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ABSTRACT

While interactive maps are important tools for risk communication, most maps omit the lived experiences and personal stories of the community members who are most at risk. We describe a project to develop an interactive tool that juxtaposes coastal residents' video-recorded stories about sea level rise and coastal flooding with an interactive map that shows future sea level rise projections. We outline project development including digital platform selection, project design, participant recruitment, and narrative framing, and tie our design decisions to rhetorical and ethical considerations of interest for others developing interactive tools with community participation.

CCS Concepts

Human-centered computing → Collaborative and social computing

Keywords

Narrative, risk communication, sea level rise, story maps

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"Spaces are produced only by narrating them…

Only narration can transmit the quality of the everyday."

—Wladimir Fischer-Nebmaier, 2015, p. 33

INTRODUCTION

Those tasked with communicating environmental risks have long grappled with how to most effectively engage public audiences on risks that have global, national, or local consequences. The traditional information deficit model of science communication, which posits that public audiences do not understand science data simply because they do not have enough scientific training, has been recognized as insufficient for communicating complex subjects, including environmental risk (Bucchi, 2008). Moreover, where risk has traditionally been defined by experts as the probability of a hazard's occurrence times the size of its impact (Okrent, 1980), contemporary research shows that public perception of risk is multidimensional (Slovic, 2010) and includes a risk's impact, an individual's confidence in scientific understanding of the risk, and perceived dread (Fischhoff, 2009). Peter Sandman (1993) captures this complexity succinctly in his definition: risk = hazard + outrage. In light of this movement towards public inclusion in risk assessment and rhetorical framing of risk perceptions, the challenges of risk communication have become more clear: the data need not only merely be accessible and available but need to matter in a way that relates to people and their mental schemas (Lakoff, 2010), their environmental frames (Nisbet, 2009), their worldviews (Akerlof et al., 2016), and their sense of place (Scannell & Gifford, 2013)—in essence, their lived experiences.

The shift from the information deficit model to more direct, critical, rhetorical public engagement models (Grabill & Simmons, 1998) has spurred a considerable number of on-the-ground studies and projects with residents in vulnerable areas, often taking form through ethnographies, case studies, interviews, and surveys (e.g., Covi & Kain, 2016; DeLorme et al., 2018). These productive studies then iterate back and inform communication strategies in more tailored, localized ways. The limitations of more on-the-

ground, conversational research projects are that they are resource-intensive and difficult to generalize beyond the local scene, given the need to attend to rhetorical contexts. In part because of these limitations, deficit models are still a part of science communication strategies (Suldovsky, 2016).

Resource limitations also help explain, in part, the excitement and optimism around advances in interactive technologies that let communicators engage more actively with audiences with whom they are not having a conversation in person. Technology has advanced to the point where those tasked with communicating risks have the available technological means to meet people where they live, often literally, without themselves going there. Smartphones have enabled significant progress in citizen science initiatives, including image collections of affected areas; modeling and simulation technology has enabled people to envision future scenarios of their neighborhoods; and GIS software has enabled computer users the opportunity to explore data in their own way through layered visualizations, allowing residents to overlay a data set onto a region, neighborhood, or even residence of their own choosing. The presumption driving these advances is that equipping vulnerable residents with varying degrees of scientific agency will translate into a sense of political agency, driven by a resident-user's newfound ability to intersect science, place, and a sense of investment.

What we see, however, is that such advances in technology do not automatically spur political action, do not necessarily engender a spirit of environmental urgency just by their very use (Richards, 2019). An increase in user agency does not necessarily lead to an increase in political agency, which we define here for our purposes as voluntary involvement in community-based, national, or global programs aimed at environmental resilience. Communication designers and technical communicators might theorize this disconnect as stemming from the continued technocratic design of the very risk communication technologies intended to engage (Stephens et al., 2015). A user might actively *geolocate* their picture of a flooded neighborhood, *experience* a dramatic projected visualization, or *explore* open data sets, but the main if not sole rhetorical interaction—facilitated as it is through impressive technology—is still with data. The rhetorical encounter with the technology might still be siloed from the greater social situation of the risk at hand, with the technology able to visualize risk scenarios but less able to contextualize which communities are most affected and what might be done about it. The technology may have changed shape from a one-dimensional message to a two-dimensional map or even a three-dimensional simulation, but the primacy of technology-driven data collection and distribution often remains. Despite the interactive, rhetorical potential imbued in twenty-first century risk communication technologies, technocratic design structures reminiscent of information deficit models of old still remain.

Given that levels of skepticism towards human factors in climate change continue to remain high (Marlon et al., 2018), and that at least some level of climate destabilization is now irreversible (IPCC, 2018), we are not arguing for the complete dismissal of public engagement of data but rather that such public engagement with data happens alongside the lives, stories, and communities being represented. What we are arguing is that advances in public-facing risk communication technologies cannot leave behind the advances in our understanding of the role of emotions, public perceptions, community, and story. The excitement and availability of profound technological advances should not preclude a situatedness in the lives and livelihoods of those most at risk. In other words, what is ironically missing from much interactive, engagement-driven risk communication technologies are people and their stories.

This paper describes a project that demonstrates how narratives—specifically experiential stories from those in vulnerable regions—can be combined with map-based sea level rise (SLR) risk visualizations to create an interactive, visual tool that gives more context or nuance to the risk. In essence, the project seeks to combine the interactive potential of GIS-based tools with the importance of using individual resident stories to help frame the messaging. Exposure to risk narratives in multimedia forms (e.g., interactive simulations) has been shown to increase audience engagement with complex environmental issues (Vervoort et al., 2010), and communication about the risks and uncertainty surrounding climate change via place-based scenarios has been shown to motivate concern and willingness to take mitigative actions (e.g., Shackley & Deanwood, 2002). As a complementary way to communicate about hazards, stories of individual experiences with environmental risks can also help develop and historicize the local risk experiences of a given community (Lejano et al., 2013), adding a significant level of detail and relatability to the larger risk narratives. In light of this research, we ask: What if data-centered interactive SLR maps could also provide access to community stories from long-term residents who have personally experienced the effects of water inundation? How do we design such tools, and what rhetorical and ethical considerations should be taken into account? And might this add a powerful layer of context and potentially persuasion to risk visualization technologies? This final question about persuasion, and potentially social action, is still speculative; more user experience research, such as the type conducted by Retchless (2018), is needed in exploring the relationship between rhetorical design choices made within the tool and the subsequent actions sought by users outside of use of the tool. For this project, we focus more modestly on the specific decisions made within a specific technological tool with the goal of merging map data with affected human voices.

