



Understanding &  
Using Hazus-MH

CONSOLIDATED REPORT:  
Hazus-MH Report Builder

Gary Anderson  
Kristine Kohlhepp  
Letty Limbach

# TABLE OF CONTENTS

---

01

RESEARCH

---

02

DESIGN AND EVALUATION

---

03

OUR SOLUTION:  
The Hazus-MH Report Builder

---

04

DATA VISUALIZATION  
RECOMMENDATIONS

---

05

APPENDIX

# INTRODUCTION

## MEET THE TEAM



GARY ANDERSON

Gary enjoys sharing the principles and philosophy of user-centered design and takes great pride in helping organizations and individuals realize the benefits of always putting the end user first. Gary is currently a UX Program Manager at Microsoft.



KRISTINE KOHLHEPP

Kristine is passionate about understanding people through quality research and loves the power the UCD process has to create innovative solutions to any problem. She currently contracts as a UX Researcher at Google, collaborating daily with designers and engineers to shape the development of new products.



LETTY LIMBACH

Letty is a graphic designer, illustrator, and front-end web developer who loves creating functional and delightful user experience, responsive design, and meaningful but beautiful visual communication. Letty works as a front-end web developer/graphic designer at the University of Washington.



## HUMAN CENTERED DESIGN & ENGINEERING

UNIVERSITY of WASHINGTON

This research was part of our Winter 2016 capstone project within the Human Centered Design & Engineering Master of Science program at the University of Washington.

The authors would like to extend special thanks to:

- Scott Miles from the Center for Collaborative Systems for Security, Safety, and Regional Resilience (CoSSaR)
- The various members of the Hazus-MH user community who contributed to this project

---

# INTRODUCTION

## PROJECT SUMMARY

In 2015, FEMA issued 75 disaster declarations, 40 of which were declared major disasters.<sup>1</sup> With extreme weather being one of the most visible effects of global warming, the frequency of disaster-level events is likely to increase and communities will need robust tools to help prepare for and mitigate their effects. Hazus-MH is a tool produced by the Federal Emergency Management Agency (FEMA) for natural disaster preparedness, mitigation, response and recovery. A comprehensive understanding about user needs for this data did not appear to exist, so we sought to build this understanding and answer the design question: How can we improve the experience of interacting with Hazus-MH to better support its users' goals?

From our extensive research, we identified design opportunities in six areas of the Hazus workflow and decided to focus on results communication because we felt this area had the largest opportunity for impact. Communicating Hazus' results is essential to inspire action and get funding for mitigation projects, but the current process of creating reports is difficult, confusing, and time-consuming. To address these issues, we created the Hazus-MH Report Builder: a report generation tool that enables Hazus users to create more effective reports in much less time. By enabling Hazus users to more effectively communicate their message, this tool can help them get their communities the information and funding they need to prepare for and recover from natural disasters.

---

<sup>1</sup> "Disaster Declarations for 2015." *FEMA*. FEMA, n.d. Web. 10 November 2015.

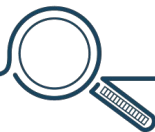
# INTRODUCTION

## OUR PROCESS

1

### RESEARCH

Our in-depth user research included semi-structured interviews, a survey, and a landscape analysis. From this work, we developed an understanding of the Hazus workflow and its pain points and identified design opportunities in six areas of the experience.



### IDEATION

2

We held multiple brainstorming sessions, which included affinity diagramming and sketching. From these sessions, we settled on our report builder tool concept and created a list of required functionality.



3

### INTERACTIVE PROTOTYPING

We created an interactive prototype in Axure RP, which enabled deeper discussions on user interactions and required functionality. It also provided a means for conducting usability tests with real world users.



### EVALUATION & ITERATION

4

Through usability testing with Hazus users, we validated our design concept and identified opportunities for improvement. We then iterated on our prototype, to incorporate those findings.



---

# 01

## RESEARCH



---

# RESEARCH

## EXECUTIVE SUMMARY

We conducted a multi-methodology research effort (landscape analysis, user survey, and user interviews) to better understand the natural disaster risk-mitigation and recovery tool environment, and more specifically, the use of Hazus-MH within this environment. Top takeaways regarding Hazus-MH usage are as follows:

---

### DEEP UNDERSTANDING REQUIRED

Effective use of Hazus requires users to have a deep understanding of the tool, which can only be gained through training.

---

### CONCERNS WITH OUT-OF-BOX USE

While out-of-box data is provided, many practitioners noted that it doesn't provide highly accurate results for site-specific analyses.

---

### GATHERING LOCAL DATA IS A PROBLEM

Gathering local data to improve accuracy is time consuming, requires expertise to gather, and has no process governance.

---

### INPUTTING LOCAL DATA IS DIFFICULT

Once local data is gathered, entering the data into the tool is a time-intensive and complex process, which enables errors.

---

### OUTPUT REQUIRES INTERPRETATION

Understanding and reporting the results of Hazus can be challenging, and it is easy for results to be misinterpreted/overstated.

---

### OUTPUT REQUIRES REFORMATTING

Hazus generated reports are difficult to consume and do not include all the information needed by consumers.

---

### OUTPUT NEEDS VARY

Communication with different audience groups requires different outputs, and surfacing limitations is critical for credibility.

---

# RESEARCH

## METHODOLOGIES

---

### 01

#### LANDSCAPE ANALYSIS

We conducted a landscape analysis of 17 alternative loss estimation and/or hazard mitigation and recovery tools to understand how hazard mitigation and recovery information needs are being served outside of Hazus-MH today.

---

### 02

#### SEMI-STRUCTURED INTERVIEWS

We conducted 11 semi-structured interviews (plus two additional interviews after our official analysis was complete) with a variety of Hazus stakeholders. The interviewees encompassed a wide range of experience with the tool (from people who have only used Hazus once or twice to those that have been using it for over 12 years), as well as a wide range of usage types (people who deal only with the reports generated by Hazus, people who run the scenarios, and people who work on the development side of Hazus).

We conducted interviews of approximately one hour each based on a script developed by one of our team members. We then held an affinity-diagramming workshop to synthesize the large amount of data we'd gathered (see Appendix: Transcribed Groupings).

---

### 03

#### SURVEY

Finally, we sent out a short Hazus usage survey to our Hazus user contacts and to broader communities by posting a link to the survey in two Hazus User Group LinkedIn pages, on Twitter, and to the [Reddit GIS subgroup](#). Because many of our interviewees were based in the Pacific Northwest, we had hoped to reach a wide Hazus user base. We received 17 responses over the 14 days that the survey was open. Six of our interviewees also responded to our survey.



---

# LANDSCAPE ANALYSIS

---

# LANDSCAPE ANALYSIS

## OVERVIEW

We conducted a landscape analysis of 17 natural hazard loss-estimation, risk mitigation, and recovery tools to achieve the following goals:

- Better understand the environment of tools within which Hazus-MH resides
- Identify common features of loss-estimation, risk mitigation, and recovery tools
- Identify prevalent user experience / interaction design patterns

The tools within this analysis were selected for review as follows:

- Referral by interviewee(s)
- Web-based search; focusing on hazard loss-estimation tools, risk mitigation tools, and hazard recovery tools as primary search criteria

This landscape analysis also uncovered a variety of loss-estimation, risk mitigation, and hazard recovery program development/communication tools. While these were observed and viewed, thorough analysis was constrained to tools which were (1) part of a web-based, desktop, or mobile application/tool and (2) featured a user interface.



For the full details of this analysis, see:

LANDSCAPE  
ANALYSIS

# LANDSCAPE ANALYSIS

## SUMMARY OF FINDINGS

### Platform and Focus Area

#### Most tools were web-based; responsive design was less common

14 of the 17 tools we reviewed were web-based and publicly accessible (see Fig. 1). Two of these tools were desktop applications and proprietary (accessible via license). It is also important to note that true responsive/ adaptive design (i.e. renders effectively regardless of screen size) was present in only 4 of the 14 web-based tools. Again, the only non web-based, non-desktop tool reviewed was the GEM IDCT Direct Observation tool, which is an Android mobile application.

#### Not uncommon for the tools to have a local focus

We evaluated a range of tools with different hazard focuses (flood, earthquake, hurricane, multi-hazard; see Fig. 2). Beyond type of hazard focus, it was interesting to note that 7 of the 17 tools targeted local populations, utilizing country or state data. Furthermore, 6 of these tools only displayed data for their represented area. In some cases, it appears that this local targeting is in part due to the utilization of the data provided by that local area (that may or may not be available beyond the localized area).

#### Low number of tools promote status as open-source development

Only 2 of the 17 tools reviewed actively promoted that they used an open-source development framework (actual number using open-source development may vary). Many of the solutions used Esri's ArcGIS platform as the background to their mapping system.

Fig. 1 Type of platform for reviewed tools

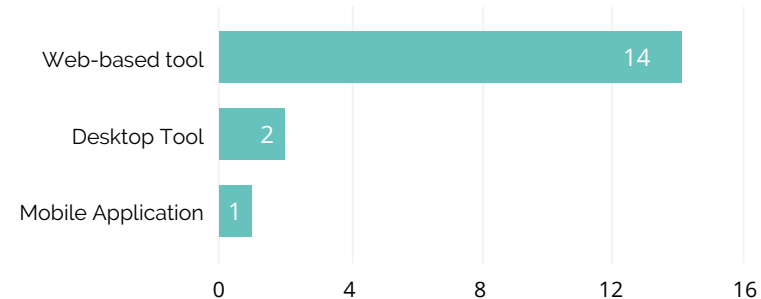
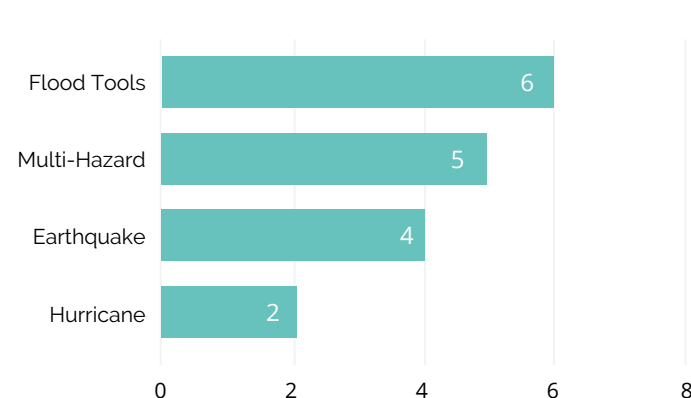


Fig. 2 Focus of reviewed tools



# LANDSCAPE ANALYSIS

## SUMMARY OF FINDINGS

### Common Features / Interactions

#### **100% of risk analysis/exposure tools use maps/geospatial visualization**

16 of the 17 tools we reviewed used a map as the primary background for the display of their data visualization(s). The only tool that did not overlay data on its map was the GEM IDCT Direct Observation Survey tool, which was dedicated to helping users conduct a mobile building inventory (not risk or exposure analysis). Many of these maps utilized expected controls/interactions: zoom support, search for specific address, etc.

#### **Utilization of multiple sources of data was the norm**

9 of the 17 tools reviewed actively disclosed the use of data sets from multiple sources of data to construct their visualizations. While many of the other tools did not actively disclose multiple data sources, it appears that this was also likely for those tools.

