Here-Now-Us

Visualizing Sea level Rise and Adaptation Using the OWL technology in Marin County, California

Project and Research Summary

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Executive Summary

In 2015, Climate Access worked with Marin County, FEMA Region IX, Owlized, Autodesk, NOAA, the San Francisco Bay National Estuarine Research Reserve, Susanne Moser Research and Consulting, and Antioch University on an innovative visualization and engagement project called *Here Now Us*.

The goal of *Here Now Us* was to test the use of a unique visualization technique to increase citizens' engagement in adaptation planning (sometimes called preparedness or resilience-building) for sea level rise. Marin County leaders were interested in increasing public engagement in the adaptation planning process they had already launched. This provided the project team a unique opportunity to explore the use of visualization in public engagement, and to study what might encourage citizens to participate in public dialogue about potential adaptive solutions.

To visualize sea level rise impacts, the project team used a viewing device called an "OWL" – a 360-degree rotating audio-visual platform that enables users to view visuals, respond to survey questions and leave audio comments. Importantly, these viewing devices are used in the very landscape in which the impacts are expected to occur in the future, thus making climate change risks real and tangible to viewers. For this project two OWL units were placed along the Mill Valley-Sausalito Multi-Use Path.

The OWL project set out with the overarching scientific objective to examine the role of visualizations in climate change engagement. More specifically, it aimed to answer three key research questions. The conclusions from this study are summarized vis-à-vis each of these questions, leading to a set of recommendations for future research and modifications to the use of the OWLs in climate change engagement.

Research Question 1: What are the specific benefits and challenges of using the OWL technology in climate change engagement?

The OWL is one of the most advanced technologies currently available for visualizing climate change impacts. Most visualization approaches use 2D, computer-based visuals viewed indoors, rather than interactive, 3D, in-situ visual experiences. This produces visuals that score highly on all recommended dimensions for effective visualizations emanating from prior scientific research: realism, immediacy, relevance, human experience and the clear link between human choice and future consequences. The resulting visual experience is cognitively and emotionally arousing, and through the interactive nature of the device – also physically engaging, thus able to generate more impactful and more memorable experiences in the viewers.

To our knowledge, no other technology currently available on the market (not to speak of widespread use in climate change engagement) combines the technological, design, and scientific strengths of the OWL, and none is as impactful in terms of the viewing experience.

Research Question 2: What are the broader benefits of using 3D visualizations in interactive, immersive educational environments for public engagement on climate change?

Data collected at and in the OWL resulted in key advances over existing scientific understanding. The large number of survey responses collected from more than 3,700 user sessions over a 14-week viewing period allowed for robust analysis and revealed patterns consistent with prior and independent research. Through a multi-method design, multiple independent, quantitative and qualitative data sources could be integrated for internally consistent and compelling findings. The size of the data sets, the statistically significant findings, the validity of constructs, and well established underlying theory on risk perception and motivation, as well as the triangulation among different data make for robust answers to the following specific research questions:

A. Do the 3D visualizations increase concern about flooding risks?

The research showed unambiguously that the OWL-based 3D visualizations raise concern in OWL users. The visualizations were particularly effective with populations that initially showed no to little concern about current flooding risks, i.e., with viewers who had either no prior or only limited experience with flooding and/or had not thought much about sea level rise risks before. This subgroup of the viewing population shifted on average two levels up as a result of viewing the sea level rise-related flooding visual. Those OWL users who came in with moderate or high levels of concern about current flood risks also moved to yet-higher levels when shown the sea level rise scenario, but their shift in concern was less prominent.

Overall, the visualizations helped overcome a significant hurdle in climate change communication and engagement, namely the psychological distance many people experience when thinking or hearing about climate change. Despite overwhelming scientific evidence, many still believe that climate change is a problem that is far away in time and space, will happen to other species and to people in other countries and communities , and is therefore not something they need to be concerned with here, now, and for themselves. By localizing sea level rise in the very place in which it is expected to occur, and experiencing it quite viscerally, the visualizations helped increase awareness and understanding of localized climate change risks.

B. Does higher concern increase the motivation to engage further?

The research also clearly demonstrated that higher levels of concern correlated positively with an interest to learn more about adaptation and to engage more actively. The overwhelming majority of OWL users was interested in learning more about the various adaptation options (more than 90% in all but one age group). Moreover, those who expressed high levels of concern about current flooding risks, those who expressed high levels of concern about future sea level rise, and those who made the greatest shifts toward greater concern all expressed a desire to engage in the more intensive forms of engagement, such as attending a meeting or taking an active role in their communities.

What is notable among OWL users is that the level of desired further active engagement is far larger than commonly found. Differently put, the OWLs succeeded in generating a motivation to learn more about adaptation options, and they were effective in generating a larger-than-expected level of desired further engagement. This was reiterated through the audio recordings and in the attendance at the community dialogue: 21% of OWL users recorded an audio message and 74% of participants in a community dialogue held nearly three months after the removal of the OWLs had some level of familiarity with the OWL project, suggesting the OWLs played some role in inspiring them to come. The combined impact of repeated media coverage and email outreach, as well as the OWL experience itself, created a buzz and motivation to actually deliver on the intentions expressed in the OWL survey.

The research could not trace conclusively, however, how people's expressed interest in learning more about adaptation or their intentions to be further engaged in the adaptation process translated into realizing these intentions in real action. Thus, the potential of the OWLs for moving people to action remains somewhat uncertain.

C. Do these benefits differ by age or incoming levels of concern?

While a comprehensive demographic profile of OWL users is not available, the last question in the OWL-based survey asked viewers for their age. This allowed the differentiation of findings by age, at least of the user group that stayed through all five questions, i.e., the most engaged OWL user segment. About half of those fell into the Gen X (26%) and Baby Boomer (26%) generations; another 21% were under 15 years of age (Gen Z), 18% self-identified as Millennials, and the smallest group (10%) were the Matures.

The different generations, showed significant differences in their levels of concern, interest to learn more about adaptation, and in their desired level of engagement. For example, the Matures and Gen X were most concerned about existing flooding risks. When shown the sea level rise scenario, the Matures, Baby Boomers and Gen Z shifted most significantly toward greater concern, producing an overall pattern of higher concern levels about future sea level rise being positively correlated with age. But the oldest and the youngest age group also had the greatest number of "not at all" concerned.

While the age groups showed varying interests in different adaptation options, a notable finding was that more than 90% in each group except the oldest generation was interested to learn more about at least one of them.

The research further revealed a distinct positive correlation between age and desired level of further engagement, with the youngest commonly wishing no further involvement or simply expressing interest but without active engagement in the adaptation process. By contrast, older adults more often wished for more information, were willing to attend a meeting, or take on an active role in the community.

Research Question 3: To what extent do visualizations, followed with a deliberative dialogue process, help increase awareness and efficacy of localized climate change risks and solutions options?

The research findings from this project largely confirm the importance of dialogic deliberation as a way to foster deeper engagement with the climate change issue. Given the high level of motivation and concern of dialogue participants as evidenced in their attendance, the dialogue made only modest contributions to further increase concern about climate change. But it did serve as an effective way to increase people's understanding of climate change risks and of Marin's adaptation planning process. A large majority of dialogue participants said that they learned at least one new thing that evening, and – as it should be – a majority said they learned most from other dialogue participants, rather than from the presenters and facilitators. While few were motivated to join the event because they wanted to connect with their neighbors, inevitably, the dialogue connected them more with each other. Write-in comments indicated how much participants enjoyed hearing the views and exchanging ideas with other participants.

The dialogue turn-out for the event was large and included residents from across the county. When asked directly, participants stated their general concern about climate change and their desire to be involved in finding solutions as the leading motivations to attend the event. Moreover, about three quarters of those who responded to the exit survey said they had heard of, had intentions to see, or actually visited the OWLs. In addition to actual OWL visits, the project website had more than 1000 page views/month, more than 100 Facebook followers, and more than 100 sign-ups on the project mailing list. Thus, the extensive media coverage and email outreach via project and particularly County-owned distribution lists, as well as the OWLs seemed to have played a role in motivating people to attend.