This article begins by positioning interactive SLR visualizations as part of the larger communication genre of interactive risk maps. We then discuss narrative and its role in communication design, in part as a follow-up critique of the limitations of what we see in many technocratic interactive risk maps. From there, we then describe the origin and development of a story map project focusing on two regions along the east coast of the United States. We describe in detail the rhetorical design decisions (by which we mean the choices we made within the available means—affordances and constraints—of the story mapping application) in constructing a story map that combines the data exploration capabilities of an interactive risk map with visual stories of residents located on the map. We end with a discussion of the potential results and further directions of this approach of combining data with narrative on SLR risk maps.

Interactive Risk Maps

Interactive maps are widely used to communicate about complex environmental risks, such as SLR (e.g., the U.S. National Oceanic and Atmospheric Administration [NOAA]'s Sea Level Rise Viewer, https://coast.noaa.gov/slr/ and Climate Central's Surging Seas Risk Zone Map, https://ss2.climatecentral.org), storm surge (e.g., NOAA's National Storm Surge Hazard Maps, https://www.nhc.noaa.gov/nationalsurge/#map), or wildfire (the Southern Group

of State Foresters' Southern Wildfire Risk Assessment Portal, https://southernwildfirerisk.com/). Broadly, these visualizations project different risk scenarios onto a background map (Figure 1). Depending on specific functionality, users may select different scenario options, zoom to a desired location, and read explanatory text about the risk (Stephens et al., 2014). The information contained in risk maps tends to consist of quantifiable, georeferenced data, such as the probability that a specific area will flood at a particular sea level and the projected amount of inundation that would occur there, or locations of vulnerable public infrastructure such as hospitals or coastal vegetation zones.

to some traditional drawbacks of information-deficit models of communication. They might overload users with data, have high technical learning curves, or simply suffer from incomplete audience awareness and adequate user testing. Interactive risk maps can, from our standpoint, be read as microcosms of the ideological design conflicts described above in that they offer rich affordances in appeals to place and personal relevance but remain largely technocratic because they are often designed by experts for experts, with "the public" as a decidedly-untested upon and absent secondary audience. When lay users interact with such maps, they can have a "personalized" user experience in that they are able to interact with the data in a customized way. Nevertheless, interactive

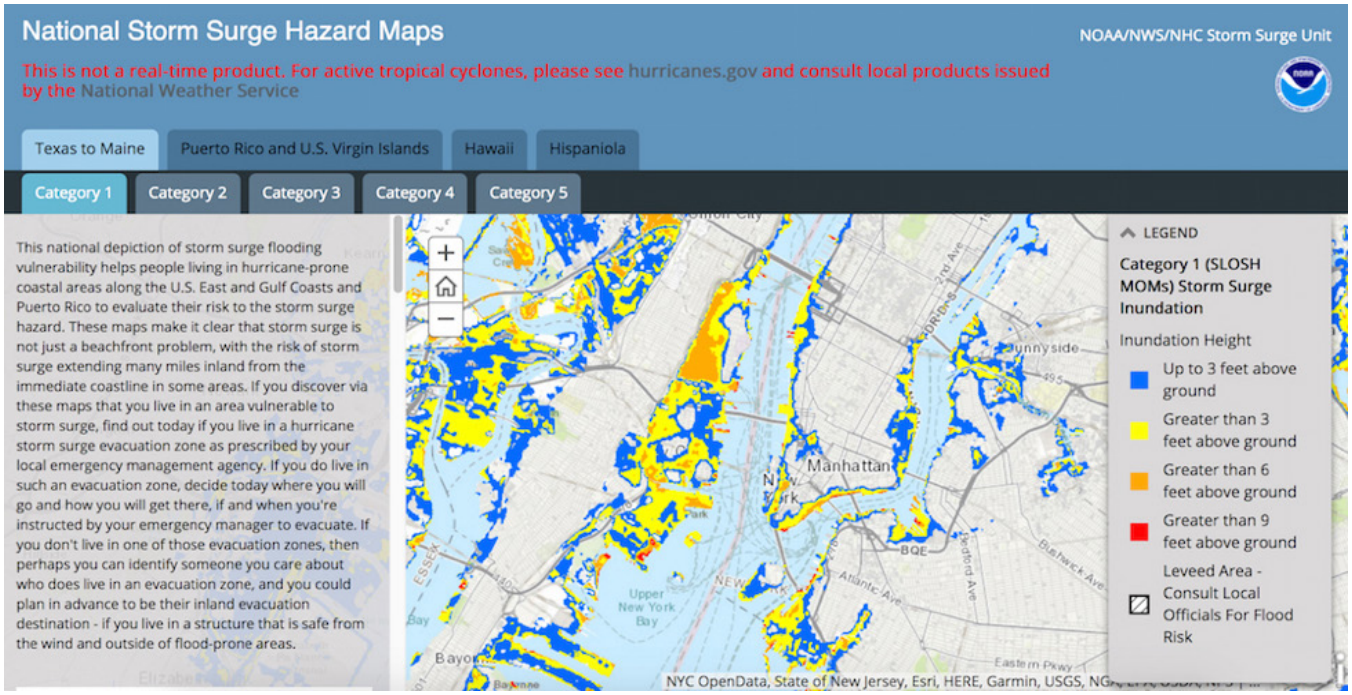

Figure 1. Example of an interactive risk viewer. Screenshot from NOAA's National Storm Surge Hazard Maps, showing the projected storm surge resulting from a Category 1 hurricane in New York City, NY, U.S.A.