#### **On-screen welcomes/user assistance was common across tools**

In 4 of the 17 applications, extensive consideration was given to large amounts of user support - introductory welcomes, usage guidelines/process support, and hover state support. User support (albeit to a lesser extent) was also observed in many of the other tools that were reviewed.

#### **Scenario generation**

Both proprietary desktop solutions and 3 of the web-based solutions allowed more complex scenario creation, allowing the user to look at comparisons between these scenarios.

### Uncommon or Rare Features / Interactions

#### **Measurement tools were infrequent, but similar when employed**

Within 3 of the tools we found measurement actions (click-and-drag to select a area to be measured). While not seen across a high volume tools, when they were employed they appeared to operate similarly.

#### **Mobile support was less common and/or less acknowledged**

Only 4 of the reviewed solutions were optimized for a mobile experience. These tools did seek to make use of unique mobile device benefits, such as “Find my Location.”

#### **A few other unique notable features were noted**

We also took note of a few features that seemed to add unique value but were very uncommon or unique to single tool:

- Display of evacuation routes (1)
- Presentation of damage number on-map (1)
- Export a PDF (1)
- Provide toggle for “public” and “expert” views (1)
- Toggle between English/Spanish (1)
- High-quality on-page data visualizations/summaries (1)
- Intelligent aggregation of icons at different zoom levels (1)
-



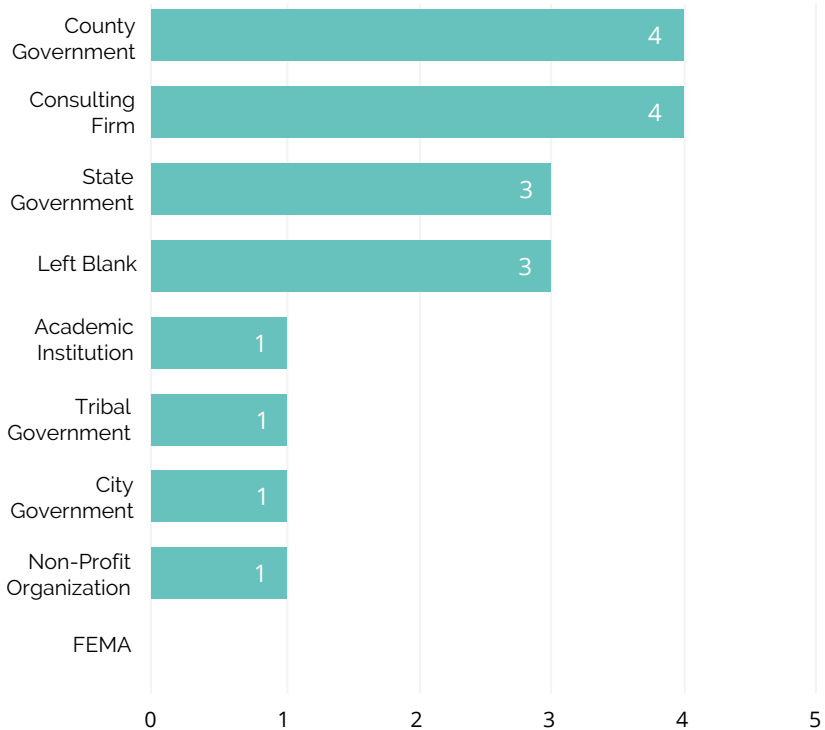
---

# SURVEY AND INTERVIEW RESULTS

# WHO USES HAZUS-MH

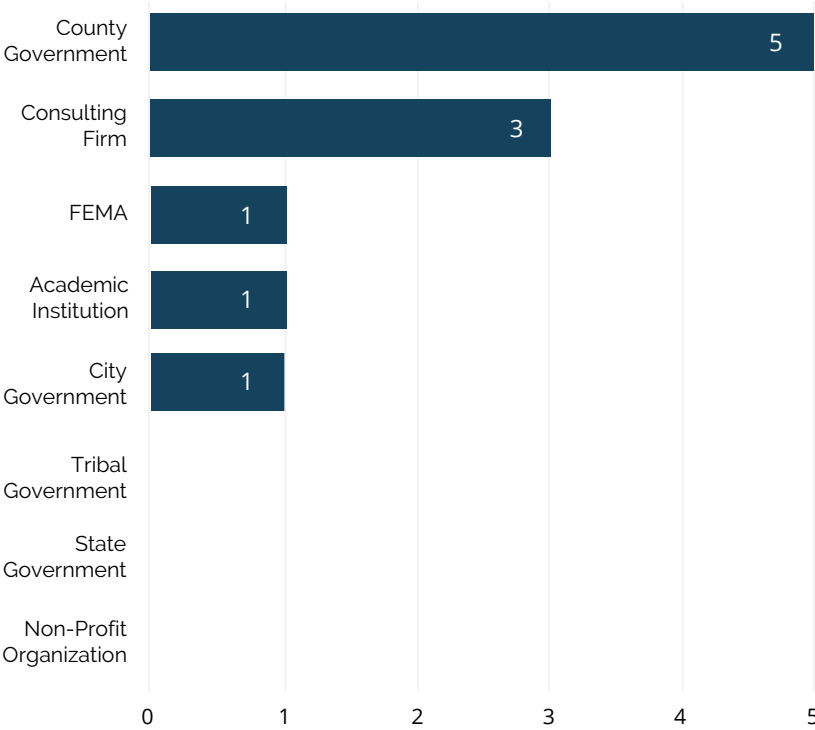
## SURVEY AND INTERVIEW RESULTS

**Fig. 3 Survey Respondents, n=18**



When asked **“What Organization do you work for?”**, interview and survey respondents fell into eight different categories (see Fig. 3 and 4). As discussed previously, six of our survey respondents were also interviewees.

**Fig. 4 Interviewees, n=11**

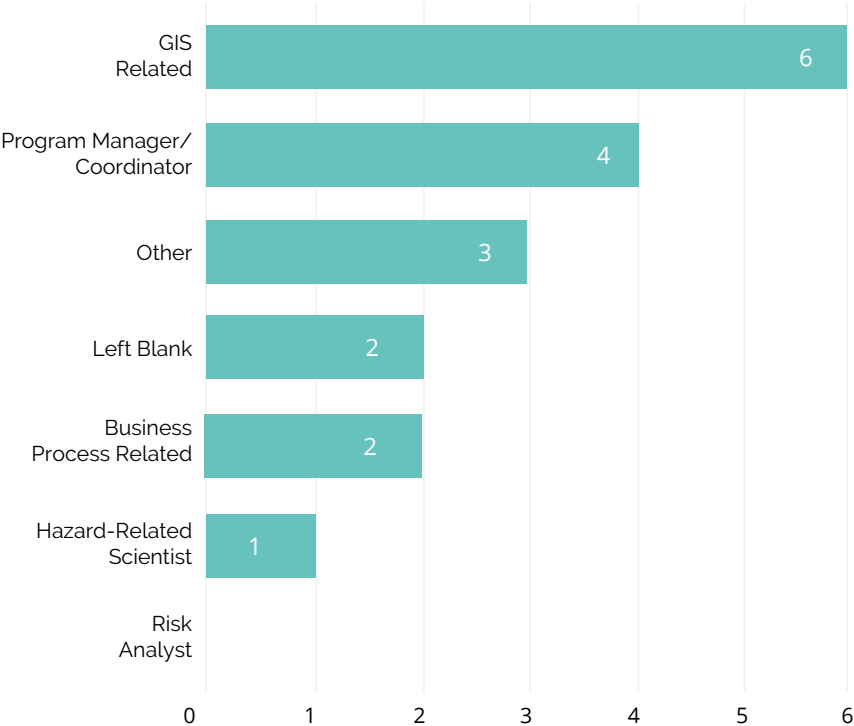


# WHO USES HAZUS-MH

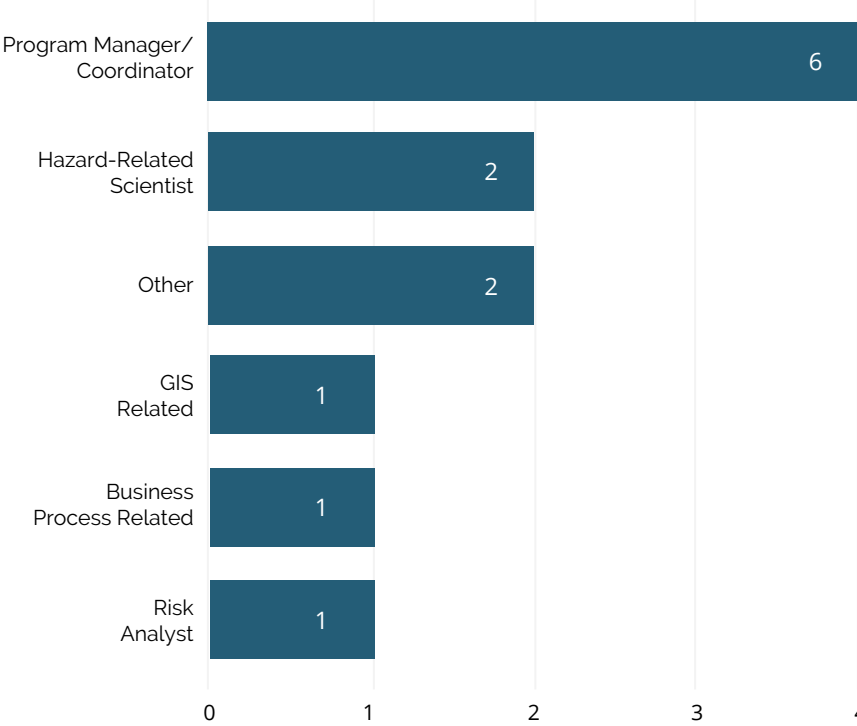
## SURVEY AND INTERVIEW RESULTS

When asked **“What is Your Role?”**, interview and survey respondents fell into five different categories, as well as an “Other” category (see Fig. 5 and 6).