Whether the dialogue event increased people's efficacy, i.e., their sense of control or ability that they can effectively do something about the climate change risks, is difficult to infer. While exit survey respondents said they learned more about the County's planning process, write-in comments hinted at some level of frustration with the slow pace of that process, inadequate coordination across agencies and levels of government, and lack of state and federal support. Thus, while many respondents were grateful to learn about what was underway, and that something was being done at all (factors that could increase their sense of efficacy), others felt impatient with the pace of implementation (a factor that could decrease a sense of efficacy). Such differences in opinion should be expected and do not indicate a weakness of the dialogue process itself. They do, however, suggest that follow-up after a dialogue event to provide process updates and keep people engaged in the process on a regular basis is important. Such continued engagement over time itself will build social capital, understanding of the governance process, and adaptive capacity in the community.

Recommendations

A number of recommendations for how to build and improve upon, and advance the use of the OWL technology and 3D visualizations, as well as deliberative dialogues in climate change engagement follow from the findings of this study.

1. **Future research**: The OWL technology was an effective means to obtain a large amount of data on the public's level of concern, interest, and desire to engage. While the number of survey questions may be constrained, the type of questions that could be asked are not. For example, other aspects of public perceptions of risk and solutions could be explored in future projects (e.g., direct inquiry into the emotional experiences of viewing certain scenarios). In addition, rather than just asking about people's interest in learning more about adaptation options, the OWLs could be used as a tool to assess preferences, i.e., allowing potential solution options to be presented, explored and then voted on. Finally, creatively combining the use of the OWL technology with social media and other traceable actions would allow future studies to come to more robust answers about the OWL's ability to motivate action. To learn whether the in-situ visualizations have a different impact on viewers than web-based ones, future projects should either work with a different website design to enable direct comparability or aim to create the best possible OWL and the best possible web experience and compare how effective the two formats are in raising concern and mobilizing individuals to action.

2. **Improvements in the OWL technology**. A number of technical issues emerged once the OWLs were installed at the site. As a prototype, this can be expected and improvements are already being implemented. Some of these pertained to the functionality of the hardware, others pertained to the audio script accompanying the viewing experience, yet others to the audio recording capability. Ongoing technological development and improvement must improve on these issues to avoid user frustration and loss of valuable data.

3. **OWL installment timing and site**. The time allowed to install and test the OWLs and ensure functionality prior to the launch was insufficient. Future projects must ensure a longer testing period before opening up to the public. Similarly, the placement of the OWL must be carefully considered not just vis-à-vis potential climate change risks, but also how diverse and interesting the depicted viewshed is and how visually different the risk and solution scenarios can be. Moreover, OWL placement must be evaluated from the perspective of natural behavior of individuals around the OWL (e.g., foot traffic, lingering in the location versus commuting or recreating). Ideally, future projects would have a high level of slow-moving foot traffic that invites people to pause for longer engagement with the OWL installation.

4. **Moving from concern to action**. The OWLs proved highly effective in raising concern and motivating people to become further engaged. It is important to bank on this elevated readiness to engage by providing OWL users immediately with something meaningful to do, preferably multiple, but not an overwhelming set of, options. Similarly, engagement events like the dialogue should also be followed up with updates, direct actions, and further opportunities to stay meaningfully involved in the community's adaptation process.

1 INTRODUCTION

PROJECT BACKGROUND

In 2015, Climate Access worked with Marin County, FEMA Region IX, Owlized, Autodesk, NOAA, the San Francisco Bay National Estuarine Research Reserve, Susanne Moser Research and Consulting, and Antioch University on an innovative visualization and engagement project called *Here Now Us.*

The goal of *Here Now Us* was to test the use of a unique visualization technique to increase citizens' engagement in adaptation planning (sometimes called preparedness or resilience-building) for sea level rise. Research for the U.S. broadly (e.g., Leiserowitz et al. 2015; Weber and Stern 2011), and for the San Francisco Bay region specifically (e.g., Moser & Ekstrom, 2012), shows that the public is now, by majority, convinced that climate changes are underway, even if they differ on what is causing it, but people tend to have little interest in and concern about it. Only a small percentage recognizes the urgency with which action must be taken to reduce global warming (mitigation) and to prepare for its impacts (adaptation) (Moser, 2014). As a result, active public participation in adaptation planning remains very low.

Marin County leaders were interested in increasing public engagement in the adaptation planning process they had already launched. This provided the project team a unique opportunity to explore the use of visualization in public engagement, and to study what might encourage citizens to participate in public dialogue about potential adaptive solutions. The project focused on engaging residents, business owners and other stakeholders in Marin County around the impacts, vulnerabilities and possible solutions related to sea level rise and associated flood risks experienced locally.

Figure 1: The OWL viewing device looks much like the old-fashioned, coin-operated art deco binoculars often found at scenic viewpoints. The 21st century version is free and lets viewers see the future. (Source: Owlized)

To visualize sea level rise impacts, the project team used a viewing device called an "OWL" - a 360-degree rotating audio-visual platform that enables users to view visuals, respond to survey questions and leave audio comments (Figure 1). Importantly, these viewing devices are used in the very landscape in which the impacts are expected to occur in the future rather than merely on a computer screen or inside a building, thus making climate change impacts more real and tangible to viewers. For our project two OWL units were placed along the Mill Valley-Sausalito Multi-Use Path to showcase two flooding scenarios and two potential response options that community members could consider. The scenarios included: an extreme weather event (similar to the one experienced in that very location in December 2014), a mid-range sea level rise scenario, a potential seawall response scenario and a potential horizontal levee response option. An audio script led viewers through these 3D virtual reality landscapes and, throughout the experience, prompted them to answer questions regarding their concern over climate change impacts and their interest in the various response options and ways to engage in the community's adaptation process.

In addition to the in-situ visualization, a project website (www.here-now-us.org) was created to provide an online visualization experience, and engage people not able to come experience the OWLs at the Mill Valley site. The website also allowed for visitors to sign up to the project mailing list to be kept informed of project-related events. In addition, a Facebook page was maintained throughout the project duration.

Near the end of the project, project partners facilitated a community dialogue between residents and leaders of the County focused on identifying priorities and visualizing solutions related to sea level rise impacts. Our guiding hypothesis was that experiential, in situ 3D visualization, along with a deliberative dialogue, would increase public engagement with climate change impacts and support for adaptive solutions. The *Here Now Us* project, however, was designed from the start to not only be a scientifically-informed engagement project, but to yield novel scientific insights into the use of visualizations in public engagement around climate risks and adaptation planning. Our goal was to test the effectiveness of using visualizations in an experiential education setting to increase concern and motivate action to reduce risk related to climate impacts, in particular those related to sea level rise.

This report details the research design and results from the study, in hopes that they can further inform Marin County's and FEMA's community engagement efforts around flooding risks, sea level rise preparedness and adaptation. Below we first describe the research questions that guided the study, detail the methods used to collect relevant data, and present results from the study. While most research and analysis focused on the OWLs, a project website, community dialogue, and focused outreach to the media complemented project activities.

The scientific project goal was to test the effectiveness of using visualizations in an experiential education setting to increase public concern and motivate action to reduce risks related to sea level rise.

Research Questions

The overall research goal of *Here Now Us*, as stated above, was to explore the value of utilizing climate impact visualizations, along with a deliberative process, in increasing concern and motivating citizens to engage in the adaptation planning process.

This overall objective can be further broken down into several key research questions:

- What are the specific benefits and challenges of using the OWL technology in climate change engagement?
- What are the broader benefits of using 3D visualizations in interactive, immersive educational environments for public engagement on climate change? For example:
  - Do the 3D visualizations increase concern about flooding risks?
  - Does higher concern increase the motivation to engage further?
  - Do these benefits differ by age or incoming levels of concern?
- To what extent do visualizations, followed with a deliberative dialogue process, help increase awareness and efficacy of localized climate change risks and solutions options?

