NCHRP 20-59(53): FLOODCAST

A Framework for Enhanced Flood Event Decision-Making for Transportation Resilience

Requirements Analysis

Prepared for

The National Highway Cooperative Research Program

Transportation Research Board

of

The National Academies

Dewberry
Venner Consulting

May 2017

CONTENTS

1 INTRODUCTION

This technical memorandum documents the research team's approach for performing a detailed requirements analysis for FloodCast through engagement of State DOTs. This requirements analysis is to identify the essential capabilities a flood forecasting and response platform should have, to support State DOTs' response, recovery and mitigation activities. A requirements analysis improves the likelihood that the FloodCast platform can be merged effectively into existing DOT activities while improving the opportunity for FloodCast to maximally leverage existing data, tools, processes and protocols in place today. The requirements analysis is a critical milestone along the path to building an effective, national FloodCast platform that DOTs across the country could use to limit losses to life and property and build resilience into our transportation system.

1.1 Background

As identified in NCHRP 20-59(53) Technical Memorandum #1 (July 2015), the research team performed an initial requirements analysis based on potential uses of existing and soon-to-be released datasets and technologies, resulting in a FloodCast prototype tool that demonstrates a number of flood forecasting and response capabilities. NCHRP 20-59(53) Final Report (October 2016) documents the FloodCast prototype system development and current system functionalities.

The FloodCast prototype tool is **a web-based platform that combines high quality forecast data with dissemination tools to support effective emergency response by transportation practitioners**. By delivering forecast data, predicted floodplains and analytics of affected transportation assets, decision-makers can receive timely intelligence to better respond to forecasted and ongoing flood events. To deliver these capabilities, the FloodCast prototype has six (6) system modules/capabilities (see Table 1).

Table 1: FloodCast Prototype System Modules.

FloodCast Module	Description
Forecasting	The system displays NOAA's Quantitative Forecast Maps (QPF) showing precipitation forecasts (in inches of expected rainfall) with an outlook of 1 week. Long-range forecasts are important because they provide DOTs with the greatest amount of lead time to prepare for flood impacts. These visualizations of forecasted rainfall can help DOTs estimate the location and timing of road closures, plan strategic detours, and anticipate staffing and operational needs.
Flood Extents & Stage-Discharge Predictions	The system displays floodplain inundation extent predictions based on Advanced Hydrologic Prediction Service (AHPS) river gage stage-discharge forecasts for various NWS-defined flood stages. This module represents the hydrometeorology and flood mapping component of flood forecasting to not only understand how much flooding there might be, but also when and the where.
Emergency Management & Operations	The system displays the forecasted riverine flood extents overlaid on critical transportation assets. In 2-hour increments from the baseline flood event, the system shows how the status of assets change as the flood event develops.
Incident Reporting and Damage Estimates	Incident tracking and summary tools provide streamlined workflows, centralized tracking, and rapid synthesis of flood event analytics to facilitate both active flood event response and assists with post-disaster recovery and reimbursement activities. The system's incident report features allows users to document attributes of impacted assets.
Event Summary	The system stores information on historical flood events in the Event Summary record database. This event summarization feature can help DOTs with event debriefing and planning, as agencies can take note of assets that are repetitively flooded to inform mitigation activities and can review event response work flows during debriefing exercises.
Communication	The communication component provides a means to deliver automatic alerts to all registered users of the system via e-mail or SMS message. This portion of the tool provides a warning system that allows users to monitor the status, criticality and passability of all assets within their affected area of responsibility. Alerts include a visualization of the predicted floodplain extent and system-generated hyperlink to additional information about the event.

1.2 Objective

The primary objective of the requirements analysis is to identify, from a State DOT perspective, the capabilities a flood forecasting and response platform should have to support State DOT response, recovery and mitigation activities. This analysis can then inform the direction of FloodCast from prototype to operational platform..

The FloodCast platform provides a proof-of-concept to the community by demonstrating how currently available technologies might interface with preparedness, response and recovery activities. The prototype system likely embodies some requirements that are in strong alignment with DOT needs and others that require some degree of adjustment. Because DOTs across the country are experiencing firsthand the impacts of flood events on travelers and assets, the research team determined it was critical to engage them in in-depth system requirements analyses using the prototype tool as a concept demonstration to facilitate discussion.

2 DETAILED REQUIREMENTS ANALYSIS

2.1 Project Stakeholders

The research team reached out to a number of State DOTs to ensure that the requirements analysis represents a diversity of geographies and a wide spectrum of strengths and challenges DOTs may encounter when establishing the data holdings and technologies necessary to participate in operational flood forecasting.

To ensure the requirements analysis captured a range of State DOT capabilities, the research team leveraged the FloodCast Capability Maturity Model (CMM) developed in an earlier phase of this project. This CMM was developed to help State DOTs define the key data, technologies and practices required to effectively achieve progress towards flood forecasting and response. The CMM was organized into capability dimensions (i.e., Meteorology, Hydrology & Hydraulics, Asset Management, Communication & Information Transfer and Incident Management) with tiers indicating levels of maturity toward that dimension. Tiers can then be used by interested entities to identify a pathway toward improving capabilities along each dimension. The research team utilized the FloodCast CMM to identify participant DOTs representing a mix of both early stage and more mature practitioners with respect to the 5 dimensions of the CMM. More detail and description on our FloodCast CMM can be found in NCHRP 20-59(53) CMM Technical Memorandum (February 2017).

The research team also focused on engaging State DOTs from across the nation to ensure the analysis captured a range of geographic regions with varying flood hazards (see Figure 1).

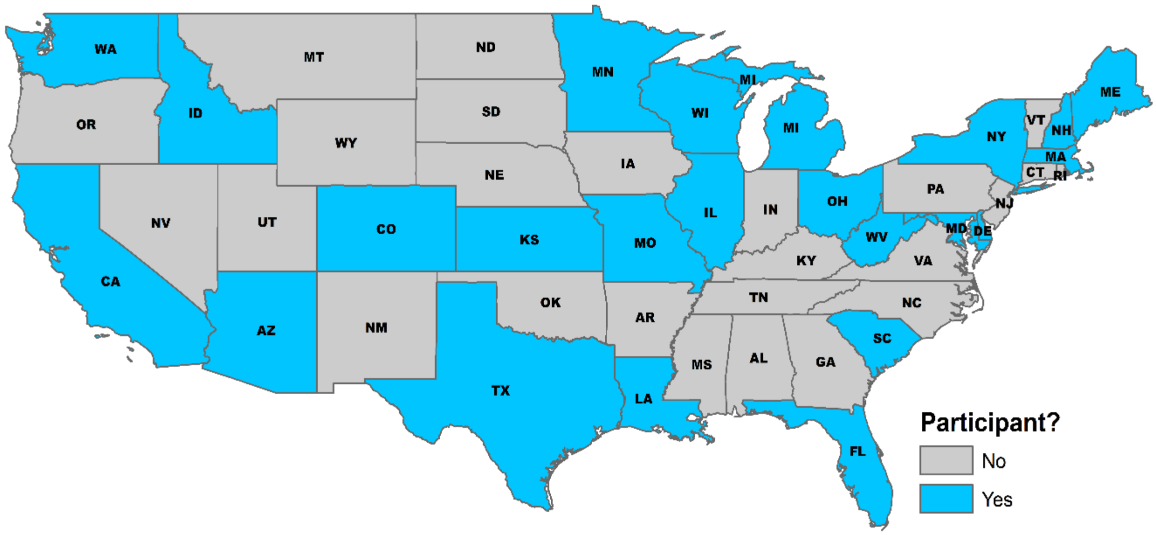


Figure 1: Participating State DOTs for the FloodCast Requirements Analysis.

