The Challenges of Exploring Local Place as a Context of Use in the Study of Interactive Risk Visualizations*

Experience Report

D. P. Richards
Old Dominion University
Norfolk, Virginia, USA
dprichar@odu.edu

ABSTRACT

This experience report shares the results of a user experience (UX) test on Climate Central's *Risk Zone Map* (riskfinder.org), a publicly-accessible, interactive sea level rise viewer. The report begins with a brief overview of the trends in risk communication and risk visualization, with particular emphasis on the concept of place. The report then outlines the design of the study and methods used: think-aloud protocol and tasks analysis through Usertesting.com's screencasting feature. Lastly, the report shares the findings of the study and discusses how they contribute to geographic place as a context of use worthy of exploration. The report ends with recommendations for UX research further exploring geographic place as a context of use.

CCS CONCEPTS

• Human-centered computing → Visualization design and evaluation methods

KEYWORDS

User Experience; Risk Communication; Visual Risk Communication; Data Visualization; Qualitative Methods

1 INTRODUCTION

As we continue to live within what Ulrich Beck calls a "world risk society" [1], technical communicators and information designers will increasingly be tasked with designing, researching, and testing online, interactive technologies that communicate data on a wide variety of public health risks, from sea level rise, to water quality, to domestic oil production. Beyond merely communicating data visually to a public audience, however, these technologies can—and one might argue, *should*—also be assistive in helping users of a given at-risk group engage in decision making to better their lives. Designing for user agency in decision making, indeed designing tools that possess *usefulness* [2] to vulnerable populations requires study of broad contexts of use and patterns of inquiry with each specific technology. But, because many public health risks are largely factored by geographical location, and because emerging scholarship in risk communication advocates for techniques tailored to specific, localized populations [3-5] UX design cannot lose sight of the importance of physical, material place in the study of widely accessible, interactive online tools. The challenge moving forward thus becomes: Despite our increasingly global understanding of public health risks, information and UX designers cannot lose sight of highly-localized attention to place.

This experience report uses the urgent topic of the effects of sea level rise on coastal communities to frame the challenge of including local place as a critical context of use in the future development and study of risk-based communication platforms. Building upon issues identified in recent qualitative UX research with interactive sea level rise viewers, or ISLRVs [6-7], this experience report discusses the ongoing work of this researcher in public usage of ISLRVs, with specific attention to the connections between user experience (UX) design and risk communication. While most research in this area has focused on the technical usability of these tools [8-9], this experience report shares and reflects on the mixed-methods results of a second iteration of a UX study.

2 TRENDS IN RISK VISUALIZATION

Residing right at the intersection of localization and visualization trends in risk communication and risk scholarship are interactive sea level rise viewers, or ISLRVs for short. To increase public and stakeholder engagement with scientific data on sea level rise, many government agencies, nonprofit organizations, and environmental advocacy outlets are designing online, interactive data visualizations that allow users the ability to explore various displayed projections of sea level rise and associated impacts in a given geographical area. While some were crafted as

SIGDOC '17, August 11-13, 2017, Halifax, NS, Canada

ACM ISBN 978-1-4503-5160-7/17/08…$15.00
https://doi.org/10.1145/3121113.3121208

powerful decision-making tools for city planners, coastal or floodplain managers, and engineers who are looking to make data-driven risk assessments pertaining to water inundation in a given region and who are looking for engaging ways to present such data to other stakeholders in the given community (as evidenced by the complexity of design), these tools can be used and harnessed by the lay public to make general risk assessments about sea level rise in their own community. They can serve as critical risk communication tools that engage the public and allow users to zoom into their location and tinker with settings to make general assessments about the timing and scope of their vulnerability to the changing climate and rising seas. As tools with the potential to empower residents of coastal states to tailor risk data to their own location, and thus empower residents to make decisions and solve problems related to their prolonged livelihood, ISLRVs represent precisely the type of technology that would be of any interest to scholars in technical communication interested in public understanding of science, risk communication strategies, and visual rhetorics of science. They offer possibilities for thinking about engagement and of environmental risks and opportunities for research.