These questions – while specific to this project – reflect persistent challenges in the climate communication and engagement field. Thus, answers generated in this project constitute a novel and unique opportunity to contribute not only to the local adaptation process, but to the broader scientific and practical debate on how best to engage the public on climate change issues.

Interested readers may find an overview of this larger debate in the next section. Further detail on the methodologies used in this study and findings are discussed in subsequent sections.

2 Climate Change Communication, Visualization, and Community Engagement: A Literature Review

Public Awareness and Engagement on Climate Change

According to the most recent survey available from the Yale Project on Climate Change Communication, conducted in October 2015, 67% of Americans believe global warming is happening and slightly more than half of those believe it is mainly caused by human activities (Leiserowitz et al., 2015). However, even though the majority of Americans believe the climate is changing, the issue still ranks low in America priorities over other national issues: 10th out of 11 national issues (Leiserowitz et al., 2014). Moreover, few Americans are 'very worried' (16%) about global warming and the majority of Americans still see it as a distant threat.

In fact, Americans have varied widely in their concern about human-caused climate change over the years (Figure 2) (Gifford, 2011; Weber & Stern, 2011). At present concern is trending higher than in the last eight years, yet is not at the highest levels since polls have begun tracking climate change attitudes (e.g., Saad & Jones, 2016). Concern is driven in important ways by value-based pre-dispositions related to political ideology, age, and gender, but also by knowledge, direct experience, news exposure, concurrent events, other situational influences, and the ways in which people process information (Weber, 2016).

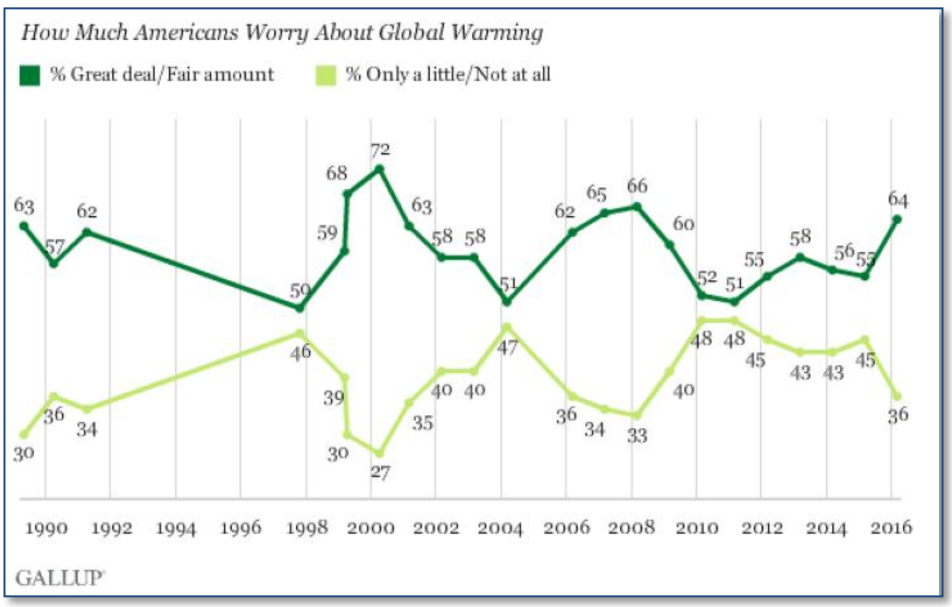

Figure 2: Americans' concern about climate change has varied widely over time. Yet even when concern was high, climate change has remained low as a policy priority.
(Source: Saad & Jones, 2016)

Given the many influences on people's concern, proposals on how to increase it have not been straightforward. Moreover, research has shown that merely increasing concern is not enough to move people to action (Blake, 1999; Kollmus & Agyeman, 2002; Blennow & Persson, 2009; Gaillard & Mercer, 2013). In fact, the prevailing low levels of active engagement on climate change have been explained by the fact that risk perception, urgency and efficacy levels remain low in the American public despite years of climate change communication and outreach (e.g., Hornsey et al., 2015; Leiserowitz et al., 2014). This raises the obvious question: how can risk perception, concern, urgency and efficacy be elevated to increase public engagement? How can we move people from basic awareness and knowledge, and even relatively high levels of concern about climate change, to getting more actively engaged and taking or supporting action (Moser, 2016)?

Answering these questions and overcoming the underlying challenges is imperative because strengthening scientific evidence and devastating weather events such as Hurricanes Sandy and Katrina, and other extreme events make it ever more apparent that communities must prepare for climate change. While adaptation planning is now underway in many communities, there is still limited on-the-ground implementation of adaptation measures (Bierbaum et al., 2014; GAO, 2009; Glavovic & Smith, 2014; Preston, Westaway, & Yuen, 2011; Picketts, Dery, & Curry, 2014; Tang et al. 2010). Municipal leaders and their staff face significant implementation barriers, including the lack of public engagement in local adaptation efforts (Carmin, Dodman, & Chu, 2013; Hansen et al., 2013; Moser & Ekstrom, 2010; Moser & Pike 2015). In fact, the Third U.S. National Climate Assessment listed implementation as the most significant gap in the state of adaptation in the U.S. to date (Melillo, Richmond, & Yohe, 2014; Bierbaum et al., 2014). In order to overcome many of the barriers encountered at the local level, community engagement is necessary to support municipal action aimed at increasing climate resilience (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007).

Figure 3: Mill Valley flooding during a storm and high tide in December 2014 makes the impacts of sea level rise imaginable. (Source: CBS Local News, San Francisco)

Engagement can be broadly understood as “a personal state of connection with the issue of climate change, [not just] as a process of public participation in policy making” (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007, p. 446). Of course, the two are related and can influence each other: fostering a personal connection to an issue might make a person more likely to also want to participate in the policy-making process; and being civically engaged can result in deeper understanding of and caring about a policy issue.

Thus, engagement can involve aspects of cognition (awareness of an issue), affect (concern of the issue) and behavior (Lorenzoni, Nicholson-Cole, & Whitmarsh, 2007; Moser & Berzonsky, 2015). Risk perception (involving cognition and affect), a sense of urgency (affect), along with a perception of efficacy (cognition), i.e., a sense that one is capable of taking action, are considered significant predictors of engagement on climate change (Bandura, 1977; Leiserowitz, 2005; Milfont, 2012; van der Linden, 2015). As visually oriented beings, humans may respond particularly well to visual displays of risks (Scannell & Gifford, 2013; Sheppard, 2012).

Motivation to Take Climate Action

In order to engage the public on climate change, it is important to understand how people relate to this issue. In particular, what prompts individuals to take action or become civically involved in an issue (Bord, Fisher, & O’Connor, 1998)? Building on Nisbet & Kotcher (2009), such civic involvement can be thought of as collaborative problem-solving of complex issues to achieve a common goal. Collectively, such collective problem-solving and pro-environmental behavior can remove the barriers to greater local resilience (Shove, 2010). But why would people become involved in such complex issues or enact a specific societally-relevant, environmental behavior such as support for policies, plans, or raising funds for the implementation of municipal projects?

Often, decision-makers and grassroots organizations focus their communication efforts on increasing the knowledge and understanding of climate science to increase civic engagement (van der Linden, 2015). This type of outreach tends to be based on the assumption that knowledge is sufficiently motivational to move people to action – a reflection of the so-called "knowledge-deficit model". The knowledge-deficit model assumes that the lack of action or engagement is caused by a lack of understanding of the issue at hand (e.g., Pearce et al., 2015). While knowledge is clearly often lacking (Leiserowitz et al., 2014), and plays a role in motivation, it is not a sufficient predictor of behavior by itself (Kollmus & Agyyeman, 2002; Jones & Boyd, 2011; Weber & Stern, 2011).

Often, the limited knowledge people have on climate change is generalized and abstract. It has not been linked in visceral ways to their own lives. Differently put, climate change remains psychologically distant: it is believed to happen far in the future, to other species, and if it happens to people at all, it happens to others in far away countries or communities (Moser, 2014). The result of such psychological distancing is that the issue is neither "real" nor urgent (van der Linden, 2015).

