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Introduction

“9-1-1, what is your emergency?” This simple question is asked countless times daily by call takers and dispatchers in Public Safety Answering Points (PSAPs) across the nation. It is the first question that leads to a cascading series of operational decisions by our emergency responders. Floods are the most common natural disaster in the United States and are only increasing in frequency, magnitude, and cost as a result of ever-changing weather patterns and increasing development. When a flood occurs, first responders and operators must make life and death decisions under considerable time constraints.

The problem public safety officials often face when making difficult decisions is not about data — rather, it is about how data becomes actionable information that changes the outcomes for survivors. A lack of reliable, timely, and accessible information often hinders the speed and effectiveness of these critical decisions, especially in locales with limited historical knowledge or experience with flooding.

NAPSG Foundation worked with first responders across the country to develop this national flood preparedness guideline to help the public safety community prepare, respond, and recover from flood disasters. The guideline includes key challenges often faced by flood-prone communities and key workflows, including the information needs, of first responders to help Geographic Information Systems (GIS) support staff compile and deliver critical information at the right time to support data driven decision making. There are three parts to this guideline:

Part One: Key Challenges in Flood-Prone Communities. This section is targeted at first responders and operators responsible for flood preparedness in their communities. Six themes are discussed based on findings from three regional workshops across the US. You will find links to supporting documents for more research, as well as recommendations on how using GIS can help address these challenges.

Part Two: Priority Information Needs. The second section is designed for GIS/IT support staff working with first responders and operators. It provides a “cookbook” of the key workflows and information needs of first responders based on priority and timing. This section discusses common data needs, provides example sources, and identifies additional technical resources to help support staff implement solutions that deliver the timely and reliable information needed to support preparedness for, response to, and recovery from a flood.

Part Three: Workshop Facilitation. To replicate the methods that the authors of this guideline used to derive key challenges and priority information needs in a community or region, the appendix provides workshop facilitation tips that were used in the development of this guideline. These materials are meant to help organizations host their own workshops, document key challenges, and prioritize critical information needs specific to their locations. While this guideline is focused on flooding, the methodology provided is applicable to all hazards.

Using this guideline provides a starting point for discussions on common challenges related to flooding, and it is a jumpstart on assembling the right information needs to support critical decision-making before the next event occurs. Each organization and location will have specific needs; utilize this guideline as an initial starting point and refine the needs and information requirements based on local expertise.
Part One: Key Challenges in Flood-Prone Communities

To help communities better prepare for floods, the NAPSG Foundation hosted three one-day, regional workshops in Baton Rouge, LA, Austin, TX, and Des Moines, IA, to identify, document, and prioritize the critical decision points of the first responder community during flood disasters. Recent flooding events in each of these regions provided opportunities to reflect on the critical decisions that were made in difficult circumstances.

Over the course of the workshops, several themes or challenges emerged in the discussion. These themes provide key insights on the challenges that all organizations should address as part of flood preparedness efforts. Each theme is discussed and supporting documents are provided for more in-depth research. Each theme also includes recommendations on how the use of location-enabled technology, like GIS, can help address these challenges.

This section is written for first responders and operators working in state government, local government, and tribal territories. It highlights common challenges that should be addressed during preparation for a flood event.

Chapter 1: Improved Alerting and Warning
Chapter 2: Resource Management and Coordination
Chapter 3: Faster Information Delivery to Decision Makers
Chapter 4: Increased Trust and Confidence in Data
Chapter 5: Common Reference Grid for Operations
Chapter 6: Information Overload
Chapter 1: Improved Alerting and Warning

People will often ignore or disregard alerts that could potentially save their lives. When alerts are not targeted at a specific population, or when they lack wording that makes the case for immediate action, citizens are less likely to take protective action. In addition, people who are traveling through areas or visiting unfamiliar places that have a significant flood risk may not act on alerts because they are unaware of the risks in this environment. Travelers often have the mindset that the alert is not specific to their location – they think it must be for someone else in a different location.

The challenges associated with targeting a specific population with actionable alert messaging highlight the need to improve geo-targeting and the need to make messages understandable to the general public. Geo-targeting refers to the use of location to avoid alerting large geographic areas, such as an entire county or community, to avoid over-alerting the population. The more frequent the alert, the more likely a person is to disable or ignore the alert – especially when it is not geographically accurate in the first place. In addition, alerts and warnings should contain actionable directions written in common language, and include common symbology, so that recipients are more likely to understand the severity and need to act on the alert.

Key Takeaways:

- Craft your action messages in advance, following recommended conventions. This means longer messages that follow the order: message source, hazard type, hazard location, hazard timing, protective action to take. If possible, indicate whether the recipient of the message has been geotargeted.
- Register with IPAWS system and take courses from EMI to learn how to integrate it into your operations. Consider how to partner with the NWS to help distribute local alerts and warnings.
- Explore how social media can augment your alerting system and crisis communications during a disaster. Consider it a two-way communication stream and dedicate resources to manage this.
- Use geofencing to better target resources and alerts and work with your GIS staff to do so. Work with your local vendors to ensure they can support geofencing in their software.
Challenges in Hazard Communications

In recent years, push notifications to cellular devices have become an increasingly important part of emergency alerts and warnings for all kinds of disasters. How to make these messages the most effective is of the utmost concern to emergency managers, since their ability to prompt action from those at risk can save lives. Common challenges faced by the first responder community include the following issues with existing alert systems, particularly in the case of flooding: message fatigue, accuracy of geotargeting, and alert clarity.

A common need expressed by the first responder community is the need for alerts that more accurately target a location where the population is at risk. Rather than alerting an entire county or community, a common practice in weather events, warnings need to be more accurately aligned with the impending threat location to avoid over-alerting civilians who are not in harm’s way. Unnecessary alerting can cause “alert fatigue” and lead to civilians ignoring the advice of the warning, both in the short term during the event as well as over the long term for future events. In addition to alerting the correct population, the warning language needs to be more actionable and include visual tools like symbology or maps and graphics to increase the rate at which recipients take protective actions.

Alerting the Community: Geofencing

A recent study of alert warnings in the Lower Colorado River Authority (LCRA) demonstrated that geofencing through a mobile application is a low-cost and effective way for local emergency departments to target their own warnings and other hazard information. Ping4, a software company, maintains an inexpensive, localized, electronic alerting platform through which emergency operators and first responders can create a custom geofence that reflects the scope of a disaster and target services and warnings to people within that area. Applications, like Flood Alerts from Ping4, use sensor data to dynamically generate a geographic shape of an affected area that is unique to a disaster. The geographic shape and extent of the disaster may cross any number of jurisdictional boundaries and is much more precise than census-designated geographies. Data from the sensors are processed through a rules engine, which decides whether to send alerts to citizens or responders within that area. The geographic precision of Flood Alerts reduces superfluous warnings and alert fatigue among citizens, which is designed to increase the probability that citizens in danger take appropriate action.

Geographic Information Systems (GIS) can be used by public safety agencies to perform similar functions. Agencies can integrate their own sensor network (flood sensor, cameras, etc.) with GIS to help monitor a weather event. By linking information from sensors into a GIS map, public safety officials can gain better situational awareness of the event with a more precise understanding to where the community is at risk. If a locality does not have gauges or a sensor system that alerts a specific geographic area automatically, agencies can still create custom geographies within GIS that reflect known at-risk areas or physical landmarks that are often impacted by flooding events, using flood plain

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maps or historical flood data as a starting point. These custom hazard area polygons can help public
safety operators and first responders more accurately alert the population at risk rather than relying on
traditional geographic boundaries from the US Census, such as county or city limits. Similar to the Ping4
application, using GIS to model the local environment can help first responders issue disaster warnings
that are much more geo-targeted and effective at reaching those in immediate danger.

**Warning Language**

Recent research on emergency alerting and warning systems corroborates the need to improve message
design to increase clarity and effectiveness. A working group at the National Academy of Sciences (NAS)
dedicated to disaster warning systems held a workshop in 2013 regarding how to effectively geo-target
alerts and warnings. Similarly, the U.S. Department of Homeland Security’s (DHS) National Consortium
for the Study of Terrorism and Responses to Terrorism (START) program, housed at the University of
Maryland, is studying the effectiveness of emergency warnings and alerts, including whether geo-
targeting can motivate potential victims to take protective action.

At the National Academy’s 2013 workshop, Michele Wood, California State University professor of
communications, explained that to prompt the appropriate actions, recipients must understand the
message and how it applies to them before they decide whether to act, a process she terms “sense-
making.” Research by the Department of Homeland Security’s START program shows that how
information is ordered in an alert is critical to this “sense-making” as well, although this order also
depends on the message length. In its study of the effectiveness of 280-character message, the
maximum that can currently be displayed on most smart phone screens, the most optimal design was to
first list the message source, followed by the hazard type, location of the hazard, time of the hazard,
and, finally, guidance on what action to take. When limited to 90- and 140-character messages, the
study shows that maps can improve understanding. Including maps and graphics generated by GIS is an
effective way to communicating when text is at a premium. Longer text, like the 280-character
messages studied, benefit from additional space to accurately describe the warning.

The length of an alert message remains a challenge. According to the Department of Homeland Security,
1,380-character messages remain the most effective, especially in overcoming “people’s pre-alert and
warning event perceptions of different hazards based on personal experience, and perceived risk and
knowledge, which may or may not match the event they face.” Longer messages remain the most

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effective for encouraging people to take protective action during disasters when people often underestimate the risk, such as flash flooding.

In studies, DHS found evidence that people respond differently to warning messages depending on the type of hazard. For instance, compared with tsunamis, when people received warnings about flash flood events, recipients had “significantly lower levels of message belief and personalization.” ¹ The fact that people do not treat all hazards equally is reflected in the specific campaign by the National Weather Service, Turn Around Don’t Drown, to improve awareness of flash floods.¹⁰ Messages about tornados and flash floods were more likely to be misunderstood by the public. The unique characteristics of a flash flood is an important issue faced by the first responder community when alerting the public. It is difficult for first responders to predict the timing and severity of flash floods, which makes alerting both critical to life safety and difficult at the same time. In addition, residents often doubt the credibility of flash-flood messages since they may not see any physical signs of the hazard around them until it is too late.

Call to action:
Create your public alert messages in advance. For systems that limit character length in outbound messages, provide immediate and actionable information with links for more details. Longer formats remain effective and can be used in some systems like social media or on websites. For all messages, list the message source first, followed by the hazard type, location of the hazard, time of the hazard, and guidance on what action to take. Also consider how you work with local media outlets to broadcast your message to the public. Including local news meteorologists in your Emergency Operations Center (EOC) is a good way to connect with the media and build a relationship to support coordinated messaging.

