sources into operationally-relevant response and recovery activities have not been as well-defined.

During subsequent phases of the project, the resources and the flow of information between those resources will be identified through a series of interviews with IND program and emergency managers, subject matter experts, and senior level decision makers. Network analysis of the resources will identify gaps and redundancies in the available resources, and define the existing federal interagency relationships necessary to support and facilitate the flow of information. The final product will be an interactive inventory of data and modeling resources available to inform operationally-relevant decision-making prior to, during, and following detonation of an IND in the U.S. This inventory will help ensure that the information required to support operational decision making for all-hazards emergency management is readily accessible and available when it is needed.

Introduction

A nuclear terrorism incident, such as a detonation of an improvised nuclear device (IND), will have devastating large-scale consequences to public health and safety. At ground zero, the blast will cause mass casualties, destroy infrastructure, damage utilities systems, stall immediate emergency response activities, and will continue to present a challenge during all phases of response and recovery. The immediate question at hand will be how to quickly save lives and minimize the impact of the disaster, which will require that critical decisions be made quickly. These decisions cannot be made without timely, accurate, and well-coordinated information. Recent technological advances have enabled the federal interagency to collect and access an unprecedented amount of incident-relevant information from data, models, and analysis tools. Much of this information can and should be used to advise decision-makers during all phases of emergency management.

An IND detonation, having no historical precedent, presents a unique challenge. While nuclear explosions of varying magnitudes have been achieved in both combat and testing scenarios, there are no historical examples of an urban, ground level IND detonation in a modern city. Thus, an effective response and recovery to such a devastating scenario will rely upon well-defined preparedness plans, which in turn draw heavily on predictive modeling and extrapolation from first principles defined during nuclear testing. The interagency coordination efforts that outline roles and responsibilities for data collection and modeling to characterize the event in the early phases of a response have largely been codified for nuclear detonations. However, in the absence of experience, many of the data and modeling resources used to inform operations required to respond and recover to the event are less well-defined.

The models and data available to the interagency to support all-hazards emergency management are as diverse as the questions they help to answer and have been used to support operational decision-making for many years. The advent of readily-available, high capacity, mobile computing systems have allowed data and modeling resources to play a progressively more active role in supporting real-time decision-making during emergencies. The expansion of data and modeling resources provide a wealth of information that needs to be organized and made accessible to emergency managers, not just during a response, but during all phases of emergency management. Given that the amount of information available is so extensive, care must be taken to ensure that the right information is available and accessible to the right people at the right time to facilitate operational decision-making. In order to guarantee that those involved in emergency management have ready access to and have experience using data and models, these resources must be identified and incorporated into interagency emergency management plans and CONOPS so they can be successfully leveraged during an event to inform operational decision-making.

In recognition that informed decision-making is key to successful emergency management, the Emergency Support Function Leadership Group (ESFLG) established the Modeling and Data Working Group (MDWG) in August of 2012 to promote better collaboration between stakeholders across the interagency on issues related to the data and models used to support emergency management. The membership of the working group is chosen by the ESFLG and continuously expanded upon request by current ESLG or MDWG members. Current members include 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.

The primary goal of the working group, as defined by the charter, is to identify and characterize the data and modeling resources available to support federal decision-makers during all phases of emergency management, particularly during the time-sensitive period of emergency response. This work is supported by Gryphon Scientific, whose role is to collect the information required and map the current data and modeling resource networks to determine when and how those resources are used in the context of emergency management. The resulting information will be collated into an interactive inventory of the currently utilized resources, accessible via a web-based graphical user-interface. A previous report described the expected timeline of a nuclear detonation event and the anticipated timeline of the associated emergency response. In this report, the questions and critical information requirements associated with the response timeline are described. These questions are mapped to a framework that outlines how information is processed to and used to support the operational decision making for all phases of emergency management related to an IND detonation scenario. In the next phases of the project, the data and modeling resources currently used across the federal interagency to support operational decision making in the context of a nuclear detonation will be collated into an interactive inventory, accessible via a web-based graphical user-interface. A gap analysis will be performed on the basis of a network map describing the linkages between these resources. The resulting inventory will help ensure that decision makers have access to the information they need, when they need it, to support operational decision making for emergency management.

Methods

The information required to prepare and respond effectively to an IND detonation scenario were gathered through a series of in-person and phone interviews with technical and subject-matter experts, IND program and emergency managers, and senior-level decision makers. In support of the MDWG, a total of 166 interviews have been completed with 240 decision-makers and subject-matter experts across the interagency. During phase I of this project, high-level decision-makers, program managers, and users of IND data and modeling resources were interviewed. Based on these conversations, the phase I report identified, characterized and described the timelines for the progression of events after an IND detonation and the anticipated response to the event. Phase II of the project focused on identifying the critical information requirements and determining how this information is used to develop preparedness and response plans to an IND detonation scenario.

The critical information requirements varied widely depending on the expertise of the interviewee and the emergency management mission for which their agency or office is responsible. Interviews were designed to capture both the general and specific information requirements related to their mission across all phases of emergency management. A dedicated note-taker captured the details of each interview, including the critical information requirements and any data and modeling resources described by interviewees that support ongoing planning efforts. The notes were subsequently verified and formatted for consistency and analyzed to extract the pertinent critical information requirements and how this information was being used.

Using the information requirements gathered from these interviews, this phase II report introduces a framework for the collection, categorization, processing, and application of critical information required to support planning efforts and response activities after an IND detonation. This framework provides context for the diverse stakeholders in the MDWG to understand how and when the wide range of available data and modeling resources can be used to support specific emergency management missions.

Although these interviews sought to focus on what IND-specific information is required and how this information is used, interviewees would frequently describe the data and modeling resources that were used. The details of these resources were captured and will be included in the final inventory of IND data and modeling resources. In addition, the IND-specific data and modeling resources mentioned in interviews have been tagged depending on which information category, such as raw data or mission-specific requirements, for which it is most useful. This categorization scheme is described in detail in subsequent sections of this report. The next phase of the project will specifically focus on gathering information from technical and subject-matter experts and IND program and emergency managers about the relevant data and modeling resources available to and used by the interagency to support planning and response to an IND detonation. These resources will be catalogued in an interactive, and easy-to-use inventory of modeling and data resources.

Information Requirements

Experience from past emergencies shows that the influx of information during an emergency is massive, ranging from Twitter feeds to data from weather satellites. Information, regardless of the source, can be organized into categories that describe how it is used during all phases of emergency management, from preparedness and planning to recovery. This section discusses the fundamental questions of emergency management, outlines the ways modeling and data resources are able to answer those questions, and introduces a framework to elucidate the use of modeling and data resources in the context of IND detonation scenarios.