Interactive SLR maps are both popular with the general public (Preston et al., 2011) and a powerful communication tool for understanding personal exposure to risk (Monmonier, 2008). Multiple actors produce SLR maps, including government agencies, non-governmental organizations, academics, and news organizations (e.g., Davidson & Miglarese, 2003; Wong-Parodi & Strauss, 2014; Stephens et al., 2015). Research has shown that maps can be more engaging than text alone for communicating risk (Retchless, 2014), and more familiar to novice users than graphs (Schnotz, 2002), but might not necessarily be more comprehensible (Covi & Kain, 2016; Richards, 2019). Given that the audiences for these tools are diverse, ranging from the general public to specialist users like community planners and land managers (Davidson & Miglarese, 2003; Monmonier, 2008; Kostelnick et al., 2013), designing maps that both engage users as well as clearly communicate a risk and its uncertainty to users with multiple levels of domain and cartographical expertise is a complex challenge (Kostelnick et al., 2013).

Our own research on and experience with interactive SLR viewers has led us to believe that these environmental risk communication technologies, despite their leaps in capabilities, may be subject

risk maps may still present risk in ways that are too complex for lay users (Richards, 2016; 2019) or lack humaneness.

One way to help lay audiences connect with mapped information is by adding qualitative information, such as narratives, that relate the lived experiences or concerns of affected communities. Our project draws inspiration from work in participatory GIS and critical cartography, which combine narrative and mapping in various ways that may facilitate a more dialogic process of science communication (Sieber, 2006). For example, participatory GIS is used to engage communities in mapping projects in order to support local knowledge-making and politically empower groups (Jelks et al., 2018). Critical cartography research points to the potential for participatory mapping projects to engage local communities (Lung-Amam & Dawkins, 2019) and empower them to, for example, re-envision natural resource management frameworks (Hayman et al., 2017).

The significance of our project lies within its expansion of the work of communicating complex, map-based SLR risk information to be more inclusive of human stories in a way that situates or localizes visualization tools by both geographic region and by narrative

voices. To date, published research on interactive SLR risk visualizations has tended to focus on data exploration and the use of mapping and other simulations to engage users in exploring their own local communities (e.g., Davidson & Miglarese, 2003; Shaw et al., 2009; Stephens et al., 2015). While some organizations have developed narratives to communicate about environmental risks, these efforts often do not connect to the everyday lived experiences of audiences (Lejano et al., 2013), despite preliminary research revealing that there is a user preference for narrative within such tools (Richards, 2016). There are only a few examples of projects that incorporate both risk mapping and explicitly narrative elements (see Nettley et al., 2014).

While SLR maps afford users the opportunity to localize data to a neighborhood or even a specific building, such interactive maps are not fully "personalized" in that they exclude human subjects from the purview of visualization and engagement (Stephens et al., 2014)—an important consideration from both ethical and rhetorical design perspectives (Dragga & Voss, 2001). We thus approach this project as an opportunity to collect, curate, and share community stories about coastal risks to help contextualize impersonal map-based scientific information, and develop a more community-oriented, locally-focused narrative about SLR.

Narrative in Communication Design

Maps as a mode of visual communication have long been of interest to researchers in technical communication, with notable attention brought to the ideological (Barton & Barton, 2004), persuasive (Propen, 2007), political, (Kimball, 2006), and public health (Welhausen, 2015) properties of cartographic design. As maps have become interactive, however, technical communication and communication design scholars face a new research challenge of building knowledge about maps in newer, more interactive contexts that focus on decision-making, personalization, and open data exploration. When it comes to thinking about interactive risk maps, we argue that emphasizing the narrative aspects and potential of risk maps can be a productive way forward. We also contend that the interactive nature of maps and visualizations present an exigency to take stock of how sufficient our extant theoretical and methodological approaches to thinking rhetorically about maps are for tackling these new advances and demands for interactivity and cartographic design.

Narrative is used in several ways in technical and scientific communication. It is often employed in an outward-facing sense for communication between experts and laypeople. Psychological research highlights the use of narrative in communication design to make complex information relatable to a lay audience, stimulate audience interest, and persuade laypeople to support specific policies or to change their behavior (Dahlstrom, 2014). Narrative can also be harnessed to demonstrate expertise of the speaker (Van Ittersum, 2014). In outward-facing narratives, there are ethical concerns about the appropriate level of accuracy, ends of persuasion versus comprehension, and whether the use of narrative by scientists is philosophically acceptable in a particular context (Dahlstrom & Ho, 2012). Nevertheless, the use of narrative has been explicitly encouraged in order to promote public engagement with climate change (van der Linden et al., 2015).

A different use of narrative in technical communication is within the context of a project or study as a method or tool to gather and analyze data. Ethnographic case study research in particular relies heavily on narrative as a technique for thick description and analysis. In ethnographic studies, researchers must choose to what extent to present their own interpretations of a situation versus presenting the individual narratives of the people who they are studying, as those narratives are described to them (Blyler, 1996). Relatedly, narrative can be a valuable method for sharing the individual and situated concerns of community members. For example, Lejano et al. (2013) use narrative analysis to understand the lived experiences of individuals as they grapple with the effects of climate change. Finally, Jones (2016) advocates for a process of narrative inquiry during participatory design projects to support the inclusion of marginalized users' voices and support social justice aims.

In this project, our decision to gather street-level stories from affected individuals originated primarily from a gap both authors identified after studying and conducting testing on existing interactive risk maps, and secondarily from a commitment to environmental justice and interest in deep mapping. Despite the efforts of the creators of interactive risk maps to design a tool that engages the public in an effective and affective way, both authors have found that lay users were still by and large walking away from their use of the tool with an equal sense of confusion or disconnect. Therefore, the exigence for this project arose out of our own research and our wish to explore how narrative elements and interactive maps may be combined.

Story Maps

While narrative in the technical communication field has largely focused on verbal stories, other fields such as archaeology and digital history have explored the potential of map-based texts for conveying narrative (Ridge et al., 2013; Early-Spadoni, 2017). Thus, this project builds on the work of researchers who have explored mapping as an avenue for combining the perspectives of members of the general public with spatial data through "story mapping." Story mapping, or spatial narrative, is a technique that introduces elements of "a specified point of departure, a particular pathway, and a known end point" to a map-based visualization in order to tell a story (Ridge et al., 2013; 178). Spatial narratives can potentially capture complexity in ways that linear narratives cannot, such as by helping communicators display social interactions with and within geography (Bodenhamer, 2015). Critical cartographers describe maps that incorporate the lived experiences of communities in a place—as opposed to simply recording the physical features of a space—as "deep maps" (Harris, 2015). This project draws from the concept of a deep map to combine the recorded stories of community members with what we know about the rhetoric of maps and interactive risk visualization. Thus, we introduce story mapping into the conversation about communicating sea level rise risks to public audiences.