**Fig. 5 Survey Respondents, n=18**



**Fig. 6 Interviewees, n=11**

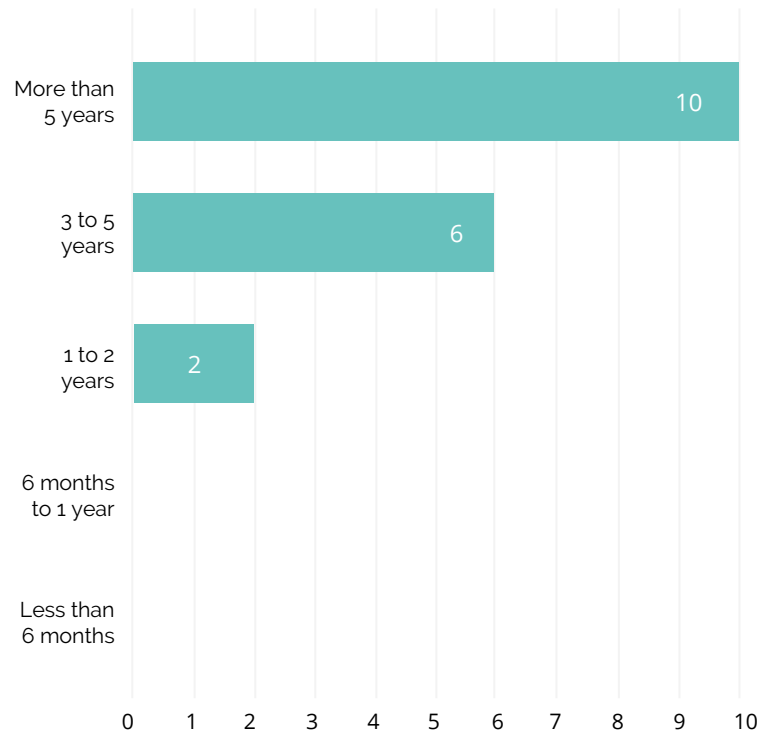


# WHO USES HAZUS-MH

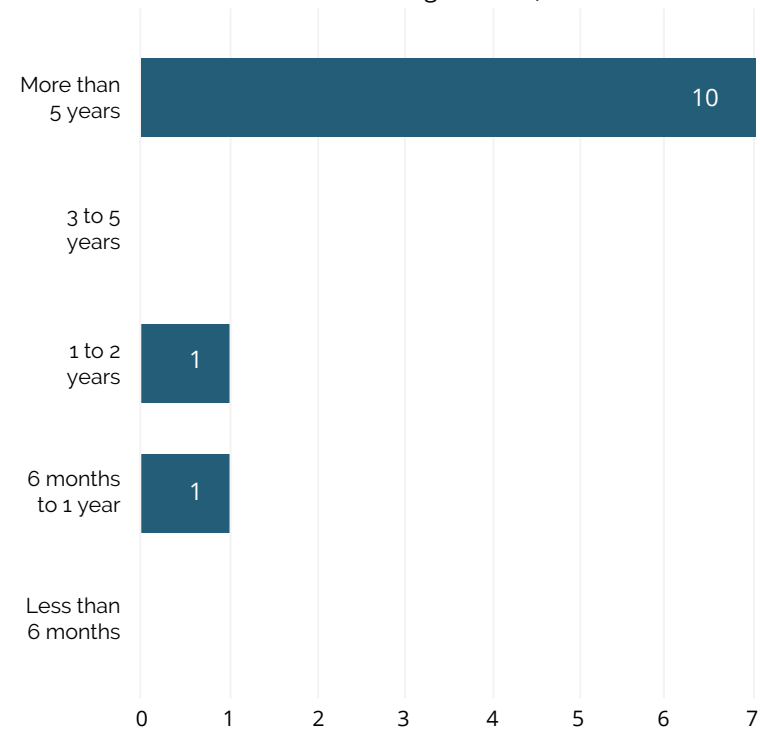
## SURVEY AND INTERVIEW RESULTS

When asked “How long have you been using Hazus?”, the majority of our interview and survey respondents were experienced Hazus users. This was likely due to our snowball sampling method (see Fig. 7 and 8).

**Fig. 7 Survey Respondents, n=18**



**Fig. 8 Interviewees, n=11 (2 did not indicate length of use)**



# HOW DO THEY USE HAZUS-MH

## SURVEY AND INTERVIEW RESULTS

Another key piece of our research related to how people use Hazus. Our research participants varied in terms of frequency of use, direct or indirect interaction with the Hazus-MH interface, and Level 1-Level 3 use.

When asked **“How frequently do you use Hazus and/or its outputs?”** very few research participants answered “daily” and our biggest pool of respondents fell into the category of “Every few months” (see Fig. 9 and 10).

Fig. 9 Survey Respondents, n=18

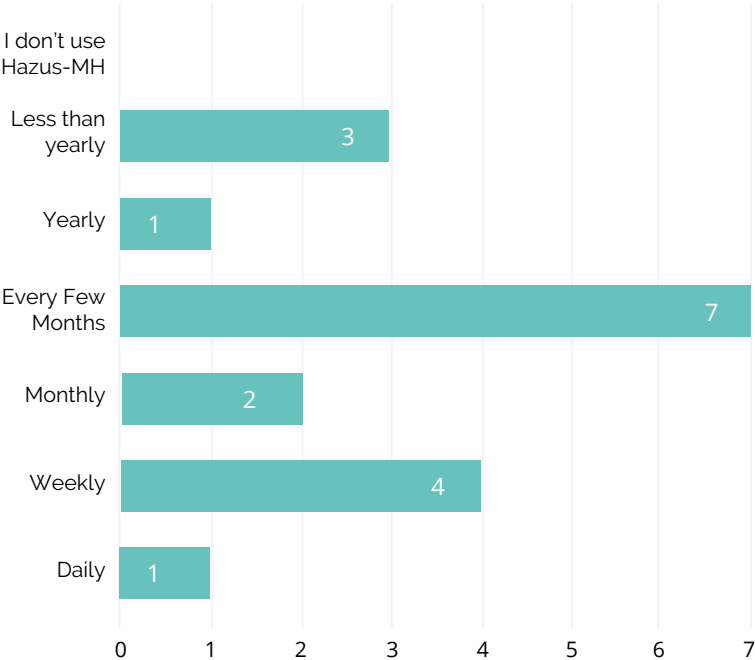
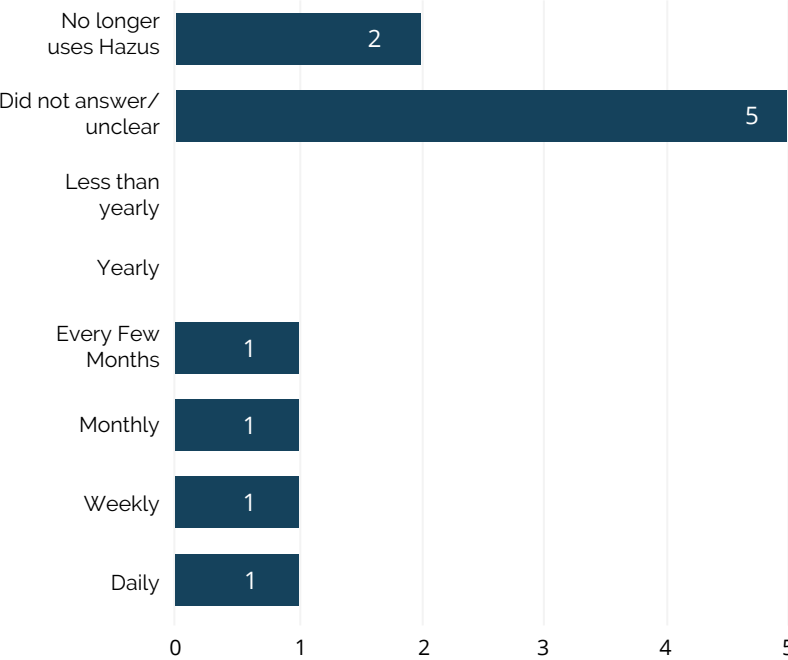


Fig. 10 Interviewees, n=11



# HOW DO THEY USE HAZUS-MH

## SURVEY AND INTERVIEW RESULTS

We also asked how research participants obtain Hazus-MH data. Due to the variety of roles that interact with Hazus, not everyone interacts with the Hazus software directly. Some users interact only with Hazus outputs.

When asked **“How do you obtain Hazus data?”**, the majority of those surveyed and interviewed indicated that they run simulations themselves, but it was also common to get data from other sources such as coworkers and consultants (see Fig. 11 and 12).

Fig. 11 Survey Respondents, n=18

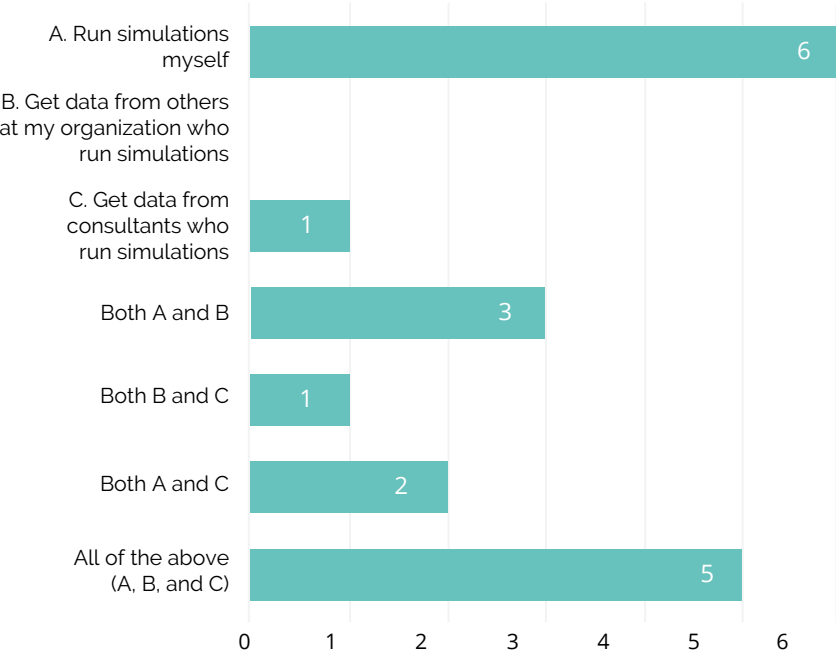
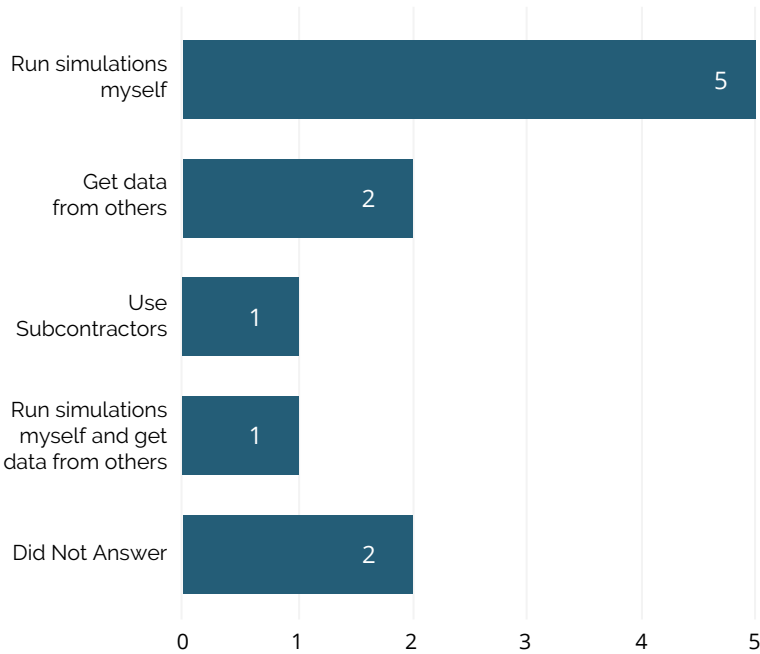
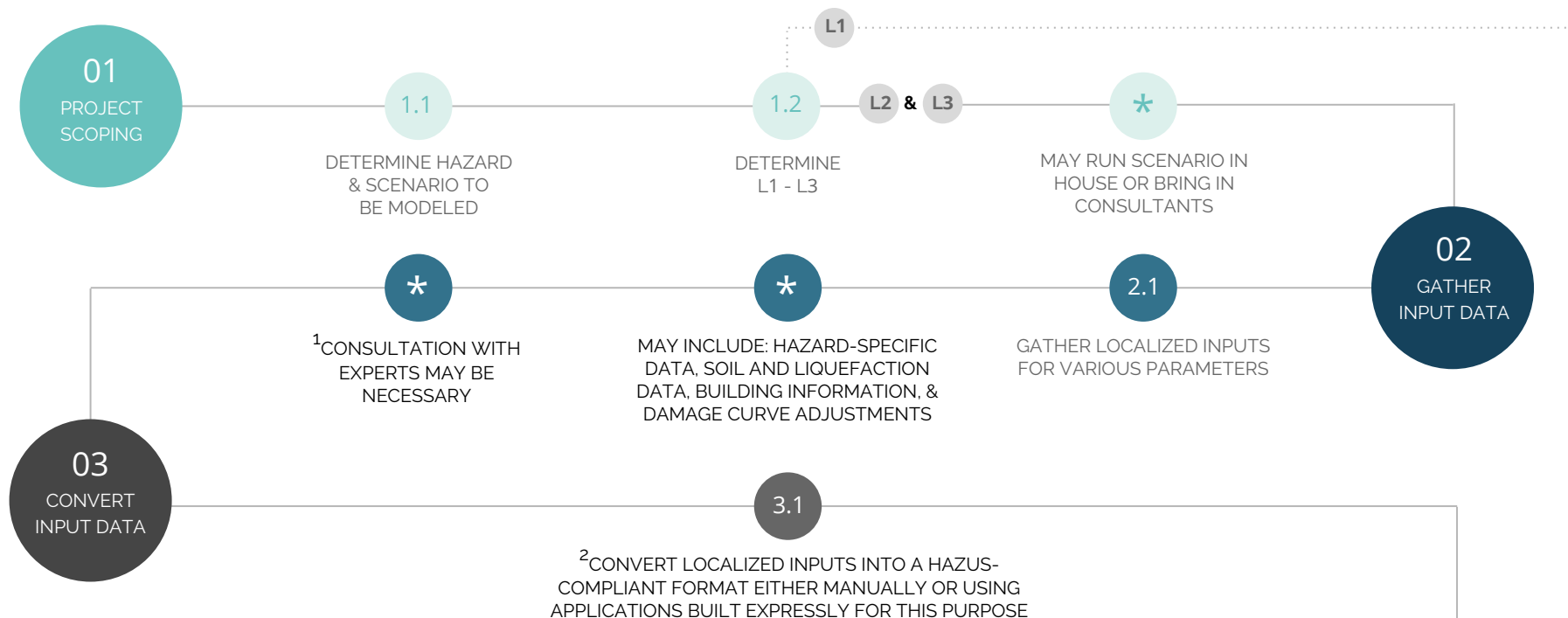