The Big Questions

An emergency response to any disaster, whether a hurricane or an IND detonation, will require the answers to three fundamental questions, “What happened?”; “Who and what was affected to what degree?” and “What needs to be done?” Figure 1 depicts the evolution of these critical information requirements as different phases of an emergency begin and end.

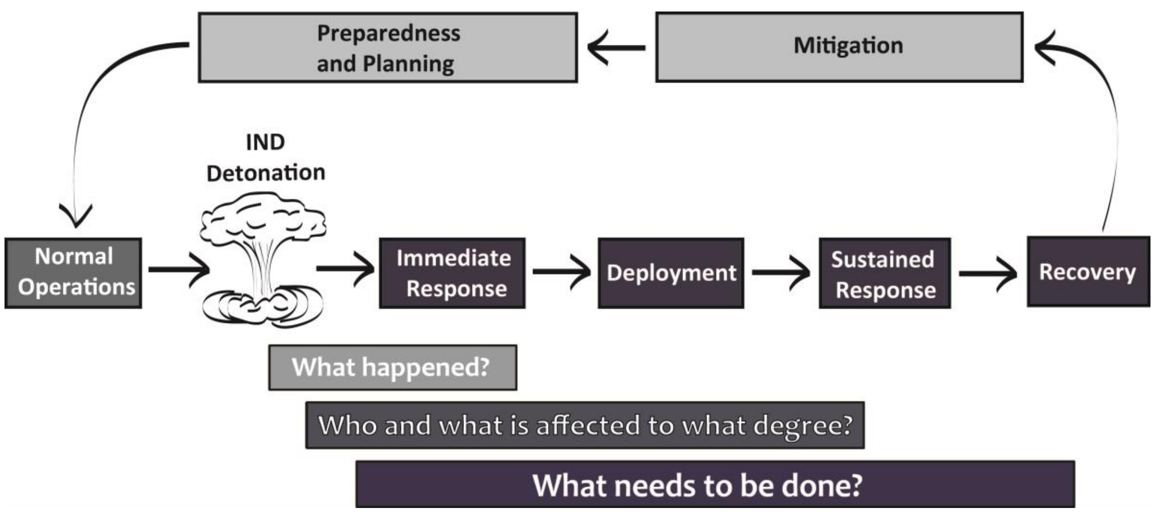

Figure 1. Critical information requirements and the phases of emergency management. The phases of emergency management are depicted along with the three fundamental questions.

The answer to “What happened?” provides information concerning the size, location, timing, and severity of an event. Knowing the details of the event itself will inform the question “Who and what was affected to what degree,” which provides information about the severity and consequences of the incident on human health, infrastructure, economy, and the environment, and others. Knowing the consequences of the event will help to answer, “What needs to be done,” to determine the number of assets and the types of actions that will be required to carry out a specific mission in response to an event.

Response Activities and Associated Information Requirements after an IND Detonation

An emergency response viewed through the lens of the three big questions allows information to be parsed and organized into categories that can be useful for emergency managers to determine how and when the information can be used to assist in operational decision-making. Clarifying the information requirements that need to be fulfilled will ensure that emergency managers are aware of what information is available, which resources can provide it, and how and when it should be used to support decision-making.

In order to determine how data and modeling resources can inform response activities, the critical information requirements associated with the response activity must be identified. An overview of the timeline of the timeline of IND detonation and the stages of the emergency response is shown in Figure 2. The response activities associated with the event can be mapped to the three fundamental questions along with the specific information required to conduct those response actions. Table 1 outlines the response activities expected after an IND detonation and associated information requirements, phrased as questions to be addressed.

Table 1. Expected response activities after an IND detonation and associated information requirements mapped to the three fundamental questions

Response action	Information from previous response actions	What happened?	Who and what are affected to what degree?	What must be done?
Recognize a nuclear incident		- Was it a nuclear bomb? - Was it a dirty bomb? - How big was the bomb? - Was it uranium or plutonium? - Is there a credible threat for a second detonation?		
Declare a State of Emergency	- *Recognize a nuclear incident*			
Establish emergency communications	- *Recognize a nuclear incident*	- What is the physical damage to communications infrastructure? - Was there an EMP?	- How many people are affected by the communication outage? - Which lines of communications are down?	- Can communication lines be restored? - What temporary measures are necessary (dropping leaflets, portable cell towers, and other measures)?
Issue shelter-in-place guidance for a 50-mile radius to public and first responders	- *Establish emergency communications*			

Activate local, county, and state EOCs	- *Recognize a nuclear incident*			
Activate NRCC, associated Emergency Support Functions, and FRMAC	- *Recognize a nuclear incident*			
Collect radiation measurements from radiation detectors and monitors	- *Declare a State of Emergency*			- Where are the functional nearby radiation measuring stations? - What aerial or other radiation measuring systems are available? - How long before radiation measurements will become available?
Conduct aerial and on-the-ground assessments	- *Declare a State of Emergency*			
Define Hazard Zones	- *Activate NRCC, associated Emergency Support Functions, and FRMAC* - *Collect radiation measurements from radiation detectors and monitors* - *Conduct aerial and on-the-ground assessments*	- Where is the radiation plume? - Which direction is the plume spreading? - Where will the plume be in the future (hours, days)? - Where is the hot zone? - Where are the damaged areas? - What is the general extent of the damage?		
Stand up the Joint Field Office	- *Recognize a nuclear incident*			
Prioritize populations to be evacuated	- *Define Hazard Zones*		- How many people are immediately affected by the radiation? - Who is at the most risk from radiation? - How many people were affected by the blast?	- What are the guidelines for prioritizing populations to be evacuated? - Where are medical centers to which radiation victims can be evacuated?

Identify safest transportation routes	- *Define Hazard Zones*		- Which transportation networks (rail, road and air) have been affected by the blast or radiation? - Will the plume move over any major transportation networks in the future?	
Deploy Strategic National Stockpile (SNS) resources to staging area	- *Recognize a nuclear incident*		- How many people were affected by radiation and blast?	- What SNS resources are available? - Where are the nearest functional staging areas?
Deploy first responders (fire, medical, search and rescue, among others)	- *Identify safest transportation routes* - *Prioritize populations to be evacuated* - *Establish emergency communications*			- How many first responders are available for deployment? - Which areas should first responders avoid? - How long can first responders stay out in hazard zones? - What is the coordination strategy?
Extinguish fires and stabilize structures	- *Deploy first responders (fire, medical, search and rescue, among others)*		- Where are the fires? - Which areas require immediate support?	
Establish evacuee and responder triage and decon sites	- *Identify safest transportation routes* - *Deploy first responders (fire, medical, search and rescue, among others)*		- Where are potential evacuation and decontamination centers? - How many people would require triage and decon?	- What are the capabilities/capacities of available centers? - Who is available to staff and run the centers? - Are there adequate supplies for the centers?
Move prioritized population to triage and decon sites	- *Establish evacuee and responder triage and decon sites* - *Deploy first responders (fire, medical, search and rescue, among others)*			- How can the victims be moved to the sites? - How can special populations be moved and cared for?