A story map is, in a way, profoundly simple: a map that tells a story; an interactive artifact that uses the affordances of cartography to guide the user through a narrative (see Figure 2). While not the proprietor of the term or concept, Esri, the builder of ArcGIS (which they themselves describe as "the world's most powerful mapping and spatial analytics software"), has been a frontrunner in the development and popularity of story maps. Their highly-usable, template-driven story map tool is flexible enough to allow for a variety of stories but structured enough to make composition technically easy on the authors.

But a story map is, in another way, profoundly complex. While blending of stories and maps can increase user engagement with a

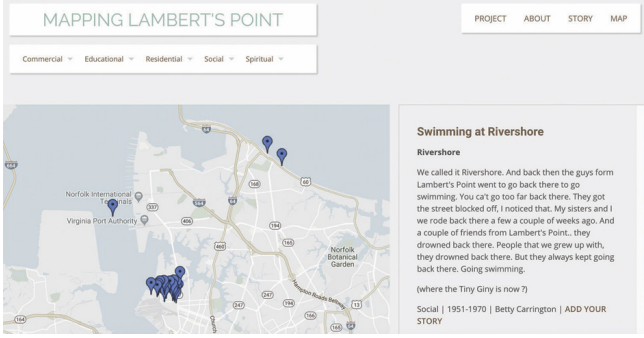

Figure 2. Example of a story map. Screenshot from "Mapping Lambert's Point" (http://www.mappinglambertspoint.org)

topic, issue, or region, the baggage that comes with both narrative and cartography as intellectual fields of study does not simply get left at the door. Blending maps with stories does not render maps less ideological or narratives less about power. There is still a person who gets to tell the story and a person who gets to decide how to represent space and place. While story maps have the potential to engage users in a specific topic—for example, to "inform, educate, and inspire decision-makers" (Wright, 2016)—they still also have the potential, if created without care, to replicate the same problems. As Harris (2016) argues, "The power of GIS lies in…its ability to reduce complex information to meaningful and understandable forms and yet this reductionism can also act against the multivalence of local knowledge and the need to maintain contradictions, arguments, and multiple perspectives" (p. 319).

While there have been ample numbers of story maps created, there has been less attention paid to the rhetorical considerations of the discrete, granular design decisions that go into composing a story map. Story maps have been used for outreach and education (Sinclair et al., 2018), to represent the history of marginalized communities within a landscape (Alemy et al., 2017), and to articulate residents' visions for the future of their communities (Lung-Amam & Dawkins, 2019), among other purposes. Research on story mapping and related participatory mapping projects (e.g., Brennan, 2018; Jelks et al., 2018) largely focuses on the participatory process itself as a site of community engagement or empowerment. For example, Brennan (2018) positions a participatory mapping project as a mechanism to inform natural science-driven management of a marine protected area about residents' lifestyle and cultural heritage concerns. While all worthy story maps playing vital roles in specific communities, none focus on how their specific design choices made within the application connect to their larger rhetorical goals. The design choices of these maps are black-boxed to a certain extent.

The fields of technical communication and communication design are well-equipped to pick up this mantle and theorize the rhetorical construction of story maps from a design standpoint, given our field's history in attention to both maps and narrative as powerful and persuasive. As we make the transition from static to interactive maps, we must be sure to take Barton and Barton's (1993) truism that all maps are ideological with us. The continued technocratic predilections of cartographic design in the context of risk maps and visualizations insist upon continued attention to representation, power, and bodies. The increasing interactivity of maps does not automatically mean they are democratic. What we present below, then, is a highly-reflexive example of the rhetorical decision points made by designers—us—of a story map right from the genesis of the project all the way to its public-facing stage. This reflexivity is done with the intention of highlighting the rhetorical decisions that can be made when designing story maps.

PROJECT DEVELOPMENT

The two main phases of this project were: (1) recruiting and interviewing coastal residents about their experiences with and concerns about coastal flooding and (2) building the risk map interface using the Esri Story Map platform. Both phases took place simultaneously and across two geographic regions: The Space Coast in eastern Florida, USA, and the Hampton Roads region in southeast Virginia, USA (Figure 3).

Figure 3. Location of study regions: Hampton Roads, VA, USA, and Space Coast, FL, USA

Projects that collect oral histories or experiences and that do not seek to develop generalizable research results are exempted from IRB review, according to U. S. federal guidelines (White, 2017). We collected narratives in order to illustrate residents' concerns about SLR on the risk map interface, and our intent was not to generalize from their responses. Prior to beginning the project, we contacted an IRB coordinator at the first author's institution to inquire whether our interpretation of the guidelines was appropriate. Based upon our description of this project, they agreed that it was appropriate to consider this use of personal narratives to be exempt from IRB review. We therefore followed best practices for ethical conduct in oral history projects as outlined by the Oral History Association (2009) for participant recruitment, video recording, and dissemination of results. Prior to interviews, participants were given a written description of the project; we discussed any questions they had about the project's goals and how their interviews might be used; and each participant signed a release form giving us permission to use their recorded interviews and statements on the website and in other media such as this publication.

Recruitment and Interviewing

Our goal was to identify and interview at least three residents in each of the two study locations who could speak about their experiences of past coastal flooding and concerns about future SLR-related inundation. We ended up with nine total participants, resulting in nine separate videos (one participant did two videos and one video contained two participants). The number of participants was less important than the depth of content because (a) our main goals for testing the effect of including the narratives on users in the future do not relate to quantity, and (b) we envision

this as a long-term project where we continually add participants' narratives. We wanted the interviews to focus on the details of the participants' lived experiences and the connections they see to larger conversations about SLR. By presenting the stories of residents of two different regions, we hoped to show both the similarities and the unique situations of these communities when it comes to coastal risk.