Fig. 12 Interviewees, n=11



# HAZUS-MH WORKFLOW

## STEPS 01-03

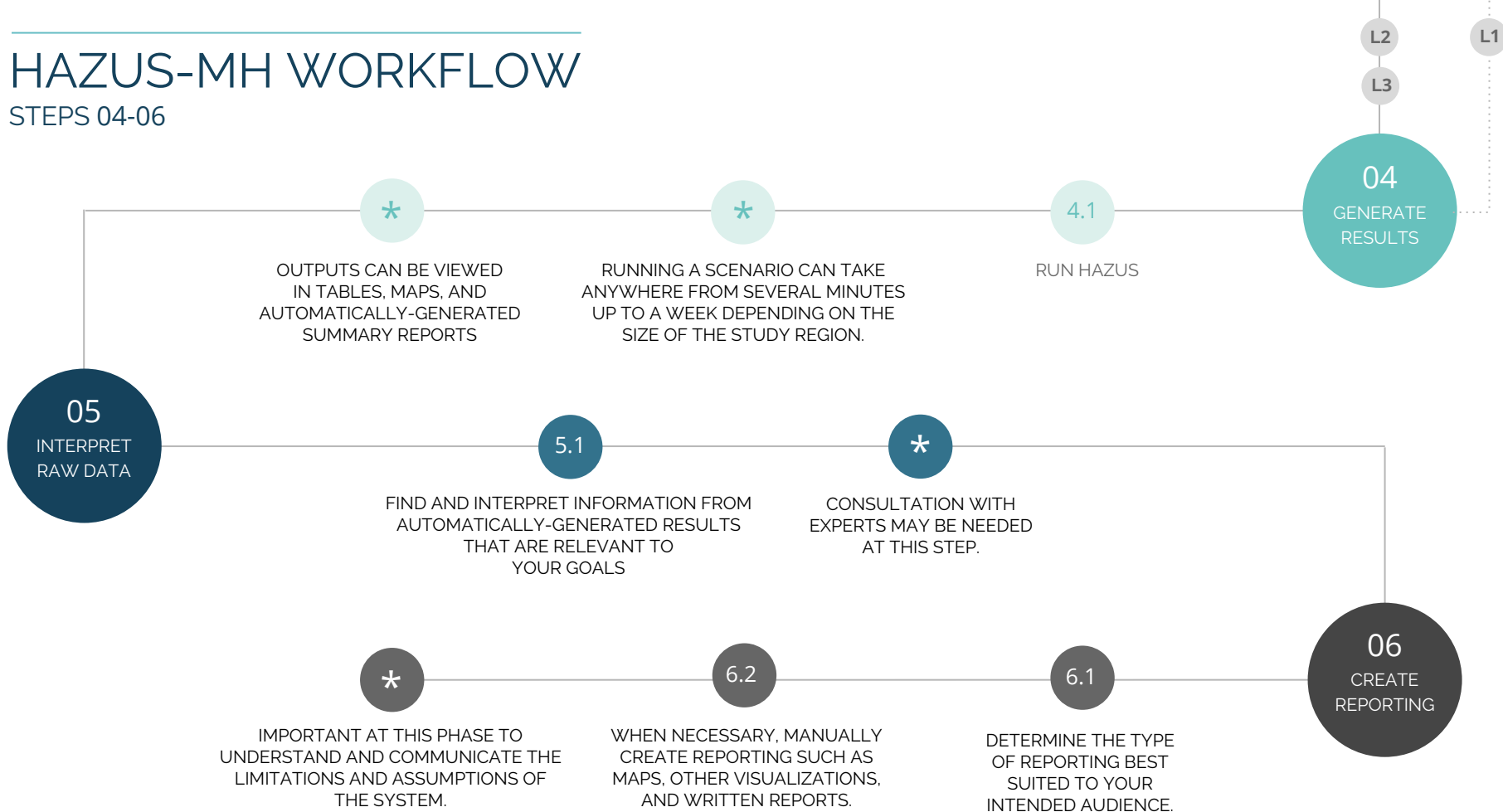


<sup>1</sup> One interviewee gave an example of a project that required a structural engineer, a dam engineer, a liquefaction expert, and a ground shaking expert

<sup>2</sup> We encountered two in our research: ShakeMap to Hazus-MH, which stopped working with Hazus-MH 2.2, and the Comprehensive Data Management System, which was developed by FEMA to help with the conversion process. One county-level office used this to convert assessor data on local building stock to a Hazus-compliant format.

# HAZUS-MH WORKFLOW

STEPS 04-06



---

# HAZUS USER GOALS

When it came to user goals, the most frequently occurring theme in the interviews and the second most frequently occurring theme in the survey involved communicating risk and visualizing impact to communities and decision makers. Therein lies the power and impact of Hazus-MH - to help people prepare and plan for natural disasters to help mitigate their potential effects.

Another key user goal that emerged was the creation of a Hazard Mitigation Plan (HMP) for FEMA, which must be renewed every 5 years. As their website states: "FEMA requires state, tribal, and local governments to develop and adopt hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance, including funding for mitigation projects."<sup>1</sup>

Other major goals surround the specifics of hazard preparedness, mitigation and response, such as risk assessment, loss estimation, and social and physical impacts, such as number of people needing shelter and building damage. For a full count of user goal categories, see Fig. 13 and 14 on the following page.

*"I can use it to communicate risk in terms of things everybody understands (\$'s, casualties, etc.) and no other tools provide this capability."*

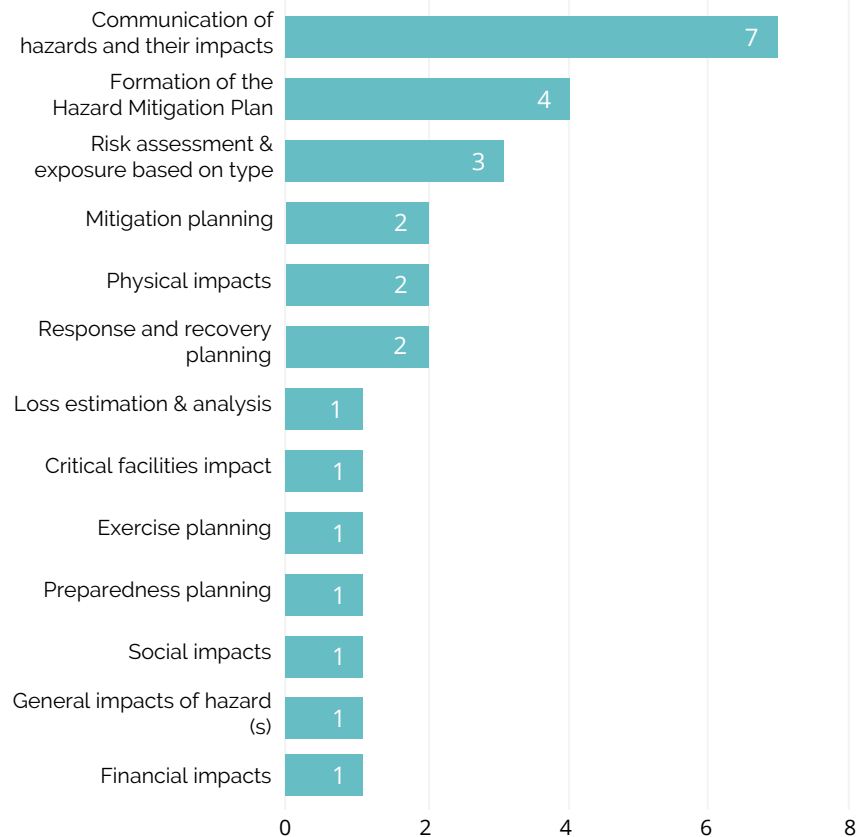
**Survey Respondent**, Non-Profit Organization

---

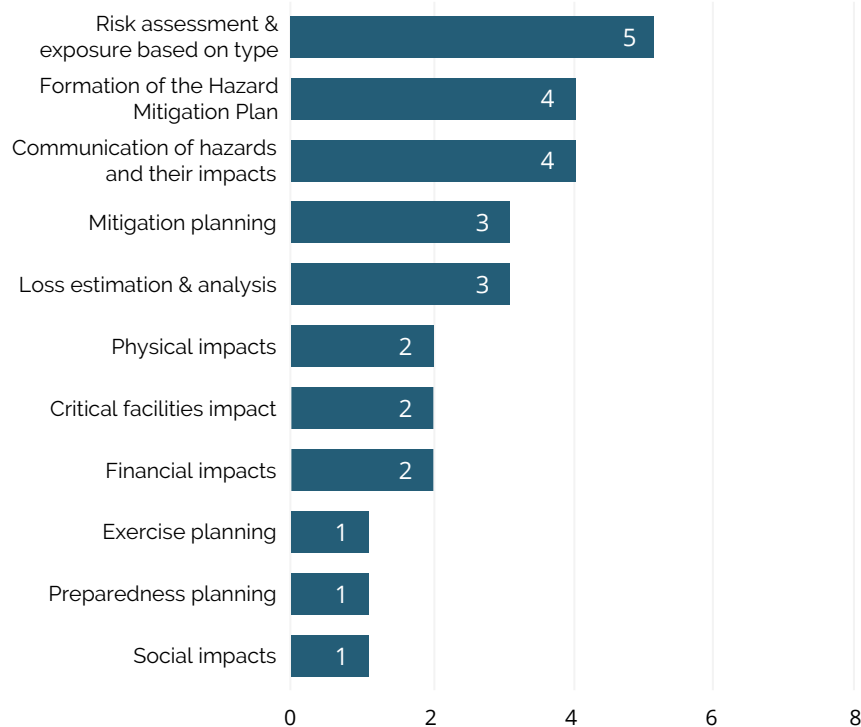
<sup>1</sup> "Hazard Mitigation Planning." *FEMA*. FEMA, n.d. Web. 24 Jan. 2016.