The research team attempted to engage the appropriate DOT staff with job responsibilities related to flood forecasting, response and recovery. The following list highlights some of the State DOT job roles that were targeted for engagement:

- Sustainability
- Drainage
- Emergency Management and Operations
- Hydraulic Engineering
- Waterway Engineering
- Maintenance and Operations
- Traffic Management
- Geospatial Services

In addition to consulting State DOT agency websites, the research team also reached out to the leaders of three AASHTO's committees to identify appropriate State DOT representatives. These groups included: Standing Committee on Highway's Subcommittee on Transportation Systems Management and Operations (STSMO); Special Committee on Transportation Security and Emergency Management (SCOTSEM); SCOTSEM Research Technical Working Group; and SCOTSEM Emergency Management Technical Working Group.

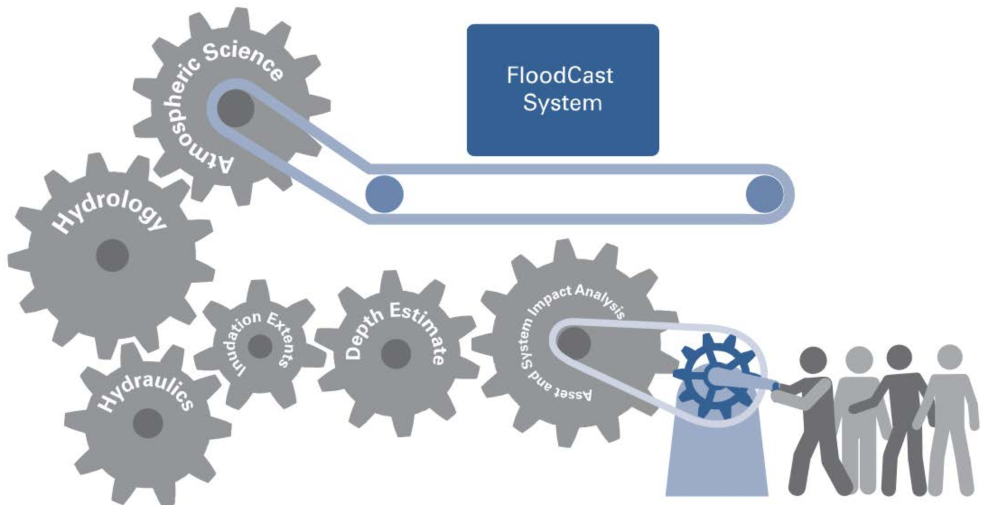
2.2 Requirements Gathering Approach

The research team gathered requirements through two main approaches: 1) an electronic survey; and 2) stakeholder webinar meetings (described in more detail in the following sections). In both approaches, the research team demonstrated the FloodCast prototype as an example of the necessary components of a flood forecasting system that could help improve flood forecasting, preparation, response and recovery. The demonstration led to group discussions on how to such a system could support DOT needs.

2.2.1 Capability and Requirements Survey

The research team created a webinar recording with information on the FloodCast project, including the evolution of the FloodCast project and a FloodCast prototype tool demonstration. The webinar recording was disseminated to participating State DOTs along with a GoogleForm survey designed to gather ideas for requirements and to understand existing State DOT capabilities. For example, the survey asked participants the following questions:

- Having attended or watched the prototype tool demonstration and associated presentation, what is your overall reaction?
- Are there any critical workflows or data that you would like to see incorporated in FloodCast?
- What other improvements would you like to see made to the system?
- The prototype translates forecasted rainfall into inundation extents and then uses this information to flag potentially threatened assets. Please provide a comment on the usefulness of this information and any feedback on how the data is being displayed.
- If broadly speaking, the gears in this figure represent the critical pieces of flood forecasting and response, what areas represent your biggest challenges? Within those challenging areas, would the FloodCast prototype tool help improve your capabilities, and if not, what would need to be added?



- The prototype presents a riverine flooding impacts scenario. What additional types of flood sources would you like to see incorporated into the system?
- The Event Summary form in the prototype tool is intended to support debriefing and long-term planning. What additional pieces of information would be useful to include? (example: GIS-format flood extents for past events with map of impacted assets)
- How do you envision this tool facilitating communications (both internally, and externally with partner agencies)?

With respect to capabilities, participants were asked a series of questions related to the five dimensions of flood forecasting (i.e., Meteorology, Hydrology & Hydraulics, Asset Management, Communication & Information Transfer and Incident Management). A list of capability-related questions and answers summarized in a graphical form can be found in the Appendix at the end of this report. This information helped the research team identify gaps, both within and between DOTs, by comparing critical flood forecasting system components DOTs already have to capabilities DOTs expressed they would like to have as part of a functional flood forecasting system. These gaps were leveraged to develop broad requirements that can are summarized in Table 2.

Table 2: Existing Capabilities and Needs for DOT Flood Response

Flood Forecasting Dimension	Existing Capability Summary	Gap/Requirement
Meteorology	• The majority of DOTs surveyed for this project actively consult predictive weather forecasts to prepare for flood events, most commonly from resources/alerts produced by NWS, NOAA, USGS, NHC, and FEMA. • Most agencies gather precipitation forecast data separately from each source every time they need an update rather than having one central system that stores all weather and hydrologic data in one place.	• A flood forecasting system that could serve as a centralized repository for flood forecasts to save time and improve situational awareness.
Hydrology & Hydraulics	• Several DOTs use the National Flood Insurance Program's (NFIP) National Flood Hazard Layer (NFHL) for 100-year and 500-year flood events or the NWS's Advanced Hydrologic Prediction Service (AHPS) depth grids and extents for NWS-defined flood stages. However, it appears that most of this information is being used for long-term infrastructure planning decisions rather than predictive flood risk planning. • There are a few DOTs that use USGS rating curves (or similar regression equations) or the USGS StreamStats program to estimate inundation extent and depth predictions for ungauged locations.	• Dynamic inundation mapping (i.e. event-based) that allows for rapid translation of stream flow predictions to extent and depth predictions, especially accurate flood modeling at ungauged locations. In particular, multiple survey respondents expressed the need to answer the following key questions in advance of an event: When will it flood?; Where will it flood?; and How deep will flooding be?
Asset Management	• Most DOTs have some sort of asset management system, but the majority of these databases are not complete, only show DOT-owned assets, are not in GIS format, do not include information about asset fragility and vulnerability to flood conditions, do not have or only have partial topology enforcement, and are missing asset elevation attributes.	• System should facilitate data asset data collection (i.e. field personnel could gather geo-located asset data), could easily update additions and changes to assets, and could interface with H&H data outputs to anticipate asset failure.
Communications & Information Transfer	• Many DOTs use dispatch lines or state 511 systems to communicate and deliver alerts about traffic incidents, closures, and detours. However, these alerts are rarely automated and occur during or post-event rather than delivering predictive information about potential flood risk pre-event. • The majority of existing communication platforms do not enable two-way communication with response crews. • Most DOTs do not, or are not aware of the Open Geospatial Consortium (OGS) guidelines for geospatial data dissemination for sharing data.	• One-click automated communication tools that can help streamline efforts for DOTs to get the word out internally, to partner agencies, to infrastructure owners, and the public are desirable. • The system should be structured to adhere to data standards and specifications so that DOT-collected data can be seamlessly transferred to external users such as partnering agencies and the public.
Incident Management	• Many DOTs expressed that their agency has a good understanding of locations and assets that are prone to flooding; most of this information is among staff, as institutional knowledge (i.e. experts who have experience with multiple historical flood events), subject to loss. • Only several agencies maintain an incident tracking database in GIS format (extent of flood and location of impacted assets) with associated damage analytics (i.e. high water mark data, how long infrastructure was inundation, damage estimates, repair/cleanup activities, etc.).	• System should allow for rapid synthesis of flood event analytics to facilitate both active flood event response as well as assist with post-disaster recovery and reimbursement activities.