Participant recruitment was accomplished via snowball sampling. Each author contacted potential participants via a combination of: (1) direct contact with personally-known coastal residents who live in the study areas of interest, (2) reaching out to colleagues (e.g., researchers who have local contacts) who might know such individuals, and (3) contacting officers of environmental organizations to inquire whether any of their members might be such individuals. We explicitly tried to contact individuals who might have a diversity of perspectives on the issue, including retired contractors, naval officers, business owners, community planners, affected and concerned residents, and environmental activists.

Potential participants were initially contacted via email with follow-up phone conversations to discuss the project's goals and scope and assess whether they were interested in participating. During these phone conversations, we discussed their specific experiences with and concerns for coastal flooding and described the purpose of the project as being to collect their individual stories. Most participants (five in Hampton Roads and four on the Space Coast) were interviewed in March 2018 with both authors present. Interviews lasted between 10 and 25 minutes per participant, and were conducted either at participants' residences (in Hampton Roads) or at public parks or community centers near the coast (on the Space Coast). The goal was to have the background of each interview video reflect the nature of their concerns so as to help "localize" the stories. For example, one participant was filmed next to a boat launch destroyed by a hurricane—a result that would affect her restaurant business, located just down the road. Another participant was filmed in the space between her residence and the creek that floods and encroaches upon her property.

At each interview, we prompted the participant by asking them to tell a personal story about their experiences with coastal flooding or sea level rise, as well as their concerns going forward. In some cases, we asked participants to expand on a point or prompted them to talk about an issue or concern that we had previously discussed on the phone. After the interviews, participants were given a gift card for an online retailer as a token of appreciation for their participation. After we completed the risk map interface, we emailed each participant the link to the project and requested that they let us know about any questions, comments, or concerns they had about the project and their representation. The participants who replied all had positive comments about the project, and no concerns were raised about their representation.

Building The Risk Map Interface

We constructed the SLR visualization tool using Esri's Story Map interface (https://storymaps.arcgis.com/en/), which is a free online platform that enables users to combine interactive maps, text, videos, and static images into interactive templates that provide a pre-set overall narrative structure (Appendix A). In our project, we selected the "Journal" template, which divides the page into a left and right panel. Each page consists of a story segment that the viewer can scroll vertically through along the left-hand side. In general, the larger right panel contains either an interactive map or a static image, and the smaller left panel contains text and the participant videos. Figure 4 shows our initial rough wireframe sketch of the overall project design. In the sketch, text and videos are on the left side of each panel pair, while photos or interactive maps are on the right. Each horizontal pair of panels corresponds to a story segment, which in this draft included: two introductory segments; the maps and videos for each location; and a concluding page orienting users towards action.

Figure 4. Initial wireframe sketch of the project design

Text and images were uploaded directly to the Story Maps website, which hosts the project (readers can access the project by visiting https://tinyurl.com/slr-stories). The participants' videos were edited for length and content and posted to YouTube, then were embedded into the project via linking. The interactive map, NOAA's Sea Level Rise Viewer, was also embedded as a live (i.e., interactive) feature; the Hampton Roads segment begins with the map centered on Hampton Roads, and the Space Coast map begins with the map centered on that region.

Due to the overall structure of the Story Maps template, the project has a narrative structure that was linear overall, with participants able to either scroll or jump between story segments or interact with videos or maps within segments. It consists of:

1. An introduction, with text explaining the project purpose and basic navigation and photos of the two study locations.
2. The Hampton Roads segment, with two parts: 1) a brief introduction to the region, instructions for using the interactive map, and an interactive map of SLR projections centered on the region (Figure 5); and 2) videos of the Hampton Roads project participants and a static map showing the location in which we had filmed them (Figure 6).
3. The Space Coast segment, with two parts as above.
4. A messaging page, with text suggesting actions users can take to understand and respond to SLR, and a landscape photo.
5. A concluding page with contact information and a second landscape photo.

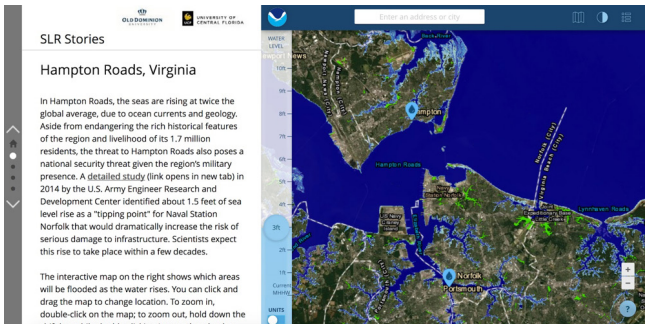

Figure 5. Screenshot of the introduction to the Hampton Roads segment. Left side: text introducing the region and explaining how to use the interactive map. Right side: interactive SLR map centered on Hampton Roads, with sea level set at 3 feet above current mean higher high water (MHHW; defined as the average height of the highest high tide in an area over several years [NOAA Tides and Currents, 2018])

The participant videos were edited for time and also to create a single cohesive narrative for each video. This entailed making editorial decisions about including specific content, as well as cutting out long speaking pauses, street noise, loud bird calls, and the like. In the Discussion, we talk about our editorial decisions with regards to the videos, images, and text in the project, and make connections to the broader field of technical communication theory.

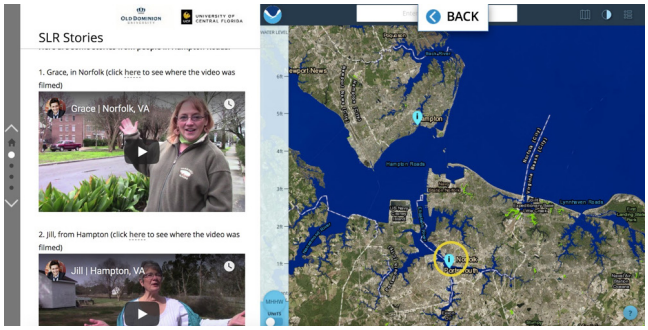

Figure 6. Screenshot showing the participant videos from Hampton Roads. Left side: personal videos. Right side: a non-interactive map with a circle around the approximate filming location. Users can switch to the interactive map using the "Back" button at the top of the map

DISCUSSION

In this section, we discuss the larger implications for communication design and technical communication of the decisions we made when designing the risk map and conducting and editing the interviews.