Research on these types of tools have revealed that some users may have difficulty with interpreting maps [10-11], and studies using subject-matter experts in the development of ISLRVs had respondents even acknowledge the issues the public might have with using these tools for decision-making [12]. As open data exploration tools, a public lay user might stumble upon an open, online ISLRV and be faced with complex challenges related to scientific and risk literacy. While users might be able to locate themselves using the interface familiar to anyone who has used Google Maps, understanding and making risk assessments presents another challenge. Most ISLRVs have sliders that allow users to select a water level (e.g., 6 feet) so users might be able to visualize at what level of inundation their property or region would be affected; but would this be accurate? And how would the user know? This would require at least some basic understanding of water levels as some tools, such as Climate Central's (Figure 2), begin the user at 5 feet—which might imply that the current coast is at 5 feet, as opposed to it starting out the user with some visualization cues and direction as to how to use the slider. Also lacking are significant contextual markers. Lay users might be led to make inaccurate risk assessments about their vulnerability and might not have the contextual, place-based knowledge to make broader statements about the risk of the region at hand. Sonia Stephens has coined this issue with ISLRVs as a problem of "too much agency" [13]. Given the openness of data and the complexity of the tools' designs, users face too many choices, too many variables, too many moving parts to even answer the most basic questions, such as: What type of event would cause my house to flood? Or, where in this neighborhood should I purchase a home? While disclaimers on several sites warn against using these tools for final decision-making, they still have the potential to influence a user's perception of risk to themselves or their community [14] and it is imperative that these tools do as much as they can to ensure accurate risk assessment and ease of localization. More work needs to be done appealing to a user's sense of place, and thus more research is needed on geographic place as a context of use (see Huatong Sun's seminal work on cultural usability and cross-cultural contexts of use [15]).

3 STUDY DESIGN

This study design was informed by the first iteration of this research project, which asked residents of a specific locale to openly explore the Risk Zone Map [7]. The first study was open enough to find out the types of tasks and problems resident users wanted to broach. The 12-person user cohort identified being able to locate a specific property and assess its vulnerability by feet of water as an important task. As such, this study—the second iteration—included this task as one of the several tasks and domains of user experience tested. The following scenario was provided on screen at the beginning of the testing session:

> Climate Central's *Risk Zone Map* shows areas vulnerable to flooding from different combinations of sea level rise, storm surge, tides, and tsunamis, or to permanent submersion by long-term sea level rise. […] Imagine you stumble upon this interactive site while researching property in a coastal state. You are curious as to what the site has to offer given your own concerns about storms and/or sea level rise. You begin to play around with the site.

The purpose of this report is to explore any connections between geographic place and use of the tool.

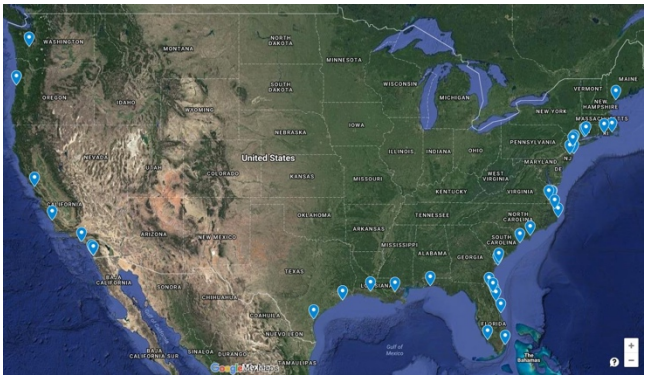

Figure 1: Google Map of locations explored by the users. All states were covered except for AL, MS, ME, and DE.

3.1 Participants

Participants were recruited and observed through UserTesting.com's audio plus screen-capturing usability tool. Participants were not restricted to coastal states but could

take the test from anywhere in the continental United States (Figure 1). Forty-one users completed the test, with three others not completing. Eight users identified as male; 33 users identified as female. The average age was 30.3 years old, with a range of 21 to 61 years old. All participants self-identified their "web expertise" as average, when asked to select from low, average, or high.