Begin phased evacuation of public	- *Move prioritized population to triage and decon sites*			- How is the public going to leave the hazard zones (walking, driving, etc)? - Is the public going to be decontaminated when leaving the hazard zones?
Provide triage and definitive care	- *Establish evacuee and responder triage and decon sites*			- Are additional resources/people required to take care of the victims?
Provide shelter and distribute food, water and clothing	- *Deploy Strategic National Stockpile (SNS) resources to staging area* - *Begin phased evacuation of public*		- How many people need shelter, food, water, and clothing? - How long do the refugees need housing, food and water?	- Where are the refugees going to be sheltered? - How will the weather affect the refugees? - Are additional supplies needed? - Is there staff to help distribute the supplies?
Provide fatality management	- *Deploy first responders (fire, medical, search and rescue, among others)*		- How many people are dead?	- Are the human remains contaminated? - Can the human remains be identified? - How will the human remains be taken care of? - Can families of the deceased be notified?
Decontaminate critical infrastructure	- *Collect radiation measurements from radiation detectors and monitors* - *Conduct aerial and on-the-ground assessments* - *Extinguish fires and stabilize structures*		- What critical infrastructure was contaminated?	- Which critical infrastructure is most important? - What resources are needed/available to decontaminate the infrastructure?
Restore essential utilities and services	- *Decontaminate critical infrastructure*			- Can the existing infrastructure be repaired/ decontaminated? - What resources are needed/available to restore the essential utilities and services?

Monitor and manage contaminated animal and agricultural products	- *Collect radiation measurements from radiation detectors and monitors*			
Remove contaminated debris	- *Collect radiation measurements from radiation detectors and monitors* - *Extinguish fires and stabilize structures*		- How much contaminated debris is there?	- How can the debris be moved safely?
Store and dispose of radioactive waste	- *Remove contaminated debris*		- How long will the waste be radioactive?	- Where can radioactive waste be stored?
Return displaced populations	- *Provide shelter and distribute food, water and clothing* - *Restore essential utilities and services*		- How many people want to return?	- What resources do displaced persons need to return?

Interdependence of Information Requirements

Emergency support functions were created with the recognition that response activities are inherently connected across mission spaces. Identifying these linkages and associated information requirements that span mission areas is critical to mounting a robust response to mitigate the effects of a disaster. On the basis of the critical information requirements in Table 1, a response action tree can be mapped to illustrate linkages to upstream response activities and associated information requirements. Figure 3 illustrates an example of this linkage. These linkages show that each response activity cannot occur in a vacuum and, in fact, depends upon knowing key critical information from upstream response activities.

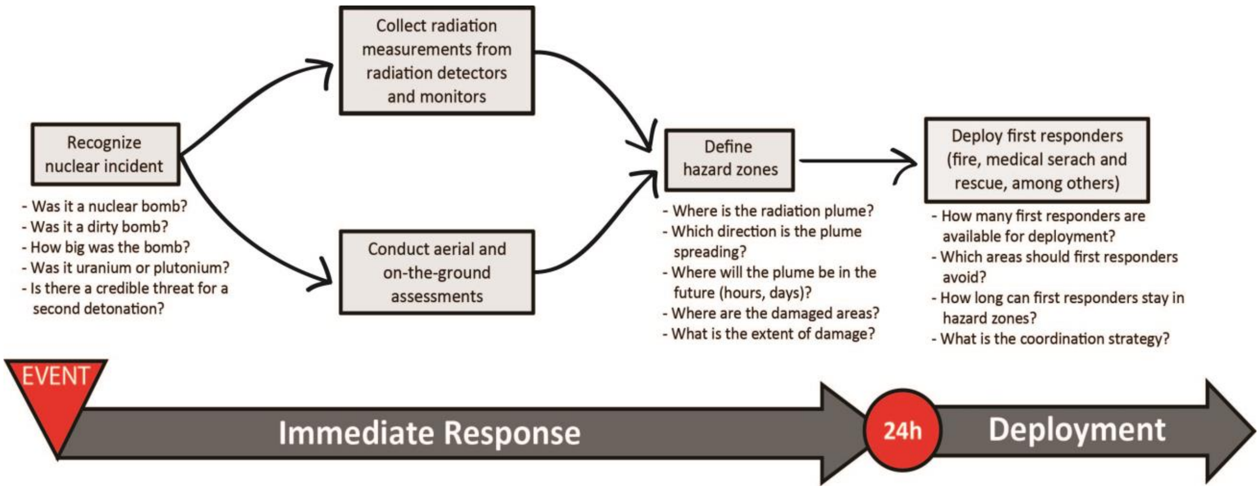

Figure 3. Example of how each response activity is dependent on critical information requirements from upstream response actions. The response action "Deploy first responders" is requires that the hazard zones are defined. Defining the hazard zones requires the assessment and collection of radiation measurements, which in turn relies upon recognizing the type of event that has occurred.

The Role of Data and Modeling

Data, modeling, and analysis tools can play a critical role in parsing the enormous stream of information to inform operational decision-making and enhance response, recovery, mitigation and preparedness and planning activities. The resources available include data and models, or data analysis tools. Data resources are defined as repositories of static or real-time assessment information, including tools that assist in the presentation and visualization of data but do not change the data itself. Modeling resources, by contrast, are defined as programs, algorithms, or sets of calculations that process data and transform it into a new type of data. Alternatively, models may combine several data resources to generate a new dataset. The flow of information in emergency management follows iterative rounds of data collection (e.g. instrument readings, impact maps, damage estimates) and modeling or data analysis (e.g. weather projections, damage calculations, decision trees).

Time-dependent Information Requirements

The information requirements of emergency management are time-dependent, regardless of mission. During normal operations, data and modeling are used to help emergency managers and those agencies involved position themselves to be more effective once the event occurs. During this phase, the questions that will need to be addressed during future events are defined, the specific information resources available are identified, and the personnel who will need to use them are trained. As the event is predicted or begins to unfold, the data and models identified during planning and preparedness are used to address questions about the specific, impending threat. Early in the response phase, the big question of "What happened?" will need to be addressed. Data and modeling resources that characterize the event can help to answer this question. Once the location, time and severity of the event have been characterized, the next big question of "Who and what was affected to what degree?" will need to be addressed. Again, data and modeling resources that provide information on the severity and impact to human health, infrastructure and economy, and others will be valuable. During the remaining period of the response and into the recovery phase, data and models that can assist in answering the question "What needs to be done?" will be instrumental in providing assistance to immediately save lives and property and, ultimately return the affected population and area to normalcy.

