
FEMA

Department of Homeland Security
Federal Emergency Management Agency

# Standard Operating Procedures for Use of the ESFLG Model and Data Inventory

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# Contents

# Introduction

Effective emergency management requires accurate and timely information, but identifying resources that collate, analyze, and process the required information is a significant challenge for the federal emergency management community. To address this challenge, the Emergency Support Function Leadership Group (ESFLG) Modeling and Data Working Group has developed an interactive inventory of the datasets and models used by the federal interagency to inform operational decision making. The inventory, the ESFLG Model and Data Inventory (MoDI), is primarily intended for use during normal operations to identify the datasets and models available to fulfill critical information requirements for all stages of emergency management and to incorporate models and datasets into operations plans. The MoDI provides users with information that supports the coordinated the use of models and datasets to meet data requirements during an event, and anticipate the availability of information to support emergency management efforts.

This document describes the MoDI, demonstrates how it can be used to identify datasets and models, and highlights the utility of each for a wide range of users. Users include planners developing response operations plans, analysts providing situational awareness during an event, and operations personnel supporting on-the-ground response. Hazard-specific appendices outline the datasets and models identified as the most widely used and immediately accessible for response operations for hurricane, earthquake, and nuclear detonation scenarios.

## Addressing User Needs

To identify the needs of the users of the MoDI, interviews were conducted with FEMA agencies, departments, and sections where models/datasets are routinely used to support operational decision making. These included the Recovery Analytics and Budget Division, Readiness Assessment/NRCC Situational Awareness Section Desk, Modeling Task Force, Enterprise Analytics, Analytical and Geospatial Craft Section, and the National Watch Center. Several key points were raised during multiple interviews and shaped the construction of this SOP, as follows:

1. Emphasize use during normal operations.
2. Link datasets and models with the critical information requirements supported.
3. Define when a model or dataset will be available during an event and from whom.
4. Define the actionable information provided by particular models/datasets.

### Emphasize use during normal operations

Once an event occurs, those involved in the response are likely to use only those tools with which they are already familiar. Datasets and models are no different. As emphasized by nearly every interviewee, the utility of the MoDI depends on its use during normal operations and for exercises and training. Any potential user of the models and datasets described in the MoDI must become familiar with those tools during normal operations in order to reliably access and interpret the information they provide during an emergency.

To emphasize the utility of the MoDI during normal operations, the majority of this SOP focuses on Phase 1a, normal operations to enable users to identify models and datasets, the owners of each tool (with point of contact (POC) and website information), and other users of each tool to facilitate interagency coordination and data sharing. The MoDI provides the information needed by the user to develop familiarity with the models and datasets of interest that will be both useful and available during an event.

### Link datasets and models with the critical information requirements supported

As described by the interviewees, use of datasets and models requires clearly articulated linkages between data sources and the information requirements following an event. Data and models will only be used if it is clear to responders how these resources meet specific data requirements.

To address this need for clear connections between the models and datasets in the MoDI and the data requirements they support, detailed timelines were developed for each of the hazards supported by the MoDI (hurricanes, earthquakes, and nuclear detonations) with data requirements matched to the datasets and models that inform decision making during each event phase (Appendix C-E). Each hazard-specific appendix identifies the most frequently used, authoritative datasets and models for characterizing the event, predicting the consequences, and defining the mission-specific requirements for each Emergency Support Function (ESF) during each phase of the response. Each of these datasets and models is described in the MoDI with information about the phases of emergency management for which they are useful, the additional hazard(s) for which they are applicable, and a series of metadata tags that provide information about, among others, the utility of the models/datasets for emergency management, how they are operated, and keywords reflecting their specific features. These tags assist users in determining which models or datasets are most relevant to their missions and how to follow up with agencies, websites, and technical contacts to arrange the necessary access or training.

### Define the who and when

Users stressed the importance of knowing who will operate and distribute information from the datasets and models available during an event. Model runs and dataset collation must be planned in advance so that it is clear who will perform these tasks, when tasks must be complete to support timely operations, and from where and how the information can be accessed.

For earthquakes, hurricanes, and IND detonation, this SOP provides a step-wise, hazard-specific description of how this is done in planning for an actual event. Each appendix includes a detailed timeline of the event that matches the datasets and models to where they are likely to be useful during an event and available for supporting response operations and briefly describes how results will be distributed.

In addition, the main body of this SOP describes how to find information about each dataset and model to make the 'who and when' determination for other tools that are not already described in Appendix C-E. For example, the metadata tags for each dataset or model can be used to determine whether a subject matter expert or access to a supercomputer is needed to operate a particular model. Other tags help the user understand whether the information from the dataset or model is updated frequently enough to meet a particular data requirement. Contact information is provided to ensure that users can reach the technical contact and request any additional information or answer outstanding questions.

### Define actionable information

Once the appropriate datasets and models are identified, the outputs are linked to critical information requirements, and the tools can be accessed in real-time during planning or response, the interviewees emphasized that the information produced needs to be actionable. Each model and dataset in the MoDI is tagged by the ESF(s) for which the tool is most relevant. Tables in hazard-specific appendices describe those datasets and models that address the critical information requirements for each ESF. This SOP provides the information needed for emergency managers and operations personnel to determine the datasets and models to meet their data requirements and how to effectively translate the outputs into concrete estimates for needed supplies and personnel.

## Datasets and Models in the Flow of Information

Datasets and models are not all used to address the same types of questions. For example, the NOAA weather models that predict hurricanes are run on supercomputers and are fundamentally different in both structure and function from the simple calculators that are used to determine the number of dump trucks that will be needed to remove debris during response to the hurricane. A framework that describes the different types of datasets and models used by the federal interagency emergency management community was developed to characterize these differences and organize the datasets and models by their utility. The framework describes the flow of information through iterative steps of data processing and analysis, as shown in Figure 1. In the flow of information, raw data are processed by event characterization models to produce situational awareness data that, in turn, are used as inputs for consequence models that estimate impacts. The impact estimates serve as the inputs for decision support tools that define mission specific requirements. Detailed examples for operationalizing this conceptual framework for individual hazards are provided in Appendix C-E and descriptions of each model and data type are provided below.

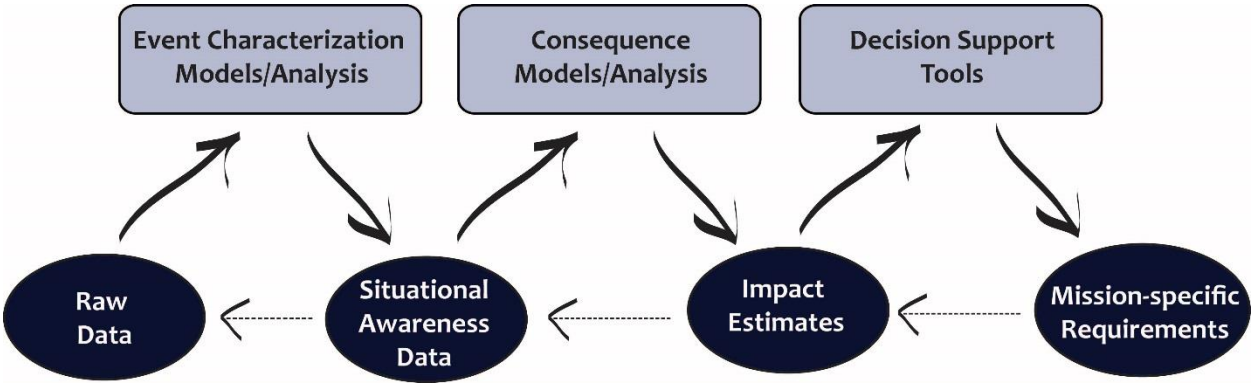


**Figure 1. Framework describing the flow of information through iterative rounds of data and modeling.** Data sources are shown in dark blue; models that process data are in light blue. Heavy arrows indicate the 'typical' flow of information from raw data through event characterization models, to situational awareness data, through to consequence models and decision support tools that define the impact and mission-specific requirements. The lighter, dashed arrows represent the idea that information from 'later' steps can feed back to refine the analysis at 'previous' steps.

### Raw Data

Raw data describe the current state of the world, including real-time weather conditions, locations of fault lines, and absolute magnitude of seismic activity. Raw data also include quantitative descriptions of past events. These data may provide useful information directly or serve as inputs to models.

### Event Characterization Models

Event characterization models use raw data about current and past events to characterize or make predictions about an event. This can include the location, timing, or severity of the event. Event characterization models are required to guide the vast majority of downstream decisions, regardless of the specific mission. The outputs can inform high-level decisions, including whether or not an event requires an emergency response, or inform concrete decisions, such as the choice to evacuate specific regions.

**Situational Awareness Data**
The information produced through the processing of raw data by event characterization models is termed situational awareness data and can be used to answer the question of "What happened?" or "What is happening?" Situational awareness data can be visualized using situational awareness viewers and can also serve as inputs to consequence models.