2.2.2 Stakeholder Webinar Meetings

The research team also arranged both group and individual requirements discussions with State DOTs, depending on availability. The first FloodCast requirements webinar meeting had a total of 39 attendees from many State DOTs nationwide. The research team structured the webinar meetings by providing project background and a live demonstration of the FloodCast prototype tool, followed by an open discussion where participants were asked similar questions to those listed in Section 2.2.1.

One-on-one meetings provided an opportunity to collect use cases, a valuable component of the requirements analysis that provide narrative scenarios describing how users would employ FloodCast to reach specific agency objectives. Toward this end, the study team asked individual DOTs about past events that challenged their ability to meet their combined operational and emergency response responsibilities. The following list provides some direct excerpts of narratives the research team collected:

- "Any type of forecasting is greatly appreciated. Our primary concern is related to tropical events along our coastal communities. However, we also have a few peak sensitive watersheds that need to be closely monitored during extreme events."
- "FloodCast seems to be good for identifying potential impacts for flood events and incidents. I wonder, though, if field personnel who respond to flood incidents will: a) have time or b) expertise to use the tool in during a crisis. The tool might be more appropriate for non-field personnel in determining priority responses based on the most critical assets and projections."
- "A good tool for flood prediction that will be of benefit to transportation entities."
- "DOT's usually have institutional knowledge of [flood] effects on their systems, but this is a great way to communicate to the public. I also think this could help floodway managers monitor the efforts of changes in their floodways over years when models need tweaking."
- "I see part of it helping in the future. Especially will be good to have with information for rivers that do not have any gauge data."
- "For river systems, we have a good system of gauges, but lots of flooding is happening in ungauged areas. Low spot in terrain. Know where road floods, but nobody knows when. Key for us is to capture when the events will happen."
- "We struggle and work very reactively – trying to become more proactive. Not necessarily the amount of rain, but the amount in the timeframe that it comes."
- "Would enhance emergency response procedures for first responders."
- "This type of tool would better meet the needs of local municipalities due to the concentration of roadways and bridges within the residential areas throughout [the State]. This forecasting software would help them better mobilize their resources to coincide with projected flooding."
- "It appears to be most effective for internal decision-making and resource allocation. After-action reviews definitely should incorporate input and evaluations of partner agencies."
- "Will produce very good communication with office and field staff on how basins respond and locations of recurring concern. Good for communication with communities and law enforcement, who may be first to arrive at a flooded highway or bridge and will need to know what to do and who to contact."
- "I think we can use this to communicate with emergency management to inform them of past knowledge and what we expect will happen with the information forecasted."
- Would be helpful for "sending alerts to field personnel and the decision makers to monitor critical infrastructure".

These use cases were reviewed and incorporated into the requirements analysis to ensure that various practitioners, both within and partnering with the agency, obtain the information they need at the appropriate time and in a format that is meaningful.

2.3 System Requirements

Requirements collected from the survey and webinar meetings were compiled and translated into a list of system requirements for FloodCast in an Excel document that accompanies this technical memorandum. This includes both “non-functional” requirements that inform the overall system/solution design as well as “functional” requirements that define specific capabilities that the system will perform and provide. Non-functional requirements, which address application usability, configurability, computability, interoperability and similar qualities, are addressed first followed by high-level system functional requirements.

Requirements were organized by functional category (e.g, Incident Pre/Reporting, Additional Map Layers/Content, Analysis and Modeling, Viewing Data, Flood Alerts/Notifications, Data Sharing and Consumption, and Flood Event Record-Keeping) and FloodCast module (e.g., Forecasting, Incident Reporting, Flood Extents & Emergency Operations, Communications, and Event Summary). In some cases, stakeholders provided requirements that do not fit into any of the existing FloodCast modules and would require a new module such as visualizing future Sea Level Rise inundation scenarios.

2.4 Conclusions & Recommendations

Overall, there was consistency among stakeholders surveyed for this project that the key elements incorporated in the FloodCast prototype would help State DOTs proactively monitor, assess and respond to flood hazards in real-time, which will in turn increase the chance for wider adoption of flood forecasting and response systems. As mentioned earlier in this report, the majority of State DOTs surveyed for this project reported that their agency does not have one central flood forecasting and response system like FloodCast and rather gathers data separately from multiple sources of information to monitor flood-related hazards. More advanced State DOTs that have already begun to develop flood forecasting and response tools still expressed value in the FloodCast platform as certain components of the system have potential to augment their existing capabilities, such as using the platform as “middle ware” to communicate and coordinate DOT operations and emergency response functions. For example, Delaware DOT (DelDOT) is currently developing a statewide Weather and Flood Monitoring System that supports a number of the high-priority requirements identified during this analysis, such as automated warnings based on flood elevation thresholds for critical assets. For optimal functionality, the FloodCast platform could interface with these types of systems to improve information exchange and support a full range of flood preparation response and recovery activities.

The requirements collected and documented in this report reflect the critical inputs towards developing a mature FloodCast program that would be maximally useful at the national scale. The study team looked at the full list of system requirements holistically to reveal high-level observations to develop recommendations for building a maximally useful and fully realized FloodCast platform (Table 3).

Table 3: Observations and Recommendations

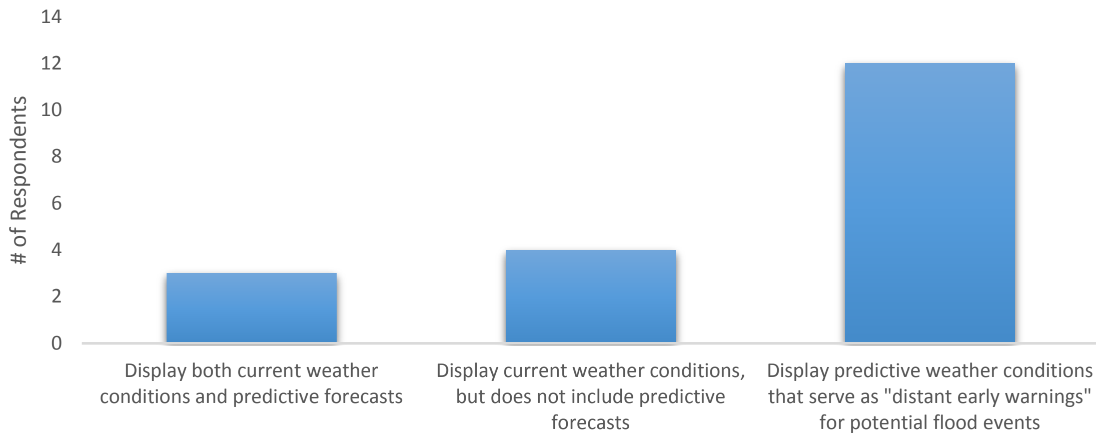
Observation	Recommendation
State DOTs want to see more action-oriented features rather than after-incident reporting.	The FloodCast Incident Report feature should include action item checklists that field personnel can easily fill out to initiate response activities.
Some DOTs provided contrasting requirements. For example, the majority of DOTs commented that the incident status terminology (i.e., "No Apparent Threat", "Monitor", "Threatened", and "Confirmed Impacted") used in the prototype is what they are accustomed to using, while some recommended different terminology.	In an effort to use terminology already familiar to many transportation practitioners and emergency managers, terminology should not change.
There were conflicting opinions about keeping the FloodCast system simple versus adding additional features/complexity.	In order to avoid additional features that might detract from response, information should stay focused on the following: • What is threatened? • How can crews implement emergency response efforts? • How to request additional resources? • How to report the extent of damage?
It may not be feasible or beneficial to include the full suite of requirements gathered for this project.	Requirements should be prioritized by: importance (i.e. more important = multiple State DOTs provided the same requirement); and feasibility (i.e., more feasible = capability already exists and could easily be integrated into FloodCast without a high level of effort). For example, many State DOTs emphasized the importance of including coastal storm surge forecasts into FloodCast; the National Hurricane Center (NHC) provides probabilistic storm surge products when hurricane watches/warnings are in effect. This requirement is therefore ranked as a high-priority requirement as it is both important and feasible. The research team assigned priority rankings to each requirement, but these rankings should be reviewed and discussed with the NCHRP Study Panel.
Several State DOTs emphasized the importance of incorporating a feature in the FloodCast tool to support climate adaptation planning.	Changing patterns in precipitation, wind, temperature, sea level and groundwater are all potential challenges to safe and cost-effective management of roads and highways, even presenting divestment questions in some cases. While incorporating a climate adaptation component into the FloodCast platform is outside the scope of this project at this time, a list and links to existing tools that can be readily enlisted to support climate adaptation planning could be included in the FloodCast interface. For example, the Sea Level Rise and Coastal Flood Web Tools Comparison Matrix (WTCM)[1] provides links to existing national and state-level climate adaptation tools.
Several State DOTs requested changes to asset symbology. For example, the FloodCast prototype currently portrays assets as points while some State DOTs currently uses lines to delineate assets (especially bridges and roadways).	There is scope in the next phase of the FloodCast project to develop data standards for FloodCast data components. Data standards have the advantage of creating a uniform format for each data type, improving compatibility and interoperability. The study team recommends consulting the OGS' Testbed-11 Symbology Mediation Engineering Report (2015) that documents symbology best practices and data standards for emergency management applications.