Knowing whether a message has been geo-targeted to the recipient is a critical aspect of convincing a person to act. If a recipient thinks the disaster warning applies to where they are located at that moment, they are more likely to take protective action. However, according to Michele Wood, communicating that a message has been geo-targeted is difficult to do within the message itself. As discussed, messages must be short to keep the message digestible and clear, but simply saying “this area” is a target of the disaster is ineffective. Recipients do not know from such a statement whether they have been singled out to receive the message. However, other descriptions of the hazard location can be too long or inaccurate, such as listing affected counties in the warning area, describing its scope using physical boundaries like roads (which non-locals are not likely to understand), or displaying maps which some people find hard to quickly read and understand.¹¹ Alerting agencies can work in advance of

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a disaster to educate and train the local public about the alerts that are issued. Specifically, that alerts are being geo-targeted and issued to save lives.

The Potential of Social Media

In addition to message design, there are mixed views on how to properly incorporate social media into alert warning systems in the public safety community. While online communities like Facebook, Twitter and LinkedIn are able to broadcast hazard information to a wide viewership quickly, these tools do not target the information to those who need it most based on location, and they have the potential to produce misinformation very quickly as messages are modified by users and passed among their individual networks. But using social media is not just about broadcasting your message, it also is a tool for listening to the community and gathering additional situational awareness of an event in the community.

Research shows that social media is becoming increasingly geographic, and geotagged social media content can easily be integrated into GIS as a data layer for additional situational awareness. One example is the Public Information Map template in ArcGIS Online, managed by Esri. Numerous software programs have been developed to sort through social media posts and identify those relevant to a disaster (see Chapter 6: Information Overload) before mapping them. Further, in a 2015 study of crisis communications, DHS noted that social media has the potential to support traditional alerting systems because it is a form of network communication and allows civilians to communicate with one another and with government agencies in near real-time. To improve the data quality of social media, DHS recommends that it be developed as a “science gateway” or portal with clearly defined tools, data, and applications that would “allow EMA personnel to supervise the sharing of risk information publicly in a streamlined, consistent manner.” Consider how you broadcast geotagged content to the community and how you gather geotagged content into your operations. By also setting up lists of known, or trusted, users in your own network, you can more effectively leverage the social network to communicate accurate details into the community.


FEMA created the IPAWS system in 2012 in an effort to modernize and streamline risk communications. It integrated several streams of alert messaging into one interface to increase coordination among alerting campaigns, reduce messaging and alert redundancy, and improve the clarity of public messages, especially regarding what actions civilians should take. IPAWS enables government authorities to use

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13 Esri. Public Information Map. [https://www.arcgis.com/home/item.html?id=c74acddcb1844eb90f8f9d40be2c823](https://www.arcgis.com/home/item.html?id=c74acddcb1844eb90f8f9d40be2c823)


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the Emergency Alert System (EAS), Wireless Emergency Alerts (WEA) and the National Oceanic and Atmospheric Administration (NOAA) Weather Radio alerting systems all from one interface. Currently, 821 alerting authorities have adopted the IPAWS system, and another 279 are in the process of doing so. Alerting authorities at all levels of government are encouraged to use the IPAWS system and integrate their local systems into the IPAWS infrastructure. As long as a local system uses FEMA’s Common Alerting Protocol (CAP) standards, it can be easily integrated into IPAWS. Training in how to participate in the program can be found through FEMA’s Educational Management Institute (EMI):


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Flooding can affect large geographic areas leading to complex resource management challenges. First responders and operators who manage resources are challenged with how to improve the processes for identifying needed resources, requesting resources from other jurisdictions, and sharing their own resources with other departments and jurisdictions. Resource management tools that accurately estimate resource availability and facilitate communication between agencies, especially if they can do so in real-time, can help operators better leverage their resources and respond more effectively to disasters.

Key Takeaways:

- Review and implement NIMS protocols and procedures for resource documentation and management. Build Mission Ready Packages to fully understand the supporting factors for a resource to sustain it over the duration of an event.
- Consider utilizing a system like IAFC’s Mutual Aid Net, or EMAC’s MASS resource management system, and utilize IRIS and the RTLT from FEMA to manage, request and offer resources in the community. These tools provide the mechanisms and tracking needed to effectively manage resources.
- Design a resource management dashboard to help operationalize your resources in relation to current event data. These dashboards should provide you metric tracking for your resources in addition to basic situational awareness data for the event. Build these in advance and exercise using them for daily or small events.
Existing Federal Systems

The Federal Emergency Management Agency (FEMA) currently provides guidance to local and state governments under the Emergency Management Assistance Compact (EMAC) regarding how to track resources so that requests for support from other Resource Providers is quick and efficient. EMAC governs the nation’s state-to-state mutual aid system, whereby states share resources during a disaster. EMAC provides agencies with the ability to build Mission Ready Packages (MRPs), templates that include standardized language and organizational tools, to help agencies categorize and identify commodities, personnel and equipment. FEMA also addresses resource management through its National Incident Management System (NIMS), a comprehensive approach for how to structure incident command systems. NIMS is meant to standardize operational structures and actions to facilitate cooperation between public and private entities during disasters. Regarding resource management, NIMS delineates what resources are required for different disasters and how they are to be ordered, reported, and mobilized. To help agencies follow these standards, FEMA created the Incident Resource Inventory System (IRIS), a software tool that “allows users to identify & inventory their resources, consistently with NIMS resource typing definitions, for mutual aid operations.” For more information on these federal systems, see:

- EMAC: [https://www.emacweb.org/](https://www.emacweb.org/)
- MRPs: [https://www.emacweb.org/training/mrp_excel/index.html](https://www.emacweb.org/training/mrp_excel/index.html)
- IRIS: [https://rtlt.preptoolkit.fema.gov/Public/Home/LinksTools](https://rtlt.preptoolkit.fema.gov/Public/Home/LinksTools)

NIMS is a set of concepts and principles that govern communications and information management. GIS is well positioned to be the system through which NIMS resource management principles and protocols are implemented. FEMA wants agencies to maintain resource inventories that are adaptable, scalable and interoperable.

GIS provides data management capabilities which meet all of these standards, and it also has functionality that enables users to analyze the relationships between resources and many other variables in a disaster and supports disaster response operations. During every phase of a disaster, the locations of resources are critical to decision-making. Location information, such as proximity to certain populations, infrastructure, or hazards, is a deciding factor in whether to deploy resources or where resources should come from when making a request. Location information is best stored in GIS, where it can be used as an organizing principle when performing analysis. Not only do maps quickly and clearly visualize operational information, they allow the user to query data based on location quickly and accurately. Questions, such as how many civilians are within the reach of different assets, what routes are available for transporting resources, or what staging locations are available, can be answered most accurately and in the least amount of time by GIS.

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19 Ibid.
Privately Run Mutual Aid Systems

MutualAidNet is a free web tool created in 2008 by the International Association of Fire Chiefs (IAFC) to improve the efficiency and effectiveness of the fire mutual aid program under the Emergency Management Assistance Compact (EMAC). It currently used by 18 states to primarily manage fire and EMS resources. MutualAidNet empowers emergency management departments to inventory and track assets across jurisdictions, as well as request and deploy resources across departments during a disaster. Using geographic information systems (GIS), MutualAidNet helps users determine the nearest appropriate resources so they can be efficiently deployed across jurisdictional boundaries. Users can access other critical details, such as the estimated time of staging, distance from the incident, current availability, and contact information. Because it is web-based, first responders and operators can use the system in the field to help make real-time decisions based on current resource needs and availability. Resources are automatically deducted from the inventory when they are deployed, so the list of available assets remains current. MutualAidNet also allows operations managers to perform actions beyond resource requests, such as creating special task forces and activating exercises. The system also generates reports regarding what resources were used during a disaster, documentation which is helpful during the recovery phase and reimbursement process. 20

Resource Management Dashboards

Emergency management departments may want to consider creating their own custom resource management dashboard to help operators and first responders make more informed decisions. A dashboard refers broadly to a visual display designed to deliver actionable information quickly and clearly to decision-makers within an organization. It is a single location of applications, widgets, and data that regularly report only the most useful and relevant information to decision makers. Dashboards are completely customizable and are an effective way of integrating geospatial information to enhance decision-making. For public safety purposes, dashboards are well-suited to managing resources since data on resource availability needs to be regularly updated and referred to by operators and responders. For resource management, a dashboard can be designed to track equipment, personnel and conditions, all by location, so operators can quickly see what resources should be deployed to what locations/sites. It can be used during all phases of a disaster: during preparedness, a dashboard can support readiness exercises, during response it can help operators make resource allocation decisions based on current conditions and potential impact, and in the wake of disaster it can track service provision.

Based on research by the National Alliance for Public Safety GIS (NAPSG) Foundation, an effective resource management dashboard should be capable of providing the following information that may be contained within resource management systems:

- **Event description**: type, complexity, extent, and general location.
- **Event forecast/magnitude and prediction** of direct and indirect impacts to communities.


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• **Demographic trends:** population, number of households, primary languages spoken, socio-economic/income brackets, populations with access or functional needs, transportation dependencies, and analysis of commodity and support service requirements.

• **Critical infrastructure impacts** community lifelines such as transportation infrastructure, electricity, communications, health systems, etc.

• **Mission/mobilization requests** details regarding response area timing and staging.

• **Resource kind** This information should be consistent with NIMS resource typing definitions.

• **Resource status/availability** response availability of a given resource and for what type/level of mutual aid.

• **Deployment time** how long it will be until the resource arrives at staging and can be employed in operations.

• **Resource cost:** Estimated cost of a resource and identification of “responsible party” with fiscal obligation to pay for the resource, searches Mutual aid agreements that involve direct payment.

• **Home and Present Locations** The resource’s home location and present location.

• **Contact and Owner Information** Point of contact for the resource as well as ownership information.

• **Time/Date stamp** for last update of the resource attributes.

In addition to providing this information, a resource management dashboard should have functionality that allows users to analyze data. A dashboard should enable a resource manager to search mission and resource requests, compare resource needs with their availability, and search resources by capability, capacity and community of practice. Visualizing these data as much as possible will enable decision makers to analyze resources based on their proximity to important locations, such as the location of victims and staging areas. A resource dashboard should therefore allow decision makers to view a map of resource locations and availability. Situational awareness information should be viewable based on the phase of a disaster. A good dashboard would alert users to important situational awareness information or nearby mission requests. Finally, a dashboard should be linked with official documentation or processes required to officially initiate mutual aid requests and other actions.