# HAZUS USER GOALS

**Fig. 13 Survey, Respondents, n=18**



**Fig. 14 Interviewees, n=11**





---

# SUMMARY OF KEY FINDINGS

---

# DEEP UNDERSTANDING REQUIRED

## Requires training

Almost all interviewees mentioned the importance of completing Hazus-MH training, in order to ensure that the tool is used correctly and the resulting data is accurately reported. However, the tool is free for anyone to download, so training is not necessarily a prerequisite. Training is offered online and in-person in Maryland, in addition to being offered locally through Hazus User Groups.

## Many considerations to keep in mind

When explaining their use of the tool, many interviewees mentioned important considerations they have to keep in mind while running the software, such as assumptions that Hazus makes in its calculations and certain results that are assumed to always be inaccurate. These factors are not marked anywhere in the interface. Instead, they need to be remembered based on what was learned in training or looked up in the lengthy user manual. Interviewees mentioned that knowing these factors is [essential to reporting findings correctly](#).

*"It's a great tool...But you need to have the skillset to be able to do it. You can't just download and use it."*

**Interviewee 01**, FEMA

*"I wish there was an easy to follow tutorial that could walk you through running the program instead of being required to attend a very technical class to use it. It does not seem that it has to be that technical to run the program."*

**Survey Respondent**, County  
Dept. Of Public Works

# CONCERNS WITH OUT-OF-THE-BOX USE

## Using Hazus-MH at a Level 1 (out of the box) produces poor results

Six interviewees, many with ample Hazus experience and including one who works directly for FEMA, suggested that Hazus should not be used out of the box for site specific analysis. One interviewee noted that using the tool without updating local building or hazards data could lead to large inaccuracy in the estimation modeling. Several interviewees did acknowledge that who they will sometimes run Hazus at a Level 1 because it is much faster and they consider it an acceptable way to collect generalized data for “if/then” scenario analysis. Another user emphasized that Hazus can be extremely useful out-of-the-box for regional-level analysis.

## Data shipped with Hazus is outdated

One interviewee mentioned that the data that comes preloaded in Hazus is based on census data, so it quickly becomes outdated. The current version of Hazus is loaded with 2010 census data.

## Local building data is incorrect

Several interviewees noted that Level 1 Hazus data inaccurately represented the regions within their analysis. This included inaccurate counts of essential facilities (e.g. hospitals) and inaccurate distribution of buildings in a given area.

## Hazard models are more accurate when using local hazards data

As with local building data, we also heard that it is beneficial to update local hazards data in Hazus before running scenarios to obtain more accurate estimations.

16 of 16 respondents surveyed reported inputting local data into Hazus before running scenarios (L2 or L3). 2 of 16 also reported sometimes running the software at L1.

*“No one should ever use [L1 analyses]. [They] should at minimum be updating the building and...local hazards data.*

***We don't want any users to use it out of the box.”***

**Interviewee 01**, FEMA

*“I encounter [misuse of data] often. It is not so much that they use it inaccurately, but they would use [Hazus] as a Level 1, and numbers could be off tremendously. They don't communicate how far off the numbers can be (with Level 1).”*

**Interviewee 02**, Private Consultancy

# GATHERING LOCAL DATA IS A PROBLEM

## Gathering data is difficult and time-consuming

Interviewees described a wide range of data that can be inputted into Hazus-MH. They explained that the more detail you go into, the better your results will be, but also the more time and effort (and likely money) that you will spend. One pain point that they mentioned was that gathering the necessary data is not a straight-forward process. For example, we heard that private land data is more difficult to access than public data and that required information needs to be gathered from various offices and experts.

## Requires multidisciplinary expertise

Three interviewees mentioned the importance of involving experts from multiple disciplines in a given project, in order to update and evaluate local data before running a simulation to get the most accurate results. These disciplines included structural engineering, seismology, geology, and social science.

## Common for governments to employ consultants

Because of the time and expertise required, we heard that government organizations often bring in outside consultants to do this step for them. One interviewee who worked previously as a Hazus consultant said that this was because consulting companies have access to experts across many disciplines, who aren't normally employed by the government.

8 of 16 respondents surveyed reported gathering or inputting local data into Hazus as one of their top two pain points.

*"You would be working with GIS data, parcel data, building footprint data, attribute data that may be owned by the community in a variety of different formats, owned by a variety of offices (within the government)... Different communities arrange these offices differently. So, now you are trying to pull together all this info about all the buildings so that you can do as deep of an analysis."*

**Interviewee 08**, Private Consultancy

*"Hazus requires multidisciplinary knowledge- structural engineer, social scientist, etc. If you want to understand Hazus, you must have multi-disciplinary expertise. You don't find that in a government agency, but you find it in a consulting agency"*

**Interviewee 02**, Private Consultancy

---

# INPUTTING LOCAL DATA IS DIFFICULT

## Formatting data correctly is challenging

Three interviewees mentioned that correctly formatting local data to be put into Hazus is a pain point. This included translating data from multiple sources into the correct fields and field types, using the lengthy Hazus data dictionary. To ease this process, one Hazus power-user that we interviewed created templates that she distributes to the community to help with this task. Another interviewee mentioned a tool developed by FEMA to help with this process called Comprehensive Data Management System (CDMS). We are not sure how widely CDMS is used by the community.

## Hard to keep local data up to date

Multiple interviewees mentioned that they wish they could keep their local Hazus data more up to date so that they could get the most accurate results; however, that wasn't practical given how long the process took and competing priorities of their jobs.

*"We need to, across the nation, identify the systems and come up with tool sets that will transform data from the format in local communities, into a format that Hazus needs it. Right now it is a costly process."*

**Interviewee 08**, Private Consultancy

*"Very fickle, very difficult to format the data you are inputting."*

**Interviewee 01**, FEMA

---

# OUTPUT REQUIRES INTERPRETATION

## Data requires interpretation and expertise

The most prevalent issue communicated by interview participants was that the output of Hazus-MH requires a strong understanding of the tool, and in many cases, an understanding of the appropriately related scientific field(s).

Due to the high requirement for expertise, three of the interviewees referenced the need to assemble additional resources (e.g. seismologists, liquefaction specialists, etc.) to help with the evaluation and interpretation of the tool's output.

## It is critical to understand the limitations of the tool

A popular story that was shared with us on more than one occasion was regarding the Nisqually Earthquake of 2001; our interviewees noted that two major reports of damage loss estimation were released to the public; one of which was “off by a factor of 10.” This dramatic misstatement is the poster child for why our interviewees stated that caution must be taken when interacting with the output of Hazus: the tool is limited to probabilistic estimations based on the data that is provided, and oftentimes “great” data is often not available, making the estimations far from perfect. It was made very clear that not understanding the limitations of the tool could easily result in misinterpretation of the data, or at worst, inappropriate action by the public.

8 of 11 interviewees specifically talked about the need to interpret and modify Hazus results in order to make the information consumable.

*“I think the results you get from Hazus are extremely difficult to interpret.”*

**Interviewee 05**, County Dept. of Public Works

*“If you want to understand Hazus, you must have multi-disciplinary expertise.”*

**Interviewee 02**, Private Consultancy

*“You have to have some geeky person in front of a computer running Hazus. It is not a plug-and-play program. Then you have to have someone interpret the results.”*

**Interviewee 11**, Private Consultancy

# OUTPUT REQUIRES REFORMATTING

## Reports don't contain all the information needed by consumers

Several of our interviewees talked about the data that came out of Hazus-MH as only one part of the information needed to create the communication necessary for public consumers to understand the implications of natural disasters and to encourage appropriate action by these parties. While the intent may not be for Hazus to be the complete solution for such communications, there appeared to be a desire on behalf of some interviewees to have it perform in this fashion.

## Reports require users to create their own data visualizations

Almost all interviewees, when discussing the output of Hazus, mentioned the need to reprocess the results found in the "out-of-box" reporting. This need is so great that one of the interviewees indicated that they hired a graphic designer to render the results of the output so that the impact would be understandable by the public.

## Reports use confusing acronyms, labeling, etc.

Four of our interviewees noted that use of acronyms, cryptic data labeling, and variance in the type of unit data would often cause them confusion when reviewing Hazus outputs. In some cases, this required the users to refer to user manuals in order to understand the output.

## Reports present different data for each type of scenario

Three of our interviewees specifically noted that each type of scenario (Earthquake, Flood, Hurricane) provides its own set of outputs. This requires the user to acclimate to each type of output (reduced efficiency) and may also make integrating multi-hazard results more challenging.

As [noted earlier](#), 8 of 11 interviewees specifically discussed that rework was required of reporting.

*"The biggest thing is that the output needs to be communicated in a way that is understandable."*

**Interviewee 01**, FEMA Risk Analyst

*"What comes out of Hazus is geographic features with attributes about loss, broken down by location types. The output is standard; you manipulate those into maps and tables and descriptive text about that information."*

**Interviewee 08**, Private Consultancy

*"It [Hazus] takes this information and puts it on the map. But, the people who use Hazus don't produce enough of it. So, I don't see enough usable output."*

**Interviewee 11**, Private Consultancy

---

# OUTPUT NEEDS VARY

## Maps are preferred for external viewers of the data

Many interviewees noted that maps were a critical component of public reviews of risk mitigation and disaster planning outputs derived from Hazus-MH. For instance, Interviewee 6, an Emergency Program Manager for a county in Washington, noted that maps are used in open-house presentations for the public.

## Tables are preferred for internal viewers of the data

While maps and easily digestible information were the elements that were important to public consumption, there also was an understanding of the importance of heavy data for internal consumers/experts. This data was oftentimes incorporated with other analyses to create more robust risk mitigation/loss prevention planning or used to populate reports such as those required by FEMA to secure hazard risk mitigation grants.