[1] http://sealevel.climatecentral.org/matrix/national.html?v=1

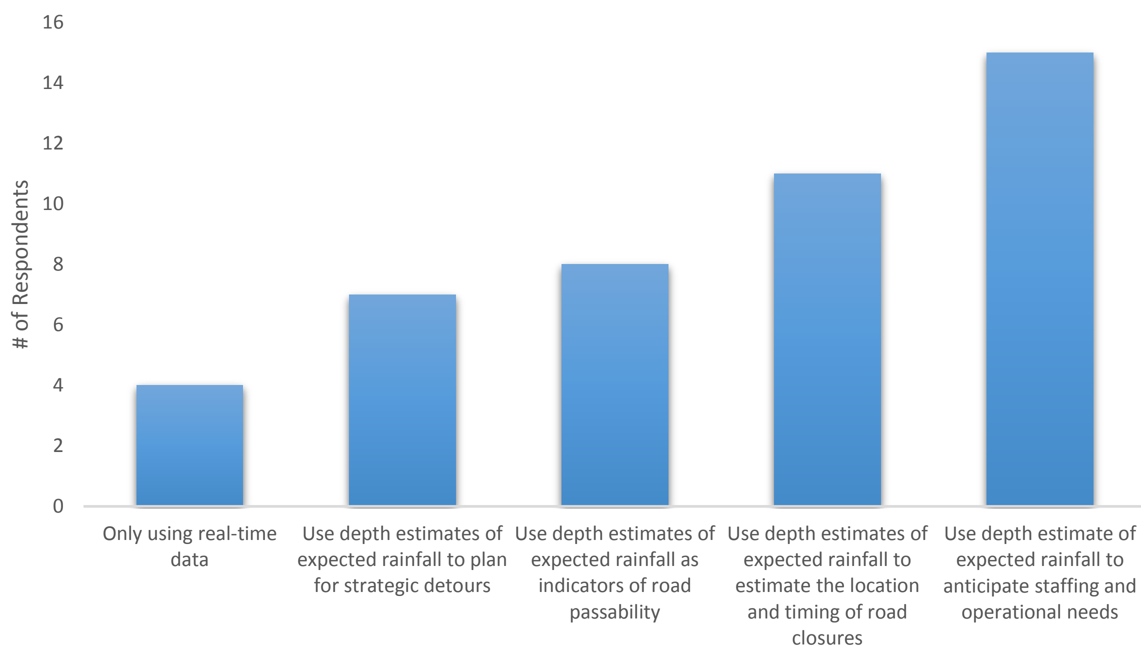
3 APPENDIX

1. **Meteorology:** Meteorology, in the context of flood forecasting, refers to an agency's capabilities to leverage local, state or federally-operated meteorological monitoring and forecasting resources to support state DOT flood planning, risk management, mitigation, preparedness operations and emergency response activities.

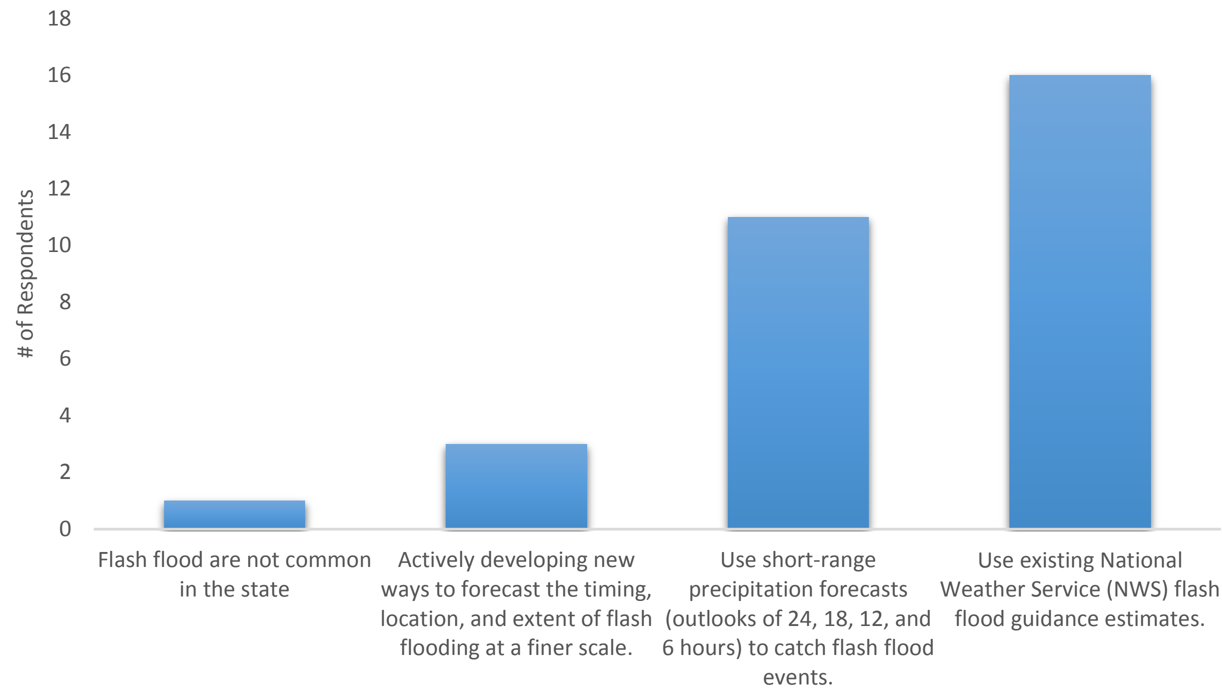
- *Which of the following describes your precipitation monitoring capabilities?*