The Stories We (and Esri) Wanted To Tell

The process of selecting a template involved an in-depth conversation, primarily focusing on how the affordances of the template would allow us to achieve our goal of combining narrative videos with SLR mapping. Our initial vision for the layout was to begin with a full-screen interactive SLR map, and then add links to the videos in the places that they had been recorded. In this vision, clicking on a given link would cause a video to "pop up" so that users could simultaneously explore the effects of SLR and flooding in a given region, establishing a more direct connection between the presence of flooding and the voices of residents. Essentially, we wanted to add stories on top of the existing exploratory tools. Our previous research on interactive SLR viewers led us to believe that adding personal stories directly to the map would be more effective than redirecting users to a separate page of stories, which would hinder usability. However, we learned that this design would require a more advanced understanding of ArcGIS than we possessed.

One strength of Esri's Story Map application is that its template-based approach to narrative affords researchers, practitioners, and journalists with varying technical backgrounds to produce high-quality, engaging stories. While higher degrees of technical proficiency allow more opportunities for modification (e.g., designing your own tool from scratch from more tailored data sets), no GIS background is required, nor is previous experience with coding or web development. While we still believe that our initial vision for a co-located layout would be ideal, constraints of time, resources, and our technical backgrounds made it infeasible. Thus, we selected a two-columned as opposed to overlaid approach to the risk map interface (see our Figure 4 initial wireframe sketch).

The pre-construction of Esri's templates also played a considerable part in our decision of how to combine narrative with the map. Esri titles their template gallery (https://storymaps-classic.arcgis.com/en/app-list/) as such: "What Kind of Story Do You Want to Tell?" This title is invitational and undoubtedly motivates prospective creators to get started, but it also reveals a way of thinking about digital storytelling. The categories Esri has produced (Appendix A) are in our estimation dynamic and diverse enough to meet a variety of project needs, but also introduce constraints to the kinds of stories being told. As with any template-driven application, the designer is given the opportunity to either negotiate their intended design within the affordances of the application or use the template gallery as an inventive space to get ideas about how they wish to tell their story.

The notion of template-driven design will not be new to any communication designer, especially those doing audio digital storytelling (Hart, 2012). Templates have unburdened professionals in non-technical areas from the labor of coding for quite some time and all trends are pointing to their continued popularity. For us, the templates were convenient and sufficient for our adjusted goals; they unburdened us from doing high-level GIS work, and allowed us to spend more time contacting participants and curating and editing the videos. That said, the very presence of such savvy templates adjusted our goals by serving as a type of middleware, meaning software that organizes and presents information in a fashion that is invisible to the end-user (Drucker & Svensson, 2016). The convenience of templates, as is the case with genre (Bazerman, 1988), also brings about the potential of narrative calcification. Over time, as templates become more and more popular, and their dissemination extends further and further, our notions of what can constitute interactive digital storytelling might become overly-constrained, framed only within a preset number of narrative structures. Communication designers should always be aware of available templates at their disposal, and how they do or do not constrain the types of stories we see valuable for a given community, a given risk, or a given topic.

Structuring the Story/Stories: Approaching the Great Divide

In the specific context of climate change communication, like with most global risks, there already exists a grand narrative (see

Lyotard, 1979) around the climate science: the world is getting warmer, we as humans caused much of it, and, if we don't act soon, what we once deemed as progress will be the cause of our demise. The "stories" of individual residents experiencing flooding are tiles on the mosaic of the metanarrative of climate change. The stories of short-term local flooding, and thus long-term SLR inundation, and thus climate change, reveal the potential for intertextuality between the grand narrative of global climate change and the local narratives of not being able to get to work because a local road was flooded. Embedding visual stories of affected residents within the most up-to-date oceanographic projections offers a unique opportunity for communication designers to more closely align our shared global future with our everyday activities, personal health, and finances. As such, the "story" of climate change and its contribution to SLR is presumed. The challenge when designing this story map, then, was: How to embed and structure the video recorded stories in relationship to the SLR viewer within the Esri template? Having chosen the Story Map Journal template, how would we structure the user experience within it?

The main challenge in working towards some sort of intertextuality between the grand narrative of climate change—as depicted in the interactive SLR map itself—and the stories of residents is the division of the screen for the user. On the left side of the interface, the user can scroll down and sequentially view the videos of residents, starting with Norfolk, Virginia and ending in Cocoa Beach, Florida. The videos were not sequenced in any specific order other than to have those from Virginia first and Florida second. This reflects the actual order in which the interviews were conducted, and more than anything else reflect our travel from Virginia south to Florida.

On the interface's right side, the user can explore NOAA's Sea Level Rise Viewer, embedded as it is within the tool, and pre-framed for the specific region (either Hampton Roads, VA, or the Space Coast in Florida). Users can also click a button to reveal a yellow circle on a static map to help them locate the precise location in which the respective video was filmed. Users can also toggle between the static image and the interaction SLR map in order to draw a closer connection between the participants being filmed and their actual vulnerability based on the latest climate and oceanographic projections.

While the goal of this arrangement from a design standpoint was to draw a link between each resident's lived story and the location-specific data in the interactive SLR viewer, we also acknowledge that the division of the screen is potentially a disruptive user experience. First, users are invited to watch the video while simultaneously or afterwards exploring the interaction SLR map, which is only granted about half a screen of digital real estate. Second, while NOAA's Sea Level Rise Viewer affords free exploration of flooding projections, the overall sequencing of our website has resulted in an experience of linear scrolling through the videos. We are left with this question: Does our attempt to merge stories with data produce a disjointed user experience that requires too much technical effort to allow for the stories to have emotional impact? In our initial envisioning of the project, we wanted users to be able to play the individual videos as they explored an area, but our technical backgrounds and the template of choice restricted this method of juxtaposition. Thus, we have questions about the integration of stories and map and whether or not they are tightly connected enough to be effective, or if they perhaps distract from one another.