Efficacy plays an integral role in communicating risk and engendering feelings of urgency (Hornsey et al., 2015; van der Linden, 2015). Efficacy describes the sense that a person has control (can be 'effective') in determining an outcome (Ajzen & Fishbein, 1980). If an individual does not feel they have efficacy in solving a problem they tend to disengage from the issue (Bandura, 1977), largely because it is too scary and disempowering to just be confronted with a big risk but have no power to change it. This insight is critically important to the design of this study, as increasing concern alone could result in emotional disengagement if there was not also attention given to feasible solutions that could reduce climate risks. Differently put, the risks and possible solutions must be equally imaginable to move people to action.

Visualizing Climate Change

Because visual communication can impact risk perception, a person's sense of urgency and efficacy in ways that prompt engagement (Scannell & Gifford 2013; Sheppard, 2012), there is good reason to examine the effectiveness of visuals more systematically. In fact, research to date suggests that visualization of climate change impacts along with a deliberative dialogue strategy may aid local governments in fostering greater civic engagement as part of their efforts to plan and implement climate adaptation strategies (Sheppard, 2012).

Visualization of climate change impacts along with a deliberative dialogue strategy may aid local governments in fostering greater civic engagement.

Visualization has been utilized throughout history to not just depict, but frame issues and to engage audiences on specific issues. In the context of science communication, impersonal graphs, charts, maps, 3D computer models, numbers and so-called social statistics have been used widely to convey information and bring issues alive. These types of visual methods have also been common in the communication of the causes, impacts and solutions to climate change (see Appendix A for a list of further reading on climate change-specific visual communication references). These methods tend to emphasize global versus regional or local effects and vary in their effectiveness in making climate science accessible to lay audiences. Often climate change visuals still require expert explanation; viewers might get lost in the technical details and miss the major take-home messages; and often, these methods are not intuitive or tell a compelling story (e.g., Bucher & Niemann, 2012; Jude, 2008; O'Neill et al., 2013; Stephens, DeLorme, & Hagan, 2015).

Thus, the way information is presented is critically important to how a person processes and interprets the information (Sheppard, 2012). Some types of visualization are particularly powerful in translating complex information into a digestible format. They can cut across the barriers between different languages and cultures, convey simple, strong messages, and thus significantly increase memory recall (Nicholson-Cole, 2005; Sheppard, 2012).

In recent years, with the technical advances in computer-based graphic design, animation, and graphic information processing software such as GIS, CAD, and Community Viz, municipal and regional planners have begun using innovative visual communication methods to better engage stakeholders in community visioning and planning processes. Instead of relying on graphs, charts and maps alone, many municipal planners incorporate 3D landscape visualization and animated depictions to represent actual places in an accessible format for people to process, explore and interpret. Planners use such tools to communicate land use change, impact assessments, redevelopment projects, or to help people envision a particular development trajectory for their community. These technologies, along with free virtual globe software (e.g., Google Earth) have allowed for 3D, real time display depicting specific and recognizable buildings, places and points of interest (Lovett et al., 2015; Schroth et al., 2014).

There is a growing body of evidence that shows that visualization and interactive displays of issues can effectively assist in the implementation of community planning goals by producing meaningful conversation between decision-makers and other stakeholders, including specifically in the context of coastal management and adaptation (Portman, 2014; Sheppard, 2012; Sheppard & Cizek, 2009; Stephens, DeLorme, & Hagan, 2015; Vervoort et al., 2010).

Overcoming Psychological Distance

Visual communication of local climate change impacts has the decisive advantage over global imagery of climate change of being able to incorporate aspects that are relevant to local audiences, illustrate the urgency of taking action here and now, specifically address the needs of local audiences by incorporating and challenging existing ways of thinking about the problem (mental models), and explore meaningful solutions (Scannell & Gifford, 2013; Sheppard, 2012). Such localized visual communication is significant for overcoming one of the greatest challenges of climate change communication: overcoming the psychological distance.

Viewers do not need a science degree to understand the impacts of climate change and possible solutions.

Framing climate change in locally significant ways increases saliency, generates an affective response, and – by showcasing the benefits of action – can motivate people to action (Spence, Poortinga, & Pidgeon, 2012). Framing climate change as a local issue also taps into the connections and attachments individuals have to the homes, neighborhoods, and communities where they live (Reser, Morrissey, & Ellul, 2011; Moser, 2014). These places tend to promote "evocative, restorative, and comforting" emotions and affect among individuals (Reser, Morrissey, & Ellul, 2011, p. 30). By using this type of visualization, local leaders interested in taking actions can create and emphasize existing meaningful socio-cultural associations through the integration of science and intuition (Sheppard, 2005). Viewers do not need a science degree to understand the impacts of climate change and possible solutions.

The following attributes of visualizations can counteract barriers to engagement by increasing risk perception and motivating action (Corner, Webster, & Teriete, 2015; Nicholson-Cole, 2005; Sheppard, 2005; Spence, Poortinga, & Pidgeon, 2012; van der Linden, 2015; Weber & Stern, 2011):

- <u>Realism</u>: Showcasing climate change impacts in pictures and videos rather than abstract graphics increases individuals' understanding of the causes and effects of growing greenhouse gas emissions.

- Immediacy: Showing visuals that depict the immediate environment and the present or near future minimizes people's tendency to keep climate change psychologically distant and to discount the future. Feeling that the issue is having an impact here and now disallows people to place it low on their list of priorities.
- Personal relevance: Showing local scenes and neighborhoods that are familiar and meaningful to people, such as places where they live, work, and recreate, creates relevancy for viewers. This can heighten their emotional response, and increase feelings of being at risk and of urgency.
- Human experience: Showing not just environmental changes in untouched landscapes, but scenes that involve people, animals, and symbolic objects undermines the tendency to psychologically distance oneself form an issue. It adds affective dimensions by tapping into familiarity, experiences of day-to-day life, memory, and the things people enjoy about their communities.
- Future consequences: Showing viewers a direct response or outcome based on choices made today can enhance a sense of response efficacy, i.e., a sense that the problem can be solved with a particular set of interventions. This directly counters disempowerment and hopelessness. It can also open a space for talking about shared values and the pros and cons of possible response options.

Combining visualization of this sort with deliberative dialogue gives people an opportunity to process their visual experience with each other. This can further increase a sense of efficacy and hope: the problem *can* be addressed, if we work together. There have been numerous studies and projects in recent years that illustrate the effectiveness of using visualization along with deliberative dialogue to increase knowledge, efficacy, relevance and concern levels on issues of land use and sustainability (e.g., Al-Kodmany, 2002; King et al., 1981; Levy, 1995). However, fewer studies exist to date that have examined the effectiveness of using visualization and dialogue in the climate mitigation and adaptation arena. None, to our knowledge, have tested in-situ visualization together with deliberate dialogue, which is the focus of our study.

Community Dialogue

Deliberative dialogue, another participatory process, has also been used successfully to engage the public in land use planning and other social issues. Deliberation can be defined as a combination of “open dialogue, access to information, space to understand and reframe issues, respect, and movement toward consensus” (Carson & Hartz-Karp, 2005). Importantly, the objective of deliberative dialogues is not just to talk together, but to think together (McCoy & Scully, 2002).

The objective of deliberative dialogues is not just to talk together, but to think together.

Who is involved in such a deliberative dialogue is an important question, and it is important to distinguish participants that one might consider to be "stakeholders" or "citizens." While often used interchangeably, in this report, we define a stakeholder as "a representative of a group or organization that has a collective interest" in a particular topic, and a citizen as "a member of the broader public" (Kahane et al., 2013). This distinction plays an important role in identifying potential participants in both the visualization experiment and in the deliberative dialogue as it entails various opportunities and limitations as well as ethical considerations.

In the context of a local climate adaptation/resilience planning process, both citizens and stakeholders may have specific roles to play, and they differ in their interests. Thus both groups may be involved in various ways and at different times. For example, while citizens may have a generalized interest in sea level rise and climate change, certain stakeholders (e.g., shorefront homeowners or businesses, local decision-makers) may be far more directly impacted and be motivated to participate in local planning and decision-making about adaptive solutions.