### Spotlight: EMAC Mutual Aid Support System (MASS)

The Emergency Management Assistance Compact (EMAC) provides users with tools to aid in response to governor-declared states of emergency or disaster. EMAC’s Mutual Aid Support System (MASS) provides an interactive dashboard for finding and requesting resources. Users of MASS also have access to common situational awareness data for additional context.
Chapter 3: Faster Information Delivery to Decision Makers

During a flash flood event, information delays put lives at risk. Decreasing the time information takes to arrive in a decision maker’s hands is vital to saving lives. Predictive modeling, integrated sensors with known triggers, and pre-planned information products can inform timely decision-making.

Key Takeaways:

• Understand your flooding risk and the potential impact of floods on your community using modeling tools like HAZUS. When the event happens, put the scenarios into action to expedite your response. Build expertise in these more advanced tools before an event occurs, and strive to replace national datasets provided by HAZUS with locally sourced data. These data are typically more accurate and current, and they will provide better results.

• Integrate data from National Water Model into GIS and operations for more actionable alerts. Learn how the new model can help with alerts for streams near your location, and find the point of contact for your area to train and exercise.

• Work with partners (USGS, NOAA, etc.) to increase local sensor networks. Consider investing in new low-cost sensor systems where appropriate to speed up the alerting in critical areas. These sensors can help you identify needed actions in common data “blind-spots” – areas where more formal and expensive sensors do not exist.

• Develop known trigger points of when to take action, and integrate these trigger points into GIS and other protocols. Many times, you know where to look for common signs that lead you to take action before data indicates it is necessary. Work with your staff to transition this knowledge into data that can help “trigger” actions more quickly in the absence of sensors and data.
Predictive Modeling: HAZUS

The Federal Emergency Management Agency (FEMA) provides guidance to state and local authorities regarding how to estimate potential losses from natural disasters. HAZUS is a free GIS modeling tool used for estimating potential impact and damage from floods, hurricanes and earthquakes using the latest in scientific knowledge. HAZUS has been used by FEMA for many years. It continues to be refined and is updated often.\(^2\) It should be noted that HAZUS requires GIS expertise and specialized training on the use of the package. It also utilizes national level data which are often less accurate, and less up-to-date than locally available data. Where possible, utilize local data first to achieve the best outcomes, and use national data as a backup if needed. Using local data that is current and accurate is the key to generating the best results from HAZUS models.

Using HAZUS, jurisdictions can create a realistic picture of the damage they will need to address after a disaster, including:

- Physical damage to residential and commercial buildings, schools, critical facilities, and infrastructure;
- Economic loss, including lost jobs, business interruptions, repair and reconstruction costs; and
- Social impacts, including estimates of shelter requirements, displaced households, and population exposed to scenario floods, earthquakes and hurricanes.\(^2\)

Predictive Modeling: National Water Model

In August of 2016, the National Ocean and Atmospheric Administration (NOAA) released a flood forecasting tool which reportedly represents the largest advancement in flood prediction modeling in the country’s history.\(^3\) Called the National Water Model, it is run on a Cray XC40 supercomputer and analyzes data from over 8,000 U.S. Geological Survey (USGS) gauges across the country. The model can simulate conditions for more than 2.7 million locations across the country’s river network, and creates forecasts for the entire network every hour. Before the National Water Model, NOAA could only predict conditions for approximately 4,000 locations every few hours.\(^4\)

There are numerous ways emergency managers and agencies can use this information to better prepare for and respond to floods. Data from The National Water model can be used by states and localities across the nation to monitor potential flood event forecasts both in the short-range (0-15 hours) and long-range...

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(0-30 days) time periods. This provides much more targeted stream forecasting and supports more actionable decisions at the local level.

Challenges of Flash Flooding

Unlike fluvial or coastal flooding, flash flooding is characterized by its sudden onset, sometimes in places with no other signs of a weather event. Flash flooding is the product of rising waters in a location with impermeable ground surfaces, or fully saturated soils, which produce runoff because the ground cannot absorb the excess water. Urban environments are particularly at risk for flash flooding due to the prevalence of concrete and other impermeable building materials. This runoff water then moves quickly across a landscape, building momentum, and sweeping up cars, civilians, and structures in its path. A flash flood can travel a long distance, impacting locales far from the original source of excess water. Irregular or hilly topography can exacerbate the movement of excess runoff, making flash floods stronger and more dangerous. Out of 522 deaths in 2015, the latest update of the Summary of Natural Hazard Statistics from the National Weather Service\(^{25}\), 129 of those were due to flash flooding — the most of any hazard reported.

Because flash floods are the result of favorable meteorologic and hydrologic conditions, they can pose technical challenges that are often beyond the scope of existing tools and systems. The American Meteorological Society explains that “gaps exist in hydrometeorological research/technological approaches,” and that research into hydrologic models that properly model runoff, soil moisture, hydrologic response of urban areas needs to be conducted. Furthermore, the Society says that the impact of spatial scales of soil moisture is an area of essential importance to understanding flash flooding and that “data requirements for conducting the research and developing predictive models necessitates the utilization of geographic information systems for specifying catchment geometrical properties pertinent to surface runoff development.” The Society concludes that flash flooding patterns are so particular to local

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environments that “fundamental uncertainties are inherent in any attempt to forecast these events.”

Common variables that influence flash flood forecasting include:

- knowing how much water runs off (as well as where it runs to)
- how strong the stream is flowing
- how wide an area is getting rain
- how hard and fast it is raining
- how long it has been raining in a particular drainage basin
- where the storm is located and how it fast or slow it is moving
- how porous the soil is and how much water it already holds
- the amount of vegetation covering the soil
- how much surface is paved
- whether there are storm drains or closely spaced buildings
- the general geography and slope of the land

Given the limitations of current flash flooding research and technology, localities which face flash flooding should make every effort to document local knowledge of flash flooding patterns, dynamics, topography, and elevation patterns to disseminate among staff, and integrate it into operational protocols. Because there is often little time to issue alerts based on sensors and models, having these pre-determined actions in place is critical.

Emergency managers often rely on informal means to understand and respond to flash flooding—for instance, when a certain creek reaches a certain level they know that there will be flash flooding consequences in another location—and rely upon certain personal connections to initiate operational responses. The American Meteorological Society also provides guidance on what they consider essential components of a flash flood warning system: Preparedness programs with citizen involvement; Rainfall-observing systems; Electronic data communication systems; Diagnostic/predictive models; Model calibration procedures; Warning dissemination systems; and action plans for local civil authorities.

Flash Flooding: Develop Trigger Points

One effective way to address the unpredictable nature of flash flooding is to integrate known “trigger points,” or known thresholds, into a location-enabled GIS system or dashboard. While this approach is applicable to all types of flooding, the nature of flash flooding makes this approach critical to early warning and action needed to save lives in flash flood prone areas. Locally understood thresholds, or “trigger” points, such as when a particular creek reaches a certain level or when rain fall is concentrated in an area known to have low soil moisture absorption, or when a sensor shows a certain alert, should be discussed

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28 Ibid.
and documented as events which will trigger certain response actions. By incorporating trigger points into the emergency operation center’s workflow and integrating them into the organization’s applications, emergency managers and first responders use their best information—which especially in the case of flash flooding, is historical knowledge/experience—to predict the course of flooding. Where possible, sensor technology or gauges can be used to help alert that a trigger point has been reached. But technological changes need not be required; a first step is to center the planning process for flood response around locally recognized early indicators.

Mapping the location of trigger points and incorporating them into mapping applications will make the most of this local wisdom. Mapping applications will help emergency responders analyze the broader impacts of trigger points as well as help model their role in disaster scenarios. By locating and mapping the known trigger points in context with other data, emergency response personnel will be able to better prepare for an event’s potential impact on nearby populations, infrastructure, and environment. Loading trigger points into GIS maps and applications will also automate workflows and protocols in the event of a disaster, to help ensure that proper steps are taken and to help notify all necessary parties, which may be decentralized and working in the field.

**Spotlight: City of Boulder**

The City of Boulder (CO) created the, “Flood Emergency Handbook” to document standard operating procedures. This includes “trigger” points for gauges, what the trigger means for the city, and when to expect water rise downstream. The Handbook also includes “Watch Points” that document locations with known issues – like debris dams – to focus monitoring efforts.

**Trigger Points: Educating the Community on Early Warning Signs**

Another way to integrate known trigger points into your response protocols is to create a community education program centered around them. Communities that are at particular risk in a given flood disaster scenario could be targeted for educational programming that would teach them how a flood event could impact their area and what actions to take. Emergency managers could draft emergency protocols for specific communities—catered to their particular geography and flooding type—and educate residents on their flood risk and different scenarios. Any known trigger points, such as when a certain creek rises to a particular level, should be included in the protocol, with specific and clear ways that residents can observe early warning signs and instructions on what to do. GIS provides communities a way to analyze and understand where populations are most at-risk and the characteristics of that population. Developing this knowledge in advance can help communities more effectively target and educate citizens.
Similar to fire emergency protocols in office buildings, agencies can create community hazard groups for civilians in flood zones to help them protect themselves in a disaster scenario. All members could sign on to an action plan that goes into effect given a certain trigger point, and designated leaders could initiate the action plan. A hazard group could use any number of tools or applications based on GIS to rapidly communicate with each other with warnings and alerts if a trigger point is reached. Similar to a building fire marshal, leaders could also account for all members of the group in a disaster. The group could also help emergency managers by reporting to authorities if trigger points are reached as well as whether any of their members are known to be in danger. Finally, research by DHS shows that individuals are more likely to act when those in their social network do too. When they receive alerts from emergency authorities, people check with family and friends before they take action. Putting information directly into the hands of communities at risk, and bringing them together as a group, will empower them to act more decisively when disaster hits.

### Spotlight: City of Austin

The City of Austin maintains a listing of known lower-water crossings and common locations that “trigger” actions when activated. This data evolved into what is known as the ATXfloods website to help alert the community to flash flood hazards.