3.2 Procedures

Users were incentivized to participate through payment received by UserTesting.com and not through the researcher or researcher's institution of employment or any affiliated organizations. Participants recruited through UserTesting.com are paid for their work on tests lasting approximately 15 minutes. The average test completion length was 27.2 minutes in length, with a range of 14 minutes to 56 minutes. The UX test consisted of 36 questions. The types of questions were divided into the following categories (Table 1). This UX test design was informed by Michael Albers' argument for testing multiple domains [16] and my own previous argument on focusing on usefulness in civic contexts [17].

Table 1: Categories and Sample Questions

Category	Sample Question	Qty.
Task/Usability	Zoom in closer to and find a specific location (e.g., house, landmark) in the region. Use the "Landmark" feature on the bottom to provide guidance if needed. [Task]	14
Interpretation	Why do you think the slider on the left hand side is at the number it is? [Verbal Response]	6
Risk Assessment	How many feet of water inundation would it take for this location to be affected by rising waters? [Verbal Response]	6
Reflection	What types of decisions related to sea level rise, property, and community would you like this tool to help you with in the future? [Verbal Response]	7
Design	What did you think of the color scheme? How could it be improved? [Verbal Response]	3

The test covered a broad array of topics, from functionality of the tool to risk perceptions and assessments due to the fact that I was gathering research for my own interest in contexts of use as well as immediately useful data to the design team at Climate Central.

3.3 Contexts of Use

To focus my findings on geographic place as a critical context of use, I had to get creative to explore in detail how users from different locations might approach a certain task differently. Building more UX work into the development of geographic place as a context of use requires specific attention to how one's place shapes one's use of a risk communication tool. Do residents of Virginia Beach, VA, for example, use the *Risk Zone Map* in a way identifiably different from residents of coastal Oregon given the different environmental frames shaping their perceptions of the environment, and thus, by extension, risk and vulnerability to the region? How does this potentially shape the way we think about the design of risk visualization technologies? The results outlined below focus on how the participants responded to the following series of questions (17 through 20):

17. Imagine you owned a home in this region that is relatively close (2-3 miles) to the coast, a river, or connected inlet. Using the tools given to you (including the "Projections" tab on bottom left), try and assess your vulnerability to water inundation in the future.
18. What techniques or features did you use to make this general assessment?
19. Can you establish some sort of timeline about your risk in the future related to your imagined property?
20. Make an overall interpretation or assessment of the area's risk or vulnerability moving forward.

I then divided the responses to these five tasks and questions into two groups: those using the tool in their home state (n=20) and those using the tool in a state in which they currently do not reside (n=21). I did so in order that I might find any patterns that might relate to the ability to accomplish a task; an understanding of timeline of vulnerability moving forward; more accurate assessments of risk; and/or more or less change in one's understanding of sea level rise. Research has shown that residents of a given area possess certain "frames" about the environment that are informed by experience [18], localized knowledge [19], and aspects of community [20]. So, it might follow that an existing understanding of one's environment could impact the use of a risk-based technology or decision-making aid. But considerable more research is needed on precisely *how* one's place or sense of environment factors into the use of a risk visualization technology.

4 RESULTS

The results below are framed as a type of compare and contrast between users who physically lived—or had lived—in the state they were exploring and those that do not or did not live in the state they were exploring. That being said, users were encouraged to select a coastal city of place that had "personal relevance to them," so even those that do not live in the explored states did have family, vacation time, or some other relatable aspect to the chosen place. Qualitative content analysis was used to identify patterns; quotes from participants are taken to illuminate main points. Below I

explore how geographic place factors as a context of use in interactive risk visualizations.

4.1 Ratings

Before getting into *how* users engaged with the tool (questions 17-20), we might glean some significance from some basic statistics and how they varied between the two groups (Table 2).