Deliberative dialogue can create the connections between individual and more broadly shared (public) concerns while fostering mutual understanding on the basis of shared values (McCoy & Scully, 2002). This type of dialogue rests on a foundation of respect, deep listening, and suspending judgment (Bohm, 1996; Moser & Berzonsky, 2015; Palmer, 2011). It is through such a respectful, open-ended, deliberation process that new solutions may be surfaced that were previously not even imagined. Alternatively, a possible solution that was highly contested might become modified and thus acceptable to all involved.

Importantly, deliberative dialogue allows for learning and the joint creation of new knowledge (co-production) between decision-makers, experts, and other stakeholders (Jasanoff, 2004; Lemos & Morehouse, 2005; Sheppard, 2012). It is this co-production of knowledge that fosters the emergence of meaningful and acceptable solutions. Importantly, increasing evidence shows that in addition to knowledge gain about an issue, deliberation can change participants' opinions, attitudes and positions (Barabas, 2004; Fishkin, 2009; Moser & Berzonsky, 2015).

Conclusion

The state of knowledge about public perceptions of climate change risks in the U.S., and the challenges of deeper engagement in climate change discourses and action reflected in this review provided both motivation for, and guidance on how best to design this study. For example, the literature suggests to not use risk scenarios without response scenarios to avoid scaring people and thus maybe cause psychological disengagement. The literature also provided guidance on the attributes of effective visualizations and suggested modes of effective engagement (e.g., deliberative dialogue).

Together with the needs and objectives of the project partners, a multi method research study was designed to test the effectiveness of in situ visualization followed by a deliberative dialogue to provide new insights on key questions relevant to both researchers and those implementing adaptation on the ground: how effective is in situ visualization and a participatory process (such as deliberative dialogue) in motivating public action on climate change? Do the 3D visualization increase concern and, if so, are there differences in concern by age? Are levels of concern related to the motivation to engage further in the adaptation planning process? And finally, how are awareness and efficacy levels impacted by the visualizations and deliberative dialogue process?

The next section describes how the study was set up and the analyses undertaken to answer these questions.

3 RESEARCH APPROACH

STUDY AREA

The study area for this research is located in Marin County, California, along the shores of the San Francisco Bay. The County consists of eleven municipalities on a 828 sq. mi.-large peninsula wedged between the Pacific Ocean to the west and northern San Francisco Bay to the east. The majority of the population lives in communities along the shores of San Francisco Bay. According to 2015 Census data, the county has a population of 261,221 residents. This population is 86% White (77% nationally) and ca. 16% Hispanic or Latino (17% nationally). The median household income in 2014 was $91,529, nearly double that for the U.S. as a whole ($53,482) (U.S. Census, 2015). Of the registered voters, 54% are Democrats, 18% are registered Republicans and 13% have no party preference (California Secretary of State, 2013). While Marin County is not representative of national demographics with regard to income and education level, it does share many of the same characteristics of other wealthy, highly populated coastal areas confronted with sea level rise.

Figure 4: The Study site in Mill Valley, Marin Co. (red highlight) (Source: Compare Infobase Ltd., 2011)

Marin County has been engaged in sea level rise risk and vulnerability assessments and adaptation planning for a number of years (Moser & Ekstrom, 2012). These efforts have recently been accelerated, for example through its C-SMART (Collaborating on Sea Level: Marin Adaptation Response Team)[1] and BayWAVE (Bay Waterfront Adaptation Vulnerability Evaluation)[2] projects. Both efforts are aimed are preparing for and dealing with the impact of sea level rise.

Marin County Supervisor, Kathrin Sears, a collaborator on this project, is the most active local elected official on adaptation to sea level rise. At the time this project was underway, a draft Vulnerability Assessment was released in October 2015, followed by a draft Adaptation Report and Local Coastal Program Amendments prepared by the County's planning department, the Community Development Agency.[3] Our project, *Here Now Us*, was designed to be an integral element of the public outreach efforts around the vulnerability assessment and the draft adaptation plan.

CO-DESIGNED MULTI-METHOD RESEARCH APPROACH

The research design, described below, was fully integrated with the media outreach and public engagement efforts spear-headed by Climate Access and the County. Research questions and technical approaches were co-designed with both County staff and the Owlized and Autodesk technical teams.

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[1] http://www.marincounty.org/depts/cd/divisions/planning/sea-level-rise
[2] http://www.marincounty.org/main/baywave
[3] http://www.marincounty.org/depts/cd/divisions/planning/long-range-planning-initiatives

From the start, the project aimed to integrate multiple data sets, gathered through multiple methods, so as to be able to triangulate among independent sources and confirm findings through similar or related studies conducted elsewhere. Such designs produce more robust findings. An ethics review was completed through Antioch University's Institutional Review Board (IRB) prior to the launch of the data collection and the research project was approved as "exempt" owing to its low-risk nature. For details, see Appendix B.

Entry Points and Diversity of Audiences

Two OWLs (one tall and one ADA-compliant and child-accessible) were placed along the Mill Valley-Sausalito-Multi-Use Path on Miller Avenue at the Almonte Boulevard entrance. Tamalpais High School is located across the street and a middle school, senior living apartments, dog parks, and play grounds nearby. From the OWLs, viewers looked over Bothin Marsh towards a residential area in Strawberry Village (an unincorporated area in Mill Valley). The location currently floods during very high tides and king tides. The path is highly frequented by people walking, jogging, and biking, especially during weekends and in the summer time.

A media launch event on May 21, 2015 started a 14-week period during which passers-by could view the sea level rise and adaptation scenarios. There were multiple ways in which people learned about, and choose to participate in, the project ("entry points") (Table 1).

Table 1: Research Participant Populations and Possible Entry Points

Entry points via	Likely audiences
Media reports (the project was announced at the launch, and through additional media news articles)	Mostly local audiences who track local news
Marin County website	A civically and politically engaged local audience
*Public meetin*gs in Marin	A civically and politically engaged local audience that learned about the project at a County outreach meeting
Deliberate/intentional or unintentional web surfing discovering the www.here-now-us.org project website	A sea level rise/climate change/adaptation-interested audience that could reside in Marin, in California, elsewhere in the US, or overseas
Direct appeal (some groups of participants were brought to the OWL deliberately to engage them in the project)	Project target audiences for deliberate engagement, including local decision-makers, business leaders, and students and their teachers from the nearby schools
Self-discovery of the OWL at the staging site, as people stopped to explore the OWL	People with curiosity about the OWL installation; including local residents and visitors from out of town; in addition, a specific audience that must be expected are the students and teachers of the schools near the staging site.
Word-of-mouth (interested OWL users may tell their family, friends, or neighbors about the installation)	Mostly local audiences

Some participants entered in an uncontrolled and random manner, in the sense that the research team did not deliberately approach or select them. Others were deliberately approached through targeted outreach.

Immediately after the installation and launch event, several technical challenges caused the OWLs to not function properly, resulting in the initially recorded data being unusable. Once the OWLs worked problem-free, a total of 3,705 user sessions[4] were recorded over the 3.5-month study period (June 9 and September 21, 2015) (see Appendix C for details on the OWL technology).

Of the 3,705 user sessions, 3,002 users answered survey question one (a 19% drop-off), 2,365 answered survey question two (-17%), 1,743 answered survey question three (-17%), 1,581 answered survey question four (-4%) and 1,523 (-2%) answered the fifth survey question, resulting in a completion rate of over 41%.