Because an IND detonation has no historical precedent, all plans for IND response operations have been developed on the basis of predictive event characterization modeling that relies heavily on parameters extrapolated from existing data on combat and nuclear testing. Although post-event assessment data will be crucial to refine modeling parameters and to accurately characterize the event, such assessment data will be unavailable immediately after an IND detonation. Emergency managers will have to rely on data and models developed during preparedness and planning to provide an initial assessment of the event in the early hours. Once the acute emergency has passed, there is an opportunity to reflect on lessons learned, as well as a chance to consider assessment data collected during and after the event. These assessment data may be used to verify, validate, and evaluate the models, data assessment tools, and specific actions taken during the event to improve the efficiency and effectiveness of emergency management efforts for future events.

Answering the Big Questions

The data and modeling resources can be organized into categories based on the type of information generated and how and when they are used during emergency management. A categorization scheme capturing the key relationships between models and data and the flow of information between them is presented in **Error! Reference source not found.**2. The flow of information categories and their interconnections constitute an ontological framework through which the iterative collection and processing of information can be understood and translated into operational decisions.

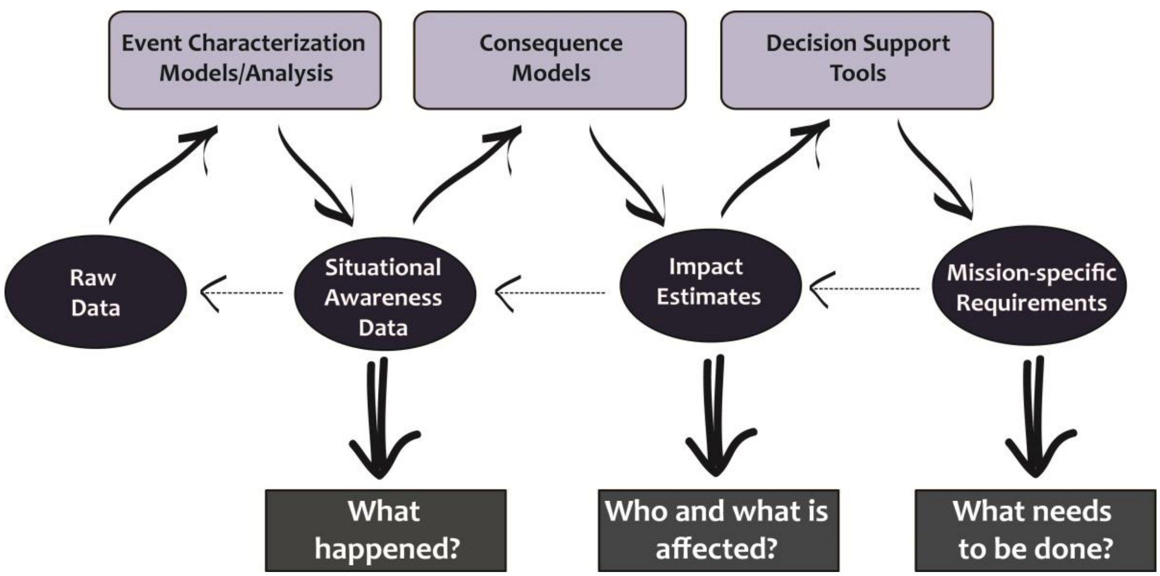

Figure 2. Framework describing the flow of information through iterative rounds of data and modeling. Information flows through modeling and data resource categories to produce answers to the fundamental questions of emergency management.

For all phases of emergency management, the primary flow of information begins with the collection of scientific raw data and culminates in the estimation of mission-specific requirements that guide operational activities related to all phases of emergency management. Raw data describing the event are processed by event characterization models or analysis, which estimate the timing, scope, and severity of the threat, and define what happened or is expected to happen. The situational awareness data produced by those models serve as inputs to consequence models, which quantify the impacts of the event on human lives and infrastructure and provide information as to who and what is affected and to what degree. Finally, these impact estimates, processed by decision-support tools, are translated into the amount and type of assets needed to mount a comprehensive event-specific response – the mission specific requirements that answer the question of "what needs to be done."

An Information Ontology: The Categorization System

The information required to respond effectively and efficiently to an IND detonation scenario have been collected through a series of in-person and phone interviews with technical and subject-matter experts, IND program and emergency managers, and senior-level decision makers. During these interviews, each resource was identified and characterized by the way in which it is used to support planning and operational decision-making in the context of all phases of emergency management and, specifically, IND scenarios.

The modeling and data resources relevant to planning for and responding to an IND detonation can be organized into the framework described by the flow of information shown in Figure 2. Information pertaining to the detonation may be produced by each category in the framework to fulfill these information requirements. Briefly, raw data, event characterization models and analysis, and situational awareness data are integral to determining the extent and severity of the IND hazard. Similarly, consequences models and impact estimates provide information about the impact to affected populations, infrastructure, economy and the environment, among others. Decision support tools and mission-specific requirements are then consulted to identify the assets necessary to respond to the hazard.

The flow of information between these categories is not unidirectional. The data processing is iterative and feedback loops serve as a mechanism for refining the information produced as new data become available. For example, the outputs of event characterization produce post-event situational awareness data, which can in turn guide the collection and assessment of additional raw data. The Interagency Modeling and Atmospheric Assessment Center (IMAAC) uses the modeling system developed by the National Atmospheric Release Advisory Center (NARAC) and models developed and run by the Defense Threat Reduction Agency under the Department of Defense (including the Hazard Prediction and Assessment Capability, HPAC), to characterize the event and support planning efforts. Following a nuclear detonation, the Federal Radiological Monitoring and Assessment Center (FRMAC) is tasked with organizing and coordinating the collection of radiation assessment data by aircraft, on-the-ground radiation assessment teams, and first responders equipped with dosimeters that report continuous time-stamped and geo-tagged dose rate measurements. These raw data would then be used to refine the inputs for updated runs of the event characterization models managed by IMAAC. These modeling runs produce updated situational awareness data and can be used by FRMAC to refine the collection of additional radiation measurements. The data and modeling resources used by these groups will be detailed in future reports.

Notably, the data categories in the flow of information are not necessarily model outputs. The National Shelter System, for example, provides the locations and capabilities of open shelters in the United States. These situational awareness data come directly from the American Red Cross rather than from a model. Thus, the framework captures data sources that enter the flow of information externally.

Although mission-specific requirements represent the most narrowly focused, actionable data in the flow of information, emergency managers also refer to situational awareness data and impact estimates when making decisions. These decisions usually feature a broad focus or serve as early estimates. For instance, the situational awareness data found in post-IND detonation briefing products generated by the NARAC modeling system would greatly influence initial shelter-in-place and evacuation decisions. As another example, FEMA Individual Assistance consults Preliminary Damage Assessment data (an impact estimate) collected during and after an event to determine the potential required size of its recovery programs. In this way, all categories of data with the exception of raw data are used as the basis for decision-making.