### Flash Flooding: Using Low Cost Sensors

For many local jurisdictions, the cost of installing, maintaining, and operating traditional sensors is prohibitive. Working with partners like the USGS, NOAA, and others to jointly build out the sensor network is a common approach. However, innovation in sensor technology – specifically smaller and lower costs sensors – increasingly provides jurisdictions alternatives to fill the gaps in traditional sensor networks. Small Business Research Initiative from DHS Science & Technology (S&T) is funding programs to design and test low-cost sensors designed specifically for flash flooding. The DHS S&T First Responders Group is partnering with the Lower Colorado River Authority (LCRA) to perform the research and development necessary to build out a sensor system which can monitor and evaluate rapidly rising flood waters. LCRA will provide to sensor suppliers the inputs needed to develop production-ready sensor devices, and then these devices will be used and tested by LCRA to develop the software needed to manage the sensor system. This allows for the placement of sensors along normally dry stream beds that are prone to flash flooding at a low cost to increase the density of alerting along high-risk areas.

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Chapter 4: Increased Trust and Confidence in Data

As the use of modeling, sensors, and supporting information increases, there is a need to increase decision maker’s trust and confidence in the information relied upon for action. This can be achieved through training and exercising the use of new data, tools, and applications, as well as by including and maintaining accurate metadata on these data. For models and forecast outputs, confidence levels should be conveyed using natural language, and forecast models should include probabilities that help decision makers know when to act. Data should be used in everyday workflows as often as possible, and incorporated into exercises and training events, to provide users more familiarity with the data, attributes, and limitations before an event occurs. Creating good data takes time and effort – both in the short- and long-term – to be successful.

Key Takeaways:

- Include the use of location-enabled decision support tools into your exercises to test data assumptions, tools and solutions, and how effective they are at helping achieve data-driven decision-making.
- Review your after-action reports (AARs) with an eye toward data needs, and perform post-event analysis to determine both data and analytical gaps that can be addressed before the next event. Include your GIS/IT staff in AARs.
- When using data feeds from outside providers, refer to the metadata, including time stamps and confidence levels, when making critical decisions. Provide the same for your internal, locally-sourced data and information products to support critical decisions.
- Regularly maintain sensor systems to ensure they are operational and test their integration into decision-making products like maps, apps and business systems.
- Communicate critical information using natural language where possible so there is less confusion on what the data indicate.
Exercise and After-Action Analysis

Public safety agencies should consider using exercises to increase confidence in field information and data. Exercises can highlight decision points within a scenario where information may or may not be very reliable and help a department focus on how to improve the quality of that information. Exercises can also simulate the integration of data for decision-making and test the validity and usability of the information for critical decision-making, thereby building trust and confidence in the available systems and data outside of a disaster. Including your GIS/IT staff in all exercises is essential to building good communication, trust, and knowledge of the technical capabilities and limitations of GIS before the next disasters hits.

After-action reports generated from both real-world events as well as from exercises can help emergency managers understand the decision points at which remotely sensed data may still need to be “ground-truthed,” a practice which can slow or inhibit operations. Ground-truthing may be the use of other sensors to validate incoming data and information, or the use of staff to visibly confirm what a remote sensor is indicating.

In addition to after-action reviews, post-event analysis can help agencies understand the quality of the data they received during a disaster away from the hectic cadence of the actual event. The Weather Forecast Office (WFO) of Tallahassee, Florida, analyzed storm forecasts over a 3-year period, from 2004-2007, to ascertain how accurate their predictions had been. The WFO systematically called road and highway departments, law enforcement agencies, storm spotters and utility companies after each storm season for input on whether extreme weather had occurred in the WFO warning area as forecasted. They augmented this first-hand information with additional damage assessments and created data verification statistics to evaluate their storm warning program.  

After-action reports that analyze the quality of the information first responders relied upon in a disaster can be used to generate data verification statistics. These statistics can be used in a manner similar to confidence levels – how accurate were the incoming data at showing real-world activity? This allows officials to give individual sensors and data feeds confidence levels and more effectively take action based on “trusted” data. Consider the process of exercising and implementing the results of after-action analysis an effort to identify “trust gaps,” or points in your workflow where responders and operators do not feel they can trust the information they are receiving.

Data Transparency & Interoperability

Agencies should also make data transparency and interoperability a primary goal where possible, especially in relation to sensors and alerting technology such as stream gauges, weather warnings, etc. Sharing data and any current metadata in an open and accessible way can help all users of the information better understand its value and intended use, and it can start dialogue about its quality and reliability for critical

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decision-making. Data sources that are intended to help responders make real-time decisions should be
enhanced with simple metadata like timestamps. This example of using a timestamp for the last update
period helps operators know how current the information is – a simple step that can go a long way towards
increasing its trustworthiness and usability of data for decision making. A timestamp is often critical to
understanding whether information is timely and relevant, especially in rapidly changing circumstances like
disasters. Defining the refresh interval for common data sets can also help GIS staff develop procedures
that ensure the most recent data are included in their information products. This expectation provides
guidance on how often a product should be refreshed and verified for decision makers.

Where possible, data that have associated confidence levels, such as weather predictions from the
National Weather Services (NWS), should be included with forecast information to help decision makers
know when and where to take action. As confidence levels are increased, decision makers also increase
their trust in the data source. This extra level of information empowers decision makers who often need to
make complex decisions under considerable time constraints.

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**Spotlight: State of Iowa**

The State of Iowa and the University of Iowa have created a public data portal to provide reliable and actionable flood data to the community. This data contains relevant metadata to assist with critical decision-making during a flood emergency.

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**Sensor Management**

To create confidence in the findings of remote sensing technology and avoiding needing to “ground truth”
information during a disaster, make sensor management and maintenance a central part of any
preparedness strategy. In 2016, failure of a sensor and gate system along a commonly flooded road in
Pittsburgh was blamed for the deaths of four people during a flash flood. The City of Pittsburgh did not
know that it was responsible for maintaining the sensor and gate; it had been turned over to the city in
2013 from another governmental agency and dropped from the city’s rolls during a change in
administration. This example shows how easily systems and sensors can become stagnant. It is important
that public safety agencies cooperate effectively and clearly delegate maintenance responsibilities to
ensure sensors work when they are needed. Integrating sensor data into a public safety dashboard or GIS
system will not only enhance situational awareness and operational effectiveness, but also keep this data in
a centralized database that can assist in operational continuity during staff changes before, during, and
after an event.

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32 Mandak, Joe. "Pittsburgh Mayor: City to take ownership of gate, sensor system." August 29, 2016.
https://www.apnews.com/08fc36d4500b43b7aa3c4ec0574a9884/Mayor:-City-to-take-ownership-of-gate,-sensor-system

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Communication: Natural Language

When assigning data confidence levels, it is important to use conventions that are widely practiced and understood. Avoid technical language and instead use “natural language,” the language used in ordinary, everyday speaking and writing rather than language which may not be understood by the average person. For example, in 2012 the National Weather Service revisited their use of the terms “Watch,” “Advisory,” and “Warning,” for describing winter weather events. Survey research they conducted found that many people were unsure what these terms meant and how they should act. To clarify these warnings, the NWS rephrased to longer messages like “The NWS forecasts the potential for…” or “The NWS advises caution for…” or “The NWS has issued a warning for a dangerous...”. Using everyday phrasing instead of terms that require definitions increase the chances that the NWS’s broad audience will understand the messages and act accordingly.33

Call to action:

In 2012 the National Weather Service revisited their use of the terms “Watch,” “Advisory,” and “Warning,” for describing winter weather events. Survey research they conducted found that many people were unsure what these terms meant and how they should act.

To clarify these warnings, the NWS rephrased to longer messages like “The NWS forecasts the potential for…” or “The NWS advises caution for…” or “The NWS has issued a warning for a dangerous...”. Communicate critical information using natural language where possible so that there is less confusion on what the data indicate.

First responders and operators need to use a common reference grid to effectively navigate flooded landscapes and coordinate resources, especially when a weather event impacts a large area. The US National Grid (USNG) is a point and area reference system that provides for actionable location information in a uniform format. Using USNG helps achieve consistent situational awareness during flood response and recovery efforts.

**Key Takeaways:**

- If you are new to using the US National Grid, start by learning how the USNG works, common implementation suggestions, and its benefits for public safety operations.
- Many national datasets exist for USNG at the 1,000m and 100,000m scale. However, local operations typically require USNG data at least at the 100m scale. Where data does not currently exist, follow common methods to create polygons for your location.
- Train and educate staff on the use of USNG, and integrate it into exercises. Learn how to enable your other solutions, like situational awareness viewers, with USNG data. Practice both digital and paper map navigation using USNG. This will help support response operations like Search & Rescue using a national standard.
- Consider pre-processing critical infrastructure and key locations to determine their USNG coordinates in advance. This will save you time during an actual event when needing to communicate USNG coordinates for these locations.
United States National Grid

The United States National Grid (USNG) is a standard area and point grid reference system that quickly enables multi-discipline and multi-jurisdictional emergency service agencies to precisely locate incidents and universally communicate locations using paper maps and/or electronic applications. It is recognized nationally and is used throughout many communities. The USNG is often safer to use than other systems, such as Latitude/Longitude (Lat/Lon). Lat/Lon can be communicated in multiple formats that can lead to misunderstandings. The USNG has one format that reduces the possibility for error.34

In the public safety arena, it is important to use USNG to ensure that your agencies operations are compatible with major federal agencies and industry leaders. The Federal Emergency management Agency (FEMA), the National Search and Rescue Committee (which governs all federal SAR operations), the National Geospatial Intelligence Agency (NGA) and the US Geological Survey have all adopted USNG as the primary coordinate system for their paper and electronic mapping products and systems.35

A common reference grid for operations is critical for situational awareness, particularly in large catastrophic events which cross jurisdictional boundaries and require operational support from multiple disciplines.36 NAPSG Foundation reports that “In every major event since Hurricane Andrew, after-action reports by the military, federal civilian responders as well as local responders have pointed out the need for a uniform geographic point and area reference system.”37 The US military, the assistance of which is often required during a large disaster, also uses a coordinate system that is the same as USNG. The Military Grid Reference System (MGRS) functions the same as USNG, enabling their responders and operations staff to communicate location-based information and quickly join forces with other first responders.38

USNG Jumpstart Toolbox

- Implementation Guide to the USNG
- Video on Introduction to the USNG for Public Safety
- How to Read the USNG
- USNG Grid Card Reader Template
- Guideline for Building USNG Polygons

35 Ibid.
Chapter 6: Information Overload

Operational cadence and information flows at public safety agencies dramatically increase during disasters. Information management tools are essential for the sharing, discovery, and use of data across jurisdictions. A shared portal, or hub, should be available for information management. In addition, decision makers need filtered and actionable information from these hubs, not raw data, to make critical decisions. Actionable information may include relevant data for preparedness needs, as well as real-time information during the response phase of a disaster, or even impact information needed during recovery. First responders need improved tools that distill and analyze these types of data so they are actionable.