## Communicating the limitations of the data is critical

Earlier it was discussed that it is [critical for Hazus users to understand the limitations of the tool](#). In a related fashion, interviewees also communicated it was important to pointedly communicate these limitations to the public when providing Hazus data, since failure to do so could result in spreading inaccurate information.

## Consumers want to understand how the analysis was created

We heard from two interviewees that it is difficult to understand how Hazus arrives at its estimates, and that it is not uncommon for other consumers to also question how the tool arrives at its estimations.

*"If you are trying to save lives, you have to convince decision makers that action is needed. This bridges the gap between Earth science and what will happen. People don't respond to 'It's going to be a 7 on the Hayward Fault'- they respond to 'my house will fall down' or 'this will cause a fire'."*

**Interviewee 02**, Private Consultancy

*"It gives you a number, but there is no simple explanation anywhere about how it arrives at that number... but you present it to your audience and they want to know how you get there. You can figure it out by looking at the manuals, but they are super long."*

**Interviewee 09**, County Mitigation Coordinator

---

# OTHER FINDINGS

## **Local Entities use Hazus-MH for creation of Hazard Mitigation Plan**

Five interviewees noted that their usage of Hazus is in part due to FEMA's requirement of Hazus data when submitting a risk mitigation plan to receive grant funding.

## **Usage is oftentimes infrequent**

Many of our interviewees noted that their use of Hazus is somewhat infrequent: "every 3-5 years" was not an uncommon response. Some users indicated that they "haven't used it recently, within the last year-and-a-half."

## **There seemed to be two common types of Hazus user: (1) Those who run/consume Hazus data and (2) those who only consume Hazus data**

4 of our 11 interviewees indicated that they do not use Hazus directly, and only use the outputs of the tool. The other group of interviewees (7) directly use the tool, with many of them also assisting with report construction using the data obtained from the tool.

## **One user only looked at comparison data**

One interviewee, an academic professor, noted that his use of the tool was primarily limited to comparison data - i.e. he would not settle on a specific estimation (due to concerns about accuracy), and instead only focuses on the amount of change in results when running scenarios with different criteria.

## **Additional technical issues reported**

Interviewees noted technical problems and/or issues that impacted their user experience while using Hazus:

- The upgrade to Hazus-MH 3.0 obsoleted existing reports created in previous versions of Hazus. This then forces users to rerun those reports using the most current version of the tool.
- Several interviewees noted that it was not uncommon for the tool to crash, creating loss of data and wasted time.
- Several interviewees noted that the tool was large and consumed a great deal of hard drive space.
- One interviewee shared a concern about the tool depositing files on a local drive (instead of being cloud-enabled/network shareable).

## **Hazus suffers from government-sponsored program limitations**

One interviewee mentioned that upgrades to the program were slow due to federal budget limitations. Another interviewee mentioned that the government's decision to not use open-source support for the tool has held the community back from crowd-sourced updates to the tool.

## **Hazus is not really free to the end user**

One interviewee noted that while Hazus is free, the underlying tool (ArcGIS) and the needed expertise to use it, is not.\*

\* FEMA/EMI will reimburse participants the cost of travel and lodging for Hazus classes.

---

# DESIGN DIRECTIONS

Based on our findings, we saw ample design opportunities to improve the following areas of the Hazus-MH user experience:

- Experience of gathering local data for input into Hazus
- Experience of inputting local data into Hazus
- Experience of conducting scenarios within Hazus
- Process of generating reports using Hazus data
- Targeting the content of Hazus outputs based on consumer need
- Clarity and effectiveness of Hazus outputs

From this research, we decided to focus in on pain points related to output interpretation and communication, because we felt that communicating effectively through reports had the greatest opportunity for impact.

We encourage FEMA and/or other organizations to further pursue the improvements that were not explored via our efforts, since we believe these out-of-scope areas would also improve the overarching Hazus user experience.

02

## DESIGN AND EVALUATION



---

# IDEATION OVERVIEW

After narrowing our scope, we began the ideation process, which included persona creation, ideation workshops, sketching, and a stakeholder review. This resulted in a report builder design concept with a list of required features, which we then used to build our prototype.

One Hazus user highlighted some of the difficulties with the current report creation process using Hazus reports:

*"It's got to be recreated. Like I would have to retype pieces of it or I would take a copy of the report and cut up sections and maybe draw lines around it or highlight it and then pass it out to different people. So, you don't have a lot of options to manipulate the report. Once it's generated it's generated. That makes it one size fits all and it's not as much fun or useful."*

---

County Emergency Planning Manager

---

# DESIGN OVERVIEW

## DESIGN CONCEPT

Stand-alone solution that utilizes Hazus data to enable easy and robust report creation for internal consumers of Hazus data.

## DESIGN GOALS

Our design seeks to accomplish three overarching user experience goals that address three of the six major pain points identified during our research:

- 1) Improving the process of generating reports using Hazus data.
- 2) Allowing the user to target the content of Hazus outputs to specific consumer needs.
- 3) Improving the clarity and effectiveness of Hazus outputs.

## DESIGN CONSIDERATIONS


Our team generated a list of considerations we kept in mind as we generated the the user interface/user experience of the solution:

### **User Interface / Interaction Design Guidelines**

- Enable a selection of simple and modern editing tools that address core editing needs.
- Avoid acronyms or obscure terminology in UI navigational elements.
- (Optional) Evaluate the inclusion of scenario comparison capabilities.

### **Output Design Guidelines**

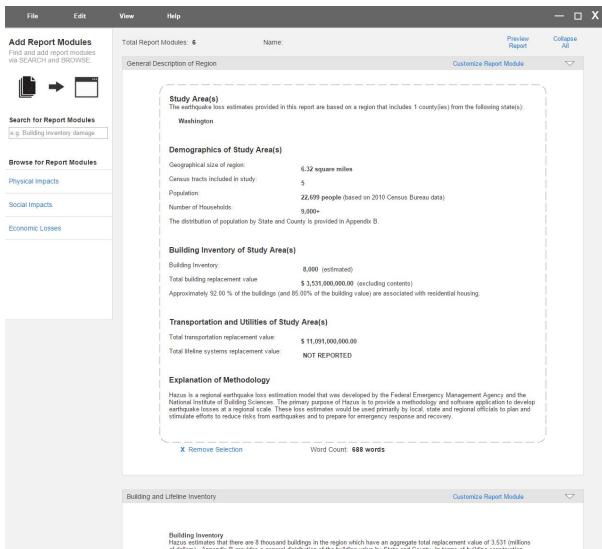
- Avoid excessive text within primary communication elements.
- Provide linkages to deep content within appendices.
- Provide easily consumable data visualizations.
- Data should be accompanied by appropriate process/methodology explanations to build consumer credibility.
- Provide appropriate default outputs that will meet most consumers' needs.



---

# USABILITY STUDY

# DESIGN PROTOTYPE



## OVERVIEW

Our team created an Axure RP Prototype to be used in a usability study to answer a number of key research questions:

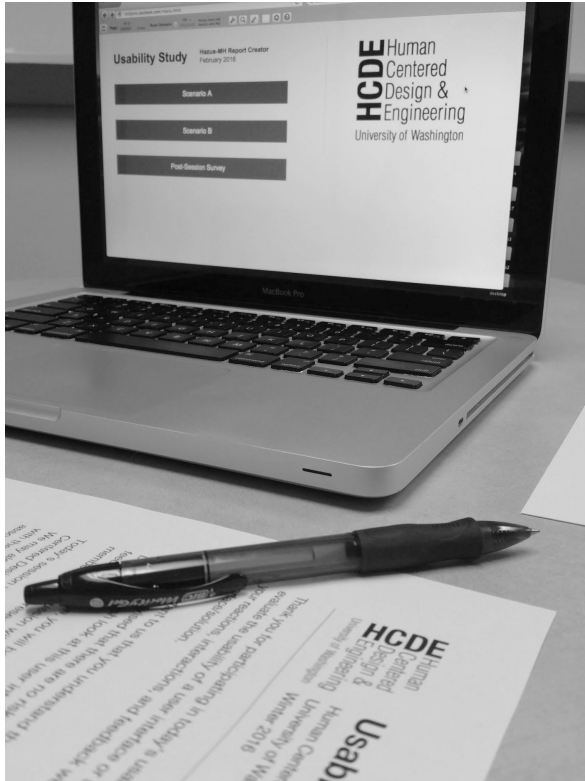
### User Perception

- Will the report creator improve the process of generating reports?
- Will suggested improvements to data visualization increase the clarity and effectiveness of Hazus outputs?
- Is targeting the content of Hazus outputs to specific consumer needs helpful? *Test of default templates (Scenario A) and question-based customized reports (Scenario B).*
- Are there additional features that would make the tool more useful?

### Behavioral Data

- Can users complete key tasks using the proposed designs?
- Are usability issues present with the designs' interactions?

# USABILITY STUDY



## METHOD

We conducted four usability test sessions using a click-through Axure prototype. Sessions were conducted remotely or in-person, depending on the participant's location and availability. Users were asked to attempt complete a variety of tasks using the tool without any prior training/exposure in order to better understand the overall ease-of-use of the tool. Verbal feedback was also via pre- and post-session discussion with the participants.

## PARTICIPANTS

- 2 local government Hazus users
- 2 power users representing secondary user groups  
(1 FEMA employee, 1 Hazus consultant)

## OUTPUT

From these sessions, we gathered feedback on our design concept and identified opportunities for improvement and iteration.

---

# KEY USABILITY STUDY FINDINGS

Of the three participants who currently write these types of Hazus reports, all said that they agree or strongly agree that this tool would allow them to create more effective reports.

A number of report builder features emerged from our sessions as particularly beneficial to our users.

## Selecting Only The Parts I Need

Three participants were excited by the idea of selecting only the parts that they needed in their report, in particular with regards to the targeting of different stakeholders. Current Hazus reports contain a lot of unnecessary data that users then need to sift through to find what they are looking for. This makes that process much simpler.

*"If I had a report writer to where I can pick my specific pieces. That would be kind of handy. I would probably go straight to that."* **Participant 4**

## Data Visualizations

Three participants saw value in the ability to visualize table data as graphs within the tool.

*"That's a pretty cool feature if you can graph out all this data."* **Participant 1**

## Editing in Tool

Two participants liked that you could edit the report directly in the tool, rather than needing to copy and paste sections into a separate editor.

*"That's pretty groovy. I like that."* **Participant 2**



*"If I had something like this...Oh my god, I can't even think of all the [uses]. In the last two years, we've been working on our mitigation plan. I'd be using it often. I would have used it for briefings to county council, I would have used it for briefings to the executive office, I would have used it for the public anytime we had meetings. I would have used it just internally in our department, to give highlights of things. We'd use it internally for exercises and it would have been really helpful."*

---

Participant 2



---

03

OUR SOLUTION:  
The Hazus-MH Report Builder

# SECOND ITERATION SUMMARY

After conducting a usability study on the first iteration of the Hazus-MH Report Builder, our team generated the following list of changes that were integrated into the second iteration of the design:

## DESIGN CHANGES / NEW FEATURES DERIVED FROM USABILITY STUDY

- Create a Table of Contents within Report Builder.
- Change style of Hyperlinks (Active/Inactive States).
- Add notification & undo feature after removal of module.
- Improve readability for Create Report checklist (Scenario B).
- Rename "Hazus Standard Report."
- Add a link/menu that allows creation of report template.
- Add ability to view table and graph data side-by-side.
- Add link to export a report.