The data and modeling resources that provide raw data, event characterization, consequence assessment and impact estimates tend to be hazard-specific. These resources are designed to provide an understanding of the specific event to determine what happened and who and what was affected to what degree. The decision-support tools and mission-specific requirements, on the other hand, tend to vary more by mission areas, rather than by hazards. In-depth descriptions of the resource types within each category in the flow of information framework are described in the follow sections.

Raw Data

Raw data are unprocessed data collected from instruments or surveys that characterize the environment prior to or during an event. Raw data may be obtained through various methods and sources. These data can be static look-up tables, on-the-ground assessment data, steady-state information, such as bridge databases, or real-time data, like observational weather data. Raw data may be collected using instruments such as weather stations that collect a variety of raw data related to local meteorological conditions. Raw data may also be collected by reporting methods, such as Census data which describe the size and demographics of various populations. Unprocessed social media and crowd-sourced data are also considered raw data. Raw data are not directly consulted to inform decision-making; they must first be converted into situational awareness data by computational or analytical means.

After an IND detonation, a significant amount of raw data will likely be gathered by specialized teams and equipment which are activated in response to radiological incidents, including data from aerial instrumentation assets, radiation detectors, aerial photography, and observational weather data, among others. Aerial instrumentation assets are expected to be deployed to sample fallout dose rates in the impacted area. Radiation measurements collected by first responders outfitted with radiation detectors would provide similar raw data on the ground. Geo-tagged and time-stamped aerial photography is an example of raw data that would later be collated to provide visual situational awareness. Observational weather data will provide real-time weather information. All of these raw data would serve as input to refine event characterization modeling or analysis prior to being useful to support decision makers.

Examples of raw data applicable to IND detonation scenarios are included in Table 2. These examples are illustrative and not intended to be all-inclusive. During future phases of this project, a list of all raw data used by the federal interagency will be collated into a complete inventory.

Table 2. Raw Data. Examples applicable to IND scenarios

Example	Function	Resource Provider
RadNet	Radiation measurements	EPA
AMS		DoE NNSA
RAMS		Oak Ridge Institute for Science and Education
Observational Weather Data	Weather measurements	NOAA
US Census	Population demographics	US Census Bureau
NAVTEQ/HERE	Road networks and maps	NAVTEQ
HSIP	Infrastructure data	HSIP

Event Characterization Models and Analysis

Event characterization models and analysis tools characterize or predict the location, time, and severity of an event. These models are used to consider specific characteristics of past, current, or impending hazards and compile raw data to identify patterns that define an event or identify the characteristics of a developing event. These models and tools provide the means for emergency managers to transform raw data into situational awareness data that can be used to support decision-making.

Event characterization models include those developed to inform planning for IND detonation scenarios, as well as those hosted by groups who perform the modeling and analysis post-event. This modeling is coordinated by the Interagency Modeling and Atmospheric Assessment Center (IMAAC). In the early hours after an IND detonation, emergency managers will rely upon the analysis performed by these centers to provide an initial assessment of the event. Coordination and communication between these analysis centers and emergency managers will be critical to inform operational decision-making during response and recovery. For example, atmospheric dispersion models accept raw data inputs (such as weather data) and estimate the trajectory and relative density of a fallout cloud. Other models determine the expected decay characteristics of the fallout cloud based on the radionuclides released or characterize the blast based on the pounds per square inch (psi) of pressure generated by the explosion. The situational awareness data produced by these models will influence many decisions on the ground, including where to locate triage centers and to map out safest evacuation routes.

Table 3 provides examples of event characterization models. These examples are illustrative and not intended to be all inclusive. During future phases of this project, a list of all event characterization models or analysis tools used by the federal interagency will be collated into a complete inventory.

Table 3. Event Characterization Models. Examples applicable to IND scenarios		
Example	**Function**	**Resource Provider**
HPAC	Dispersion characterization	DTRA
HYSPLIT		NOAA ARL
ADAPT/LODI		NARAC
NucFast	Blast characterization	Applied Research Associates
SHAMRC		

Situational Awareness Data

Situational awareness data are used during or after an event to characterize its location, time, or severity. These data are produced by an informed extraction, transformation, or analysis of raw data. Situational awareness data address the question of "what happened?"
Situational awareness data can be the outputs of event characterization models which process raw data or may be obtained through the extraction, transformation or analysis of raw data such that they can be used to describe or characterize the event. For example, after a nuclear detonation, situational awareness data could consist of maps showing the time- and location-dependent levels of radioactivity. Although a single radiation measurement does not provide actionable information, aggregated and geo-tagged measurements can show emergency responders the boundaries of high-risk radiation zones that should be avoided. This information can also be used to validate the output of event characterization models that estimate the plume trajectory and radioactivity levels.

Situational awareness data include collated raw data, if it has been processed or validated. For example, the RadResponder network is a source of collated, validated radiation measurement data uploaded and shared during response to a radiological event

Examples of situational awareness data applicable to IND detonation scenarios are given in Table 4. These examples are illustrative, and they are not intended to be all-inclusive. In future phases of this project, a list of all situational awareness data used by the federal interagency will be collated into a complete inventory.

Table 4. Situational Awareness Data. Examples applicable to IND scenarios		
Example	**Function**	**Resource Provider**
RadResponder	Radiation monitoring	NNSA FRMAC, FEMA, EPA
Local National Weather Service (NWS) Forecasts	Weather forecasts	NOAA NWS
OnTheMap for Emergency Management	Worker demographics	US Census Bureau

Consequence Models

Consequence models 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. For example, these models can be used to estimate economic loss and infrastructure damage to help characterize the affected populations impacted by a specific hazard. These models are typically hazard-specific, though some support loss predictions for multiple hazards. The outputs of these models do not determine the number and types of resources required to address consequences.

Although hazard-specific consequence models, like those for earthquakes or hurricanes, estimate impacts differently from IND consequence models, these consequence estimates could be tailored to source terms specific to INDs and use similar algorithms to calculate the impacts.

The most effective and widely-used consequence models, such as those used for natural disaster scenarios including hurricanes and earthquakes, are those that span a wide mission space and allow for the analysis of a wide range of possible scenarios within a single hazard type. In the context of IND-relevant consequence modeling, effective consequence models would be able to predict a wide range of impacts, including loss estimates of local hospital resources due to destruction or contamination, the extent of environmental contamination, health effects, infrastructure damage, and others. In addition, such a model would be able to predict the impacts of both relatively small and large detonation events either with or without advanced notice. Versatile IND consequence models would help emergency managers overcome the lack of historical experience and data, increasing the quality of planning guidance.