Key Takeaways:

- Build an information hub to manage and exchange data within your organization and across partner agencies. Common platforms exist that allow you to exchange data in both public and secure ways. Leverage community best-practices and solutions where appropriate to allow for the broadest interoperability of your chosen system.
- Create mission-focused applications on top of this hub to provide decision makers critical information. Consider how you transition from massive catch-all applications, that include all your data and tools, into an environment that better serves the user.
- Targeted applications will help you avoid information overload. Part Two of this guideline provides a starting point regarding common information needs related to floods.
- Utilize standard symbology to bring clarity and common understanding across all your applications. When you begin to share information within and among partner organizations, common symbology helps to tell a clear story. A public safety symbology guideline and library are available on the NAPSG Foundation website.
Build an Information Hub

Information-sharing is vital for decision making both within and agency as well as among partner organizations during all phases of a disaster – planning, preparedness, response, recovery, and mitigation. Without access to relevant and timely information, decision makers are forced to make decisions blind and in potential conflict with other ongoing actions. Information-sharing hubs that provide both secure and public data exchange can facilitate the movement of vital information into the hands of decision makers at the right time. Many examples exist in the public safety community, such as the US Data.gov portal, the DHS Homeland Infrastructure Foundation-Level Data (HIFLD) data portal, and the commercial provider Esri’s ArcGIS Online. Each example supports the use of common, standards-based, open data exchange. Investing in a similar capability and configuring it to match your organization’s mission and structure is the first step to true data management and information exchange.

Spotlight: State of Louisiana

The Louisiana Governor’s Office of Homeland Security & Emergency Preparedness provides an Online information sharing portal for partner Organizations. This site allows users to discover and contribute data. This platform supports public and secure information-sharing.

In addition to building the information hub, consideration should be given to developing information sharing agreements where needed to ensure that data are available, and that data are used appropriately. Information sharing agreements may come in many different formats depending on the agency and data being transferred: Non-disclosure agreement (NDA), Memorandum of Understanding (MOU), or Memorandum of Agreement (MOA). The National Geospatial Advisory Committee (NGAC) provides a primer titled, “Interagency Data Sharing” which covers some of the basic considerations for sharing data among partners.

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40 Homeland Infrastructure Foundation-Level Data (HIFLD), Open Data. [https://hifld-dhs-gii.opendata.arcgis.com/](https://hifld-dhs-gii.opendata.arcgis.com/)
Configure Mission-focused Applications

On top of the information hub, mission-focused applications can be configured and built to take advantage of the data held within the hub. Applications have evolved beyond just Common Operating Pictures (COPs) that contain all data tools ever designed, into very focused and mission-specific tools for each member of the organization. Following the organizational structure of an agency, or common organizational structures outlined in the NIMS guidance, consider how to build and configure applications aligned to each member’s role. These applications can be mobile-, web-, or desktop-based. By focusing on mission-centric applications, “noise” such as the extra data layers not needed for the current mission, or the tool that is not useful for the user, are removed in order to better serve the user and avoid information overload. Part Two of this guideline provides a starting point for how to develop mission-specific applications that support flood preparedness, response, and recovery.

Utilize Standard Symbology

To increase the confidence and trust of operators and first responders in communications, it is important to use consistent and clear conventions. During fast-paced disaster response efforts, which usually use visual tools like maps, it is especially useful to adopt visual symbols for common incidents and operations. In 2009, the NAPSG Foundation identified the need for a common set of incident symbology across the public safety community. It created a working group devoted to designing standard incident symbology and created symbols for everyday incidents and response operations that would be governed by the principles of the Incident Command System (ICS) and the National Incident Management System (NIMS). The symbols NAPSG Foundation designed are categorized into three major types: pre-incident, hazard and incident command. The working group designed the symbols to communicate a hierarchy of information, to be flexible and to adapt to different map scales.

Symbology Jumpstart Toolbox

- Incident Symbology Framework & Guideline
- Technical Implementation Guidance: How to implement the guideline
- Technical User Guide: How to download and install symbols from the library

Read more about the NAPSG Foundation symbology guideline, and download symbols for use in various applications online at: https://www.napsgfoundation.org/napsg-incident-symbology-guideline-symbol-set/

44 http://solutions.arcgis.com/emergency-management/gettingstarted/
For the preparedness, response, and recovery phases of a flood disaster, workshop participants prioritized the most important information needs and key decisions of the first responder and operator community. Upon completion of the three workshops, each region’s prioritized information needs were compared and compiled to develop a list of national priority information needs for first responders. These national needs mirror the regional outcomes and provide a baseline for critical information needs during each phase of a flood disaster. The top 3 information needs for each phase are listed below.

One overarching data theme to consider is that data should always start local when possible, and the data should be collected and maintained prior to the event. The information needs below are best served by combining authoritative data from local, state, regional, and national providers and regularly maintain these connections year-round. The most current, accurate, useable data are often found at the state and local levels. While the exact sources will vary across the country, there are strategies for identifying the location these data. Some are as simple as performing a Google Search in a specific locale. Others are more complicated. Once data has been located, take time to evaluate it for currency, accuracy and usability.

If data does not exist locally, or is not readily available at the local level to support one of the solutions below, it is best to begin with nationally available data and work toward creating local data over time. Federal agencies often have many programs and offer a wide array of data products and web services which can seem overwhelming at times. Be prepared to spend a little time becoming familiar with the data offerings. While national data may be useful as a starting point, there are times that the data will not be as accurate, complete, or reliable for a community as local data would be.

When searching for local or state data, the following portals can be useful:

- National States Geographic Information Council GIS Inventory: State and Local data
- Federal Open Data Portal: Federal data, including non-geospatial formats
- Federal Geospatial Platform: Federal geospatial data
- Homeland Infrastructure Foundation-Level Data: federal level geospatial data for public safety

This section is written for the Geographic Information Systems (GIS) and Information Technology (IT) professionals. To help communities respond to flood disasters, it provides guidance on the data and technical resources these professionals are likely to need. The tables identify the core data layers needed, source information, and hyperlinks to more information for the data layer. In many instances, there is more than one possible source for specific data. By developing the solutions outlined below during normal operations, communities can be better prepared when a flood disaster arises.

Chapter 7: Preparedness
Chapter 8: Response
Chapter 9: Recovery
Chapter 7: Preparedness

1. Event Forecast

The most important preparedness information need of the first responder community is accurate event forecast information. This includes the need to define both the location, time of onset, and duration, of the weather event. A live and dynamic Weather Map that assembles relevant data feeds can help equip first responders with this information for their geographic area of interest. This map will provide the base for additional impact analysis in later preparedness tasks below. This is the first building block for many flood-related preparedness, response, and recovery actions.

Assembling current weather data in a web map can provide decision makers with current weather conditions and their predicted duration, strength, and accumulation. To create a Live Weather Map, layer the following common datasets in a web map. Follow best practices for setting symbology, transparency of the layers, and configuration of pop-ups on the data. Using a web map will then allow you to utilize configurable applications for multiple purposes tailored to the end user. This map should be “clean,” meaning it is free of other datasets that might detract from the message of the forecast and its potential impacts on the community.

Common Data Needs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Weather Radar</td>
<td>NOAA</td>
<td>Example NOAA Rest Service</td>
</tr>
<tr>
<td>Short Term Weather Warnings and Watches</td>
<td>NOAA</td>
<td>Example NOAA Rest Service</td>
</tr>
<tr>
<td>Precipitation Accumulation Estimates and Projections</td>
<td>NOAA</td>
<td>NOAA Weather Prediction Center GIS Products Website</td>
</tr>
<tr>
<td>Stream Gauges &amp; Flood Stage Monitoring</td>
<td>USGS, NOAA, State Water Office, Local Flood Control Districts,</td>
<td>Example Rest Service</td>
</tr>
<tr>
<td>Storm Surge</td>
<td>National Hurricane Center (NHC)</td>
<td>NHC Data Portal (activated for storms)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Review which storm surge product you should use and when (NHC)</td>
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</table>
Configurable Applications:

<table>
<thead>
<tr>
<th>Description</th>
<th>Operations Dashboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Esri</td>
</tr>
<tr>
<td>More Information</td>
<td>Esri Website for Operations Dashboard</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Public Information Map Template</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Esri</td>
</tr>
<tr>
<td>More Information</td>
<td>Esri Solutions Site</td>
</tr>
<tr>
<td>Example Sites:</td>
<td>New Orleans, LA, Austin, TX</td>
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<table>
<thead>
<tr>
<th>Description</th>
<th>Briefing Story Map Template</th>
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<tbody>
<tr>
<td>Source</td>
<td>Esri</td>
</tr>
<tr>
<td>More Information</td>
<td>Esri Solutions Site</td>
</tr>
</tbody>
</table>

Additional Resources:

- NOAA nowCOAST web services and mapping portal
- National Water Model Rest service

2. Projected Impact on People and Infrastructure

Analyzing data spatially will help you determine what a weather event’s potential impact is on people and infrastructure. Building on the web map above, you can add data that define areas at risk for flooding. Know what areas will be the most vulnerable to a flood disaster by first creating, or consuming, the following three layers in a map: 1) FEMA Flood Insurance Rate Map or other flood risk layer, 2) Critical Facilities and Infrastructure point data, and 3) Social Vulnerability. These layers are critical to completing a risk assessment and to ensuring that decision makers have timely information concerning the possible impacts of a flooding event.

Critical Infrastructure facilities include assets such as Police and Fire Facilities, Schools, Hospitals, Emergency Operations Center, Electric Substations, Nursing Homes, Vehicle and Equipment Storage Facility, Government Facilities, and Shelters. According to the CDC\(^{45}\), social vulnerability refers to the resilience of communities when confronted by external stresses on human health, stresses such as natural or human-caused disasters, or disease outbreaks. Specifically, where are people most at-risk the effects of disasters due to social characteristics. Through spatial analysis, use the floodplain and/or the forecast data to determine what critical facilities and vulnerable populations may be impacted. Response and recovery efforts should be focused on at-risk populations in the community. Configurable applications, like Esri’s Impact Summary Map template, can visualize a flood event and convey the impact potential to decision makers.