**Consequence Models**
Consequence models are used to estimate impacts to human health, the economy, and infrastructure to answer the question "Who and what is affected?" These models integrate data about the event with data layers specific to the region to characterize the consequences of the event.

**Impact Estimates**
Impact estimates define the consequences of an event, again to answer the question of "Who and what is affected?" They can be predicted by the consequence models or based upon an assessment of post-event or historical data. Consequence estimates directly support decision making and can serve as inputs for decision support tools to subsequently guide specific response activities.

**Decision Support Tools**
The information produced by decision support tools help to answer the question "What needs to be done?" by calculating the personnel and resources necessary to support mission-specific activities. This requires incorporation of information from the previously described datasets and models to ensure that these decisions are guided by real-time or predicted event-specific information.

**Mission-specific Requirements**
Mission-specific requirements quantitatively define the resources necessary to support a given mission, including materials and personnel. These data help to answer "What needs to be done?" in concrete terms. As outlined above, decision support tools may be used to generate mission-specific requirements. During an event, many mission-specific requirements will be calculated on the basis of post-event assessment data. However, an analysis of historical data combined with predictive modeling can also be used to guide pre-event decision-making and resource allocation.

# Phase 1. Steady State

## Phase 1a. Normal Operations

Phase 1a is the most critical for use of the MoDI because users have the time to identify models and datasets relevant to their mission, understand model/dataset capabilities, become familiar with models/datasets, arrange for access or training, and plan to use those models/datasets during specific types of events. In addition, the MoDI can be used to identify information gaps in the models/datasets are currently used by the interagency.

The following sections describe how to navigate the MoDI website and describe the features and capabilities of the MoDI. These features are largely not phase-specific, but are intended primarily for use during planning.

### Accessing the MoDI

The MoDI can be accessed using Mozilla Firefox, Google Chrome, or the Good Browser. The MoDI code can alternatively be run locally without an internet connection. If accessing the MoDI from the FEMA website, users will be automatically directed to the latest version. If accessing the MoDI from a copy of

the MoDI code that has been downloaded to a computer, it will be necessary to periodically request an up-to-date copy of the code to ensure the latest version is being used. The "Last Updated" stamp appears at the bottom of each page in the MoDI.

The main inventory can be accessed from mobile devices connected to the internet, though some features are not available, including the interactive data analytics found in the Analysis pages.

## Basic navigation

### *MoDI homepage*

The homepage is the first screen users see upon accessing the MoDI. The website header contains the homepage button, the search box, and tabs that can be clicked to access other pages in the MoDI (Figure 2). The header is visible from all pages in the MoDI and can be used for basic navigation and to perfom a text search for models and datasets.

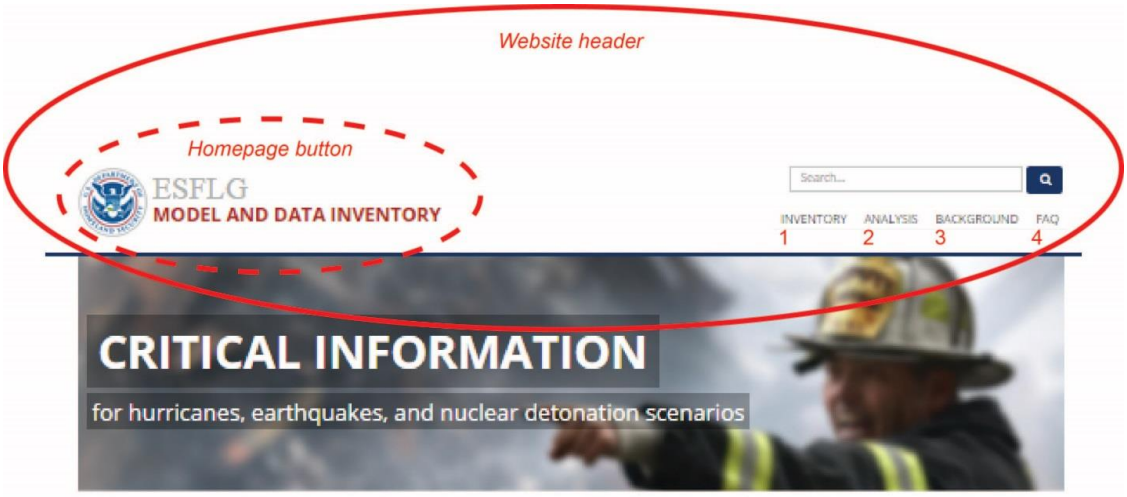


**Figure 2. MoDI homepage header with labeled components.** The"Website header" circled in red, "Homepage button" in the dashed red circle, and red labels numbered 1 through 4 all correspond to the description of these items in the text.

#### Homepage button

The dashed oval in Figure 2 outlines the homepage button, the logo on the left side of the header with the text "ESFLG Model and Data Inventory." Clicking this button will return the user to the homepage at any time when using the MoDI.

#### 1. Inventory

The "Inventory" button below the search bar navigates to the Inventory page (Figure 2, item 1). The Inventory page is the main list page of the MoDI website and allows users to browse information on models and datasets.

#### 2. Analysis

The "Analysis" button below the search bar opens a menu to navigate to the Inventory Statistics page and the Network Explorer page (Figure 2, item 2). These pages contain interactive data analytics that are not operationally focused features, but may be useful for strategic planning.

### 3. Background

The "Background" button below the search bar navigates to the Background page (Figure 2, item 3). This page contains information about development of the MoDI. The metadata used to describe each model/dataset are defined in this section.

### 4. FAQ

The "FAQ" button below the search bar navigates to the FAQ page (Figure 2, item 4). This page contains frequently asked questions related to use, features and terminology in the MoDI.

## *Navigating from the homepage to the inventory*

The following four procedures each redirect the user from the homepage to the inventory page (Figure 3). Two methods result in an inventory page with a subset of all MoDI models/datasets that match a search term or keyword. The other two methods display the entire inventory.

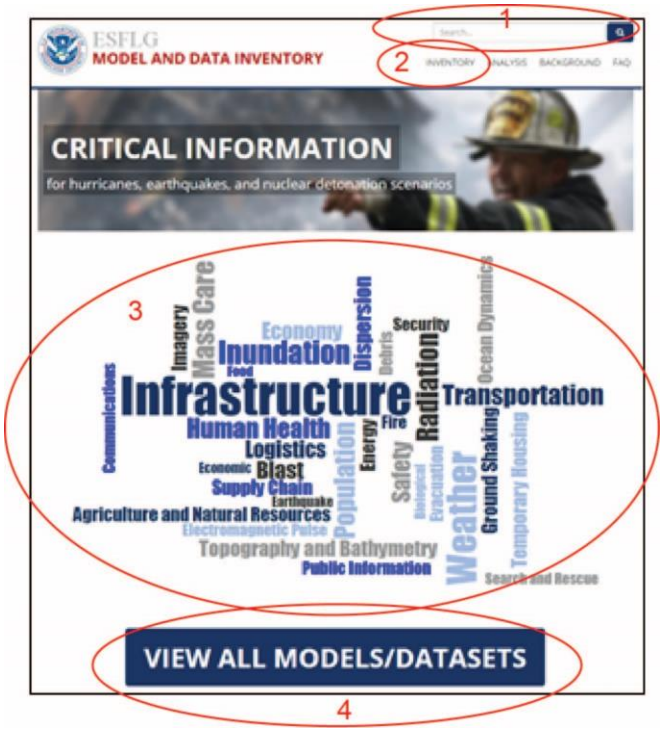


**Figure 3. MoDI homepage screenshot with numbered components that link to the inventory page.** The number labels 1 through 4 correspond to the header for description of these navigation links in the text.

### 1. Search bar

The search bar is found at the top right of the header (Figure 3, item 1), and is used like an internet search engine to identify models/datasets matching any term the user enters. For example, searching for "surge" returns any model/dataset with the word "surge" in its name, summary description, or other metadata.

### 2. Inventory button

The "Inventory" button (Figure 3, item 2) navigates to the Inventory page. The Inventory page is the main page of the MoDI website for browsing information on models and datasets.

### 3. Word cloud of keywords

A cloud of keywords describing models and datasets is shown on the middle of the homepage (Figure 3, item 3). Keywords from a pre-defined keyword list are provided for each model and dataset. The size of each keyword in the word cloud is proportional to the number of models/datasets in the MoDI that are tagged with that keyword. Clicking on a keyword of interest in the word cloud directs the user to a list of models and datasets tagged with that keyword.

Keywords are useful when searching for models and datasets that address specific elements of information without narrowing the results by hazard. For example, users developing response plans may click the keyword "Evacuation" to view those models and datasets which are applicable to evacuation. A full list of keywords is available in the MoDI Background section.

### 4. "View All Models/Datasets" button

The "View All Models/Datasets" button is located below the word cloud (Figure 3, item 4). Clicking this button navigates to the "Inventory" page and shows all models and datasets in the MoDI.