Most IND-relevant consequence models that have been identified so far have a relatively narrow scope and focus on one mission space, such as health consequences. Although mission-specific consequence models are useful for the specific purpose for which they are designed, a coordinated emergency response depends on consistency in the planning and response assumptions that are embedded in and produced by these consequence models. For example, a health-effects-focused consequence model and an infrastructure-damage-focused consequence model must assume the same initial conditions if they are to be used to estimate impacts for the same event.

Examples of consequence models applicable to IND detonation scenarios are given in Table 5. These examples are illustrative, and they are not intended to be all-inclusive. In future phases of this project, a list of all consequence models used by the federal interagency will be collated into a complete inventory.

Table 5. Consequence Models. Examples applicable to IND scenarios

Example	Function	Resource Provider
CATS	General CBRNE impacts	SAIC, DTRA
RESRAD	Residual radiation	Argonne National Laboratory
BT-GAM	IND medical consequences	BARDA

Impact Estimates

Impact estimates define the consequences of an event, answering the question “who and what is affected and to what degree?” These estimates include the outputs of predictive consequence models or post-event assessment data that has been collected and processed to provide an analysis of the event impacts. These data can be used to inform activities from the stockpiling of the type and amount of medical countermeasures pre-event to targeting of response missions to damaged areas and the distribution of disaster relief supplies to populations displaced by radiological hazards post-event.

An effective impact estimate resource would provide access to a compilation of archival outputs of consequence models run or libraries of historical post-event assessment data. Such repositories would be critical to support decision-making immediately following an IND detonation event, prior to the completion of event-specific consequence modeling or the acquisition of assessment data.

Nuclear detonation scenarios are a challenge for emergency management planning because such events have never been experienced by those in the field, and historical post-event assessment data are not available. Therefore, the rapid collection and processing of assessment data will be critical to drive response efforts and refine the inputs of consequence models to better inform the ongoing response.

Although no historical assessment data exist for IND detonation scenarios, outputs of consequence models could generate impact estimates that will inform operational decision-making during all phases of emergency management. For example, the number and type of anticipated casualties as predicted by impact estimates will directly influence the strictness of triage guidelines for first responders. Also, damage estimates to critical infrastructure could be used to anticipate which populations are most likely to be threatened by dangerous secondary hazards and would therefore benefit from earlier evacuation.

Although no impact estimate libraries are currently available for IND detonation scenarios, theoretical examples are given in Table 6. These examples are illustrative, and they are not intended to be all-inclusive. In future phases of this project, a list of all impact estimate datasets used by the federal interagency will be collated into a complete inventory.

Table 6. Impact Estimates. Examples specific to IND scenarios.
Function
Extent of power outage
Number of people exposed to a given level of radiation
Number of burn patients
Number of collapsed buildings

Decision Support Tools

Decision support tools are those that define the amount and type of resources, including materials and personnel, necessary to support mission-specific activities. These tools are typically used by responders on the ground or by emergency managers responsible for coordinating missions.

The most effective decision support tools process impact estimate data to determine specific actions required for response and recovery missions. Examples specific to IND detonation scenarios would include tools that recommend evacuation routes and departure times, the medical resources required to treat casualties (e.g., numbers of beds, equipment, blood and other material, personnel by occupational specialty, and transportation requirements), and the resources required for clean-up, including debris clearing and fatality management. These tools may use the outputs of consequence models or assessment data collected post-event as inputs. For example, radiation dosages for patients exposed to fallout from an IND may be processed by a decision support tool to produce triage recommendations for medical technicians in local hospitals.

High-resolution decision support tools are required across all emergency support functions to inform decision-making during emergency management. Because these tools are more tailored to the specific mission of the operational practitioner, tools that are used in the context of natural disasters could be adapted for emergency response to nuclear detonation events. For example, Iron Sights is an Urban Search and Rescue (USAR) tool recently developed by FEMA in collaboration with the National Geospatial-Intelligence Agency that could be equally useful for USAR teams working in a post-IND environment as a post-tornado environment. Similarly, tools developed to estimate required response and recovery assets, such as the number of dump trucks needed to clear debris, would be equally useful across a wide range of hazards. Effective adaptation of such tools would require harmonization between the outputs of nuclear detonation-specific impact estimates and existing decision support tools.

Examples of decision support tools applicable to IND detonation scenarios are given in Table 7. These examples are illustrative, and they are not intended to be all-inclusive. In future phases of this project, a list of all decision support tools used by the federal interagency will be collated into a complete inventory.

Table 7. Decision Support Tools. Examples applicable to IND scenarios

Example	Function	Resource Provider
RTR System	Radiation medical response decision support	HHS REMM
Turbo FRMAC	Radiation response decision support	Sandia National Laboratories
NUEVAC	Evacuation decision support	
USACE Debris Estimating Model	Debris estimation and clearing requirements	USACE
Temporary Housing Model	Housing requirements	
ODA Scalability Model	Surge personnel required to respond to loan applications	SBA

Mission-specific Requirements

Mission-specific requirements define the amounts and types of material and personnel resources necessary to support each missions, answering the question “what needs to be done?” These requirements may be derived from the outputs of predictive models or from post-event assessment data and are typically produced by decision support tools. They provide a concrete description of the assets needed to support missions ranging from the distribution of general disaster relief supplies, the long-term sheltering of displaced populations, and the removal of debris from the impacted area to informing decontamination efforts.

Mission-specific requirements tend not to be hazard specific; instead they vary more by mission areas or emergency support functions. For instance, the resources required to repair the structural damage to a building depend more on the amount of damage it has sustained and less on the cause of the damage. Many of the mission-specific requirements that are useful for IND scenarios are currently used during natural disasters, such as the outputs of the debris estimating model or the temporary housing model developed by the US Army Corps of Engineers.

Examples of mission-specific requirements applicable to IND detonation scenarios are given in Table 8. These examples are illustrative, and they are not intended to be all-inclusive. In future phases of this project, a list of all resources used by the federal interagency that provide mission specific requirements will be collated into a complete inventory.

Table 8. Mission-specific Requirements. Examples applicable to IND scenarios

Example	Function	Resource Provider
DSARS	Tracking damage assessments	Red Cross
LCMIS	Managing supplies and logistics	FEMA Logistics
USACE Debris Estimating Model Output	Debris estimation and clearing requirements	USACE
Temporary Housing Model Output	Housing requirements	
ODA Scalability Model Output	Surge personnel required to respond to loan applications	SBA

Information Challenges for IND Scenarios

Nuclear detonation scenarios present a unique set of challenges for the emergency management community. While nuclear explosions of varying magnitudes have been analyzed in both combat and testing scenarios, no historical examples of an urban, ground level IND detonation exist. These data have been used to develop powerful event characterization models and are being used to inform consequence models such events. However, the challenge is to translate these data for use in operations post-event for mission-specific activities. This key difference profoundly affects the planning and response approaches as a large number of time-sensitive decisions will need to be made on the basis of limited post-event assessment data immediately following the event.

