Executive Summary

Preparedness and Response Practices to Support Water System Resilience: Fundamentals, Good Practices, and Innovations

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Key Findings

- This project identified practices and procedures that can help utilities increase resilience and better prepare for, and respond to, emergencies.
- The applicability of many practices may depend on unique utility characteristics and the relative maturity of the utility's resilience program.
- Finding acceptance for new technologies in the water sector is a challenge; however, cutting edge technologies have the potential to increase utility resilience and provide for better outcomes in emergency situations.
- The most notable gap in resiliency practices was noticed in the area of cybersecurity. Other gaps occur in the sector's acceptance of cutting edge technologies such as drone use, virtual reality, and 3D printing.

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Objectives

This project identified practices and procedures in published literature or in use at utilities around the country that can be shared to help all utilities better prepare for, and respond to, emergencies. This project provides a "snapshot" of various practices that could be used to increase a utility's resilience and build on, or improve, its emergency management program.

The following objectives were identified at the start of the project:

- Identify existing best and innovative preparedness and response practices
- Develop an initial outreach product for the water sector describing the identified practices
- Develop a mock-up of a future Internet database, tool, or app for enhanced digital dissemination of the identified practices
- Identify gaps in practices that may require the development of new practices
- Suggest approaches for filling identified gaps.

Background

The water sector in the United States, including its lead federal agency (U.S. Environmental Protection Agency) and supporting associations, has worked diligently for several years in the wake of 9/11 to advance emergency preparedness and response practices for utilities. Immediately following 9/11, those efforts focused on terrorism and intentional acts, but through the years the focus shifted to an all-hazards approach. For example, Hurricane Katrina in 2005 showed the country that major weather disasters could bring critical infrastructure and communities to their knees. Further, climate change is now being understood as a phenomenon that will continue to generate more frequent and more intense extreme weather events, as demonstrated by Superstorm Sandy in 2012. With each and every major response, lessons are being learned (e.g., better record keeping), and needs (e.g., analytical methods for contaminants not regulated under the Safe Drinking Water Act) are still being identified by utilities.

There is a need for utilities to be able to quickly and easily locate preparedness and response practices that will be useful to them, and for utilities to share what they have learned with others. Although there may never truly be quick "one stop shopping" for water sector innovative preparedness and response practices, this project captures a current snapshot of practices that could be used to increase a utility's resilience and to build on, or improve, emergency management procedures. This allows for quicker identification and application of relevant practices for each utility, greatly reducing the time burden on utility staff to investigate and research preparedness and response measures.

Approach

The technical approach to this project included surveys and interviews to identify existing practices and needs, as well as a literature search to identify practices from other sectors and industries that might be applicable to the water sector. To start the project, emergency management professionals within the water sector participated in a brainstorming session to develop survey questions designed to elicit responses in support of the project objectives. For example, to help identify any innovative backup communication methods, the question "When landline, Internet and cellular service are interrupted, how do you communicate with staff and others?" was asked. Answers would then help to either identify options for the sector or identify a planning gap in the sector. The survey, conducted over the Internet via SurveyMonkey®, was distributed to personnel from water, state primacy, public health, and emergency management agencies. Sector associations helped distribute the sector-specific survey to individuals through a combination of direct emails and electronic newsletters.

Sector associations that were contacted to help distribute the survey links included: Water Research Foundation (WRF); American Water Works Association (AWWA); National Rural Water Association (NRWA), which in turn notified all its state affiliates; Metropolitan Washington Council of Governments (MWCOG); Water Environment Federation (WEF);

Water Environment Research Foundation (WERF); Association of State Drinking Water Administrators (ASDWA); Association of Clean Water Administrators (ACWA); National Association of County & City Health Officials (NACCHO); National Emergency Management Association (NEMA); the Federal Emergency Management Agency's Emergency Management Institute (EMI); and the International Association of Emergency Managers (IAEM).

The research team contacted each survey respondent who indicated an interest in a follow-up interview. These individuals were contacted twice by email and once by phone in attempts to schedule interviews. A questionnaire was developed for follow-up interviews. The interviews were informal to encourage natural conversation that could potentially capture unexpected ideas or practices. Most follow-up interviews occurred by telephone; however, face-to-face interviews were also opportunistically conducted at sector events such as the AWWA Annual Conference and Exposition.