Table 2: Rating Stats between the Two Groups

Question	**Home State (n=20)**	**Non-Home State (n=21)**
Does the site information content meet your needs? (1=strongly disagree, 5 = strongly agree)	3.79	3.67
Did the site provide sufficient information? (1=strongly disagree, 5 = strongly agree)	3.63	3.62
Would you recommend this tool to others? (1 = not at all, 10 = definitely)	6.95	7.10

The above questions in Table 2 were asked after the UX test had taken place as follow up markers that would be useful to the design team at Climate Central. As we can see, there is no item that is statistically significant, but we might take note of the recommendation scores for the two groups. One might have hypothesized that the user group exploring the tool within their home state might have higher recommendation scores given the urgency of their situation and the higher amounts of people they know who are similarly at risk or in vulnerable coastal regions.

4.2 Duration

Connected to the above findings is the difference in time spent using the tool. What was found is that home state users spent considerably more time (average of 29.9 minutes) on the test than did non-home state users (average 23.6 minutes). This might suggest two findings. The first is that, given the lower rating scores, home state users might have had less positive experiences with the tool in struggling to accomplish tasks. The second, in the opposite direction, is that home state users had more familiarity and knowable places to explore and thus spent more time on task than the non-home state users. Perhaps more time was spent attempting to gain an accurate assessment of their own property given what is at stake.

4.3 Task Completion and Local Knowledge

For the purpose of this experience report I will focus on one major task asked of all participants (questions 17 and 18): "Imagine you owned a home in this region that is relatively close (2-3 miles) to the coast, a river, or connected inlet. Using the tools given to you (including the "Projections" tab on bottom left), try and assess your vulnerability to water inundation in the future." I analyzed task completion—were users able to accomplish the task?—and also analyzed the follow-up question asking them to share the techniques they used, searching for any evidence of local knowledge as a factor in shaping tool usage. I evaluated the users' ability to complete the above task of assessing their vulnerability in the future with the "imagined location" by indicating each attempt as either: incorrect/ incomplete (I), tool/technical issues (T), partially/broadly correct (PC), or correct (C). The latter two—PC and C—count as a task completion. Here are the results:

Table 3: Task Completion Rates

Task Assessment	**Home State (n=20)**	**Non-Home State (n=21)**
Incorrect/Incomplete	1	6
Tool/Technical Issues	6	2
Partially/Broadly Correct	6	6
Correct	7	7
Completion rate	13/20 (65%)	13/21 (65%)

The task completion rates between those exploring their home states and those exploring states of non-residence are essentially the same. This is not inconsequential, as one might expect that more accurate assessments are made by those in their home states as they are able to incorporate existing knowledge of local risks and vulnerabilities into assessments. These findings might modestly suggest that users do not as readily incorporate their local knowledge of risks into decision making with online tools as much as one might think. Given the sheer complexity of the tool, I might argue that a user's technical proficiency might play a more significant role in making accurate assessments than one's geographic place, especially given the amount of people who struggled to use the tool to project vulnerability moving forward.

Users were prompted after being assigned this task assess their vulnerability in the future to reflect on the techniques or tool features they used to make their assessment. What I was looking closely for in this question was whether or not and to what extent users incorporated local knowledge into their assessments. This might add a qualitative layer to the quantitative data in Table 3, which seemed to suggest that geographic place did not factor into making risk assessments. I marked local knowledge (LK) in the transcripts each time a user made reference to geographic place (street name, landmark, residence, etc.), used historical knowledge of a previous event in the region, or used knowledge from personal connections in the community not only to see how often local knowledge is integrated into the users' decision-making but also how. This is really the most productive direction of geographic context of use: *how do users integrate local, geographic knowledge of place in order to make decisions? How does one's place effect their perception of risk?*

This is where it gets a bit more complicated. Many users referenced geographic places, such as landmarks and streets, during their risk assessment task, but not all who did indicated experience as shaping their assessments when asked to reflect. Further, users who mentioned places such as streets did not always make an accurate risk assessment. For example, four users in the home state group referenced specific streets or residence locations but could not make accurate assessments of vulnerability moving forward because of issues with the technology. An excerpt from the transcript of one home state user read as such (square brackets indicates unstated action):