## PLANNED CHANGES FOR SECOND ITERATION

- Introduce color and branding (light visual design elements).
- Add in color graphs (samples).
- Add in a map visualization (sample).

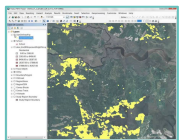
A number of items were left out of scope in the second iteration of prototype due to implementation complexity, but are still noted as recommendations for any future development of the Hazus-MH Report Builder tool:

- Robust and accurate text editing, full editing controls, and copy/paste functionality are only minimally represented within the prototype.
- Ability to add or rearrange modules and content sections via drag-and-drop interactions.
- Ability to have multiple reports open at the same time.



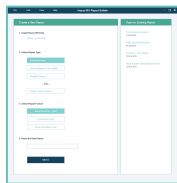
# REPORT BUILDER PROCESS

The basic process flow of “report building” within the Hazus-MH Report Builder is outlined below. Greater detail for the interactions which occur in these steps are noted in the complete design specification (see: [Supplemental Material - Design Specification](#)).



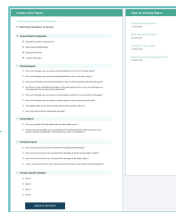
## Use Hazus-MH to generate data

Hazus-MH is used to generate the related scenario data that will be imported into the Hazus-MH Report Builder.



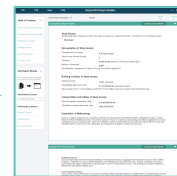
## Select report type & output needs

Upon loading the Report Builder, the user will input their Hazus-MH data (.hpr files). User will then have the opportunity to select the desired report type and report format (e.g. Word, PowerPoint, Excel).



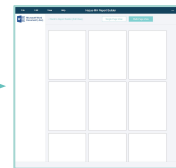
## Select key questions (optional)

For custom reports, users will be asked which key questions they want the report to answer. This will dictate the initial offering of modules which are included in the report.



## Edit report content and arrangement

After the user has created their report, they have the opportunity to adjust modules (add/remove/move), edit the content within the modules, and even select data visualizations that are appropriate for their report.



## Preview and export final report

When the user has finished their edits, they have the opportunity to do a final preview before export.

When they are finished, the report is exported to the selected file format! They can also save the report as a template for use in future reports.

# REPORT BUILDER

## Create New Report

[View in Prototype](#)

The screenshot displays the 'Hazus-MH Report Builder' application window. The interface is divided into two main panels: 'Create a New Report' on the left and 'Open an Existing Report' on the right. The 'Create a New Report' panel is further divided into four steps, each marked with a green circle containing a number:

- 1. Import Hazus-MH Data:** A button labeled 'Select .hpr data file'.
- 2. Select Report Type:** A list of report types: 'Summary Report' (highlighted), 'Hazard Mitigation Plan (HMP)', 'RiskMAP Report', and 'Create Custom Report'.
- 3. Select Report Format:** A list of file formats: 'Word Document (.doc)' (highlighted), 'PowerPoint (.ppt)', and 'Excel Spreadsheet (.xls)'.
- 4. Name the New Report:** A text input field for naming the report.

At the bottom of the 'Create a New Report' panel is a 'CREATE REPORT' button. The 'Open an Existing Report' panel shows a list of existing reports with columns for name, date, and format.

## 1. Standalone Tool with Hazus Data Input

### PAIN POINT

Hazus-MH functionality is not modifiable without support of FEMA.

### SOLUTION

After running Hazus, users upload the resulting data into the Hazus Report Builder - a separate tool that serves as a support of the main Hazus-MH tool and enables easy report generation.

### WHY THIS APPROACH?

- A standalone tool can be built/maintained without intervention from the Hazus-MH program.
- A standalone tool can utilize its own architecture and interaction design approach, enabling an enhanced user experience.

## 2. Select Report Type and Format

### PAIN POINT

Current data output from Hazus-MH is limited to Adobe PDF documents or data files that require complex manipulation by technically-skilled resources.

### SOLUTION

With the Hazus Report Builder, users can choose from a variety of report types and formats to support their different communication needs.

### WHY THIS APPROACH?

- Users need to create reports in different formats, depending on their audience and goals.
- Allows the selection of type of report and format drive the initial type of report modules included in the initial report, which enhances efficiency/effectiveness of report building.

# REPORT BUILDER

## Select Key Questions [View in Prototype](#)

Create a New Report

[Back to Report Type and Format Selection](#)

5. Select Key Questions To Answer

General Report Components

☒ General Description of Study Area

☒ Data Analysis Methodology

☒ Executive Summary

☒ Contact Information

Physical Impacts

☐ How much damage can we expect overall building stock to incur in the study region?

☐ How much damage can we expect essential facilities to incur in the study region?

☐ How long will it take those essential facilities to return to full functionality after the earthquake?

☐ Are there any high potential loss facilities in the study region and if so, how much damage can we expect them to incur during the earthquake?

☐ How much damage can we expect our transportation systems to incur during the earthquake?

☐ How much damage can we expect our utility systems to incur during the earthquake?

☐ Will probable water and/or electric power systems be impacted, and how?

☐ How much debris will the earthquake generate?

Social Impacts

☐ How many people will need shelter after the earthquake occurs?

☐ What amount of casualties can we expect from this earthquake (not include a count for minor injuries, requires hospitalization, life-threatening injuries, and fatalities)?

Economic Impacts

☐ How much economic loss can we expect from building related damage?

☐ How much economic loss can we expect from damages to the transportation system?

☐ How much economic loss can we expect from damages to the utility system?

☐ Over a 15-year period, how much indirect economic losses can we expect from the disaster?

Scenario Specific Questions

☐ Item A

☐ Item B

☐ Item C

☐ Item D

CREATE REPORT

Open an Existing Report

Flood Analysis-Region 3  
11 FEB 2016

Multi-Hazard All Hazards  
04 JAN 2016

Hurricane\_Test\_Report  
13 NOV 2015

ReportCreator-SampleReport Flood  
12 NOV 2015

### 3. Select Key Questions to Answer

#### PAIN POINT

Hazus's out-of-the-box (OOB) reports contain a lot of excess data, yet often not all the information that is needed to complete a report.

#### SOLUTION

Users can filter the data by selecting the questions that they are interested in answering for their audience, thereby leaving out irrelevant information. When selected, each key question will dictate the inclusion of a related module that helps to answer that question.

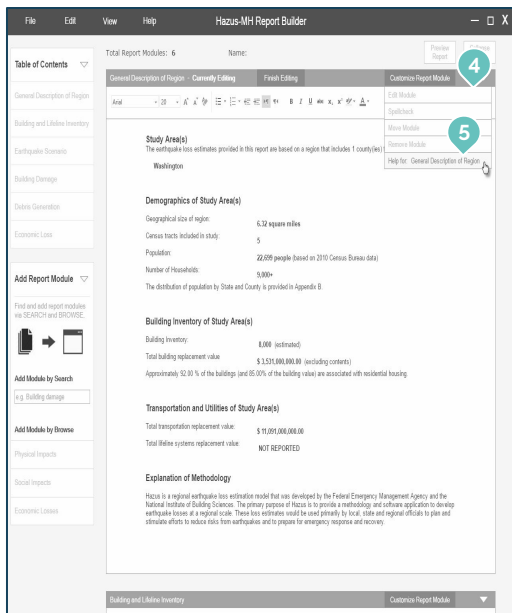
#### WHY THIS APPROACH?

- Reporting needs vary by audience and report goals. This approach allows users to target the questions they are interested in answering, without the need to sift through excess data.
- For customized reports, selecting the questions to answer is a more intuitive process than selecting a Hazus module and then adding/removing report modules to assemble the report.

44

# REPORT BUILDER

Compose and Edit Report [View in Prototype](#)



## 4. Editable Report Modules

### PAIN POINT

Hazus's OOB reports are not editable, so users have to copy and paste information into other tools to piece together what they need to create targeted reports to specific stakeholders.

### SOLUTION

The Hazus Report Builder converts data into fully editable report modules that can be easily rearranged. Users can edit those modules directly in the tool to add details specific to their community and audience.

### WHY THIS APPROACH?

- By allowing users to select their data and edit it all in the same place, the tool improves the efficiency of report creation.
- Removes the need to copy and paste information into other tools, but does not preclude the ability for users to copy and paste from other tools into the Report Builder.

## 5. Contextual Help

### PAIN POINT

Understanding and reporting the results of Hazus can be challenging. It is easy for results to be misinterpreted/overstated or for users to not understand how results are generated.

### SOLUTION

The Report Builder includes contextual help that describes how Hazus generated the displayed results. This makes the data easier to interpret and enables the report creator to more easily explain to consumers how the data was generated.

### WHY THIS APPROACH?

- This type of help information is not always required. Therefore, providing the information as contextual help ensures it is available, without forcing itself upon the user.
- Providing information for each report module is important to enable the deeper understanding of the processes used to derive the data for that module.

# REPORT BUILDER

## Data Visualizations

### 6. Suggested Data Visualizations

#### PAIN POINT

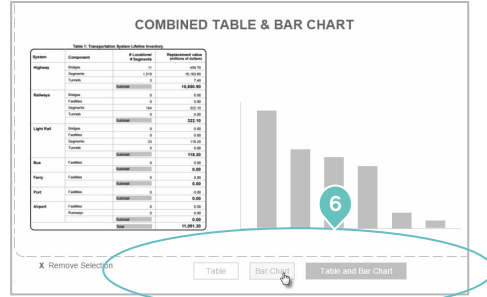
Hazus users need to manually create visualizations if they want to include them in their reports. Additionally, it can be difficult to determine the most effective visualizations that people understand.

#### SOLUTION

The Hazus Report Builder suggests data visualizations based on data visualization best practices. Users can select from multiple suggested visualizations to best communicate their message.

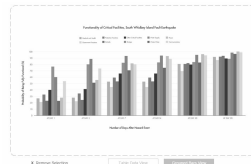
#### WHY THIS APPROACH?

- Ensures that an appropriate data visualization is used to display the information. This alleviates the expectation that users must have advanced training/understanding of data visualization best practices.
- Encourages the user to utilize data visualization when they might not have considered it should the options not been presented.
- Continued efficiency for report building.



**FUNCTIONALITY OF CRITICAL FACILITIES**

Planning Unit	# of Critical Facilities	Probability of Some Type Functional No.				
		at 10% I	at 25% I	at 50% I	at 75% I	at 100% I
Medical and Health	55	28.0	33.3	32.7	32.0	30.7
Government Functions	126	71.2	72.0	69.2	69.3	66.7
Production Functions	245	130.0	140.0	130.1	130.1	124.9
Utilities	227	120.0	124.4	122.4	121.4	119.2
Other Critical Functions	123	65.0	65.0	65.4	65.4	63.7
Bridge	400	79.0	80.0	80.4	80.4	78.7
Water Supply	40	19.0	20.0	20.2	20.2	19.2
Waste Water	31	15.0	15.2	15.0	15.0	14.4
Power	1	0.0	0.0	0.0	0.0	0.0
Communications	4	2.0	2.4	2.0	2.0	1.6
<b>Total/Percentage</b>	<b>1,046</b>	<b>58.0</b>	<b>60.9</b>	<b>60.2</b>	<b>60.4</b>	<b>58.5</b>





04

# DATA VISUALIZATION RECOMMENDATIONS

---

# OVERVIEW

## PRINCIPLES AND BEST PRACTICES

This section aggregates information and guidance to help users translate data generated from Hazus into more effective visualizations. This will enable better communication with stakeholders, including decision makers and community members.