## Using the "Inventory" page

### *General features of the "Inventory" page*

Using any of the methods described above will redirect the user from the homepage to the Inventory page (Figure 4). By default, the MoDI displays all models and datasets on this Inventory page when users click the "Inventory" button at the top of the homepage or the "View All Models/Datasets" button at the bottom of the homepage. For searches and word cloud clicks, only models that match the search term or selected keyword are displayed.

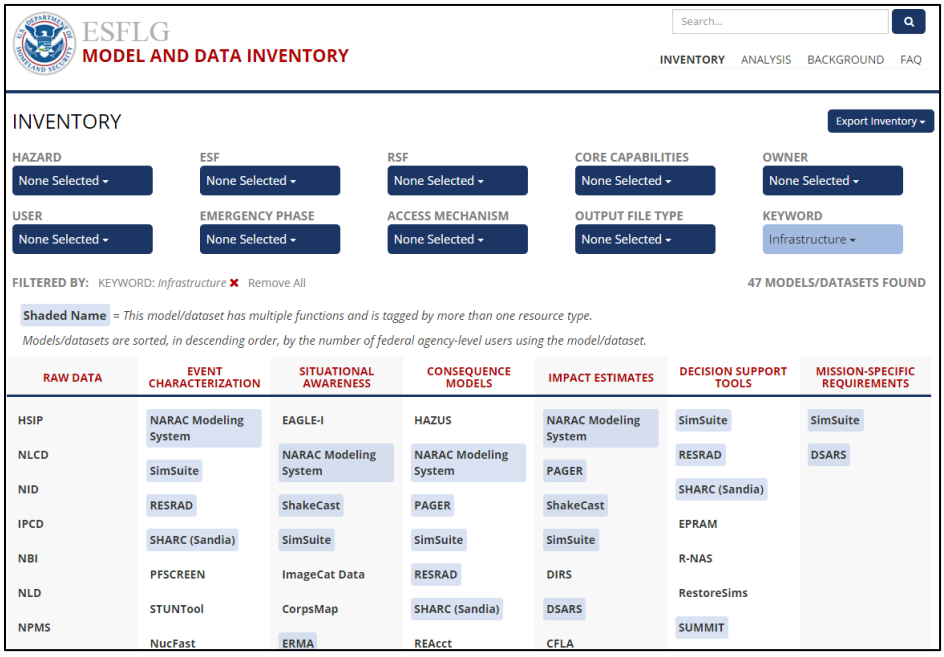


**Figure 4. MoDI Inventory page.** The Inventory page lists all models and datasets in the MoDI or a subset if a filter has been applied.

The models/datasets are listed under the seven red category labels from "raw data" on the left to "mission-specific requirements" at the right. Each column is sorted by number of known agency users so

that models heavily used within the interagency are located near the top of each category. This categorization allows users to quickly determine what kind of information is provided by each model or dataset based on its column. For example, SLOSH is listed under event characterization because it predicts storm surge and flooding heights for hurricanes, which help to answer "What happened?" By contrast, FEMA's Deployment Tracking System (DTS) is listed under mission-specific requirements because it is used to track the locations and deployment status of FEMA emergency operations personnel. Datasets and models that serve multiple functions are listed under each applicable heading and are marked by a blue shaded box. For example, the NARAC Modeling System is listed under event characterization, situational awareness and consequence models because it performs all these functions.

### *Filters*

Ten categories of filters can be applied to narrow the results and find specific datasets and models (Figure 5, dark blue boxes with white text). Filters can be chosen to limit the datasets and models shown based on topics of interest (Hazard, ESF, RSF, etc.). An example is shown in Figure 5 where a user reached the Inventory page by clicking the keyword "infrastructure" in the homepage world cloud. Notice that keyword is displayed in the KEYWORD filter box and the "FILTERED BY:" display (Figure 5, red ovals). Only models and datasets tagged with that keyword are shown.

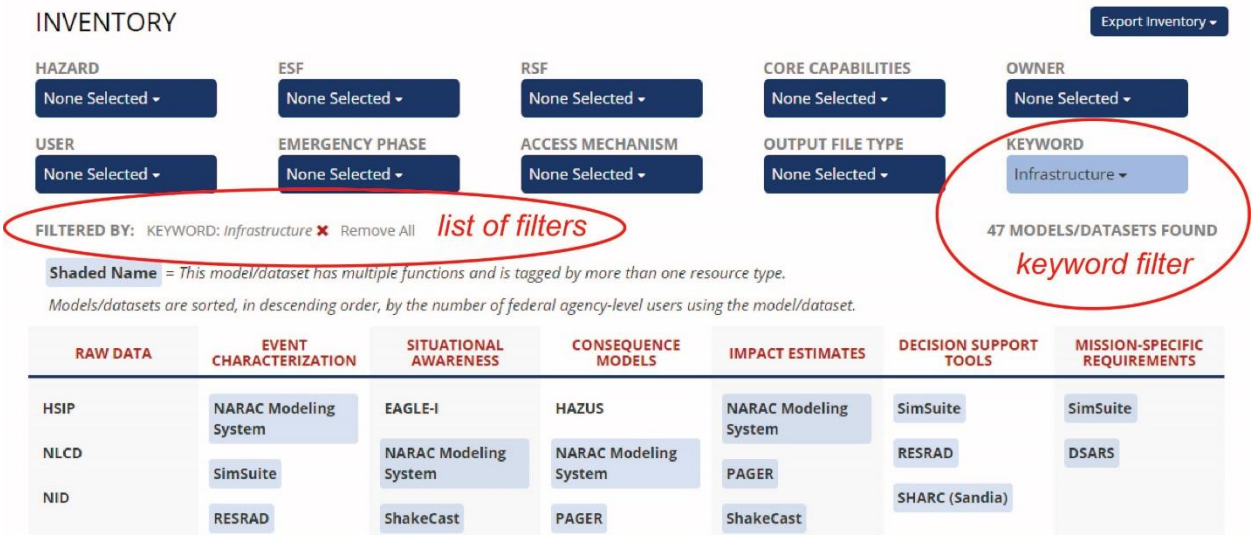


**Figure 5. MoDI Inventory page with keyword filter for "Infrastructure."** The ten blue boxed across the top of the Inventory page are different categories of filters that permits users to display only models/datasets that match specific requirements.

The ten pre-set filters – hazard, emergency support function (ESF), recovery support function (RSF), core capabilities, owner, user, emergency phase, access mechanism, output file type, and keyword can all be used to limit the search results. For example, the models/datasets shown on the Inventory page can be limited to those applicable to hurricane hazards by choosing the "Hurricane" filter in the HAZARD filter box. All-hazards models/datasets are automatically included in the list of models/datasets when hurricane, earthquake, or nuclear detonation is selected. Additional details about the filter categories are presented in the "Model/Dataset Information Page" section.

The following procedure describes an example of how to apply a hazard filter for models relevant to hurricane response (Figure 6). A similar procedure is useful for all ten metadata category filters and

multiple filters can be applied to sequentially refine the model/dataset list (e.g., hurricane for hazard, ESF 6 for ESF, and FEMA for Owner).

1. To filter models/datasets by the hazard hurricane:
    a. Check the box next to hurricane.
    b. Click the red "Apply" button.
    c. An updated list of models/datasets, filtered by the selected hazard, now fills the Inventory page.
    d. On the right side of the screen, the user can see how many models/datasets are currently displayed (how many match the filter criteria).
    *[Note: To view only models/datasets that are all-hazards, check the all-hazards box]*
    e. The same procedure is used for any of the filter categories (ESF, RSF, KEYWORD, etc.), including multiple simultaneous filters.
2. To remove filters:
    a. Uncheck each box within the filter drop-down.
    b. Click on the red "Apply" button.

**[OR]**

    a. Click on "Remove All" to return to the unfiltered inventory.

**[OR]**

    a. Click on the red "x" to the right of the filter to be removed in the "Filtered by" section below the blue filter boxes.

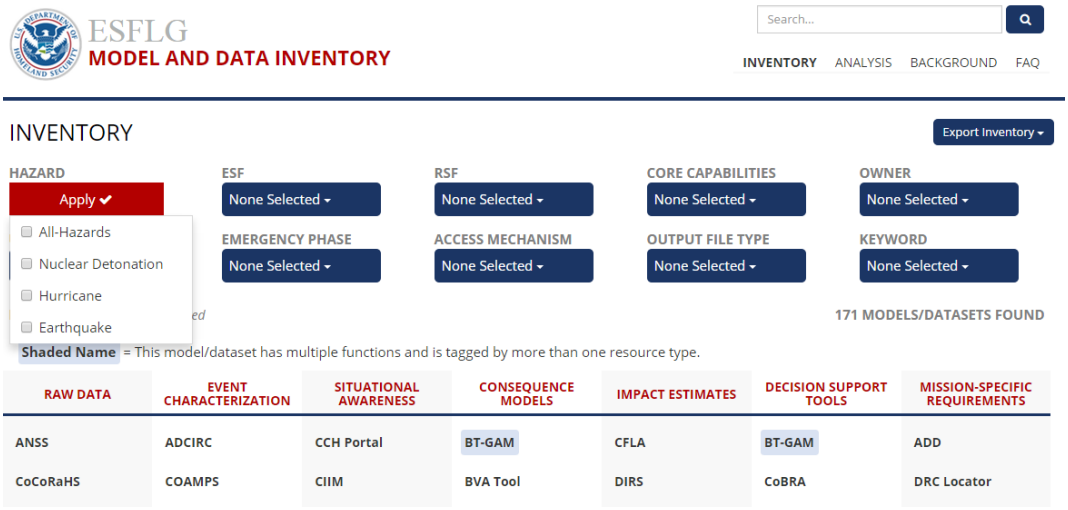


**Figure 6. Inventory page screenshot showing a filter selection in progress.** After checking the box next to all desired filters, the red "Apply" button must be clicked to apply the filter and update the list of models/datasets on the Inventory page.