\(^{45}\) Center for Disease Control (CDC) Social Vulnerability Index (SVI): [https://svi.cdc.gov/](https://svi.cdc.gov/)
The Federal Emergency Management Agency (FEMA) provides guidance to state and local authorities regarding how to estimate potential losses from natural disasters. HAZUS is a free GIS modeling tool used for estimating potential impact and damage from floods, hurricanes and earthquakes using the latest in scientific knowledge. HAZUS has been used by FEMA for many years. It continues to be refined and is updated often. \(^4\) It should be noted that HAZUS requires GIS expertise and specialized training on the use of the package. It also utilizes national level data which are often less accurate, and less up-to-date than locally available data. Where possible, utilize local data first to achieve the best outcomes, and use national data as a backup if needed. Using local data that is current and accurate is the key to generating the best results from HAZUS models.

**Common Data Needs:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Flood Zones</th>
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<tbody>
<tr>
<td>Source</td>
<td>FEMA 100 and 500-year flood zones</td>
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<td>More Information</td>
<td>FEMA Rest Service</td>
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<tr>
<td></td>
<td>FEMA Flood Maps</td>
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<td></td>
<td>Example Site: Austin, TX</td>
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<table>
<thead>
<tr>
<th>Description</th>
<th>Flood Depth and Analysis Grids (Velocity, Severity)</th>
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</thead>
<tbody>
<tr>
<td>Source</td>
<td>FEMA, Local Modeling</td>
</tr>
<tr>
<td>More Information</td>
<td>FEMA Guidelines and Standards for Flood Risk Analysis and Mapping</td>
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<tr>
<td></td>
<td>FEMA Guidance for Flood Risk and Analysis and Mapping</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Description</th>
<th>Critical Infrastructure and Facilities (schools, hospitals, nursing homes, etc.)</th>
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</thead>
<tbody>
<tr>
<td>More Information</td>
<td>Rest Services for HiFLD Data from DHS</td>
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<table>
<thead>
<tr>
<th>Description</th>
<th>Social Vulnerability Data for Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Various (CDC, Univ. of South Carolina, etc.)</td>
</tr>
<tr>
<td>More Information</td>
<td>CDC Social Vulnerability</td>
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<tr>
<td></td>
<td>Example Social Vulnerability Rest Service</td>
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</table>

**Configurable Applications:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Impact Summary Map Template</th>
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</thead>
<tbody>
<tr>
<td>Source</td>
<td>Esri</td>
</tr>
<tr>
<td>More Information</td>
<td>Esri Solution Website</td>
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</tbody>
</table>


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3. Resource Assessment and Planning

Assessing resource needs and making decisions regarding how to preposition these resources will largely depend on preparedness steps one and two from above. Based on the size, location, and potential impact of a flood event, resource needs must be determined in order to properly respond and recover from a flood. The data required for resource analysis includes information on which areas are impacted, estimates of the population affected, and the type of resources that are needed versus those that are available. A resource assessment should identify the resources that are needed and the locations that need the most support.

Once you determine the potential impact of the flooding event on communities, you can then identify the areas that will need to be evacuated, where it is best to activate emergency shelters, and the approximate amount of supplies needed to support the shelter population. A social vulnerability analysis will determine factors such as the elderly and special needs population, as well as those without vehicles, which helps determine the best place for an evacuation team to operate for example. Prepare maps that identify the locations of the features mentioned in the critical facilities and vulnerable populations list, as well as flood zones, population and housing density, transportation corridors, and public transit, to understand what additional resource are required for response and recovery efforts.

The Local Government Information Model (LGIM) by ESRI provides a Public Safety Planning feature dataset that includes a Public Safety Resource feature class to catalog resources or skills that are inventoried in a system like the NIMS Incident Resource Inventory System (IRIS), in a data management system like WebEOC, or even in a simple spreadsheet. Using this model will help you identify what resources are available by category, type, address, quantity available, and include contact information and other important information.

Start by mapping resources, then progress to analyzing the number needed in partnership with your emergency management staff. Data for your resources may already exist in your local agency’s resource management system – discuss where the data are stored and how often it is updated. Learning about mutual aid and resource typing is beneficial as you start this conversation. Be prepared to determine distances between resources and areas of need, estimate transit time given the status of roadways, and be sure you can query and show resources by type. Response time can be calculated using tools like the Find Nearest and Drive Time analysis tools in ArcGIS Online if you use the web environment. Consider using the configurable apps, like the Web Application Builder from Esri, to present data to decision makers, or augment this application with a dashboard to help monitor resource levels and locations during an event.

Common Data Needs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Resource Locations and Type (Esri Local Government Information Model)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Multiple local agencies who own various resources. For example: Police Department, Public Hospital District/EMS Provider, Emergency Management Office, Fire Department, Public Works Department.</td>
</tr>
<tr>
<td>More Information</td>
<td>Example data model for mapping resources – a starting point to create data if none exists already.</td>
</tr>
</tbody>
</table>
## Configurable Applications:

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flood Planning Template</td>
<td>Esri</td>
<td>Esri Solution Website</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>My Hazard Information Template</td>
<td>Esri</td>
<td>Esri Solutions Website</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>WebApp Builder</td>
<td>Esri</td>
<td>Esri Website</td>
</tr>
</tbody>
</table>
Chapter 8: Response

1. Situational Awareness of Operations

Providing decision makers situational awareness of the current road conditions, ongoing operations, and current weather alerts is critical to response efforts. This provides decision makers an overview of the situation and supports their decision-making regarding where and when to direct resources to save lives. Your map should display where road barriers have been placed, reported high water on roads and road closures, and highlight the areas where transportation is and is not available. In the case of an evacuation, citizens will oftentimes move to a shelter either using public transportation or transportation services provided by government officials. Keeping the map current, with updated road closures and impacted areas, will ensure that people are transitioned to shelters smoothly.

In case of an evacuation, pre-planned evacuation routes should be integrated in your map. You can get this data from the state’s Department of Transportation (DOT) or your local engineering and/or emergency management department. The State and Federal DOT can provide information on major highway and interstate road conditions, such as whether they are closed, damaged, or under construction. Many State’s maintain a traveler 511 system with this information. Local street conditions will often come in via engineering or public works departments, but may also be tracked by your 911 department. Include current construction as well. To help with the manual tracking of these dynamic closures, your web map should include editable layers that can be instantly changed as updates are received, such as new high water roads and barricades. This information should be displayed in a configurable app that is user friendly, like the Public Information template from ESRI.

Your community will have a specific way to collecting and tracking this information. Take the time to define this workflow and look for ways to standardize the process so that data is collected from all relevant partners and agencies. Keeping this information current is often problematic during a dynamic situation like a flood. Meet with your local partners to develop a data creation and maintenance workflow for these data points – who will enter the data, who is responsible for updating it and when, who will have the authority to remove the data? Knowing this in advance and exercising the workflow will help you during an actual event.

Common Data Needs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Street Centerlines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>State and/or Local Department of Transportation and Engineering; 911 Districts; US Census Bureau TIGER data, Commercial Providers</td>
</tr>
<tr>
<td>More Information</td>
<td>Start with your State DOT, then consider US Census TIGER data or a commercial provider.</td>
</tr>
<tr>
<td>Example Site</td>
<td>State of Texas GIS Data Portal (TNRIS)</td>
</tr>
</tbody>
</table>

DRAFT Version 2.1
<table>
<thead>
<tr>
<th>Description</th>
<th>Road Closure &amp; Status Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>State and/or Local Department of Transportation and Engineering; National Bridge Inventory; Commercial Providers; Social Media/Citizens</td>
</tr>
</tbody>
</table>
| More Information | [Waze Citizen Traffic Reports](#)  
[LA County Road Closure Example Map](#)  
Example Site: [City of Baton Rouge (LA) Traffic Map](#) |

<table>
<thead>
<tr>
<th>Description</th>
<th>Evacuation Routes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>State and/or Local Department of Transportation and Engineering</td>
</tr>
</tbody>
</table>
| More Information | [HIFLD Data for Evacuation Routes](#)  
Example Site: [State of Florida](#); [State of Texas](#) |

<table>
<thead>
<tr>
<th>Description</th>
<th>Real-time Traffic Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>State and/or Local Department of Transportation and Engineering; Commercial Providers</td>
</tr>
<tr>
<td>More Information</td>
<td><a href="#">HERE dynamic/real-time traffic service</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Incident Command Locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Local/State/Federal Emergency Management Agencies</td>
</tr>
<tr>
<td>More Information</td>
<td><a href="#">Example data model for mapping resources</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Current Weather Radar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>NOAA</td>
</tr>
<tr>
<td>More Information</td>
<td><a href="#">Example NOAA Rest Service</a></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Short Term Weather Warnings and Watches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>NOAA</td>
</tr>
</tbody>
</table>
| More Information | [Example NOAA Rest Service](#)  
[NOAA Weather Prediction Center GIS Products Website](#) |

<table>
<thead>
<tr>
<th>Description</th>
<th>Stream Gauges &amp; Flood Stage Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>State Water Office, Local Flood Control Districts, USGS, NOAA</td>
</tr>
</tbody>
</table>
| More Information | [Example Rest Service](#)  
[Example Rest Service](#)  
[USGS Current Water Data Website](#) |

<table>
<thead>
<tr>
<th>Description</th>
<th>Storm Surge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>National Hurricane Center (NHC)</td>
</tr>
</tbody>
</table>
| More Information | [NHC Data Portal (activated for storms)](#)  
[Review which storm surge product you should use and when (NHC)](#) |
Configurable Applications:

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operations Dashboard</td>
<td>Esri</td>
<td>Esri Website for Operations Dashboard</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Information Map Template</td>
<td>Esri</td>
<td>Esri Solutions Site</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Briefing Story Map Template</td>
<td>Esri</td>
<td>Esri Solutions Site</td>
</tr>
</tbody>
</table>

2. Search and Rescue

Maps are at the core of any Search and Rescue (SAR) operation. After a catastrophic event occurs, SAR teams will begin a systematic search for individuals in the impact area. Maps provide vital information at every stage of the operation, for example the location of structures that may be destroyed, the type of structure (residential or commercial), the places where individuals are likely to be trapped, such as in basements or multi-story structures, as well as track which areas have been searched and which have not.

Use configurable apps, like Esri’s Web AppBuilder, to build an interactive application with the ability to search locations using USNG, Lat/Long, and Parcels or Address locations. For search and rescue, include a status attribute for the USNG polygons (i.e. not started, in progress, completed) to track SAR missions in the field. One of the most difficult aspects of SAR is ensuring where teams have searched and completed the process. GIS provides the tools to visually help in this assignment of SAR teams – use the USNG polygons to help in this effort.