The literature review was conducted using a set of key search terms and groupings of these key terms. Initial search engines included Google, Google Scholar, and Bing, as well as databases and digital libraries such as the U.S. Department of Homeland Security (DHS) Lessons Learned Information Sharing Program, JSTOR, and WaterISAC. Based on similar results from these platforms, researchers ultimately used Google, Google Scholar, and WaterISAC for most of the literature review process. Initial searches produced information from well-known water sector associations such as WRF, AWWA, and WEF, as well as from government agencies such as the U.S. Environmental Protection Agency (EPA). The research team, in consultation with the Project Advisory Committee (PAC), decided not to list these resources in the final guidance document since most utilities within the sector are already very familiar with these sources of information. Rather, the research team focused on finding and listing resources from outside the water sector when those resources included practices or ideas that were relevant to the sector. Examples include articles in emergency management journals or active shooter procedures described by DHS.

Results/Conclusions

The research team received a total of 478 completed online surveys from water and wastewater personnel (355 surveys), state primacy agency personnel (28), emergency management personnel (63), and public health personnel (32). Of the utilities, 65% of the respondents identified themselves as very small utilities (serving <3,300 people), 23% as small utilities (serving 3,300 to 49,999 people), 2% as medium utilities (serving 50,000 to 99,999 people), and 8% as large utilities (serving 100,000 people or more). Two percent of the respondents did not complete the question regarding utility size.

The research team conducted interviews based on survey responses indicating an interest in being interviewed, interview recommendations from other professionals in the sector, and conversations with individuals at sector events (e.g., AWWA Annual Conference and Exposition). A total of 87 half-hour interviews were conducted. Fifty-two of the interviews were conducted with water sector personnel, 12 with state primacy agency staff, 12 with emergency management professionals, and 11 with public health personnel.

The research team conducted the literature review by linking descriptors and topics, as indicated in the table below, to create search terms such as "water utility lessons learned."

Descriptors	Topics
water utility, wastewater utility, emergency management, incident management, emergency response, generator, fuel planning, cybersecurity, FEMA, public assistance, damage assessment, SCADA, hurricane, tornado, earthquake, drought, climate change, typhoon, ice storm, blizzard, polar vortex, tsunami, wildfire, flood, emergency spending	lessons learned, best practices, best management practices, case studies, tips, practices, techniques, planning, preparedness, plans, success stories, innovations

Sources for the review included articles, book chapters, government documents, and institutional publications, among others. Ultimately, 225 literature sources were identified and grouped into 23 subject areas. Of these subject areas, most resources (70%) were classified under emergency planning/preparedness (58 resources), security (23), communications (18), natural hazards (17), extreme weather/climate change (16), technology (16), or geographic information systems (10). The literature review was most useful for locating emergency preparedness and response practices for hazards or procedures not typically planned for by the water sector, such as addressing an active shooter scenario or composing emergency text messages.

Many practices identified would work for some utilities, but not others, depending on unique utility characteristics and the relative maturity of the utility's current resilience program. Therefore, the project results could not be coalesced into a comprehensive preparedness and response framework or "neat package" for all utilities to follow. This realization helped to shape the project's final deliverable, which serves as an interactive, highly navigable PDF-based tool designed to steer users to the individual resiliency practices that they may find the most valuable for their utility's circumstances. While a user could read the final deliverable in the traditional sense, it is intended to be used as a filter to quickly find project results of the greatest interest to the user. This format lends itself well to potentially converting the final deliverable into a web-based tool for ease of updating and potentially for further content development by the user community.