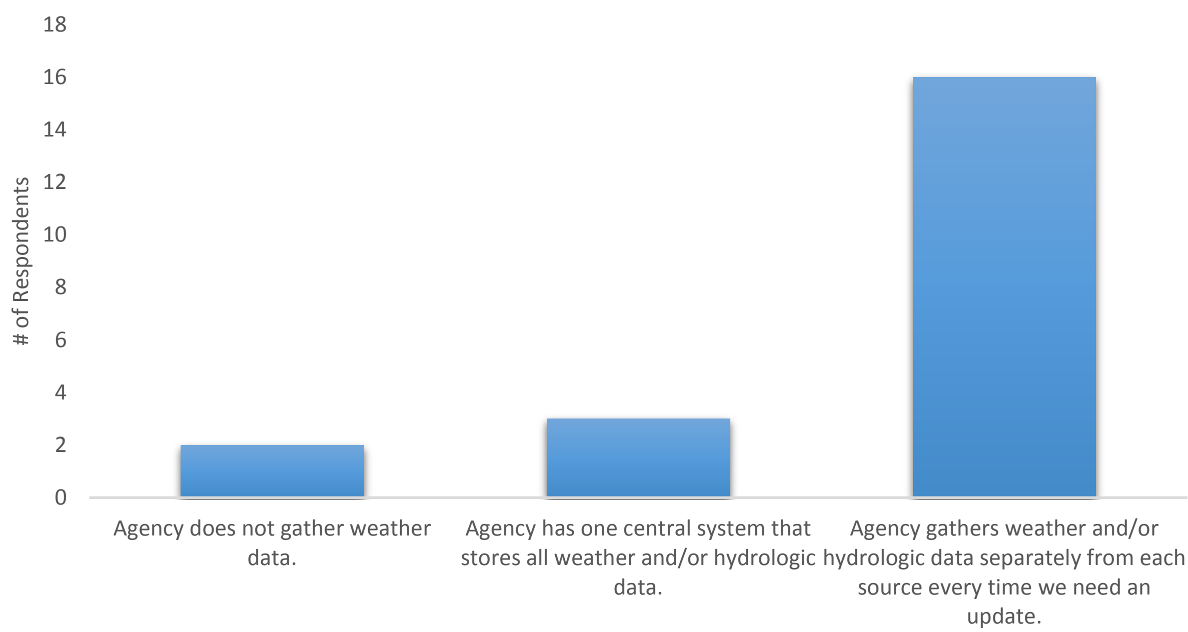
- *How does your agency use meteorological data to make transportation management decisions during a flood event?*



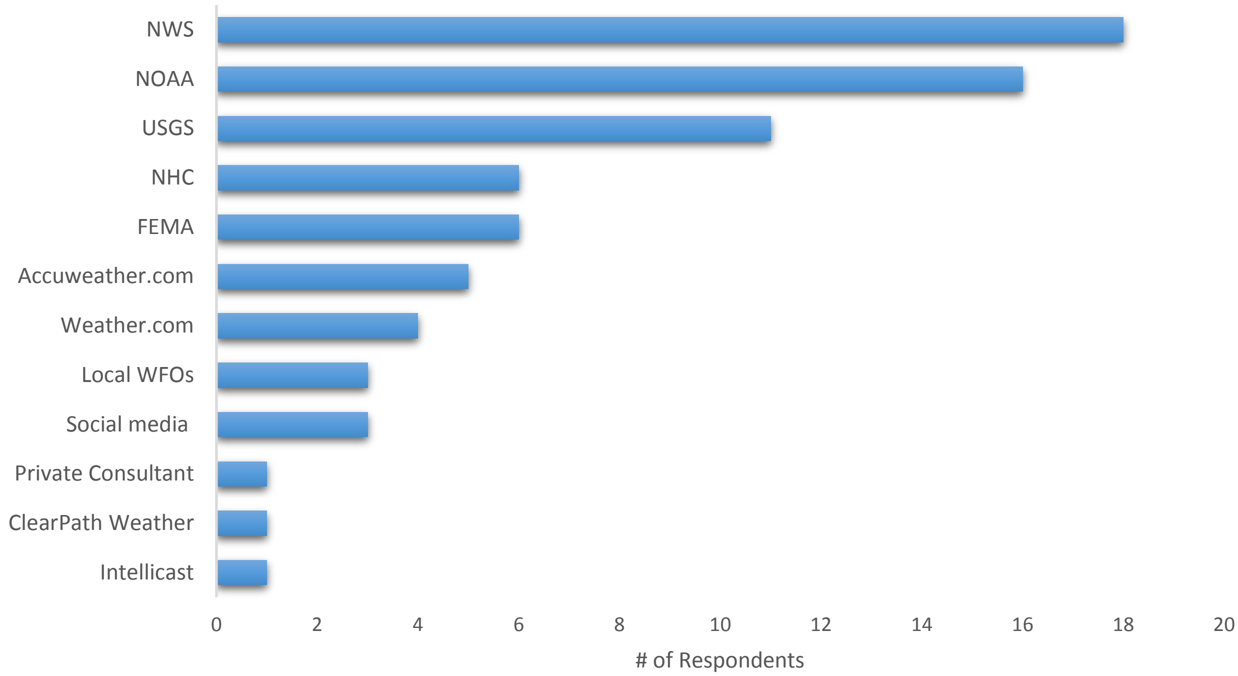
- *In what way does your agency attempt to use flash flood forecasts?*



- *Does your agency gather all weather-related (meteorological and hydrologic) data into a single location/system, or check these data sources individual for information/updates?*

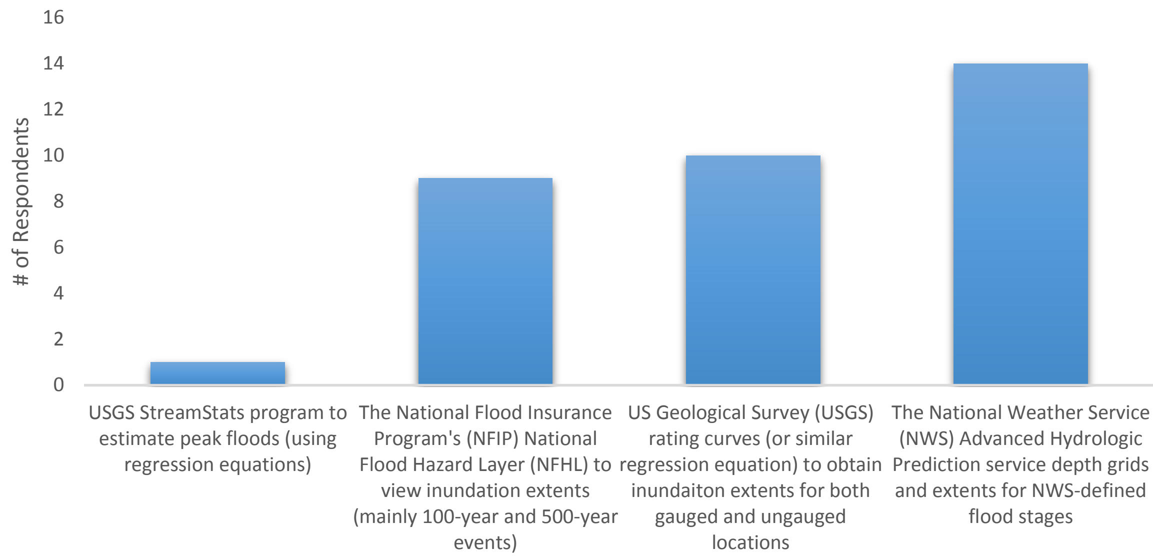


- *What are the primary sets of information that you use in developing or monitoring flood forecasts and responding to problems?*