Best practices, suggestions for implementation, and referrals to additional information are provided for the following topics:

- Using data to effectively answer questions
- Best practices for using graphs
- Best practices for using maps
- Best practices for using tables

## WHAT IS DATA VISUALIZATION?

Data visualization is a general term used to describe “the graphical display of abstract information for two purposes: sensemaking (also called data analysis) and communication.”<sup>1</sup>

## WHY USE DATA VISUALIZATION?

When data visualization is used effectively, it helps the viewer:

1. Comprehend information more quickly.
2. Identify relationships and patterns.
3. Understand the “story” that the underlying data is telling.

---

<sup>1</sup> Few, Stephen. *Data Visualization for Human Perception*. The Encyclopedia of Human Computer Interaction, 2nd Ed. Interaction Design Association, Mar. 2016. Web. < <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/data-visualization-for-human-perception> >.

---

# ANSWERING QUESTIONS

We reviewed our research and design concepts with noted data visualization expert [Noah Iliinsky](#) during the ideation phase of our project.

Noah reminded us that **data visualizations are used to answer questions effectively - not to provide generic, untargeted data.**

This translated into an exploration of the methodology we ultimately designed for custom reporting, seen earlier in [Selecting Key Questions](#). This proposed design literally asks the user to select the questions they are seeking to answer, which in turn dictates the type of report modules and data visualizations that will be initially provided in the report.

This main concept is critical to keep in mind when selecting a way to visually display data, particularly when dealing with data sets as large and comprehensive as those generated by Hazus-MH, and the remaining content within this section represents specific approaches that will improve this process.



*"If there is an action you want people to take, you don't give them the ingredients, you give them the cake and say 'here is the cake'."*<sup>1</sup>

---

Noah Iliinsky

---

<sup>1</sup> Iliinsky, Noah. Personal Interview. 13 February 2016.

# SELECTING A DATA VISUALIZATION

## SELECTING A DATA VISUALIZATION

Selecting the right visualization becomes much easier when you have a clear answer to the following key questions: <sup>1</sup>

- Who's going to use it?
- What do they need to learn?
- What actions are they going to take?
- What information will support those questions above?

## DATA VISUALIZATION CHECKLIST <sup>2</sup>

Does the data visualization you are selecting meet this criteria?

- ✓ Clearly indicates how the values relate to one another (i. e. part-to-whole relationships).
- ✓ Represents the quantities accurately.
- ✓ Makes it easy to compare the quantities.
- ✓ Makes it easy to see the ranked order of values, such as from the leading cause of death to the least.
- ✓ Makes obvious how people should use the information - what they should use it to accomplish - and encourages them to do this.

<sup>1</sup> Iliinsky, Noah. Personal Interview. 13 February 2016.

<sup>2</sup> Few, Stephen. *Data Visualization for Human Perception*. The Encyclopedia of Human Computer Interaction, 2nd Ed. Interaction Design Association, Mar. 2016. Web. < <https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/data-visualization-for-human-perception> >.

# TABLES <sup>1</sup>

## WHEN TO USE TABLES

Use tables when you:

- Want to provide precise values
- Do not need to show relationships/patterns

## BENEFITS OF TABLES

Tables allow the viewer to:

- Obtain precise values
- Look up individual values
- Compare individual values

## BEST PRACTICES FOR TABLES

- Right align numbers and their related column headers.
- Left align dates and text, and their related column headers.
- Use a font and font size that makes the content easily readable.
- Color should be treated as a relational element; it should not be used for ornamentation.
- Consider removing or reducing the intensity of grid lines within the table (e.g. light gray instead of black).

<sup>1</sup> Carr, Rebecca and Harrington, Mary. *Effective Communication Through Visual Design: Tables and Charts*. Strategy Institute. 2001. Web. < <http://aaude.org/system/files/documents/public/strategy-institute-handout-final.pdf> >.

# GRAPHS <sup>1</sup>

## WHEN TO USE GRAPHS

Use graphs when you:

- Want to show relationships or patterns
- Have dense data that is difficult to understand when rendered as text

## BENEFITS OF GRAPHS

Graphs allow the viewer to:

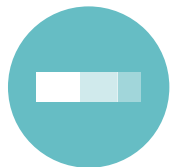
- Identify patterns, trends, and exceptions
- Reduce analysis time (quicker than text data)
- Easily communicate a story to others

## BEST PRACTICES FOR GRAPHS

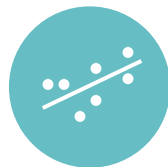
- Reduce or remove “non-data pixels/ink” - i.e. anything that is not directly part of the data visualization or necessary to enhance understanding of the data (examples: borders, unnecessary grid lines, ornamentation).
- Use color meaningfully and with restraint - keep the palette of color small; you may even consider using shades of gray. Color conveys information, and if used incorrectly, can confuse or slow analysis.
- Do not rely on color to carry the meaning - especially red and greens (may appear the same for color-blind individuals). Use colors with sufficient contrast, or include other ways of distinguishing data (e.g. icons).

<sup>1</sup> Carr, Rebecca and Harrington, Mary. *Effective Communication Through Visual Design: Tables and Charts*. Strategy Institute. 2001. Web. < <http://aaude.org/system/files/documents/public/strategy-institute-handout-final.pdf> >.

# WHAT TYPE OF GRAPH? <sup>1</sup>



**Stacked-bar charts** for part-to-whole relationships and cumulative totals.



**Scatterplots** can be used to show correlations. (Advanced viewers)



**Bar charts** for ranking relationships and comparison of a group.



**Box plots** for a range of values. (Advanced viewers)



**Line graphs** for showing numerical interval data that has a distinct order.



**Pie charts** are not recommended, due to human inaccuracy with determining size.

*"For this project [Hanus-MH risk planning and mitigation data], probably **line graphs** or **bar graphs** will be your best bet. If it is a casual audience that is not experienced in data, the other types of visualizations will lose them."* <sup>2</sup>

Noah Iliinsky

<sup>1</sup> Few, Stephen. *Effectively Communicating Numbers: Selecting the Best Means and Manner of Display*. Perceptual Edge. November 2005. Web. < [https://www.perceptualedge.com/articles/Whitepapers/Communicating\\_Numbers.pdf](https://www.perceptualedge.com/articles/Whitepapers/Communicating_Numbers.pdf) >.

<sup>2</sup> Iliinsky, Noah. Personal Interview. 13 February 2016.

# MAPS <sup>1</sup>

## WHEN TO USE MAPS

Use maps when you:

- Want to show spatial patterns
- Need to distribute geographic data

## BENEFITS OF MAPS

Maps allow the viewer to:

- Easily add context to spatial/geographic data (e.g. locate familiar locations and understand how the data may impact that location)
- Identify geographic trends (i.e. spatial patterns)

## BEST PRACTICES FOR MAPS

- As with graphs, make sure the right amount of detail is used for the need (e.g. satellite map details may be unnecessary; a [choropleth map](#) may be appropriate).
- It is recommended to only use 3-7 data classes within a single map; the more classes that are included, the lower the legibility and the higher the risk of reading errors.
- Remember expectations or industry standards when creating a map; some audiences may expect certain colors to mean certain things due to industry standards.
- Utilize a [visual hierarchy for map labels and text](#).

<sup>1</sup> *Thematic Cartography Guide: A short, friendly guide to basic principles of thematic mapping*. Axis Maps. Reviewed 2016. Web. < <http://www.axismaps.com/guide/> >.

---

# FURTHER READING

## BOOKS

Designing Data Visualizations: Representing Informational Relationships  
Noah Iliinsky and Julie Steele. O'Reilly Media. 2011

Information Dashboard Design: Displaying data for at-a-glance monitoring  
Stephen Few. O'Reilly Media. 2013

Show Me the Numbers: Designing Tables and Graphs to Enlighten  
Stephen Few. Analytics Press. 2012.

The Visual Display of Quantitative Information  
Edward Tufte. Graphics Press. 1983.

Visualize This: The FlowingData Guide to Design, Visualization, and Statistics  
Nathan Yau. Wiley. 2011.

## ONLINE RESOURCES

[Choosing Visual Properties for Successful Visualizations](#)  
Noah Iliinsky. IBM Corporation. May 2013.

[Data Visualization for Human Perception](#)  
Stephen Few. Interaction Design Foundation. 2014.

[Effective Communication Through Visual Design; Tables and Charts](#)  
Rebecca Carr, Mary Harrington. Strategy Institute. 2011.

[Effectively Communicating Numbers: Selecting the Best Means and Manner of Display](#)  
Stephen Few. Perceptual Edge. November 2005.

[Properties and Best Uses of Visual Encodings](#)  
Noah Iliinsky. Complex Diagrams. June 2012.

[Thematic Cartography Guide: A short, friendly guide to basic principles of thematic mapping](#) Axismaps. 2016.

[When to Use Maps in Data Visualization: A Great Big Guide](#)  
Paul Bradshaw. Online Journalism Blog. August 2014.

---

## WORKS CITED

Carr, Rebecca and Harrington, Mary. *Effective Communication Through Visual Design: Tables and Charts*. Strategy Institute. 2001. Web. <<http://aaude.org/system/files/documents/public/strategy-institute-handout-final.pdf>>.

"Disaster Declarations for 2015." *FEMA*. FEMA, n.d. Web. 10 November 2015.

Few, Stephen. *Data Visualization for Human Perception*. The Encyclopedia of Human Computer Interaction, 2nd Ed. Interaction Design Association, Mar. 2016. Web. <<https://www.interaction-design.org/literature/book/the-encyclopedia-of-human-computer-interaction-2nd-ed/data-visualization-for-human-perception>>.

Few, Stephen. *Effectively Communicating Numbers: Selecting the Best Means and Manner of Display*. Perceptual Edge. November 2005. Web. <[https://www.perceptualedge.com/articles/Whitepapers/Communicating\\_Numbers.pdf](https://www.perceptualedge.com/articles/Whitepapers/Communicating_Numbers.pdf)>.

"Hazard Mitigation Planning." *FEMA*. FEMA, n.d. Web. 24 Jan. 2016.

"Hazus." *FEMA*. FEMA, n.d. Web. 23 Jan. 2016.

Iliinsky, Noah. Personal Interview. 13 February 2016.

*Thematic Cartography Guide: A short, friendly guide to basic principles of thematic mapping*. Axis Maps. Reviewed 2016. Web. <<http://www.axismaps.com/guide/>>.



---

## CONTACT

[garyjanderson@gmail.com](mailto:garyjanderson@gmail.com)  
[kristine.m.kohlhepp@gmail.com](mailto:kristine.m.kohlhepp@gmail.com)  
[lettylou@gmail.com](mailto:lettylou@gmail.com)