While the limited survey questions did not allow us to distinguish the audience types listed above, nor the gender of the viewers, the fifth survey question asked respondents to identify their age. Figure 5 shows the age distribution of OWL users who answered question five.[5]

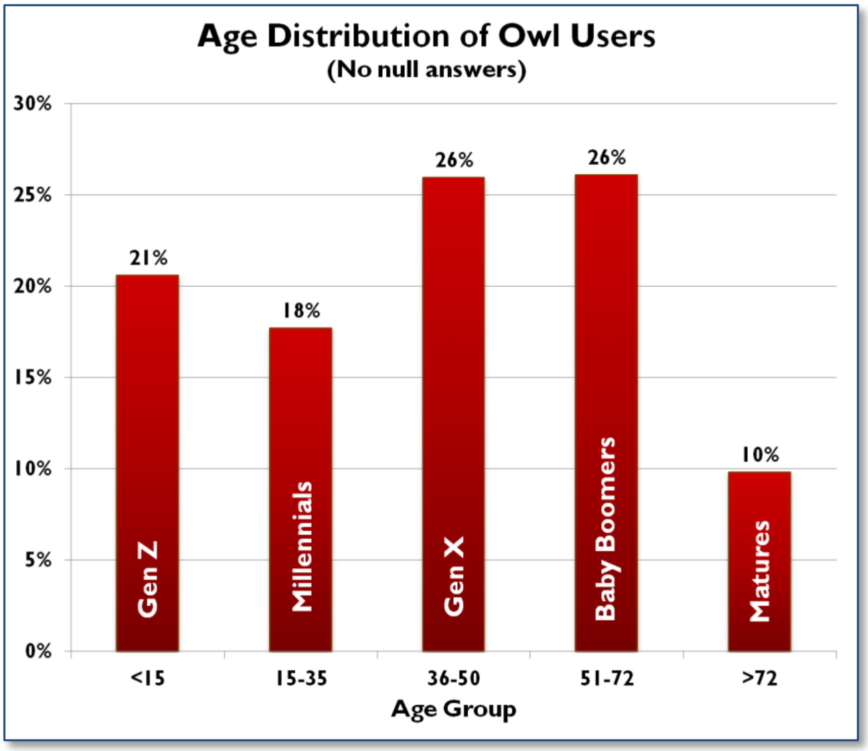

Figure 5. The majority of OWL users fell into the Gen X and Baby Boomer age ranges (36-72 years old), with a significant number of children and youth also visiting the sea level rise viewer.

The project design did not allow us to determine how OWL visitors actually learned about the project. But Marin County partners and Climate Access engaged in extensive and repeated outreach over the three-month period, including owned media promotion via the County, Climate Access, and project websites and social media as well as email mailings, active outreach to local newspapers, magazines, TV and radio, mentions at public in-person meetings, and active outreach to local schools and NGOs. The project –

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[4] A user session is defined as every instance when an individual activated the OWL. It is possible that individuals used an OWL more than once, thus the number of user sessions is not necessarily the number of unique individuals. A user session also does not need to be fully completed (viewing all scenarios and answering the survey questions embedded in the viewer) to be counted.

[5] It is impossible to determine whether the age distribution of the 3,705 users who initiated an OWL session is identical to the one of the viewers who stayed all the way through question five.

a first of its kind – earned widespread follow-up news coverage in local, regional and even national media. See Appendix D for a listing of the project press coverage, and additional information on media tracking below.

It was not possible to determine how many OWL users came to the viewer more than once and how many first discovered the project website and then came to see the in-situ visualizations, or vice versa. While the website was also set up with an online survey, the response rate was very small and the data not directly comparable due to website design choices. Thus a comparison between web and OWL survey data was abandoned and web survey results are not further discussed here.

Length of Engagement

A key interest in employing the OWL technology was the length of time users remained engaged in the OWL experience. The length of engagement can be influenced by many factors, but is indicative of the level of interest and thus the depth of cognitive and affective engagement that is obtainable using this visualization technology.

A number of factors can determine how long users spend on the OWL, including:

- their interests (e.g., curiosity in the OWL technology, interest in coastal issues, interest in climate change and sea level rise, interest in the future of Marin);
- their values (e.g., environmental protection, unrestricted development, individual freedom, community safety);
- local conditions such as nearby distractions, current weather conditions, any perceived comfort or discomfort; and
- perceived time constraints (e.g., obligation to be elsewhere, desire to do something else, need to return to work, family or other activity (such as dog walking or running), perceived pressure to engage for a longer or shorter period of time due to the presence of other individuals).

Initial technical challenges may also have caused frustration with the device for some and thus loss of interest. Importantly, however, individuals were not coerced, but self-selected to participate. They also were completely free to determine how long they stayed at the OWL. As a motion-sensor controlled device the OWL recorded the beginning and end of each session, as well as the length of time a user spent on each scenario and question. Thus, a complete record of this free-choice learning experience was obtained.

Individuals interacted with the OWLs on average for 63 seconds, ranging from one second to a maximum of just over five minutes. The average duration spent on each scenario and accompanying survey question was similar across scenarios/questions, ranging from 12.8 (question one) to 11.8 (question five) seconds. This relatively short duration of time spent on each question constitutes an important finding regarding the limitations of using the OWL technology to engage people on climate change.

Hosted sessions at the OWL, however, invited people to linger longer, engage with other participants, and ask questions of the hosts or others present, suggesting that the length of engagement can be extended with direct and active hosting.

Engagement Patterns

As a free-choice experience, potential study participants had access to the OWLs 24 hours a day, 7 days a week. By recording OWL use over the 3.5-months period, use patterns emerged that can be described as "natural use patterns," reflecting daylight hours and daily activity patterns (such as lunch and dinner breaks, later afternoon recreational use of the path, and quiet nighttime hours) (Figure 6). More than two thirds (68.3%) of all

OWL user sessions occurred between 10am and 5pm. A weekly activity patterns also emerged clearly, with weekends showing higher frequency of use than week days (Figure 7). More than one third (36.8%) of all OWL user sessions were recorded on the two weekend days alone. These patterns hold consistently across the 14 weeks the OWLs were available for use.

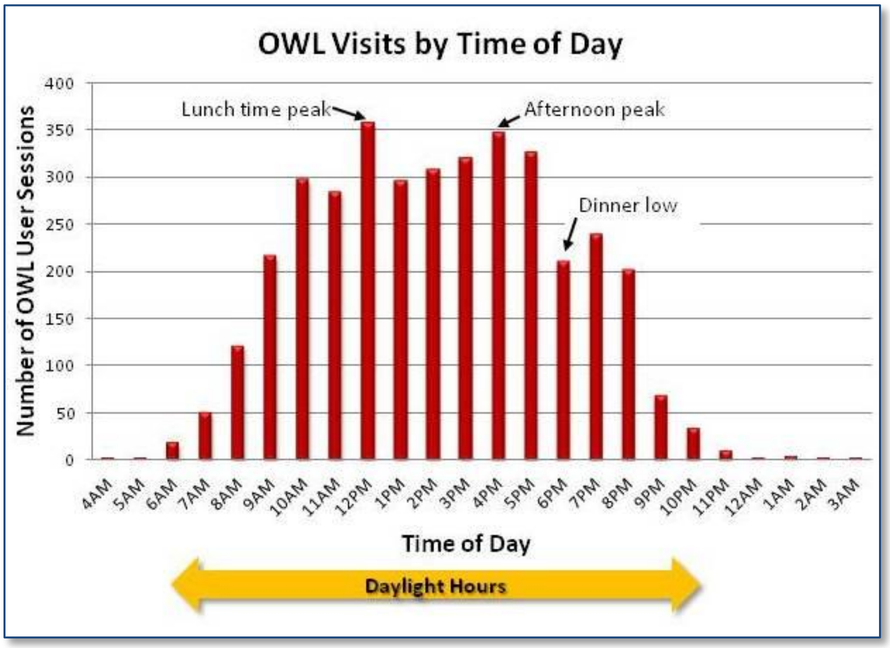

Figure 6: The daily OWL use pattern shows typical peaks around lunch time and during the later afternoon hours, as well as a dip during dinner time.