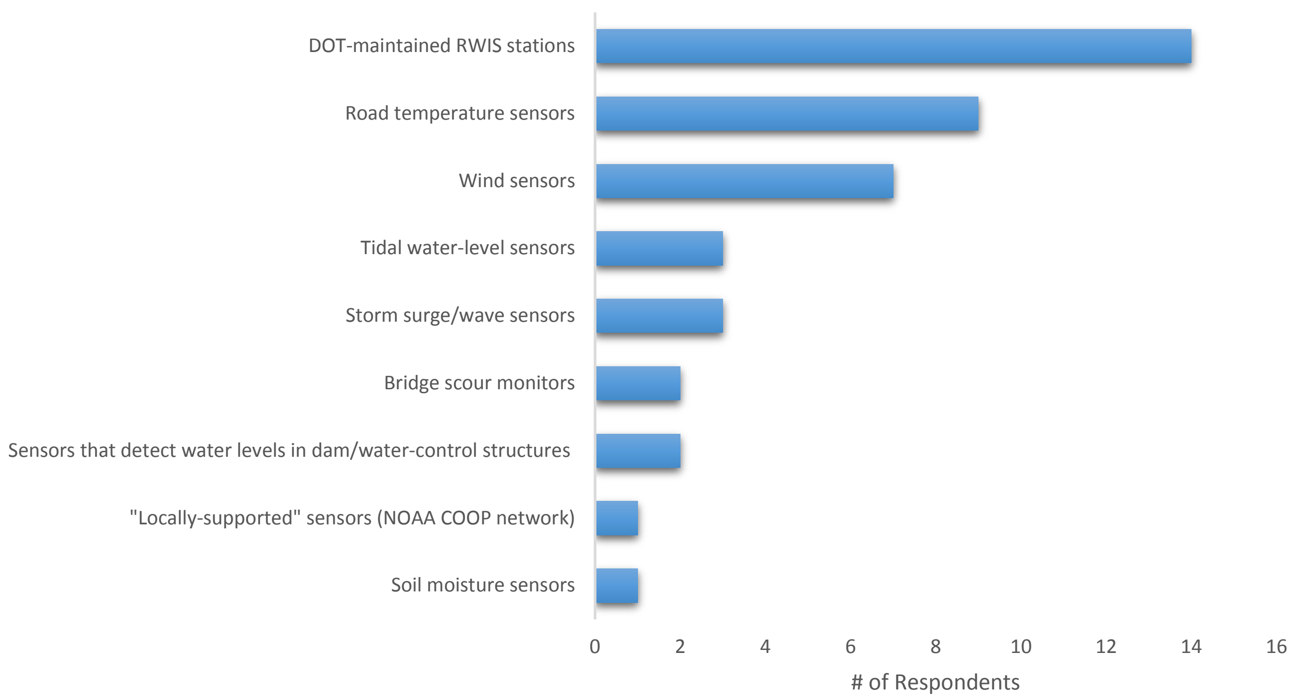


2. **<u>Hydrology and Hydraulics (H&H):</u>** The hydrology and hydraulics (H&H) components of a flood forecasting system involve the hydrometeorology and flood mapping capabilities (i.e., translation of precipitation forecast information into extent and depth predictions to identify potential vulnerabilities of the transportation network).

- *Which of the following forecast-based riverine flood extents does your agency use to identify potentially threatened transportation assets?*