### *Exporting the entire inventory*

To export the entire inventory as a CSV file or to Microsoft Excel, click the "Export Inventory" button on the right side of the Inventory page (Figure 7, red circle). A menu with options to "Export to CSV" or "Export to Excel" appears. At this time, a list of filtered models/datasets cannot be exported; only the

entire inventory can be exported. This feature is useful if users need to share inventory data with others who do not have access to the MoDI, or if they need to integrate MoDI data with other applications.

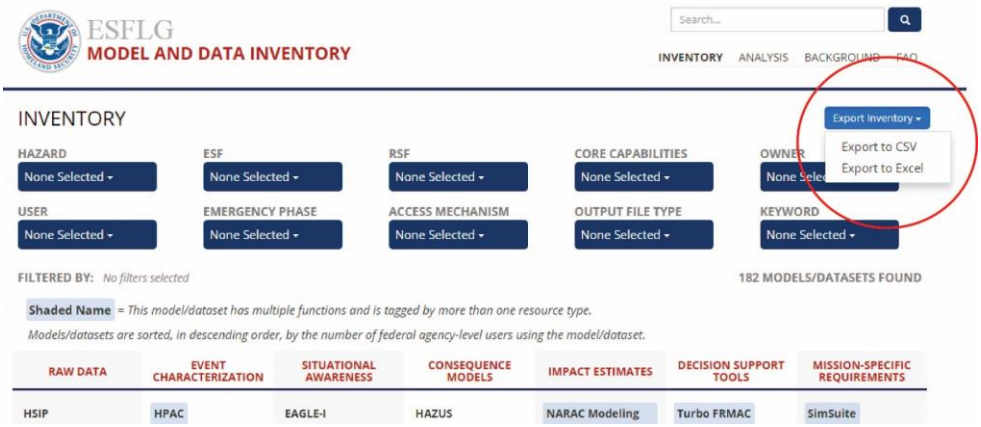


**Figure 7. Inventory page with marked export inventory tool.** The location of the export inventory tool is marked with a red circle demonstrating the drop-down option to export the MoDI data as CSV or Excel file formats.

### *Quick view*

To quickly view information about a particular dataset or model, place the cursor over its name. A window will appear listing the owner at the top, a "What is it" description, and "How do I get it" instructions (Figure 8). Quick view is useful to find out what a model or dataset does, who owns it, and how to get it without navigating away from a list of models/datasets on the Inventory page. The quick view feature is particularly useful in the exploratory stages of plan development while searching for models and datasets to determine whether the search filters are returning results relevant to the user.

#### Owner

The owner of the model or dataset is listed in the header of the quick view box right after the model/dataset name. This information can be used during normal operations by all user types to determine what models and datasets may already be owned by their own agencies and which belong to other agencies.

#### "What is it?" and "How do I get it?"

"What is it?" and "How do I get it?" sections of the quick view box provide brief answers to these questions for each model and dataset. This information is useful for users developing plans because it allows them to quickly determine what the model or dataset does and how it can be accessed, along with any access restrictions that need to be addressed prior to an event.

#### "View Details" button

The "View Details" button navigates from the quick view box to a model or dataset's information page. The information page provides a detailed summary of the model/dataset, contact information for the developer and real-time operation of the tool, and other technical information. More information on the features of the model/dataset information pages and how to use them is provided in the next section.

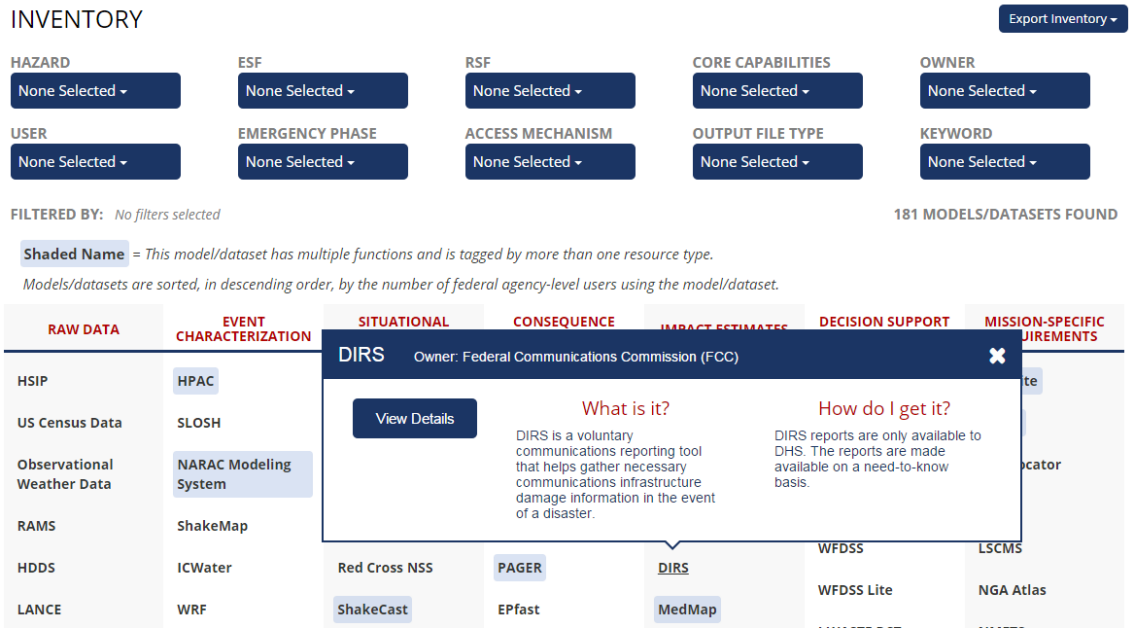


**Figure 8. Screenshot of the quick view window for DIRS.** While on the Inventory page, users can quickly view a summary of information about a model or dataset by hovering the cursor of the model/dataset name.

### *Accessing the model/dataset information pages*

Each model/dataset has its own page, to view the model/dataset information pages (as in Figure 9):

1. From the Inventory page, hover the cursor over any model/dataset to display the quick view box.
    a. Click on the "View Details" button on the left side of the box.

**[OR]**

2. From the Inventory page, click on the name of any model/dataset.

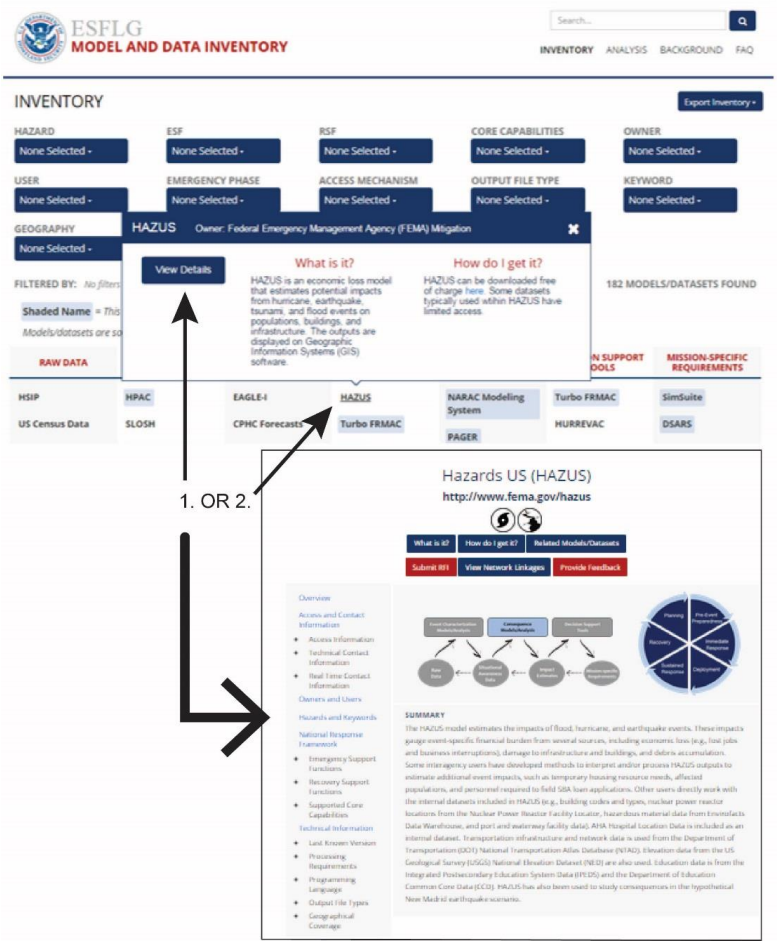


**Figure 9. Screenshot demonstrating two links from the Inventory page to the model/dataset information page for Hazus.** Options 1 and 2 correspond to the two methods described in the text above.