Despite these concerns, we believe that adding personalization to SLR risk maps and interactive viewers adds value. The diversity of types of stories, from individuals with diverse backgrounds and careers, opens up more opportunities for user engagement by providing more diversity of worldviews about the same issue. As Akerlof et al. (2016) discuss, "cultural worldviews which contribute to politically polarized beliefs about climate [are] predictive of perceptions of sea level rise risk" (p. 314). If an SLR tool can include voices from cultural worldviews of eight people in two locations, (see Table 1), the data might be seen in a different frame. The stories of the participants with relatable concerns frame the data, as opposed to the data being itself the frame. The tool also gains credibility when the data reflect the stories of individuals (e.g., one participant's account of wading through water up to her waist is reflected in the 3-foot SLR projections in her neighborhood).

Our decision to film our project participants outside (save one, who was filmed during inclement weather) was intentional. We wanted the participants' stories to take place in an area of relevance to their story. For some, this meant actually being filmed along the causeway which, if inundated, would affect industry and recreation. For others, this meant standing in between the space separating their home from the encroaching body of water. The visual co-locating of story and body in situ helps, from a design perspective, with appeals to place. Previous research has shown that levels of engagement and risk perception are tied to one's sense of place (Scannell & Gifford, 2013) though personal concern does not necessarily lead to willingness to act at a community level (Akerlof et al., 2016), and also that risk messages are more effective when localized (van der Linden et al., 2015). Therefore, aligning the visual of the SLR map with the potential for evocation of emotion from familiarity of place might be an effective rhetorical technique to make more concrete connections between the grand narrative of climate change and the stories of vulnerable residents.

Curating Stories of Residents

Before pressing record on our camera, we simply instructed participants to tell us a story about flooding or SLR in their community. We did not want to overdetermine the nature or type of story that the project participants presented, but rather wanted them to discuss what first came to their minds when they were prompted as such. Were these stories of their own personal experience? Stories about their community? A family member? Stories based on science, or based on historical experience? The participants shared a variety of different types of stories; we present a brief overview of each story in Table 1.

We edited the videos for length, noise interruptions, moments where we conversed with the participants, and content. The participants all had varying degrees of confidence and comfort in front of a camera, so some brought notes, some wanted prompting, and others could have talked for hours. From a user experience standpoint, we wanted each story to be about three minutes long. This necessitated making difficult editorial decisions about what to cut. The three main reasons for cutting the clips were time considerations, relevance of story, and tone. This was a balance between our editorial hand and the real, felt perspectives of the participants. For example, in one video the participant was very outspoken and critical about their city's handling of stormwater and lack of attention to critical infrastructure. This of course is an understandable emotion that an affected resident would have; however, the tone of this critique, we think, would add an overtly-political (in the partisan sense) layer to the tool, and our intention

Table 1. Overview of participants and their interpretations of "story"

Participant	Location	Interpretation of "Story"/Key Moments
Grace	Historic Ghent, Norfolk, VA	Tells a story of how she was unaware that the neighborhood flooded as much as it did, and now has taken it upon herself to purchase a bullhorn and notify other new residents that a specific part of the street floods and that they should move their cars. This is a story about neighborly connection and helpfulness.
Jill	Fox Hill neighborhood, Hampton, VA	Tells a story of a three-day Nor'easter that affected her small neighborhood, where she has been living for a short period of time since retiring from the Air Force. She asks, "How are you going to live with water?", and notes that leaving the "hidden gem" of Hampton would involve grief and financial burdens.
Heidi	Virginia Beach, VA	Tells a story of moving in with her mother after she sold her house in a highly-vulnerable part of the city after Hurricane Matthew. She recounts a time in which she had to wade out of her house and through the neighborhood with water up to her waist, and found a neighbor with a boat to ride with. She stated that she "could not live like that," and, concerned for her mother, she relocated.
Rich	Larchmont neighborhood, Norfolk, VA	Tells a story of how a family gets to know the city very quickly through flooding. A military service-member with three-year orders to Norfolk, the story is told from the perspective of a temporary but concerned resident.
Laurilee	Causeway, Titusville, FL	Filmed in two locations, she tells stories of how a popular boat ramp was destroyed twice, by Hurricanes Matthew and Irma, and how it not being rebuilt causes confusion and anxiety amongst residents. She tells another story about how critical the causeway is for recreation, wildlife, and connecting barrier island communities to the mainland.
Randy	City Hall, Satellite Beach, FL	Tells science-based stories about inundation projections using the canal outside City Hall as an example. He showed how high the water would reach at different levels of flooding and gave an explanation of how SLR could combine with high tides to exacerbate flooding.
Leslie	Public library, Palm Bay, FL	Tells multiple stories about storms that caused community flooding, and how each storm came with an example of an individual in need of assistance. Her story was about neighbors coming together to respond to the threat.
Joanie	City Hall, Cocoa Beach, FL	Tells the story of how a small, coastal city has come to revise a 2001 stormwater master plan to deal with coastal flooding, and how the city has dealt uniquely with inundation through various urban stormwater management techniques.

was not to do this.

We also had to make decisions about scientific accuracy as they pertained to the goals of our project (see Covi & Kain, 2016). For example, some participants focused on storm-driven flooding rather than SLR. The two phenomena are scientifically distinct. From a science communication standpoint, the issue of conceptual accuracy is an ethical question, as well as a rhetorical one (Dahlstrom & Ho, 2012). While our participants described real events that had occurred in the world (or which might occur in the future), some of their stories were not accurate representations of the phenomenon being communicated (i.e., SLR). However, temporary stormwater flooding does give those who experience it emotional and experiential context for future SLR-associated long-term inundation. Our decision was to include these narratives as exemplars of the types of situations that might arise from SLR-associated inundation, because the goal of our project was to give context to the data rather than help users attain a precisely accurate mental model of SLR.

These conflicts between usability, editorializing, honoring participant perspectives, and scientific accuracy raise the issues of design and rhetorical ethics. In her work on narrative inquiry, Jones (2016) discusses the political nature of design, particularly design that might be used to give agency to project participants by foregrounding their voices. She argues that designers' choices can either "perpetuate systemic and structural oppression or enhance the agency of users" (p. 489). Our project did not have explicit social justice aims, though we believe that by adding coastal residents' narratives about flooding to scientific data, we afforded project participants opportunities for agency. Our video-editing decisions, however, may have limited the agency that participants had to tell their stories. Moreover, it is important to acknowledge that while our project had a goal of representing ethnic and gender diversity in participants, ethnic diversity was limited. The participants you see on the tool are everyone who directly responded to our recruitment efforts, so this is in part an issue of snowball sampling and in part likely related to available time and willingness to be video-recorded. More steps will be taken to meet the goal of ethnic diversity in future development of this project.