> "[Clicks projections] So, we are going to [moves back to San Diego, zooms in to original area; slider still at 7ft] OK, so let's just say we live over here in this area, 5th Avenue and G Street. OK, so scenario, let's see [plays with scenario options] I'm going to say this is downtown so this is pretty polluted [thinks it indicates pollution of area; goes between low and moderate] …moderate is in same area? Numbers are changing…2200, 2170, not entirely sure. I don't quite understand what the relevance of this is, I'm not sure what exactly this means, 'unchecked pollution,' I'm not sure about what this projection means. Yeah, I don't understand it—don't know what it means, don't know significance of it. Where it gets really flooded in this area, that would be the point? the pool of water maybe? I really don't know."

This is a representative example of how knowledge of a specific region can only get a user so far in making an assessment if the tool is unclear or complex, which in this case, and in many cases in both user groups, it was. What we can do in this case then is look more towards how users incorporate knowledge in order to make accurate assessments.

In the home state user group, out of 20 there were three users who explicitly disclosed using previous knowledge of experience or place as factoring into their decision-making process. One user was able to make a more specific assessment based upon their interest in property in the area. Another user incorporated their knowledge of flooding in the area based upon their college tenure and understanding of how much feet would affect a given neighborhood. However, of particular interest here is the third and final home state user who used local knowledge in their assessment. This user experienced conflict in trying to incorporate local knowledge with the risk assessment features of the Risk Zone Map; specifically, this user was trying to negotiate their experience with flooding in the area with the data visualization given by the tool:

> "My first apartment was up here [Zooming] on Bonita St. where my first little studio apartment was. [Plays with projections and scenarios]. Not seeing any changes from unchecked pollution to moderate carbon to extreme, zoom back in, [Trying to find confirmation] I'm going to say living right around here is mobile home park, use that [Still playing around with scenarios] Not seeing any changes [Trying to find and see changes] Not seeing any vulnerability and spending time in here, on the screen, not seeing anything. No data or no impact and I can't believe there is no impact, so there must be no data. I used the tools and I don't see any vulnerability, and I know based on scenario [referencing own experience] there should be some. Let's take it down to 5ft [Tide gauge not in picture] I see concerns at 10ft but that is not using the projections. I have no vulnerability but I know that's not true; must be lack of data."

What we read here is a user who is trying to reconcile their knowledge of flooding in the region based on previous lived experiences with the tool data. They are searching to find "changes"—referring here to changes in water level inundated the location they have specified—and are unable to do so with the tool. This user goes on to insist that the area is at risk and more vulnerable than the tool indicates and consistently positions themselves against the data. Geographic place as a context of use might be positioned as useful knowledge, but in this case local knowledge of place might have the opposite effect in that it might not allow for clear interpretation of data.

In the non-home state user group, only one out of 21 used local knowledge, and that user was partially or broadly correct in stating that the Outer Banks of North Carolina were at risk in the next hundred years of being in trouble.

4.4 Establishing Timeline

The next two questions (19 and 20) asked users to take a step back, so to speak, from the highly specific task given at question 17 and make broader generalizations about the risks of the locale moving forward. This allowed users to not rely predominantly on the tool to make assertions. My hypothesis and expectation in this section of questions was that users, when not given specific technical instructions to use a complex facet of the tool, might be more open to integrate external domains of knowledge into their assessment or decision-making.

This was partially confirmed in the changes that took place from questions 19 to 20. Question 19 asked users to "if they are able to establish some sort of timeline about the risk to their property in the future." In the home state group, I assessed that only four of the 20 were able to establish some sort of timeline (e.g., 100 years away from being flooded in this specific area). The other 16 were not. This makes for a 20% success rate. All four users incorporated local knowledge into their assessment, whether it was through work on coastal erosion in their job, an article they read on the local threats, or a broad understanding through years of living there. In the

non-home state user group, only three out of 21 were able to establish a timeline.