Reliance on Predictive Modeling

All IND planning scenarios are based upon predictive models as there are no empirical data available for an urban, ground-level IND detonation. The prompt effects, delayed effects, health effects, and subsequent impacts of an IND detonation have been predicted through models and extrapolation of existing data. For example, it is understood that the extent of the blast, thermal radiation, and other prompt effects will likely be reduced by the structures found in urban environments. However, the degree to which such urban shielding will occur has only been modeled on reasonable assumptions and never empirically measured. Models used to predict the fallout hazard in an urban setting are subject to similar uncertainty.

In addition, emergency managers will have to consider the potential error in both the anticipated physical characteristics of the event and the outputs of models used during the response to the event. Throughout pre-event preparedness efforts, the range of expected error in modeling results will have to be considered and incorporated into response planning operations. “Best case” and “worst case” scenarios may need to be considered in the planning process so as to account for the range of error in modeling results.

Rapid Collection of Assessment Data Post-Event

Most predictive modeling relies heavily on assessment data collected during previous events to refine the modeling parameters and validate the outputs. These data include situational awareness data, impact estimates, and mission-specific requirements derived from observations of the real event. For example, in hurricane scenarios, assessment data is collected both during and after the response in the form of maps showing actual hurricane paths, storm wind speed measurements, and high water marks denoting maximum surge heights. The performance of the hurricane models used prior to landfall is improved by adjusting model parameters and assumptions to fit the predictions to the available data. However, only very limited historical assessment data are available for nuclear detonations, which significantly hinders this process of model refinement.

Given this uncertainty in the available modeling, the collection of assessment data will need to be prioritized during response to a nuclear detonation to provide an accurate assessment of the event as it occurs and to allow the real-time refinement and updating of on-going modeling efforts. Given that the physical characteristics of a detonation are uncertain and the impact estimates guiding the IND emergency response have not been validated, situational awareness generated by modeling efforts should be confirmed by actual measurements and observations of the hazard. Predictions of the fallout plume trajectory produced by models must be substantiated by on-the-ground data. These data will ensure that life-saving decisions, such as evacuation routing and timing, are supported by accurate information. Moreover, assessment data will be invaluable for the verification and validation of models after the incident. Once the situation has been stabilized and long-term recovery begins, there will be an opportunity for reflection and the documentation of lessons learned. During this time, models can be verified and validated with assessment data from the response to the IND detonation. This process will increase their fidelity and utility for future events.

No-notice vs. Advanced-notice

Similar to earthquakes, an IND detonation will likely be a no-notice event in which there will be no pre-event warning period to prepare for the imminent threat. Information about the details of the event, including the detonation site and bomb yield, will likely not be known in advance. Therefore, clear plans for the coordination of information sharing will have to be established and exercised to ensure that critical information is obtained quickly enough to answer time-sensitive questions during an actual event. These plans should specify what resolution of data will be required at each point and for whom, how often certain kinds of data will need to be gathered, who will process or interpret the data, and finally how and to whom the resulting useful information will be disseminated. As part of these plans, the modeling and data resources that will be used to satisfy critical information requirements at every phase should be identified in advance. This is especially crucial given that the majority of data applicable to IND detonation scenarios are not publically available. Preparedness plans that identify restricted data sets and the owners of that information ahead of time will prove useful during the response to an IND detonation.

Alternatively, it is possible that the intelligence or law enforcement community may be aware of an imminent threat of a nuclear detonation. In such a scenario, just like hurricanes, response assets may be able to be pre-positioned to relevant locations. During this period, the emergency management community can rely heavily upon existing predictive modeling to determine evacuation routes, medical and triage requirements, what type, and how many resources to move, among others, in order to mitigate the damage to human life and property.

Initial Gap Analysis

A preliminary analysis of interviews from technical and subject matter experts, IND program and emergency managers and senior-level decision makers have revealed gaps and areas for improvement specifically relevant to emergency management for nuclear detonation scenarios. The gaps identified thus far are described below. In subsequent phases of the project, this analysis will be expanded upon the basis of a complete inventory to highlight areas for additional research and assessments of current tools that can assist in operational decision-making.

Comprehensive Consequence Modeling

Although robust event characterization models exist to describe nuclear detonations, interviews conducted thus far suggest that available consequence models for INDs are limited to specific mission areas. Consequence models are needed to predict a wide range of impacts from a nuclear detonation, such as loss estimates of local hospital resources due to destruction or contamination, the extent of environmental contamination, health effects, infrastructure damage, and others. Although mission-specific consequence models are useful for the specific purpose for which they are designed, a coordinated emergency response depends on consistency in the planning and response assumptions that are embedded in and produced by these consequence models and applicable to a wider mission space. Additionally, in the context of IND modeling, modeled scenarios would need to include both very large and very small detonation events, as well as those for which advance warning were available. Such tools can help guide planning efforts despite the lack of historical experience, data and required resolution about the actual event.

Response Modeling

In addition to comprehensive consequence modeling, consensus suggests that there is an interagency need for response modeling for nuclear detonation scenarios. For example, knowing how quickly first responders can get to the victims is crucial to identifying how and when medical countermeasures will be used during a response; if a certain medical countermeasure is only effective within 6 hours, but emergency responders cannot administer the drug for at least 24 hours, this will affect HHS' planning decisions as to which medical countermeasure to stockpile. Similarly, understanding the factors that most quantitatively impact the effectiveness of a response can help inform and prioritize decisions that need to be made in the time-sensitive, information-overloaded environment of an emergency response.

Libraries of Impact Estimate Data

An analysis of currently used data and modeling resources suggests that there are no sources or repositories of impact estimate data available for IND detonation scenarios. As the event unfolds, consequence models and assessment data will result in event-specific impact estimate data. However, prior to the collection and processing of these data, decision makers need access to information about similar scenarios to make early decisions. Effective impact estimate resources would provide access to a compilation of outputs of consequence models available pre-event or libraries of historical post-event assessment data. Such resources are developed on the basis of planning scenarios and comprehensive planning efforts and would be critical to support decision-making immediately after an event.

Optimally, impact estimate data feed decision-support tools that can be used to inform mission-specific activities and resource requirements to support response and recovery efforts. For example, the number and type of anticipated casualties as predicted by impact estimates would directly influence the strictness of triage guidelines for first responders. Damage estimates to critical infrastructure would be used to anticipate which populations are most likely to be threatened by secondary hazards and would therefore benefit from earlier evacuation. These data could also be used to inform decisions such as the type and amount of medical countermeasures stockpiled pre-event, targeting of response missions to damaged areas, and the distribution of disaster relief supplies to populations displaced by radiological hazards post-event. A searchable library of impact estimates that collates information on damage assessments to all emergency support functions, including damage to human health, the economy, infrastructure, and the environment, among others, will be critical to inform decision-support tools and associated mission-specific requirements.