## Model/Dataset information page

Each model/dataset information page contains a description, metadata that describe the attributes of the model/dataset, and access and contact information. Together this information allows MoDI users determine whether the model/dataset can help fill certain data requirements and, if so, how the information should be generated or accessed. Figure 10 is a screenshot of the initial model/dataset information page for Hazus, with individual components marked to identify the sections that describe them below. The information header (1, A-G) and navigation bar to the left (numbered 2-7) remain visible at all times while using the information page while items H-J are part of the Overview and will be replaced with new content (access and contact information, owners and users, technical information, etc.) as users click on links to learn more about the model/dataset.

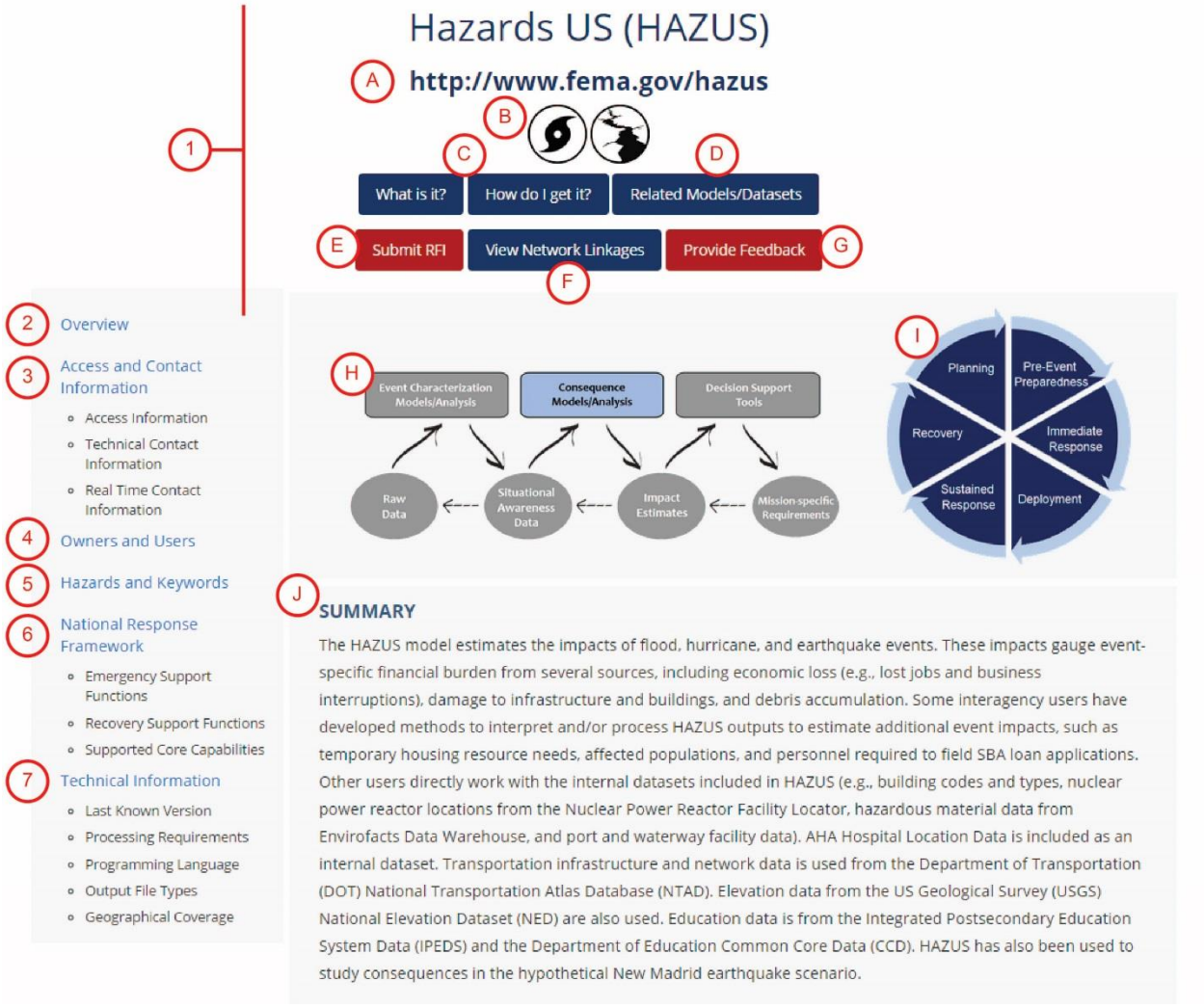


**Figure 10. MoDI model/dataset information page.** Each MoDI model/dataset has an information page that provides answers to fundamental questions ("What is it?" and "How do I get it?"), a link to its website, and sections containing detailed access and technical information. Lists of related models/datasets and diagrams of the models/datasets that directly link to it are also accessible from this page.

## 1. Model/Dataset Information Header

This Model/Dataset Information Header refers to the entire block of model/dataset information that is shown near the top of the model/dataset information page. This information appears just below the name of the model/dataset, and it stays visible as users browse different sections of the information page.

### *A. Website(s)*

When available, relevant websites are hyperlinked below the name of the model/dataset on the information page. In some cases, additional information about the model or dataset is provided at the linked site or the model/dataset itself can be accessed or downloaded. When no website is listed, the user can use the contact information listed under "Access and Contact Information" to access the model/dataset (described in more detail below).

### B. *Inventory hazard icons*

Below the model/dataset name and any applicable website links, icons denote the relevant hazards, including earthquake, hurricane, nuclear detonation, and all-hazards (Figure 11). Additional hazards have not yet been addressed by this effort. Text defining each icon will appear as a hover-over. Clicking the icon will bring the user to the Inventory page filtered for that hazard.

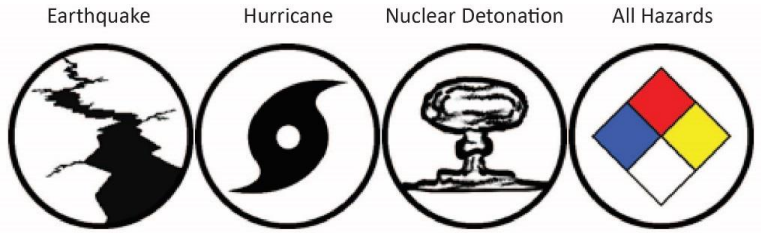


**Figure 11. Inventory hazard icons.** These icons appear on the model/dataset information pages to represent the hazard(s) tagged to that model/dataset. In this figure, each icon is itentified by its corresponding hazard.

### C. *"What is it?" and "How do I get it?" quick views*

The "What is it?" and "How do I get it?" buttons that appear in the quick view on the Inventory page are also provided on the model and dataset information pages. As before, "What is it?" and "How do I get it?" provide information without leaving this page.

### D. *Related Models/Datasets quick view*

Users can view models and datasets related to the current entry using the "Related Models/Datasets" button. This feature is useful because it guides users to alternative or supplementary sources of emergency management information, which can be useful when developing response plans.

For example, related models and datasets may provide additional useful information or allow users to answer questions in other ways. Hazus, an economic loss model that provides Geographic Information Systems (GIS) output, can take two hours to generate detailed event-specific information with more complex runs often taking up to six hours. However, the US Geological Survey (USGS) PAGER model, listed under Related Models/Datasets for Hazus, automatically generates earthquake impact estimates in near real-time and posts them online, but at a coarser resolution than Hazus.

### E. *Submit RFI*

This tool allows users to submit a request for information (RFI) to the technical contact of a model/dataset. As long as users review this template in advance to ensure it meet their needs and those of the model/dataset owner, then the RFI template is a rapid method to access information during an event. After clicking the "Submit RFI" button, a form appears in the same window. Inputs of the form include the user's contact information, description of the event, information being requested, and the date by which the RFI response is needed. The user can see the email as they complete the form and submit it with a single click of the "Submit Email" button at the bottom of the Submit RFI form.

### F. *View Network Linkages*

In developing emergency response plans, it is useful to know which models/datasets are linked to determine which may be interdependent or require common input data. Linkages between the models and datasets in the inventory can be viewed using the "View Network Linkages" button on

each information page. An example of the graphic is shown in Figure 12. For example, particular datasets or model outputs may be required as inputs for a downstream model. Importantly, linkage between one model/dataset and another does not preclude connections with other data, including some that might not be in the MoDI.