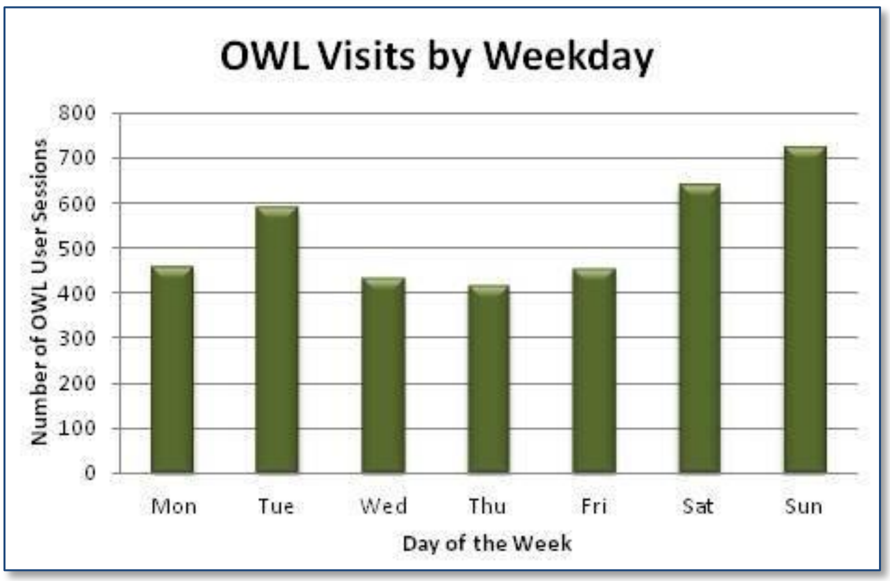

Figure 7: The weekly OWL use pattern shows typical peaks on the weekend, and lower use during the work week.

Due to the remarkably stable and moderate climate in the summer in coastal California, i.e. typically no rain or high-wind events and moderate temperatures, the influence of weather on use patterns in this location was thought to be negligible, and thus was not further considered in this project. In other places around the country, such an *a priori* assumption cannot be made. The exception was a brief period of extreme heat during the last week of the OWL installation, with very few user sessions in the heat of the day.

In addition to the observed natural use patterns, there was also a clear pattern over the 14-week period, wherein the early weeks had greater visitation than the last few weeks, owing to the newness of the installation early on. Indirectly, this pattern points to the curiosity value of this viewing technology. It also suggests that the location was frequented by a majority of local residents who use the path on a regular basis for recreation and commuting to school and work rather than different sets of individuals each week. (If the latter were the case, there would be no logical explanation for why earlier visitors would be more interested than later groups of visitors.)

THEORETICAL PATHWAYS OF ENGAGEMENT

Research participants engaged for varying and unpredictable amounts of time with the OWL and/or online via the project website. Each scenario depicted a different level of sea level rise-related risks and response options (see below). Participants were asked to answer simple survey questions (yes/no or Likert-scale rating questions) as they moved from visual to visual to capture their pre- and post-exposure risk perceptions, interest in solutions and preferences for further engagement. Because participants could "jump off" the OWL or the website at any time, the visualizations and the survey questions needed to be interesting and engaging, easy to complete, and simple to navigate to maximize possible engagement time. Appendix E lists the survey questions installed in the OWLs with the possible response options.

Research participants followed one or more of several theoretically possible pathways of engagement with the visualizations leading from initial engagement with either the OWL or the website to increasingly greater levels of engagement and potentially to action (Figure 8). The percentage of passers-by, i.e., of people who did not engage with the OWL at all, could not be reliably assessed for the entire installation period. During hosted/observation periods (described below), however, the number of passers-by versus OWL users could be recorded.

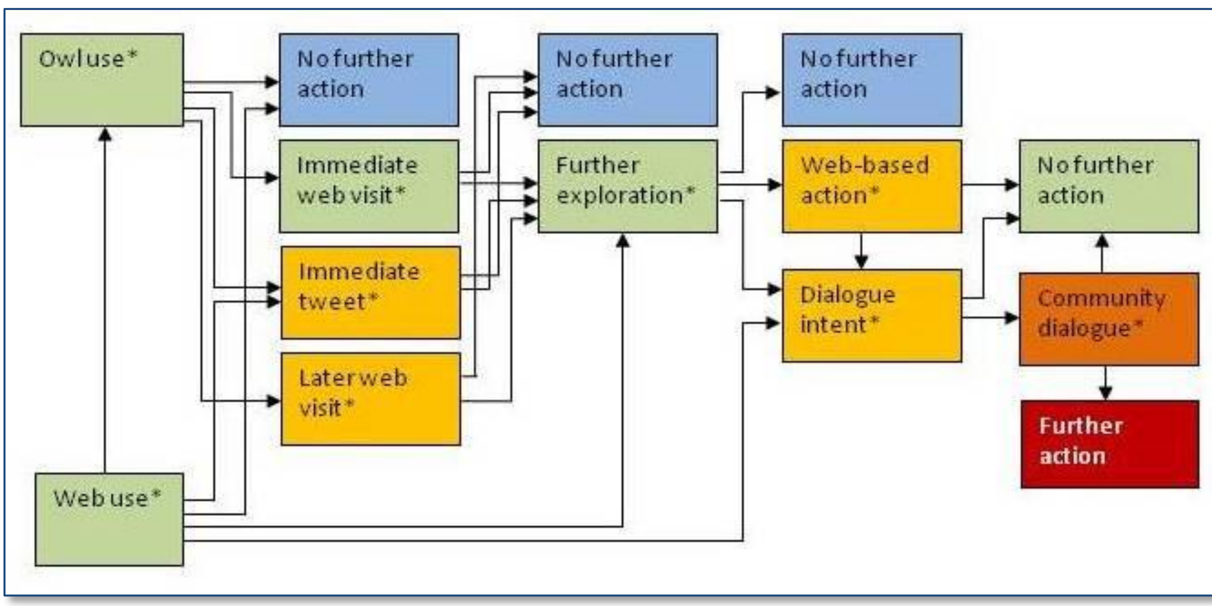

Figure 8: There are multiple engagement pathways from awareness to action using the OWLs or website.

Note: The coloring indicates pathways of varying degree of engagement: **blue** - lowest levels of engagement; **green** - low-to-medium levels of engagement; **yellow** – medium-to-high levels of engagement; **orange/red** - highest levels of engagement. The asterix (*) indicates quantifiable steps in the engagement pathways.

The OWL technology allows users to interact with the viewer via on-screen prompts and buttons on the handles. A typical interaction looked as follows:

When a user walked up to the OWL and looked into the visor, s/he was greeted by a "welcome" page with text and voiceover explaining what s/he was about to see as well as graphical instructions for how to click a handle button and proceed to the visualization. Upon clicking a button, the user saw the first visualization showing king tide flooding similar to that which occurred in that location during a storm in December 2014 and was encouraged to move the viewer around to see the extent of flooding in all directions. When ready, the viewer could click again and was prompted with the first survey question and, after clicking through the options to the desired answer to this question, clicked the button again to select that answer and advance to the next visualization. This continued for each of the visualization scenarios. After the last survey question, viewers were encouraged by the voiceover to leave an audio recording about what they just saw, experienced, felt or thought. Then a final "thank you" page loaded on the screen and the OWL reset for the next user.

The OWL installation site hosted signage explaining the project, in part to attract and interest people in looking through the OWL, in part to invite people into the OWL viewing experience, in part to "edutain" individuals while waiting in line to look through the OWL.

Climate Risk and Response Scenarios

After extensive deliberation among project team members and advisory partners, four scenarios were developed. They depicted two levels of flooding risk and two potential response scenarios:

- **Scenario 1 – "Current Condition":** Illustrated current storm and flood conditions already experienced in the area from sea level rise to date with a king tide event. This visualization re-created a storm that occurred in December 2014 that was a king tide with a 20-year storm surge layered on top and flooded the area where the OWLs were located.
- **Scenario 2 – "Sea level Rise/No Action":** Illustrated an additional 3 feet of sea level rise (above the current sea level baseline), with a king tide event and a 20-year storm surge layered on top.
- **Scenario 3 – "Sea level Rise/Seawall":** Illustrated a potential near-term protective adaptation response to the sea level rise from Scenario 2. The scene depicted an 8ft concrete seawall to protect the roadway next to the bike path where the OWLs were located, blocking the view to nearby houses and cutting off access to the waterfront for residents.
- **Scenario 4 – "Sea level Rise/Green Infrastructure":** Illustrated a different potential near-term protective adaptation response to the sea level rise from Scenario 2. The scene depicted a vegetated, gently sloping eco-berm or horizontal levee with a bike path on top that showed residents recreating and enjoying the view toward the Bay over constructed wetland areas.