4.5 Risk Assessments

In the next question, users were asked to "make an overall interpretation or assessment of the region's risk moving forward," not requiring any technical task, and 18 out of 20 in the home state group were able to make some sort of correct assessment of the location's risk moving forward. Fifteen out of 21 in the non-home state group were able to do so. This mild difference in results might lead us to believe that living in a place merely makes one more knowledgeable of its risks, most likely through media exposure, public works projects, and conversations with other residents. Regardless of the differences, it might be more useful to, again, investigate further the specific ways local knowledge manifests itself in framing or influencing risk perception. In both user groups and across success rates—that is, across all 41 users—local knowledge manifested itself in the following ways:

- Local employment (i.e., one user worked for government on coastal erosion along Louisiana coastline).
- Literature (e.g., articles about risk in their region).
- Previous flood experience (i.e., understood how much feet would affect place, and what events would cause it, but not necessarily when).
- Family connections (i.e., knowledge of flood insurance issues through parents).

These factors, generally speaking, led to more accurate and informed risk assessments but not necessarily so. More research is needed in this area to draw more conclusive connections.

5 DISCUSSION

Much literature in risk communication suggests that place—whether referring to a person's attachment to or knowledge of—factors into risk perception. This research seeks to apply this idea to use of a specific visual risk communication tool to see if we can glean through UX research any meaningful data on how geographic place might operate as a context of use of these types of technologies, which are increasing in popularity and use. This research attempted to explore this topic by analyzing quantitative and qualitative UX testing data on Climate Central's *Risk Zone Map* to uncover any meaningful connections or ways in which users integrated their sense of place into use of the tool, with the hypothesis that users exploring their "home" state would have more informed and thus more accurate risk assessments. This hypothesis was only partially confirmed, and actually there is data to suggest that sense of place might not factor as much into risk assessments as other factors, such as complexity or ease of use of the tool. More research is needed in that area.

There are certainly other methods of exploring geographic place as context of use. One might attempt to group the participants by national region (e.g., Pacific Northwest, Southeast, Mid-Atlantic, Northeast, etc.) and tease out any patterns in usage from those along the Atlantic to within the Gulf of Mexico or the Pacific broadly. This might also consist of a more political layer of analysis as well, if one could overlay political data with regional usage. Do users in coastal Virginia use such risk visualization tools noticeably different from users in coastal Oregon? Such patterns might help in further efforts of designer-based localization.

The challenge in this particular research was establishing causality. All I did here was identify patterns between the equal user bases but this does not mean that their location is the main contributing factor to their use of the tool. More controlled research methods will be needed to further develop this line of inquiry and broader area of study.

What was discovered, unsurprisingly, is that the tool is very difficult to use (it was originally designed for an expert audience, including city planners and coastal managers) and very few if any users used their own current understanding of their location. To be honest this research uncovered more about the use of the tool here than about local cultures factoring into use of the tool. This might suggest that when a tool is difficult to use there are limitations on the types of expertise employed and contexts of use offering influence to help answer a question or solve a problem. The second drawback is the lack of feedback for Climate Central on user comprehension of the science being communicated. No questions were asked to assess each participants' level of knowledge about the connection between climate change and inundation or about projected timelines for vulnerable regions to be under water. Despite these limitations and drawbacks, this research study and its corresponding methods afforded Climate Central applicable data to at least begin considering how to move the design of ISLRVs in the direction of a more publicly-oriented decision-making tool.

6 CONCLUSION

This research study was aimed exploring geographic place as a context of use, specifically through the use of interactive risk visualizations focusing on sea level rise. Geographic place is an underexplored context of use in the field of user experience (UX) but as risk communication tools get more interactive and as more research is published in risk communication establishing place attachment and knowledge as predictors of action, studies such as this will not only help UX researchers become important players in the visual communication of risk—might this also be phrased as, *visual risk literacy*?—but also will provide useful data to the designers of tool such as the *Risk Zone Map* to help connect critical information to the populations most at risk in an engaging and informative way.

REFERENCES

[1] Beck, U. (1999). *World risk society*. Malden, MA: Blackwell Publishers Inc.

[2] Mirel, B. 2004. *Interaction design for complex problem solving: developing useful and usable software*. San Francisco, CA: Elsevier Science.