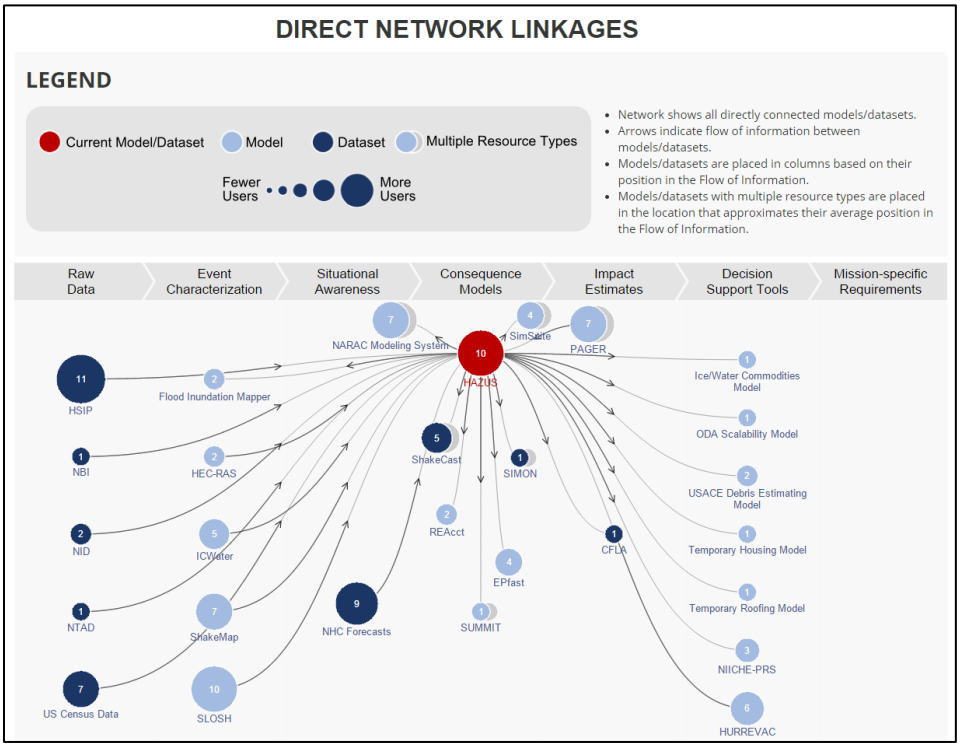


**Figure 12. Direct network linkages for the Hazus consequence model.**

To return to the model/dataset information page from the direct network linages page, click the "Back to Model/Dataset Details" button. For reference in the following description of the additional features of the model/dataset information page, the example model/dataset information page from Figure 10 is duplicated as Figure 13.

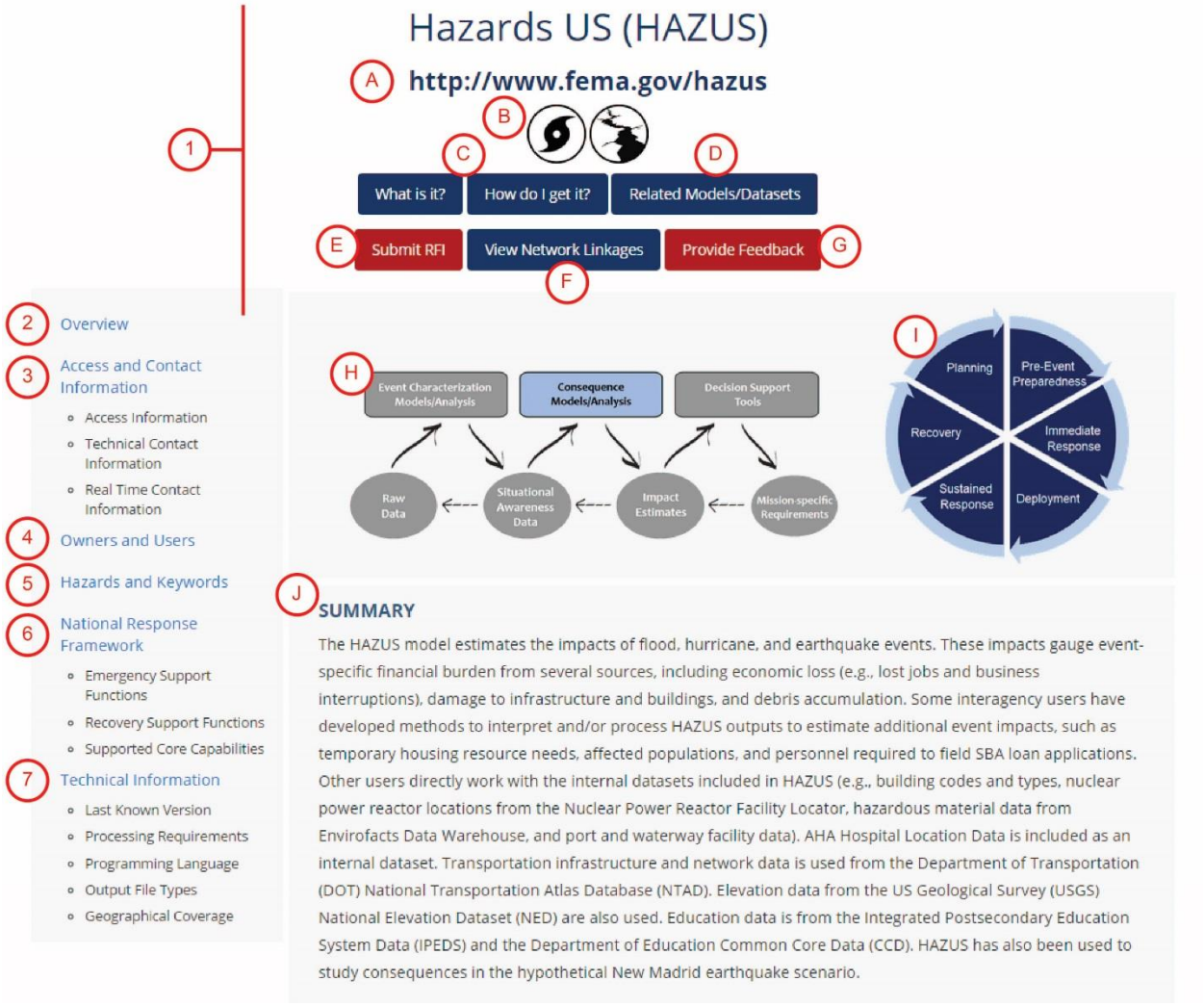


**Figure 13. Duplicate example MoDI model/dataset information page.** See description in Figure 10.

### *G. Provide Feedback*

The feedback section is a method in which the user may provide feedback about a model/dataset's metadata. Metadata fields are provided in this form and users may suggest changes to these metadata. Clicking on the question marks provides additional information on each the metadata field. Users can supply any other necessary information or clarifications by adding text to the "Additional Notes" input field. The requested changes will be submitted to the MoDI Maintenance Team for review.

### *H. Resource Type*

The center graphic of the Overview page shows the resource type of the model/dataset, which describes how it supports emergency operations (for Hazus this is Consequence Models/Analysis, light blue). This graphic allows users to determine, at a glance, what type of information a model or dataset provides. For example, event characterization models, like the USGS ShakeMap model for earthquakes, characterize or predict the location, timing, or severity of an event.

#### *I. Phase-specific Utility*

The second graphic on the Overview page shows the phases of emergency management during which the model or dataset may be useful: Planning, Pre-event Preparedness, Immediate Response, Deployment, Sustained Response, and Recovery (in a circular graphic)[1]. Models and datasets marked solely as useful during Planning would be primarily useful for scenario development and establishing planning factors during normal operations, and not as sources of information during an exercise or a real-world event. By contrast, a model or dataset marked as "Immediate Response" could be used during an exercise or during the early phases of a real-world response.

Clicking a wedge of the phase on the phase-specific utility graphic will return the user to the "Inventory" page with models/datasets filtered by that phase.

#### *J. Summary*

The overview section of the information page includes a summary at the bottom, which describes what the model or dataset does, as well as any notable use cases.

### 2. Overview

The Overview page is the default shown when users first navigate to a model/dataset information page. The "Overview" link, labeled as item 2 in Figure 13, provides users the ability to return to the overview page after navigating away to other sections. Resource type and phase-specific utility graphics are shown on the Overview page for each model/dataset (Figure 13 H-I) with a summary of the tool (Figure 13 J) to help users understand how the model or dataset can be used to support emergency management. It is the default section shown on the information page, and can be accessed by clicking Overview in the navigation menu on the left.

### 3. Access and Contact Information

The Access and Contact Information section describes how a model/dataset is accessed and provides a POC from whom additional information about the model/dataset is available. Each designation is described below.

#### *Open or Limited Access*

Open access models/datasets are available to users without restriction. Examples include forecasts posted online, open access web-based datasets, or software that can be downloaded to a laptop/desktop computer and run by the end user. An open access model may still require experience to operate. For example, the Hazus consequence model is an open access, standalone tool that can be downloaded to a computer desktop, making it readily available to a wide range of users. However, the model requires significant expertise to operate.