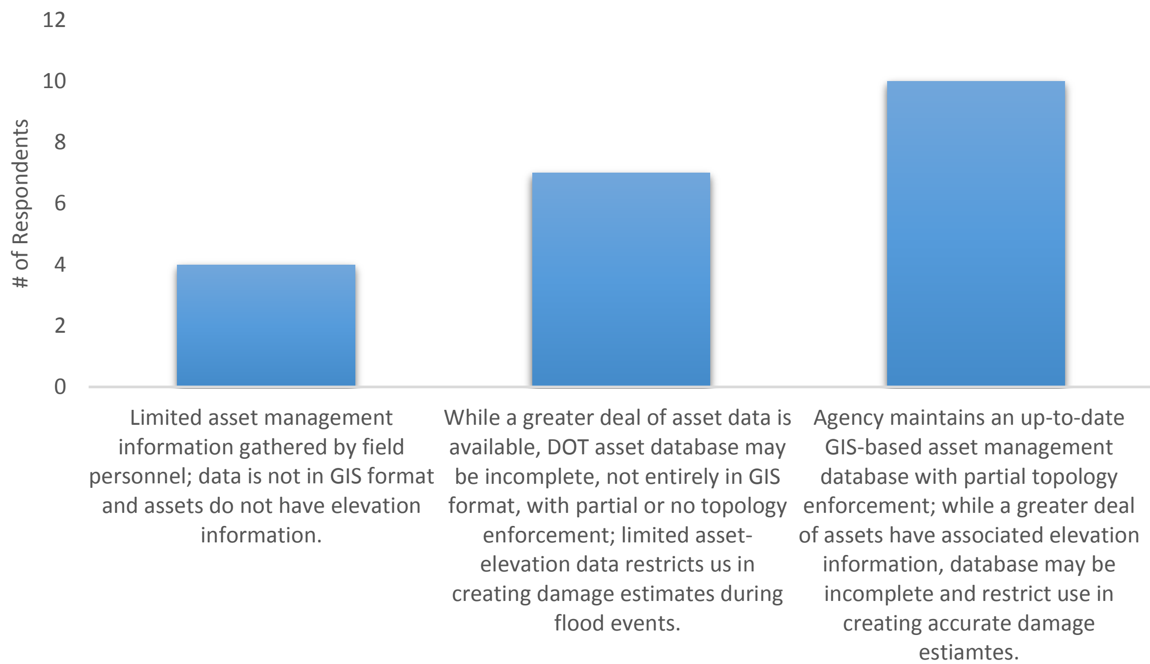


- *What types of flood sensor technology does your agency use?*

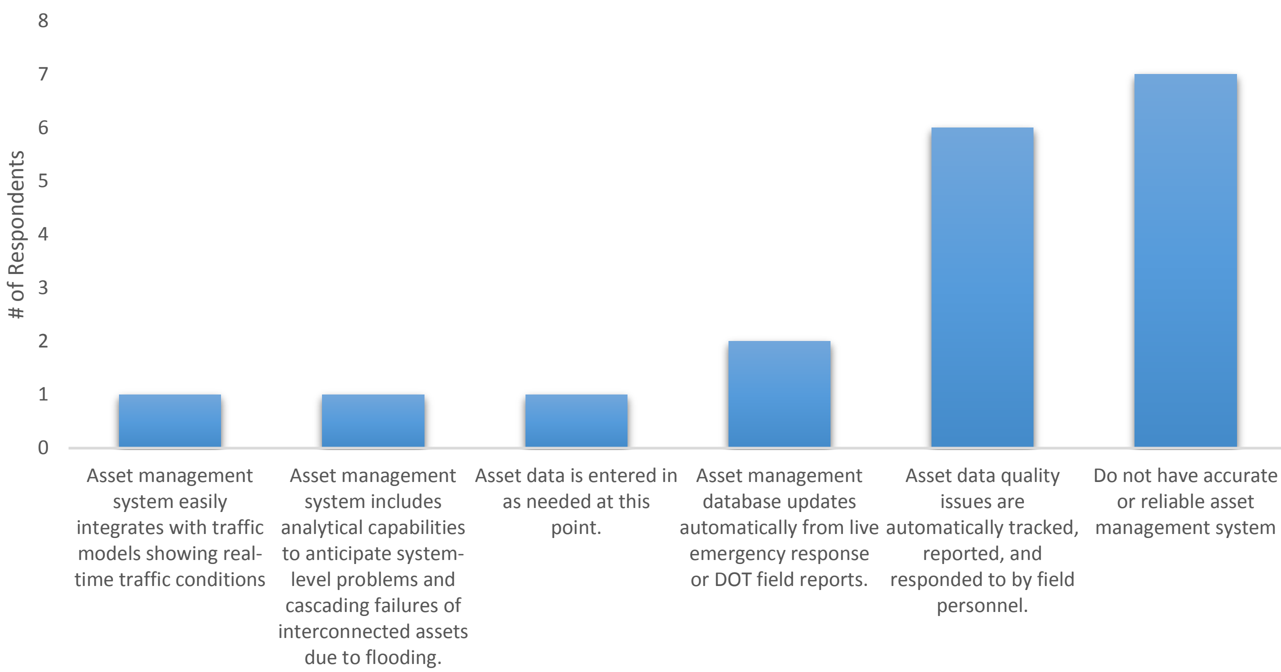


3. **<u>Asset Management:</u>** In the context of flood forecasting, asset management refers to the quality and completeness of an agency's asset management database as well as technical understanding of design parameters and fragility characteristics of assets at risk of flooding.

    - *Which of the following statements best characterizes your agency's asset management information/database?*

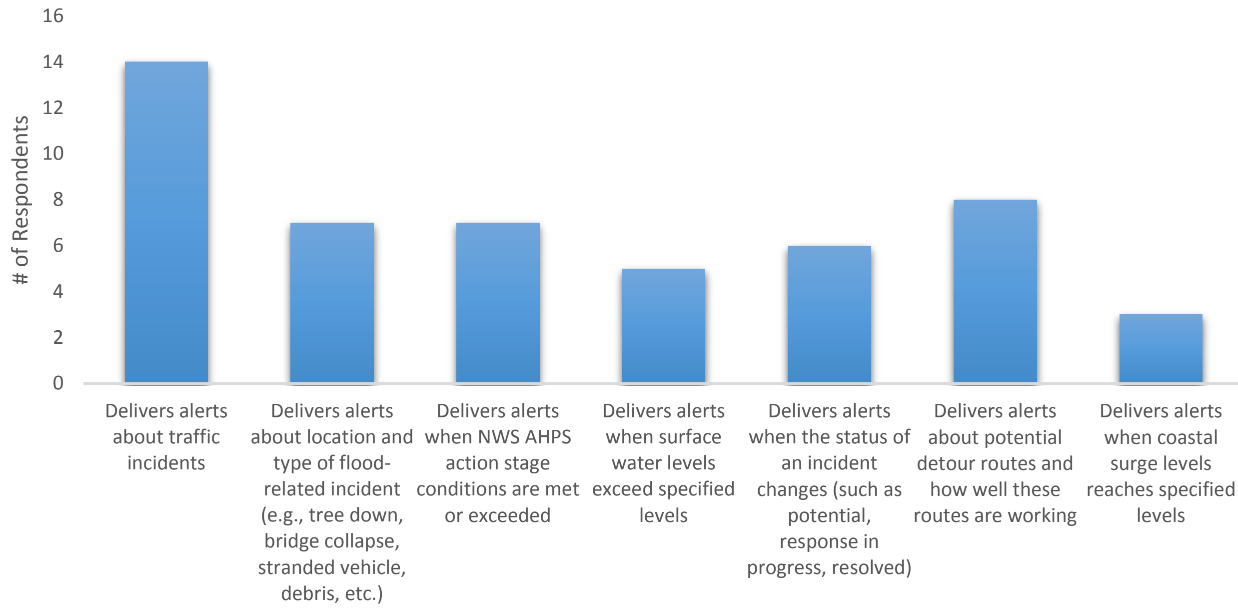


- *Please select all of the characteristics that apply to your agency's asset management system/database.*

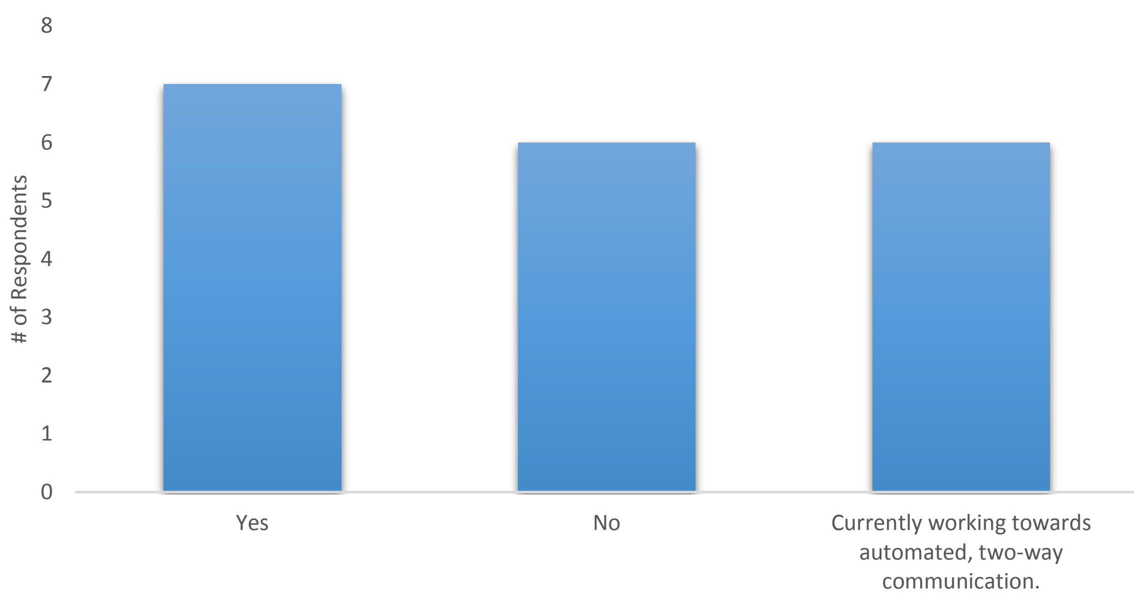


4. **<u>Communications & Information Transfer:</u>** Effective communication before, during and after a flood event requires dissemination of flood event information to multiple platforms (e.g., in-house, partner agencies, the public and traffic alert systems).

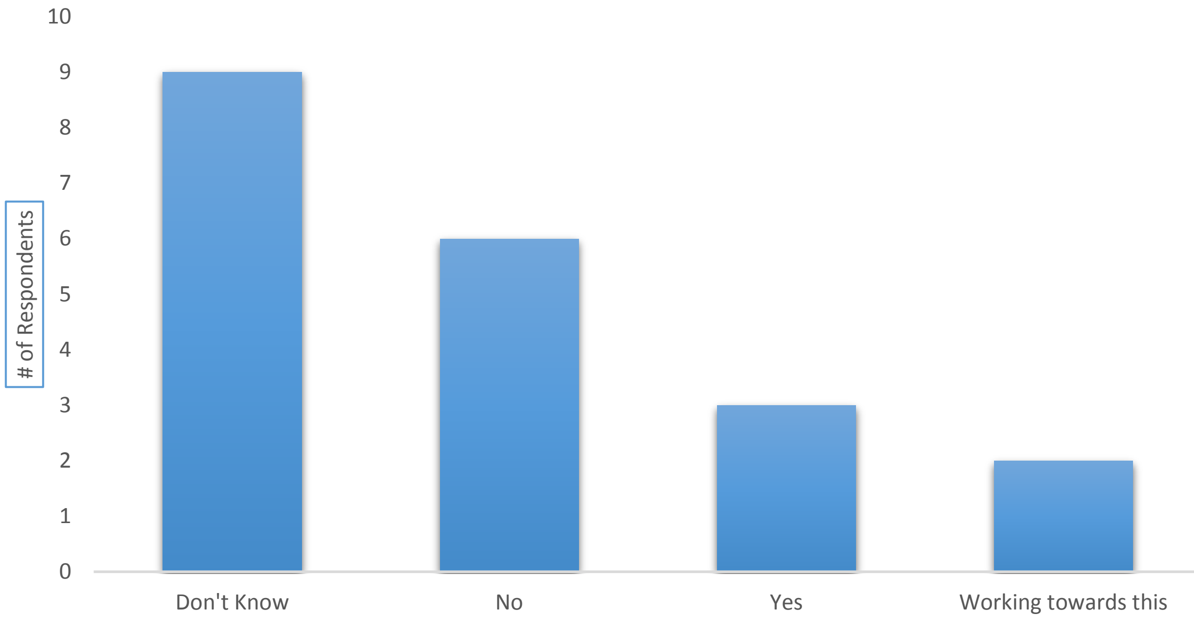
- *Which of the following questions does your agency communicate about internally during a flood event? Check all that apply.*