[3] Scannell, L, and Gifford, R. (2011). Personally relevant climate change: The role of place attachment and local versus global message framing in engagement. *Environment and Behavior, 45*(1), 60-85.

[4] Bradford, R. A., & O'Sullivan, J. J. (2011). Improving communication strategies for effective flood risk management. *National Hydrology Conference*, 52-63.

[5] Harbach, M., Hettig, M., Weber, S., & Smith, M. (2014). Using personal examples to improve risk communication for security and privacy decisions. *ACM. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, 2647-2656.

[6] Stephens, S.H., DeLorme, D.E., and Hager, S.C. 2014. An analysis of the narrative-building features of interactive sea level rise viewers. *Science Comm.* 36, 6, 675-705. DOI=10.1177/1075547014550371

[7] Richards, D. P. (2016). Helping local residents make informed decisions with interactive risk visualization tools. *SIGDOC '16: The 34th ACM International Conference on the Design of Communication Proceedings*. New York: ACM, 2016.

[8] Slocum, T., Cliburn, D., Feddema, J., and Miller, J. 2003. Evaluating the usability of a tool for visualizing the uncertainty of the future global water balance. *Cartography and Geographic Information Science* 30, 4, 299-317.

[9] Wong-Parodi, G., Fischhoff, B., and Strauss, B. (2014). A method to evaluate the usability of interactive climate change impact decision aids. *Climatic Change*, 126, 3/4, 485-493. DOI=10.1007/s10584-014-1226-9

[10] Kain D., & Covi M. (2013). Visualizing complexity and uncertainty about climate change and sea level rise. *Communication Design Quarterly, 1*, 46–53.

[11] Charriére M., Bogaard T., Mostert E. (2012). Disaster managers' perception of effective visual risk communication for general public. In Zlatanova S., Peters R., Fendel E. M. (Eds.), *Proceedings of the 8th international conference on geo-information for disaster management—best practices* (pp. 11–20). Enschede, the Netherlands: University of Twente.

[12] Stephens, S.H., DeLorme, D.E., and Hager, S.C. 2015. Evaluating the utility and communicative effectiveness of an interactive sea-level rise viewer through stakeholder engagement. *J. of Business and Tech. Comm.* 29, 3, 1-30. DOI=10.1177/1050651915573963

[13] Stephens, S.H. 2015. Interactive data visualization for risk assessment: Can there be too much user agency? *SIGDOC '15 Proceedings* (July 16-17 2015). DOI=http://dx.doi.org/10.1145/2775441.2775446

[14] Herring, J., VanDyke, M. S., Cummins, R. G., & Melton, F. (2017). Communicating local climate risks online through an interactive data visualization. *Environmental Communication, 11*(1), 90-105.

[15] Sun, H. (2012). Cross-cultural technology design: Creating culture-sensitive technology for local users. New York: Oxford University Press.

[16] Albers M. J. (2003) Multidimensional audience analysis for dynamic information. *Journal of Technical Writing and Communication, 33*, 226–279.

[17] Richards, D. 2015. Testing the waters: Local users, sea level rise, and the productive usability of interactive geovisualizations. *Communication Design Quarterly* 3, 3 (May 2015), 20-24. DOI=http://doi.acm.org/10.1145/ 2792989.2792992.

[18] Nisbet, M C. 2009. Communicating climate change: Why frames matter for public engagement. *Environment: Science and Policy for Sustainable Development* 51, 2, 12-23. DOI= http://dx.doi.org/10.3200/ENVT.51.2.12-23.

[19] Kellstedt, P. M., Zahran, S. and Vedlitz, A. 2008. Personal efficacy, the information environment, and attitudes toward global warming and climate change in the United States. *Risk Analysis* 28, 1. DOI=10.1111/j.1539-6924.2008.01010.x

[20] Akerof, K. L., Rowan K. E., La Porte, T., Batten, B. K., Ernst, H., Sklarew, D. M. (2016). Risky business: Engaging the public on sea level rise and inundation. *Environmental Science & Policy, 66*, 314-323.