The information gathered from the surveys, interviews, and literature review was categorized with PAC input into six broad categories:

- Administrative – Practices related to legal frameworks, contracting mechanisms, funding arrangements, and creative partnerships
- Communications – Practices centered on improving communications
- Resource Management – Practices focused on how response personnel or equipment can be better managed or maintained
- Preparedness – Practices to improve overall utility preparedness
- Incident Management – Practices to better organize and manage a response
- Problem Solving – Practices that help to solve a particular preparedness or response challenge

In addition, not all practices identified were considered to be "innovative" by the research team and the PAC. However, these "non-innovative" practices were considered to be foundational to building a strong utility resilience program. Also, what may be considered commonplace by one utility could be considered innovative by another. To accommodate this, practices were further grouped into fundamentals, good practices, or innovations under each broad category listed above. Fundamentals may already be in place at many utilities. Good practices serve as models for most utilities, and

innovations include “out of the box” thinking or cutting edge technologies that may help increase resilience at most utilities. To help utilities take full advantage of the information in the final deliverable, a simple “scorecard” table was included so that users could track practices already in use at their utilities and list practices for future implementation. Utilities are also encouraged to adapt and modify practices as needed to better fit their unique circumstances.

Resiliency practices were identified and an initial outreach product for the water sector was developed, which could serve as a mock-up for a future Internet database, tool, or app. Additionally, gaps in resiliency practices were noticed, particularly in the area of cybersecurity. While some practices are in use by the sector, it is clear that cybersecurity is one aspect of resilience that the water sector has approached cautiously. Almost a third (28%) of the 355 utility survey respondents noted that they “have nothing formal in place” when it comes to preparing for or managing cyber risks. Other gaps occur in the sector’s acceptance of cutting edge technologies such as drone use, virtual reality, and three-dimensional printing.

Applications/Recommendations

It was noted during the course of the research that an Internet-based information exchange, such as a bulletin board, would be helpful to facilitate the exchange of resiliency ideas and practices in real time, and to assist in keeping the project’s results up to date in the future. This is an idea that WRF may wish to explore further, and one possibility could be to partner with WaterISAC to make use of WaterISAC’s existing dashboard on its website.

Gaps in practices could also be closed or partially closed. For example, recent cybersecurity work within the water sector, such as the cybersecurity assessments of selected Virginia waterworks, may help to fill gaps as data on practices are gathered and compiled by others. Both AWWA and the EPA are sponsoring cybersecurity workshops that utilities could be encouraged to attend. The WRF project #4670, *Defining Optimum Security and Communication Methodologies for Intelligent Water Networks*, is inventorying the different types of information sources currently being used by water utilities along with the associated communication media and protocols, assessing the security risks, and determining whether the current cybersecurity measures in use provide acceptable protection. In cases where the current measures appear inadequate, alternate approaches will be recommended by the project’s research team. Additionally, a water sector survey is being used to gather best practices in security and communications. These efforts may also help to close the cybersecurity gap.

Finding acceptance for new technologies in the water sector is a continual challenge. The sector is heavily regulated, meaning technologies have to be proven, and funding is scarce to try new things. However, cutting edge technologies have the potential to increase utility resilience and provide for better outcomes in emergency situations. The more utilities can see other utilities using cutting edge technologies and deriving benefits from them, the more likely they are to adopt them as well. Webinars, case studies, and cutting edge technology tracks at sector conferences can all help to hasten the water sector’s acceptance of new technologies.

Multimedia

To make resiliency practices easy to find and the final report easy to navigate, the final product was designed as an interactive PDF document that functions much like a website, with navigational features such as “forward” and “back,” a home page, and shortcut links throughout the document. Color is also used extensively to help users identify which section of the document they are reading.

In addition, a worksheet summarizing the results of the literature review is provided on the #4601 project page of the WRF Website, under Web Tools.

Research Partners

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Participants

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Participating Utility: DC Water

- Patti Lamb
- Dusti Lowndes
- Jonathan Reeves

Project Advisory Committee

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- Steve Bieber, Metropolitan Washington Council of Governments
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Related WRF Research

- Business Continuity Plans for Water Utilities, project #4319
- Defining Optimum Security and Communication Methodologies for Intelligent Water Networks, project #4670
- Enhanced Water Quality Monitoring During a Large Public Event to Detect Possible Contamination, project #4531
- Flushing Guidance for Consumer Premise Plumbing and Service Lines to Avoid or Address a Drinking Water Advisory, project #4572
- Gap Assessment for ASME-ITI/ AWWA J100-10 Standard and Leading Vulnerability Assessment Tools, project #4358
- Proceedings of the 9th Water System Seismic Conference, project #4603