- *If your agency has an operational flood forecasting system, does it enable two-way communication with response crews? For example, can location-based damage data collected by field crews be posted in real-time, routed and prioritized by staff and assignments posted back to response crews?*



- *Does your agency comply with Open Geospatial Consortium (OGS) guidelines for geospatial data dissemination so that DOT-collected data can be seamlessly transferred to external users such as partner agencies, the public, other relevant agencies, and traffic alert systems?*

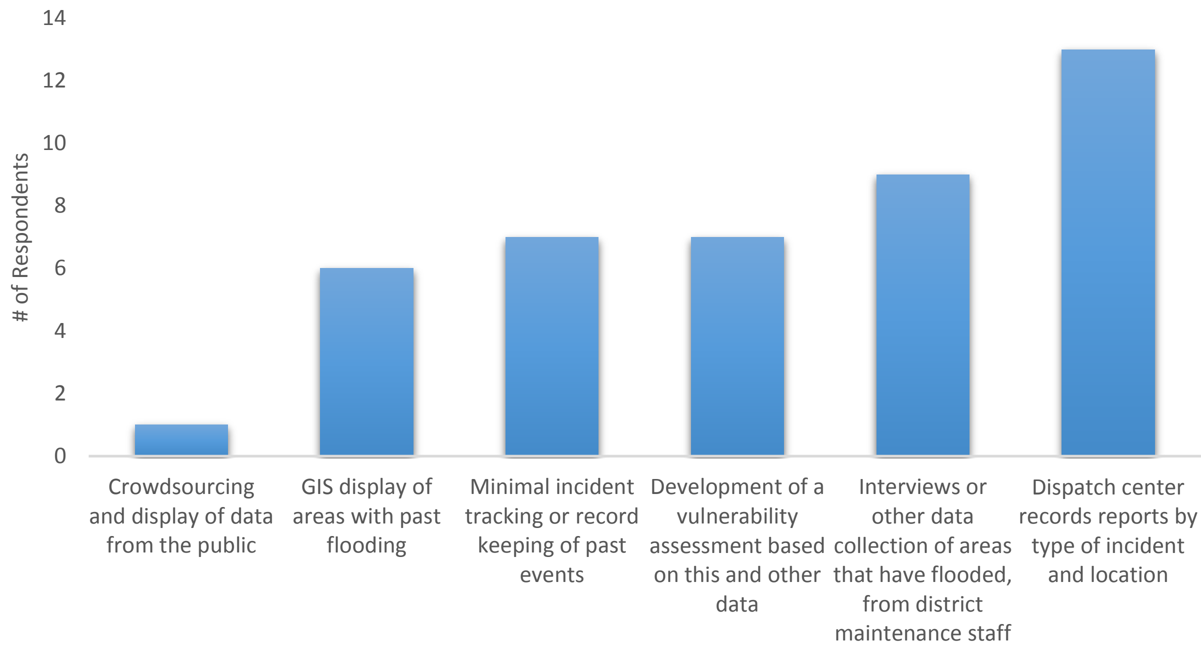


- *How do you currently "FloodCast"?*

  - No system currently used.
  - Emergency operations readiness system.
  - NOAA, NWS, Hurrevac, Weather forecast from TAMFS, RIVER Weather Forecasting Center.
  - Regional coordination, verbal, NWS data, historical data, pre-staging, previous damage assessments, regional institutional knowledge. 511NY for public information (i.e., weather and road conditions plus incident information system). Twitter feeds. Statewide Transportation Incident Command Center.
  - Mostly Plan of Actions (POA) and real-time inspections along with temporary instrumentation.
  - Sophisticated traveler information system (511) that identifies issues or problems on our statewide transportation system.
  - Often it's field personnel hearing local weather forecasts and responding. An automated process would greatly help shrinking staff in the field. Field personnel drive their areas during the storm and look for locations of concern. Damage is assessed during and afterward and fixed ASAP. We consider water over the highway, to any depth, as a reason to close routes to traffic.
  - Trying to follow a National Incident Management System (NIMS) structure.
  - Normally receive calls from the county 911 operators or from our neighboring DOT personnel. We also have a good working relationship with National Weather Service and the forecasting of the river levels. Based on the National Weather Service forecast, we will develop a plan for the gauged rivers. If the flood occurs, we will have reviewers from the office and personnel in the field determine the damage and how we plan to repair the damage.
  - Personnel drive the routes to locate flooded roadways, then report that back to the district office for inclusion in the flooded road database which shows the closures on our traveler information map. Those crews then perform any needed repairs that are within their abilities. Otherwise, contractors are left for major damage repairs.
  - Internal Bridge Scour Program. Also work with NOAA, USGS and NWS.
  - Custom built application, Emergency Operations Reporting System (EORS), for all emergency response operations. This system is used largely for snow removal operations and is used during other severe weather events, such as hurricanes, tropical storms and derechoes. All impacted engineering districts across the state enter information on their operation type, road conditions, weather and deployed resources (e.g., personnel and equipment). This system does interface with the State's weather forecasting package, which includes Roadway Weather Information Systems. In addition to EORS, our Statewide Operations Center tracks all lane closures, including their cause and duration.
  - District Offices handle responding to flood events but State DOT will assist and provide training if District Offices request it.
  - No single "system" that is used for prep, response and recovery activities. We track weather and gauge conditions using GIS web services and ArcGIS Online [AGI]. There are "stove-piped" 511 and maintenance management systems that track road conditions and damage assessment and response, respectively. The 511 system is the primary means that the LADOTD Operations staff communicate among each other and push information to the public. None of these systems are currently interoperable and this created problems in creating a common operational picture and moving data to decision-makers.
  - Internal communication by maintenance staff.
  - Transportation Operations Center tracks and manages all incident data, water over roadway, police response, etc. We have a network of several hundred CCTV cameras that all feed into the central control room, along with Microwave Vehicle Detection Systems (MVDS), and other remote sensing technologies.
  - Google Earth and different KML from NOAA and NWS.
  - NOAA, Dam Bureau programs, stream gauges, field monitoring.

5. Incident Management: The incident management component of an operational flood forecast system involves flood event incident tracking, storing and reporting to facilitate early recovery post-disaster grant application and hazard mitigation.

- *Which of the following characterizes your agency's capabilities related to incident tracking, storing and reporting to facilitate post-disaster grant applications and hazard mitigation? Check all that apply.*



- *Which of the following types of event record information does your agency store to characterize the impact/damage to transportation assets?*