#### *Standalone, Reachback, and Subject Matter Expert Designations*

For models, access information also describes how the model may be run during an event. Models can be run standalone, through a reachback capability, or through interaction with a subject matter expert. Since the particular entity responsible for running a model will depend upon the event type and phase, the information in the MoDI can be used to guide the development of detailed hazard, event level, and region specific documents. For example, a model may be run by a particular agency

[1] The phases of emergency management used in the MoDI are simplified from the eight phases described in the Response Federal Interagency Operational Plan (FIOP), into six phases, as described in Appendix A.

only for Level One events, and alternative arrangements would be need to ensure availability of its outputs for other events.

Standalone models may be run by particular users or supplied by an analyst in a specialized agency. While standalone models do not necessarily require the resources of a specialized modeling center, they may require particular analyst skills or training in order to be run in-house during an event. If no special training is needed or if that training is complete, a standalone model can be run by any individual with access, which can include access through a web portal.

A reachback capability model is accessed through interaction with a reachback facility. This refers to models run and managed by specific organizations and accessed through formal RFIs for model outputs or for activation of a modeling center in response to an event.

A subject matter expert model can only be accessed through personal interactions with the model developer or owner. Often, the outputs from models runs by subject matter experts are publicly accessible, but the model itself is restricted for use by the subject matter expert. Models are also tagged as subject matter expert if they are run on a schedule based on computing limitations that preclude additional runs of the model outside the set schedule. Each of these considerations must be reviewed and accounted for during the planning process.

Clicking a tag listed in the bulleted list in the ACCESS INFORMATION box will return the user to the main Inventory page with a list of models/datasets that match that Access Mechanism tag (e.g., all open access models in the MoDI).

#### *Technical Contact*

The technical contact serves as an expert resource to answer questions about a model/dataset during normal operations. They are also a resource to identify training opportunities and technical support. Technical contact information provided in the MoDI can be used to coordinate with the POC for a model or dataset to be sure all necessary information is incorporated into the RFI, that all parties understand the time necessary to run a particular model, and when results must be available to support response operations.

#### *Real Time Contact*

The real time contact is the individual dedicated to support a model/dataset during activation for an event. In many cases the real time contact will perform runs of a model at the agency responsible for developing or maintaining the model. But, in some cases, the real time contact may support external users as they perform their own model runs. Not all models/datasets have a real time contact. If no real time contact is available, the technical contact is the next best option. Technical contacts should not be expected to be available for real time communication during an event.

### 4. Owners and Users

The owners of each model/dataset and its known federal agency-level users are provided.[2] This information can be used during normal operations to determine what models and datasets may already be owned or used by their own agencies or to suggest other users who may be able to provide useful operational experience about using the model/dataset.

[2] An agency is marked as a user of a model or dataset if, during the interviews and research to develop the MoDI, that agency described using model or dataset to answer emergency management-related questions.

## 5. Hazards and Keywords

The datasets and models used by the federal interagency have only been identified for three hazards – earthquakes, hurricanes, and nuclear detonations. These hazards are those listed as "Inventory Hazard(s)". Any additional hazards for which a specific dataset or model may be relevant are listed under "Other Relevant Hazards."

Keywords selected from a pre-defined keyword set serve as a general proxy for the information analyzed by or contained within a model/dataset. Keywords can be used to identify other sets of related resources or resources relevant to a specific topic. Keywords can be accessed in the form of a filter drop down list on the Inventory page or from the word cloud, as described previously.

Clicking a tag listed in the bulleted list in the INVENTORY HAZARDS box or the KEYWORDS box will return the user to the main Inventory page with a models/datasets filtered by that hazard or keyword.

## 6. National Response Framework

The National Response Framework describes the mission and responsibilities associated with each Emergency Support Function (ESF), Recovery Support Function (RSF), and Core Capability[3]. Each model and dataset in the MoDI is, correspondingly, tagged by the ESFs, RSFs, and Core Capabilities that they may support. This information is accessed by clicking "National Response Framework" in the navigation menu to the left.

During normal operations, these metadata categories can be used to identify sources of information in the MoDI by the relevant emergency management policy concepts and coordinating structures. For example, users may filter the MoDI by a specific ESF to view models and datasets that may be useful in supporting the roles and responsibilities of that ESF.

Clicking a tag listed any of the bulleted lists in this section will return the user to the Inventory page with a list of models/datasets filtered by that National Response Framework element (ESF, RSF, or Core Capability).

## 7. Technical Information

The Technical Information section of the information page describes processing requirements, programming language, and output file type(s) of a model/dataset. The processing requirements help a user determine if they have the necessary computing resources to access the model/dataset. Programming language is most relevant to more technical users when integrating new datasets with models or identifying other datasets or models that may be effectively linked to enhance capabilities within a mission. Finally, output file type is useful for understanding how specific models/datasets can be integrated with other resources, such as situational awareness viewers. Additionally, it will provide insight into whether a particular model/dataset output can be distributed to users with limited access to specialized software during an event or how easily an output might be incorporated into a senior leadership briefing.

### Processing Requirements

The MoDI provides a brief description of the hardware required to use each model or dataset. Processing requirements are: supercomputer, desktop/laptop, web-based application, and mobile device. In certain cases, a dataset or model may be tagged with two or the three processing

[3] Response Federal Interagency Operational Plan (Department of Homeland Security, 2014)

requirements. For example, a weather model that can be run on a desktop computer but is often run on a supercomputer, would be tagged as both 'desktop/laptop' and 'supercomputer.' A model, like the NARAC Modeling System, that runs on a supercomputer but pushes its output data to users through a web portal, would be tagged as both 'supercomputer' and 'web-based application'.

The hazard-specific scenario examples (Appendix C-E) demonstrate how to understand specific processing requirements in the context of actual response operations by defining how run key models are run during an event. For example, IMAAC is the central resource that would distribute atmospheric plume modeling from the NARAC Modeling System following an IND detonation while any first responder can access RadResponder from a smartphone.

### Programming Language

When possible, the MoDI provides the programming language with which a model is coded. This information is provided for developers or other highly technical users to help them understand requirements to update, modify, or adapt a model.

Clicking a tag listed in the bulleted list in the PROGRAMMING LANGUAGE box will return the user to the main Inventory page with a list of models/datasets filtered to match that programming language. This would be useful to technical users looking to integrate models/datasets with one another or to develop new resources with compatibility to existing models/datasets.

### Refresh Rate

Refresh rate is only listed for models/datasets with a consistent update or run cycle. For datasets, this category specifies how often new information is uploaded into the dataset and provides users with information about how up-to-date information is likely to be when they access it. An example would be the HSIP infrastructure dataset which is updated approximately annually. For models, it indicates whether the model is routinely run, and if so, how frequently. The refresh rate of the model is useful because it describes how often to expect updated model outputs during an event (for example, the frequency of National Hurricane Center forecasts). Many weather forecasting systems are run on a predetermined schedule because of the processing limitations of their supercomputers and cannot be run more frequently during activation. As users understand the structure of model run schedules they can account for these considerations in response plans.

### Filetype or Output File Types

Certain file types may require specific software and because different users will require information in different formats during an event. Depending on the model or dataset, information may be provided in videos, spreadsheets, geospatial files, images, documents, binary files, and other formats. The output file types are organized into more general categories to facilitate browsing and locating file types of interest. For example, geospatial analysts may scroll to the Geospatial category and filter for the geospatial file types that are compatible with their specific GIS platforms (e.g., shp, kml, kmz, or GeoTIFF). By contrast, operations personnel, who need ready-to-use file types for senior leadership briefings with minimal processing, might filter for file types under the Images category and the Documents/Slides category.

Clicking a tag listed in the bulleted list in the FILETYPE box will return the user to the main Inventory page with a list of models/datasets filtered for that output file type.

### Determine how data will be accessed during events

Once a model/dataset has been identified for use, the user needs to determine how the information will be produced and distributed during an event. In some cases, this information has already been determined and is recorded in the hazard-specific appendices (C-E). In other cases, it will be necessary to make this determination as part of the planning process. The MoDI can be used as described above to determine the resources needed to operate a particular model (available for each model/dataset in the MoDI under "Technical Information") or to determine if access or training needs to be requested in advance. Coordination with those responsible for or providing outputs from models or datasets of interest should to be performed prior to an event whenever possible. Steady-state communication with the technical contact provides an opportunity to develop a relationship with the owners and developers of tools to ensure smooth data sharing and information transformation during events. Such communication prior to the event can also help ensure that users understand what input data they need to provide to run the model and helps set accurate expectations for timing and content of model outputs. Additionally, if a charge will be levied to provide model runs, these costs can be anticipated in advance. Such information can be incorporated into planning documents to outline what will occur during an event.

To facilitate communication with the technical and real-time points of contact for each dataset and model, a standardized or custom e-mail request for information (RFI) can be automatically generated for any model/dataset in the MoDI using the Submit RFI tool (Figure 14).

EXAMPLE TEMPLATE: REQUEST FOR INFORMATION

From: [email address]

To: Technical Contact event.model.contact.@nationallab.gov

CC: [cc email addresses]

Subject: Request for Information: [model/dataset]

In response to [event related to RFI], [organization] is requesting information regarding [model/dataset]. The information needed is as follows:

Example: Guidelines for emergency worker exposure levels to radiation.