MapSAR Online enables quick and easy web mapping for SAR operations and it provides essential data layers that are key for effective GIS integration. Research and pull in the sample service to help mapping of SAR during a response. Printed key maps with USNG grids are also useful in the field for SAR teams. By using the topographic maps provided as part of the USGS National Map program, users will be able to see the contour lines along with elevation values, as well as trails, creeks, rivers, and boundary lines. It may also be helpful to include features such as utility lines, as well as drainage structures like aqueducts.

Common Data Needs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Search Boundary, Clues, Locations, etc.</td>
<td>MapSAR (focused primarily on wilderness SAR focused, but applicable for coordination and mapping urban SAR)</td>
<td>Example Rest Service</td>
</tr>
</tbody>
</table>

47 MapSAR. [http://www.mapsar.net/](http://www.mapsar.net/)
<table>
<thead>
<tr>
<th>Description</th>
<th>US National Grid (USNG)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Local/State mapping or NGA/FEMA for federal sources</td>
</tr>
<tr>
<td>More Information</td>
<td>Resources to learn and implement USNG, Example Rest Service</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Address Points or Parcels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>City or County engineering departments or tax appraisal districts</td>
</tr>
<tr>
<td>More Information</td>
<td>Example data model for mapping resources</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Elevation and Topography</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>USGS, State or Local data.</td>
</tr>
<tr>
<td>More Information</td>
<td>USGS National Map</td>
</tr>
</tbody>
</table>

### Configurable Applications:

<table>
<thead>
<tr>
<th>Description</th>
<th>MapSAR Basic Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>NAPSG Foundation</td>
</tr>
<tr>
<td>More Information</td>
<td>NAPSG Foundation Website</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>WebApp Builder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Esri</td>
</tr>
<tr>
<td>More Information</td>
<td>Esri Website</td>
</tr>
</tbody>
</table>

### Additional Resources:

- NAPSG SAR Working Group Introduction Materials and Resources:
  - [http://www.arcgis.com/home/item.html?id=edad1f27a8df44388c7bc5c9808f5d21](http://www.arcgis.com/home/item.html?id=edad1f27a8df44388c7bc5c9808f5d21)
- Sample web application applying MapSAR template for training:
  - [http://napsg.maps.arcgis.com/apps/webappviewer/index.html?id=b0f9a83ba4cf40b48689db7de30257c0](http://napsg.maps.arcgis.com/apps/webappviewer/index.html?id=b0f9a83ba4cf40b48689db7de30257c0)

### 3. Resource Management

First responders and operators who manage resources are challenged by how to improve the process of identifying needed resources, requesting resources from other jurisdictions, and the sharing their own resources with other departments and jurisdictions. Resource management tools that accurately estimate resource availability and facilitate communication between agencies, especially if they can do so in real-time, can help operators better leverage their resources and respond more effectively to disasters.

Utilize the resource mapping conducted during preparedness efforts to show where resources are located. Combine this mapping with location information about the incident management areas of the...
ongoing response to show where resources are in relation to the event itself. Users can access the incident location feature classes in the Emergency Operations Feature Dataset in the Esri Local Government Information Model (LGIM) and use apps like Esri’s configurable Web App Builder.

The Situational Awareness widget in Web App Builder can display summarized information from the layers in the map. By drawing the area of interest and configuring the layers to display you will get a summarized view of data (resources, shelters, etc.). Routing capabilities can be integrated into the map by using tools like the Directions widget, which will give turn-by-turn directions and can be printed and distributed to first responders as needed. You can then use the map to analyze the geographic positioning of your resources, the rate at which goods are being distributed or used, and to make initial assessments of your response efforts. Consider also utilizing dashboards to help monitor resource levels and locations during the event.

**Common Data Needs:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Resource Locations and Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Multiple local agencies who own various resources. For example: Police Department, Public Hospital District/EMS Provider, Emergency Management Office, Fire Department, Public Works Department.</td>
</tr>
<tr>
<td>More Information</td>
<td>Example data model for mapping resources</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Incident Command Locations: staging areas; shelters, D-SNAP, etc.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Local/State/Federal Emergency Management Agencies</td>
</tr>
<tr>
<td>More Information</td>
<td>Example data model for mapping resources</td>
</tr>
</tbody>
</table>

**Configurable Applications:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Operations Dashboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Esri</td>
</tr>
<tr>
<td>More Information</td>
<td>Esri Website for Operations Dashboard</td>
</tr>
</tbody>
</table>

**Additional Resources:**

- Sample application for mapping and visualizing resource locations as well as basic routing and query to find resources in your dataset:
Chapter 9: Recovery

1. Damage Assessment

Conducting a preliminary, rapid damage assessment helps decision makers understand not only the scope and scale of a flood event’s impact, but also its economic impact on the community—information which is needed when requesting disaster funds.

Esri provides a Damage Assessment feature class sample in the LGIM that can be configured to conduct damage assessments in the field. It can also be used to monitor field assessments and estimate damage costs to determine if it exceeds State or Federal declaration thresholds based on valuation data for each affected structure. This feature class can be combined with either Collector for ArcGIS or Survey123 for data collection in the field.

As field crews inspect impacted areas, using a reference grid (USNG) can assist in tracking which areas have already been inspected. The locations of each of the damaged structures can be used to develop graphics depicting the concentration of damage within a community. Using online mapping tools, like ArcGIS Online, also allows you to create a quick public reporting application to collect a list of questions over the web so citizens can report their own damage. A dashboard can bring the data together and create a convenient view of the damage assessment progress and totals. Users can also use filters to configure charts, gauges, and graphs to view the status of Commercial, Residential and Public Facilities.

Common Data Needs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Address Points or Parcels</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>City or County engineering departments or tax appraisal districts</td>
</tr>
<tr>
<td>More Information</td>
<td>Example data model for mapping resources</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Damage Assessment Form/Template</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Local/State Emergency Management Agencies; FEMA</td>
</tr>
<tr>
<td>More Information</td>
<td>Example Data Model and Apps to implement mobile damage assessment</td>
</tr>
<tr>
<td></td>
<td>Example Site: State of Maryland</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Tax Assessor Records (Assessed Value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Local city or county tax assessor; city or county appraisal districts</td>
</tr>
<tr>
<td>More Information</td>
<td>Assessed values help with estimates on damage total value as the damage assessment is completed.</td>
</tr>
</tbody>
</table>

Configurable Applications:

<table>
<thead>
<tr>
<th>Description</th>
<th>Operations Dashboard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Esri</td>
</tr>
<tr>
<td>More Information</td>
<td>Esri Website for Operations Dashboard</td>
</tr>
</tbody>
</table>
Additional Resources:
- FEMA Preliminary Damage Assessment for Individual Assistance Operations Manual:
  - [https://www.fema.gov/media-library/assets/documents/29569](https://www.fema.gov/media-library/assets/documents/29569)
- FEMA Damage Assessment Example Reports from past incidents:
  - [https://www.fema.gov/preliminary-damage-assessment-reports](https://www.fema.gov/preliminary-damage-assessment-reports)

2. Public Information
Social Media is increasingly being used to notify the public of what events might affect them. Mapping applications can be shared through social media and viewed in mobile devices; as maps become updated with new information, such as Points of Distribution (POD), Disaster Recovery Centers, and Disaster Supplemental Nutrition Assistance Program (D-SNAP) sites, the app will instantly reflect the most up-to-date information.

Create a map that will show Disaster Recovery Centers, Shelters, PODs, D-SNAPs. The Local Emergency Management Agency should have a list of POD and Shelters that your GIS staff can use. When a POD or shelter becomes activated, it should be displayed in a map for the public to see. Using a web map and configurable web application, data can be instantly updated for the public to view. Information important to the public, such as available resources and supplies, directions, contact information, and hours of service can also be configured in a pop-up display for the public to view. Using configurable apps, like the Directions app template by ESRI, users can see a list of locations based on distance away from their location, and get turn-by-turn directions using the GPS service on their mobile device.

Note that your jurisdiction may have specific requirements on what data is shared publicly. For example, some locations may not share the location of shelters with the public. Instead, they provide locations for the public to assemble prior to transport to a designated shelter. Work with your local emergency management office to determine the appropriate workflow and data in your public information maps.

Common Data Needs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Source</th>
<th>More Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disaster Recovery Center Location and Information</td>
<td>Local/State Emergency Management Agencies; FEMA</td>
<td>FEMA website to locate open recovery centers</td>
</tr>
<tr>
<td>Example POD map for the public from Lake County, OH</td>
<td>Example POD map for the public from Lake County, OH</td>
<td>Configurable Web Application to provide directions to these locations</td>
</tr>
</tbody>
</table>

DRAFT Version 2.1
<table>
<thead>
<tr>
<th>Description</th>
<th>Donations management and community resource management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Local/State Emergency Management Agencies; FEMA; Volunteer agencies (VOAD); Faith-based community.</td>
</tr>
<tr>
<td>More Information</td>
<td>Example organization for helping manage recovery using GIS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Shelter Locations and Capacity/Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>American Red Cross (ARC); Faith-based community; State and Local Emergency Management Department</td>
</tr>
<tr>
<td>More Information</td>
<td><a href="http://www.redcross.org/arcshelterfinder">ARC Shelter Finder Website</a></td>
</tr>
</tbody>
</table>

### Configurable Applications:

<table>
<thead>
<tr>
<th>Description</th>
<th>Public Information Map Template</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Esri</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description</th>
<th>Briefing Story Map Template</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>Esri</td>
</tr>
</tbody>
</table>

### Additional Resources:

- Sample data model and starting point for mapping PODs and Shelter features locally:

### 3. Utilities Assessment and Monitoring

Floods have the potential to impact the services citizens rely on every day—both in the short- and long-term. This includes electric power outages, water treatment disruption, and drinking water contamination. Monitoring the status of these services as an indicator of recovery is vitally important to both the public safety community as well as to citizens.