The Action Page

In addition to the editorial decisions we made with respect to video editing, we also made choices regarding the wording of text, inclusion of specific photos, and developing a concluding segment with SLR preparation information and our contact information. On the final page of the tool, we provided viewers with a list of steps they could take to prepare for SLR in order to leave them with a concluding message that suggests pathways for action or self-education that may empower them. This decision was prompted in part by the linear Story Maps template structure, which seemed to us to require some sort of concluding information or message or have a built-in presumption of praxis. When audiences are exposed to messages about the certainty of global climate change, they may feel fatalistic or powerless to respond, unless they are provided information about concrete actions they can take to prepare (Milfont, 2012). Therefore, we chose to include this type of information at the end of the project in order to suggest further pathways for action that users might take, which also falls in line with the spirit of productive usability forwarded by Simmons and Zoetewey (2012).

CONCLUSION

This project demonstrates one way to combine personal stories and georeferenced scientific data in interactive risk maps using an accessible story mapping application. It evolved out of our research and reflects an ethical stance about the humaneness of maps as they merge with larger data sets. During this project, we found the need to make significant rhetorical choices at four conceptual levels: selecting a Story Maps template, developing a story structure, editing individual narratives, and concluding with an overarching message. We recommend that others interested in developing similar projects take into account the rhetorical implications of technical and editorial decisions at each of these levels.

In the introduction to this article, we asked: Why haven't leaps in computer modeling and simulation and user agency in exploring and generating data led to subsequent national change in environmental engagement? In many local communities, SLR mitigation, adaptation, and response projects are being done; however, national policies in the U. S. and many states have lagged. We believe work on engaging communities must continue, as bottom-up models of risk communication might in the end prove more effective than top-down. But these projects should, in our estimation, center on the people in the affected community.

Our goal with this project was to put together a tool that would help give local, personal, context to scientific data. It is possible, though, that this may not be the most effective approach to motivate personal or collective action. Future work might focus on the points for consideration raised in our Discussion, namely bringing a greater diversity of perspectives to the project and explicitly centering the voices of residents in a participatory mapping approach rather than editorially framing the stories. For example, a deep mapping project that centers on a community's concept of SLR and their concerns for the future might serve as a resident-driven representation of place and an effective focal point for community engagement. Conversely, developing a more focused editorial message might help motivate action. Our immediate future plans for this project are to conduct a UX study with local audiences to explore the effects of layering and locating personalized stories onto SLR maps. This will help us provide design suggestions for others interested in developing similar projects with different rhetorical goals.

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APPENDIX A

Overview of template options presented by Esri's Story Map application, with our considerations for application to interactive risk mapping for the SLR Stories project.

Esri Category	Esri Name	Esri Description	Considerations
A Sequence of Place-enabled Photos or Videos	Story Map Tour[SM]	"Present a set of photos or videos along with captions, linked to an interactive map. It's ideal for walking tours or any sequence of places you'd like your readers to follow. Choose between three different layout options, including a new Side Panel layout that makes your beautiful photos fill most of the display."	This template would have allowed us to center the interactive risk map and add clickable points on the map that would allow "pop-up" images or text boxes to convey personal narratives. From a technical standpoint, however, we did not have the coding experience to integrate videos instead of static images.
A Rich Multimedia Narrative	Story Map Journal[SM]	"Create an in-depth narrative organized into sections. As readers scroll through the sections in your Map Journal, they see the content associated with each section, such as a map, 3D scene, image, video, etc. Narrative text and images can be displayed in a side panel, or in a floating panel that appears on top of your 'main stage' content."	This template divides the screen into two columns, one of which could contain an interactive map, and the other which could contain text, images, or videos. While this creates a separation between map and personal story, the scrolling navigation allowed a smooth transition between stories. Additionally, the "journal" metaphor of having image follow along with text was in line with our goals.
	Story Map Cascade[SM]	"Create a visually and editorially engaging full-screen scrolling experience for your audience blending narrative text, maps, 3D scenes, images, videos, etc. Sections containing text and in-line media can be interspersed with 'immersive' sections that fill the display, including map animations and transition effects."	This more technical version of the rich multimedia category went beyond what we needed, as we did not require animations or transition effects in our maps. Additionally, this template created a completely linear story that would have dissuaded users from free-form exploration.

A Series of Maps and Other Content	Story Map Series[SM]	"Present a series of maps that your readers can easily browse and switch between using tabs, numbered bullets, or our expandable 'side accordion' control. There's an optional description panel for presenting narrative text and other content associated with each map. In addition to maps, you can present images, videos and other embedded web content, such as other web apps and even other Story Maps!"	This template has potential for other risk map purposes, specifically with regard to sea level rise, but we were using one map only: NOAA's Digital Coast imagery. Toggling between maps would have disrupted, in our view, the user's sense of place.
A Curated Set of Places	Story Map Shortlist[SM]	"Present a large number of places organized into tabs based on themes, for example, food, hotels, and attractions. As your readers navigate around the map, the tabs update to show them just the places in their current map extent."	This template would not have worked well with the embedded interactive map (again, based in part on our coding expertise). Additionally, we were not interested in focusing on the individual places so much as the stories themselves.
Two Maps	Story Map Swipe and Spyglass[SM]	"Let your readers compare two maps by simply swiping back and forth, or by peering through one map to see another with our 'Spyglass' tool. You can present two different maps, or enable readers to compare different layers in the same map. A Swipe Series option lets you present multiple map locations that your readers can choose between using tabs."	While this template has potential for risk maps (the swipe approach is already used by organizations like Climate Central and NOAA), it only shows before-and-after states of being. It would not allow free exploration of a risk map with multiple choices.
Just One Map	Story Map Basic[SM]	"Present a map via a very simple user interface. Apart from the title bar and an optional legend, the map fills the screen. Use this app to let your map speak for itself."	We literally did not want the map to "speak for itself"; we wanted the people represented on risk maps to speak for themselves. However, this template might have been helpful if we had the coding skills to manually add videos directly to the map.

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