We are requesting this information no later than [date by which RFI is needed].

Please submit to [name] at [email address] and cc to the following email addresses, [cc email addresses]. If you have any questions regarding this RFI, please contact [name] at [email] or [phone].

Very respectfully,

[name]

**Figure 14. Example Submit RFI email.** Users can generate an RFI for a particular model/dataset from its MoDI entry which follows this pattern. Information entered by the user is indicated in brackets. All other information and text are automatically integrated.

### Maintaining the MoDI

The goal of the MoDI is to identify, characterize, and collate an up-to-date list of the datasets and models used at the federal level to inform operational decision making for emergency management. To meet this goal, the MoDI requires ongoing maintenance. This maintenance should be a standardized part of normal operations and is outlined in more detail in the Maintenance Guide in Appendix B.

MoDI users benefit from regular addition of useful models and datasets, either newly developed or newly identified. By contrast, if a model or dataset is no longer available or used, it must be removed from the MoDI. As datasets and models gain additional capabilities or if inter-model compatibility changes, the MoDI will require updates to reflect these new integrations. Finally, lessons learned during events will refine the selection of datasets and models from the MoDI and may also help improve the accuracy and fidelity of critical models and datasets by catalyzing communication and collaboration among agencies.

## Phase 1b. Elevated Threat / Phase 1c: Credible Threat

As an event develops, as during Phases 1b and 1c, the MoDI is useful in helping identify sources of information for unexpected event-specific data requirements not anticipated as plans were developed during normal operations. The models/datasets available to address those questions can be identified using the search and filter functions MoDI functions in the same manner described in normal operations section.

The ability to submit an RFI directly from the MoDI is also useful during the elevated or credible threat phases so that users can begin to anticipate potential impacts and consequences. The technical and real time contacts can also help provide information about the specific use of or provide outputs from models or datasets of interest, particularly for requests outside the scope of a detailed RFI.

Notably, Phases 1b and 1c are only relevant for advance-notice events (e.g., hurricanes or advance warning of an IND attack provided by intelligence sources). For an advance notice incident, it may be possible to run models and access datasets identified in Phase 1a: Normal Operations prior to the event itself. For example, Appendix D outlines how models/datasets support planning for a hurricane response before the storm makes landfall. Once forecasts have identified a potential threat, these initial analyses serve as a guide to begin determining, “What will happen?” While the answers will evolve as real-time assessment data become available after an event, this approach already begins to answer the central questions: “What happened?”, “Who and what is affected?”, and “What needs to be done?”

# Phase 2. Response

The timing of information availability from models and datasets to support the response phase differs for advanced and no-notice events, but the use the MoDI remains the same. Since the MoDI is a database of information about model and datasets, not a source of analysis itself, its use is the same for all phases and event types. However, special consideration must be given when using the MoDI to identify datasets and models during the response phase because time and resources are limited compared to during normal operations planning. For example, a model that lacks a real time contact may be more difficult to access during an event, as technical contacts may not be scheduled for work when the information is needed or may be deployed as part of the response itself. For user-run models/datasets, it is important to consider whether the model/dataset can be used in a timely manner without special training or request for access.

For all models, whether established in plans or identified through the MoDI as an event unfolds, the data availability depends on whether analysis begins before or after the incident. In a no-notice event, such as an earthquake, models become particularly important in the first 24 hours to help answer "What happened?" with event characterization models and then "Who and what is affected?" using consequence models so that the immediate response can be guided by impact estimates before assessment data are available. Furthermore, models will not already be up and running as they could be in Phase 1b/c of an advanced-notice event. A detailed consideration of datasets and models for use in each phase of the emergency response to an earthquake is provided is Appendix C and for a nuclear detonation scenario in Appendix E.

For an advanced notice event, such as a hurricane, alignment of pre-selected datasets and models with the realities of the current situation begins during the response phase and models/datasets are used iteratively, incorporating real time event data for models that were run prior to landfall (Appendix D).

Whether an advanced or no-notice event, the use of models and datasets is an iterative process. Initial runs of event characterization and consequence models are refined as additional raw data and situational awareness become available in the response phase. This iteration may be especially critical as the event moves into the second and third days and efforts increasingly focus on "What needs to be done?" and on deploying and sustaining response operations at the appropriate levels. These decisions often need to be made on the basis of limited real-time assessment data, and the combination of predictive modeling and assessment data can provide a much better understanding of the current conditions that either independently.

## Phase 3. Recovery

An increased reliance on ESF-specific tools is likely as the response phase continues and transitions to the recovery phases. Most decision support tools and mission-specific requirement data are ESF-specific. As highlighted in the section on Phase 1a: Normal Operations and for individual hazards in Appendix C-E, users will identify, train on, and exercise with these models/datasets during normal operations so they can be used effectively during a real event. The MoDI continues to serve as a centralized resource to identify additional models and datasets as unanticipated data requirements newly arise during the recovery phase. As in previous phases, the MoDI provides a quick reference for technical and real-time contacts and for RFI submissions.

# Appendix A: Adaptation of emergency management phases

## Simplified phases of emergency management used in the MoDI

The phases of emergency management used in the MoDI are simplified from the eight phases described in the Response Federal Interagency Operational Plan (FIOP),[4] into six: Planning, Pre-event Preparedness, Immediate Response, Deployment, Sustained Response, and Recovery. Using only six phases captures the most important information about how the use of models and datasets differs across phases while keeping the overall classification system as simple as possible. Figure A1 illustrates how these six phases correspond to the eight FIOP phases.

[4] Response Federal Interagency Operational Plan (Department of Homeland Security, 2014)

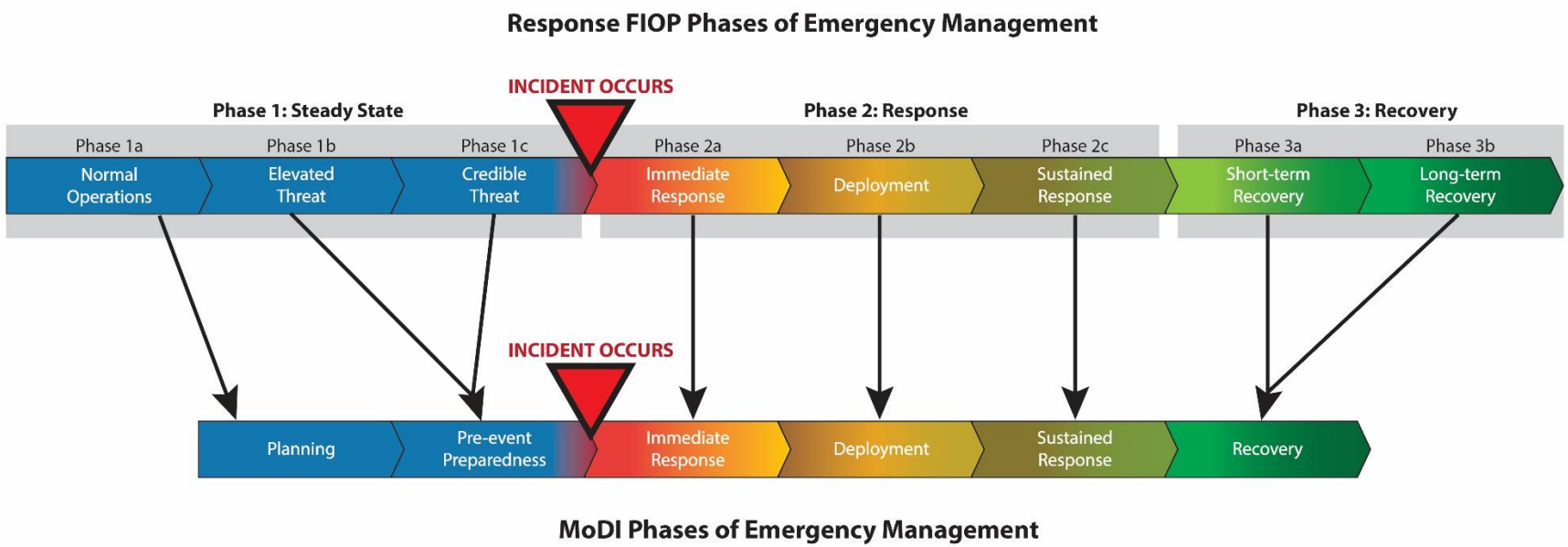


**Figure A1. Phases of emergency management as described in the Response FIOP (top) and as used in the MoDI (bottom).** Planning corresponds to 1a: Normal Operations, and is called Planning to emphasize that the MoDI is used for planning during this period. Pre-event Preparedness corresponds to 1b: Elevated Threat and 1c: Credible Threat to capture that activities in these phases concern preparations for a specific impending hazard. The Immediate Response, Deployment, and Sustained Response phases correspond to the Response FIOP phases by the same names. The Recovery phase corresponds to 3a: Short-term Recovery and 3b: Long-term Recovery.