Prepare public-facing web applications that allow you to report outage and status information for the public, from both internal and external service providers. Such applications would not only track and report outage information, but help reduce the number of calls to 311 centers or your local office. Consider testing all applications in a mobile environment to ensure usability, since many users are likely to access them on cell phones. Many providers will report outage information on their websites by zip code or by administrative boundary; when possible, include this data to present users a complete view of the impacts on their locations.
Common Data Needs:

<table>
<thead>
<tr>
<th>Description</th>
<th>Utility service areas and providers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source</td>
<td>State Public Utility Commission; Municipal providers; utility districts; private utility companies</td>
</tr>
<tr>
<td>More Information</td>
<td>Example rest service for local power outages</td>
</tr>
<tr>
<td></td>
<td>Example website for public tracking of power outages</td>
</tr>
<tr>
<td></td>
<td>Example connection to WebEOC to generate PDF of current outage information</td>
</tr>
</tbody>
</table>

Configurable Applications:

<table>
<thead>
<tr>
<th>Description</th>
<th>Operations Dashboard</th>
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<tbody>
<tr>
<td>Source</td>
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</tr>
<tr>
<td>More Information</td>
<td>Esri Website for Operations Dashboard</td>
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<tr>
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<td>Esri</td>
</tr>
<tr>
<td>More Information</td>
<td>Esri Solutions Site</td>
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</tbody>
</table>

<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
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<td>Source</td>
<td>Esri</td>
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<td>More Information</td>
<td>Esri Solutions Site</td>
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Additional Resources:

- Configurable web applications to communicate outage information to the public:
Part Three: Workshop Facilitation

The challenges, themes, and priority information needs discussed in this guideline were collectively determined by the first responders and operators working in flood-prone regions of the nation. Their first-hand knowledge and experiences provide a roadmap for others to follow, and they define opportunities for technologists to build solutions that will serve the public safety community well in advance of the next flood emergency.

In Part Three, the guideline provides a repeatable methodology that can be customized to the needs of a specific location. The methodology details how to create the right participant mix for the workshop, proposes outcomes and objectives for the day, and provides a sample agenda that can be adjusted based on local needs. The final component is the documentation and prioritization of the key information needs of the workshop participants. The materials below provide guidance on how to facilitate this discussion and a methodology to help with capturing the priorities.

Key Takeaways:

- Identify key stakeholders in the region who can serve as a workshop management committee. These key individuals will help you identify other stakeholders, avoid potential challenges in the community, and serve as a local voice to the community. Lean on this team as you plan and execute.
- Carefully consider the workshop invitation list and the mix of first responders/operators to technical staff. The primary participants are first responders and public safety operators working at the local level. The secondary participants are technologists and GIS professionals. This is deliberate, to focus the workshop on first responders and operators.
- Engage local thought-leaders and respected executives for introductory presentations that get everyone on the same page with the flood risk and history of the area.
- Keep the workshop small where possible. The more participants there are, the more difficult facilitation and discussion becomes. The objective is to get people talking and communicating. Audiences larger than 50 should be split into smaller groups for facilitation during the workshop.
- Workshops are not a hot-wash or an after-action of a specific past event. The workshop is to focus on general flood events and discuss the collective experiences and needs identified across all past events.
- Develop an action plan based on the findings and revisit annually for preparedness efforts.
Workshop Structure & Objectives

To address the need for timely, reliable, and accessible sources of current operational and preparedness information to support local decision-making for flooding events, this workshop has been developed with the sole intent of defining the most critical local information needs for flood preparedness and response at the local level. Objectives for the workshop are:

- To bring together selected first responders and public safety officials from a cross-section of the area.
- Facilitate a discussion around recent flooding events to document key decisions and/or needs for the next event.
- To derive a priority list of datasets and attributes that support these key decisions and/or needs.
- To identify when/where each information product would be most useful and helpful for critical decision-making.
- To identify owners (organization or agency) of each dataset required in the region and means of distribution to the community.

The workshops will consist of two main activities: a tabletop exercise and facilitated discussion. The tabletop exercise will simulate a real-world flood scenario to ground-truth the operational decision points and information needs of the participants. The facilitated discussion will inform the prioritization of the datasets and the mission-critical attributes.

Workshop Outcomes

At the end of each one-day workshop, the project team will have determined the key information requirements for the region in response to a flooding event. Information needs include data, attribution, and scale needed to support critical decision-making by the participants. These information needs will have been prioritized by the participants, and ownership of each supporting dataset will have been identified.

Participant Profile

First Responders and Public Safety Operators

Primary participants at the workshop are assumed to be first-responders or public safety officials. They are not assumed to be technical or GIS professionals, though some may have knowledge of these technologies and their capabilities. All communication and discussion should be kept at a non-technical level.

GIS Professionals

Secondary participants at the workshop are assumed to be GIS professionals that support public safety operations, either full-time or part-time, as part of their duties. While they are more technical in nature, communications and discussion should be aimed at the primary participant level.
Sample Agenda

9:00-9:30 Welcome, Project Introduction and Participant Introductions
   • Welcome and Logistics – Local Host Lead
   • Project Introduction and Background – Project Team
   • Participants personal introduction:
     o Who and What Organization
     o How you supported past flood events

9:30-9:45 City Flood Response First Responder Presentation (City Participant TBD)
   • Local first responder perspective on the recent flood event

9:45-10:00 County Flood Response First Responder Presentation (County Participant TBD)
   • County first responder perspective on the recent flood event

10:00-10:15 State Flood Response First Responder Presentation (State Participant TBD)
   • State first responder perspective on the recent flood event

10:15 – 10:30 Break (Coffee Provided)

10:30-12:00 Flood Table Top Exercise and Discussion
   Primary Focus: First Responders and Operators
   • “Replay” of the local flooding event with facilitated discussion that documents
     the key decision points for 24, 48, 72 hour operational periods.
   • Participants will document any and all decisions that need to be made
     individually while in group discussion to ensure all ideas are captured. They
     should do this using sticky notes provided to each participant.
   • All decisions will then be aggregated by the participants into logical groupings of
     like items.
   • Groupings will then be discussed individually to derive all data and attributes
     needed to support the required decision

12:00-1:00 Lunch Provided

1:00 – 2:00 Flood Table Top Exercise and Discussion
   • Continued effort to document and discuss decision points to the flood event

2:00 – 3:00 Prioritization Effort for Defined Information Needs
   Primary Focus: First Responders and Operators
   • Facilitated effort to prioritize the information needs with an emphasis on “Top
     10” being agreed upon by the group.

3:00 – 3:15 Break (Coffee Provided)
Data Ownership Identification

Primary Focus: GIS/IT professionals

- Starting with the “Top 10” datasets and working down, identify and document the data owner in the region. While this may vary from across the region, we are looking to capture common owner locations that will inform national guidelines as an outcome.

Final Priority Check and Consensus

- Last opportunity to review “Top 10” information needs before the group achieves consensus.

Summary and Closing

- Project Team and Local Host.

Facilitator Tips

- Slide Deck is available on the project SharePoint site for use across all workshops for consistent messaging.

- Consensus does not mean unanimous agreement. There may be certain participants that disagree with the majority of others. Our role is to listen, discuss, propose changes to the group, and then accept the majority’s consensus (Figure 1). The end result should be that the group agrees they can accept the proposed solution.

- As you proceed with the workshop, there may be times you sense that consensus is at risk. If so, use discussion and have each person determine if they are one of the following:
  - Block: I have a fundamental disagreement with the core of the proposal that has not been resolved. We need to look for a new proposal.
  - Stand aside: I can't support this proposal because ... But I don't want to stop the group, so I'll let the decision happen without me.
  - Agreement: I support the proposal and am willing to implement it.
- **Flood Table Top Exercise and Discussion Tips for developing information needs**
  
  (1) Assign a record keeper to document the decision points discussed by the group. The record keeper should also work to aggregate decisions into logical groupings for later use as the conversation progresses.

  (2) Each participant should be supplied with sticky notes on which to write their own decision points. Each participant will use their own words and capture each as they determine necessary during the discussion.

  (3) To establish logical groupings under which participants will order their individual decisions, the following method is suggested:
    (a) The record keeper should manually derive categories or groups based on the ongoing conversation as they track notes.
    (b) These categories should be used, and then discussed for any modifications by the participants through discussion.

  (4) Once groups are set, participants should use their sticky notes to self-place their decision needs into the appropriate group. This is done for all note cards a participant has. Outliers should be aggregated to a separate group for discussion and split as needed into additional groups.

  (5) The facilitator should then read through the notes with the participants and seek any clarification of notes/wording as needed.
The outcome of this process should be a list of common decision needs (critical infrastructure status, affected population counts, etc.) with all related decisions from the group aggregated under each.

Finally, the decisions should be discussed in terms of the data needed AND the attributes required to answer the decision (census population data with age category attributes). Work your way through each group as quickly as possible at this point to try and determine what data is required (GIS professionals can help with input here) and what attributes are needed (first responders and operators should be key here).

Document these data layers, and their attributes with the record keeper in a spreadsheet (can be shown over a projector to the group as you work)

**Prioritization Effort for Defined Information Needs**

1. List all the information needs finalized above from A-Z (literally list and assign each a letter A-Z, AA-ZZ, etc.)
2. Based on the number of information needs listed, divide by 3 and that is the number of votes each person will get (N/3 is a common facilitation formula). For example, if there are 21 information needs listed, each person would get 7 votes (21/3=7).
3. Now, ask each participant to pick their top information needs from the list. Each person should choose the number from the formula above, in our example that means everyone should choose 7 items from the full list. Ask them to write one letter on a sticky note for each item they chose.
4. Next, have all participants rank their choices from most important to least important. Write a number next to each letter to rank them from least to most important (1-7 in our example. 1 is least important; 7 is most important.)
5. Finally, have the full group assemble their sticky notes on the whiteboard or surface by letter (all A’s together, all B’s and so on.)
6. Have the record keeper tally the numbers on each post card for each letter. This is the group’s rank for each letter (information need).
7. Discuss the outcome/ranking with the group to achieve consensus. If there are ties, you can repeat the process for the ties to re-rank them.

For the final priority and gut check, this is a time for anyone who has been thinking about a dataset not being ranked appropriately to speak up. Remember the idea is to achieve consensus and that may not be a unanimous agreement. Make that clear to participants up front.

**Workshop Logistics**

The following supply list is only an estimate based on 50 participants. Adjust quantities of each as needed based on final registration.

**Materials:**

- 50 Sticky Note Pads (one per participant)
- 25 Pens (extras)
- 4 Flip Chart with sticky strip for hanging
- 4 Color Marker Sets
- 2 Color Dry Erase Markers
1. Projector and Screen
2. Laptop with Microsoft Office
3. 50 Printed Agendas and Slides
4. Sign-in Sheet

6. **Food and Beverage:**

7. - Coffee and Water (50 people for 2 breaks)
8. - Boxed lunch (50 people)
9. - Water and Tea for lunch (50 people)

11. **Facility Setup:**

12. - Seating for 50 classroom style with tables if possible
13. - Whiteboard or wall space for hanging sticky notes, etc.
14. - Projector and screen
15. - Space for breaks and lunch to be setup
16. - Restroom facilities