Translating Data and Modeling Outputs for Decision-makers

Robust data and modeling tools have been developed that characterize an IND event and provide information about specific impacts of the detonation. These models have been used to inform several U.S. city-specific planning scenarios.[1] [2] Event characterization models have been used to estimate air and ground contamination, including the trajectory and density of the fallout cloud. Other event characterization models determine the expected decay characteristics of the fallout cloud based on the radionuclides released or characterize the blast based on the pressure generated by the explosion. Consequence models for health impacts have been used to predict casualties from trauma, fallout, and burns. During an event, these models will be refined with real-time assessment data to provide a more accurate picture of the event.

Although robust tools to characterize an IND event are widely available and used, it is less clear how the information from event characterization and consequence models will be used to inform operational decision-making, such as triage needs, mass care, and transportation, among others. For example, models that can predict evacuation routes that are based on the location of the fallout cloud are available, but emergency managers do not know how those evacuation routes will be impacted by traffic accidents, mass exodus of the public and transportation of resources into the affected areas post-IND detonation.

In order to provide usable information, the scientific community that develops the models needs to be aware of the critical information needs of emergency managers. Likewise, emergency managers also need to understand what models can and cannot do in order to make effective decisions about response operations after an IND detonation. The outputs of predictive event characterization modeling will need to be translated and linked to each emergency support function, so that all emergency managers, across

[1] Joint FEMA Region V, State of Illinois, and City of Chicago Operations Plan (June 2012). Improvised Nuclear Device Regional Operations Plan.

[2] Buddemeier B *et al* (November 2011) National Capital Region Key Response Planning Factors for the Aftermath of Nuclear Terrorism. Lawrence Livermore National Laboratory.

all mission areas, have access to and understand the outputs of the models to inform decisions as to how and when to use event characterization information to support planning, response and recovery activities. This translation will require both understanding the outputs of the models themselves (the quantitative data and associated error) and understanding the time-sensitive and information-overloaded environment faced by operations leads in the field.

Conclusions

This report describes the big questions that arise after an IND detonation and identifies how data and models can be used to facilitate decision-making during all phases of emergency management. In order to develop preparedness plans for an IND scenario, the anticipated event and response timelines need to be mapped out along with the critical information requirements. Immediately following an IND detonation, many time-sensitive questions will need to be addressed. Several of those questions concern information about the event itself, such as “where is ground zero” and “how large was the blast?” Once initial situational awareness is obtained, emergency managers must ask questions about the impact of the detonation, including “what numbers, types, and severity of casualties are there” and “what infrastructure losses have occurred?” Finally, when diminishing radiation permits first responders to be deployed to the affected area, mission-specific details will drive response activities: “given these casualties and losses, what actions and resources will be necessary for a complete response?”

Although robust tools to characterize an IND event and assess health consequences are widely available and used across the federal interagency, it is less clear how the information from event characterization will be used to inform operational decision-making, including triage needs, mass care, and transportation, among others. The challenge is to better understand how the information produced by the event characterization models can be used to inform IND preparedness and response plans. There is a clear need to better connect the outputs of event characterization and consequence models to mission-specific requirements that will detail what needs to be done to mitigate the impacts of the disaster and will assist in efficiently using the available resources.

The flow of information and corresponding categories provide a framework with which to address these questions. Each set of questions is supported by particular kinds of models and data. Raw data is processed by event characterization models and analysis to produce situational awareness data, answering the question “what happened?” Next, consequence models and assessment data are used to obtain impact estimates which describe “who and what was affected to what degree.” Finally, decision support tools generate mission-specific requirements which determine “what must be done.” The resources available to the federal interagency should be considered within this framework to ensure that all response activities after an IND detonation will be supported by robust, quantitative information. The resulting inventory can be used by the federal interagency to determine how and which data and modeling resources can best answer their questions to ultimately inform decision-making at all stages of emergency management.

Next Steps

Thus far, timelines for the progression of events after an IND detonation and the anticipated response to the event have been developed and characterized. This report introduces a framework for the collection, categorization, processing, and application of critical information required to support planning efforts and response activities after an IND detonation. The next step is to establish an inventory cataloging the modeling and data resources that can be used to support IND detonation response and planning efforts. Targeted interviews with technical and subject matter experts, IND program and emergency managers and senior-level decision-makers across the federal interagency will continue to reveal which resources are available and being used by the interagency. The resulting information will be collated into an interactive inventory of the currently utilized resources, accessible via a web-based graphical user-interface, which will facilitate a better understanding and diagnosis of the complex process of information flow during emergency management. Finally, network analyses will be performed on the inventory to reveal gaps and redundancies in the currently available resources.

Appendix 1: Abbreviations

ADAPT/LODI	Atmospheric Data Assimilation and Parameterization Techniques and Lagrangian Operational Dispersion Integrator
AMS	Aerial Measuring System
ARA	Applied Research Associates
ARL	Air Resources Laboratory
BARDA	Biomedical Advanced Research Development Authority
CATS	Consequences Assessment Tool Set
CONOPS	Concept of Operations
DHS	Department of Homeland Security
DOE	Department of Energy
DOT	Department of Transportation
DSARS	Disaster Services Automated Reporting System
DTRA	Defense Threat Reduction Agency
EPA	Environment Protection Agency
ESFLG	Emergency Support Function Leadership Group
FEMA	Federal Emergency Management Agency
FRMAC	Federal Radiological Monitoring and Assessment Center
HHS	Department of Health and Human Services
HPAC	Hazard Prediction and Assessment Capability
HSIP	Homeland Security Infrastructure Program
HYSPLIT	Hybrid Single-Particle Lagrangian Integrated Trajectory
IND	Improvised Nuclear Device
IP	Infrastructure Protection
LCMIS	Life Cycle Management of Information Systems
LLNL	Lawrence Livermore National Laboratory
MDWG	Modeling and Data Working Group
NNSA	National Nuclear Security Administration
NOAA	National Oceanic and Atmospheric Administration
NUEVAC	NUclear EVacuation Analysis Code
NWS	National Weather Service
ODA Scalability Model	Office of Disaster Assistance Scalability Model
PPD	Presidential Policy Directive
Psi	Pound per Square Inch
PPE	Personal Protective Equipment
RAMS	Radiological Assessment and Monitoring System
REMM	Radiation Emergency Medical Management
RESRAD	RESidual RADiation
RTR System	Radiation Triage, Treatment, and Transport System

SBA	Small Business Administration
SHAMRC	Second-order Hydrodynamic Automatic Mesh Refinement Code
USACE	U.S. Army Corps of Engineers

Appendix 2: The ESFLG Modeling and Data Working Group (MDWG) CHARTER

August 6, 2012

1. 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. 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. 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. 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. 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. 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. 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. 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. 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 3: 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.