Figure 9 on the next page shows these four visualizations, together with a fifth depiction of current dry conditions, encountered during the viewing period by research participants.

It was important to the research team to balance risk and response visuals so as to not leave viewers with a one-sided "gloom-and-doom" impression. Moreover, each scenario depicted common activities (traffic, residential areas, runners and bikers on the path, vegetation and birds) currently underway and common in that area to create a sense of familiarity and realism for viewers. An implied message was that "life goes on" even with sea level rise. The key difference between scenarios (and the currently experienced dry situation) was where that activity takes place and how it looks. The scenarios were viewed in a static sequence (1-2-3-4, i.e., not in random order).

Figure 9: OWL users experienced dry conditions during the installation period (as shown in the picture at the top).

Two visualizations in the OWL depicted flood risks: the first visual showed a flood similar to the December 2014 event that resulted from a 20-year storm with king tides and current sea level.

A second risk visualization showed a flood from a similar storm and king tides on top of 3 feet of sea level rise.

The remaining two visualizations showed possible adaptation response options: an 8 ft.-high seawall protecting against the kind of flood shown above but cutting off the view and access to the waterfront.

The second adaptive option showed an eco-berm or horizontal levee with a bike path on top.

(Source: Visualizations created by Owlized)

The specific visualization scenarios were chosen to ground climate change impacts in the here and now by showing flooding impacts already experienced the previous December. This allowed us to bypass any arguments about the validity or 'reality' of climate change impacts. Next, showing 3ft of sea level rise, rather than the higher-end projected impacts of 6.6ft for California (NRC, 2012) was to ensure that the depicted impacts could be thought of as possible in the relatively near-term future (i.e., within the next 50 years or so), and therefore is something the County might consider actively planning for today.

The inclusion of two response scenarios was heavily influenced by previous work on risk perceptions, affective responses to climate change, and visualization by one of the project advisors, Dr. Stephen Sheppard, University of British Columbia (see literature review above). This body of work has shown the importance of linking impacts to solutions to avoid fatalistic responses, despair, or numbing. An important goal of this project was to be able to pivot from impacts to solutions so as to allow people to feel that they could constructively engage with the County in finding and co-creating solutions to the challenges sea level rise pose, rather than feeling despondent about the magnitude of potential impacts.

Data Collection

Four basic methods were used to collect data on people's responses to the visualization scenarios and their level of engagement. Each is described in some detail below.

OWL-based Survey

As OWL users began to interact with the OWL, an audio prompter briefly introduced what viewers were seeing and how to operate the OWL. OWL users were then prompted with a set of clear and simple survey questions (yes/no/don't know, multiple-choice, or Likert-scale ratings; survey questions attached in Appendix E) as they explored the visual scenarios. The questions inquired about the level of concern about local flooding risks at current sea level rise and the level of concern about flood risks with 3 ft. of sea level rise, as well as viewers' interest in learning more about the depicted adaptive response options and the desire to get more deeply engaged on the issue. A final question asked the respondent's age. The number of survey questions was limited to five.[6]

OWL visitors were also prompted on the project sign directly adjacent to the OWLs to take immediate actions, if they so desired, such as tweet to the project Twitter account (@HereNowUs), go to the project website (www.here-now-us.org) to explore sea level rise risks in Marin more deeply, find out more about response strategies, and provide their email to stay informed on the project or come to the community dialogue event. OWL-based engagement on site was entirely voluntary. Tweets were registered separately and could not be linked to specific OWL survey responses. Website visits, email sign ups, and actions taken online were collected separately and could not be linked to OWL survey responses.

OWL-based Audio Recordings

Respondents were also encouraged to leave an audio recording at the end of the OWL experience if they so wished. Participation in this activity was opt-in and only highly motivated participants left recordings. What participants wished to express in these recordings was entirely open-ended. They had a maximum of 2 minutes of recording time to leave a comment to let the research team know their thoughts and feelings about the project or what they had just seen.

A total of 327 active recordings were left through the two OWLs (ca. 21% of OWL users who completed all five questions and thus were prompted to leave an audio recording if they wished). Of these, 121 were usable[7], providing an unexpectedly rich data source on OWL users' experience and opinions. Recordings could be made at the tall OWL and at the ADA-compliant, child-accessible OWL. Accordingly, adult and children's voices are distinguishable. Figure 10 illustrates the predominance of children at the small OWL, however, many also left messages at the tall OWL. Women and men participated actively in leaving voice messages.

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[6] See Appendix F for further details on site protection against vandalism, manipulation and secure data storage and access.
[7] The relatively high percentage of unusable recordings (ca. 62%) were due to wind noise, multiple voices speaking at once, other background noise, or technical issues.

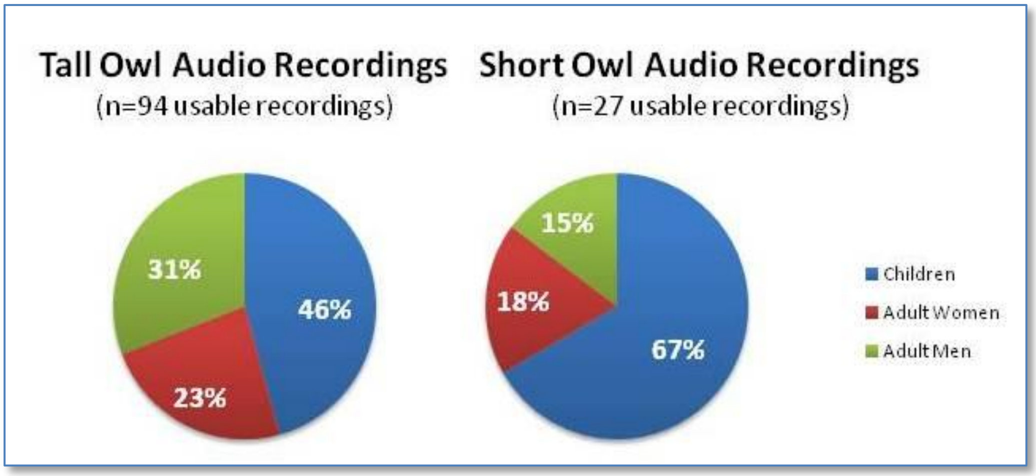

Figure 10: Children dominated the audio recordings at both the tall and the ADA-compliant, child-accessible, short OWL, but adults also participated actively in leaving voice messages.

On-site OWL Use Observation

Observation of the OWLs was conducted at several points during the installation, largely, in this pilot study, to learn more about OWL interaction and proper technical functioning. While observations were systematically collected, they were meant to provide qualitative, contextual information, rather than data for future analysis.

Cara Pike and Amy Huva conducted initial hosting of the OWLs in the first week of the installation, with observation sheets filled out for each conversation hosted. Climate Access' intern Seth Cauman observed OWL use during several days in July 2015.

Observers systematically noted whether the observed OWL use was an organized or random visit, and tried to describe the observers (numbers of OWL users, gender (if possible), age group (e.g., child, younger adult, older adult) (if possible)) and the observers' OWL use behavior (e.g., length of OWL use, differences between viewing behavior when alone or in groups, and notable viewer interactions). Basic viewing conditions (sunny/rain; warm/cold; windy/still) and time of day were also noted. The observers also attempted to count how many passers-by stopped to engage with the OWL and how many did not stop to explore the OWL.

Completely non-intrusive observation – as initially planned – proved difficult to implement due to the exposed nature of the installation site. A lack of nearby seating or other pedestrian infrastructure that would allow an observer to be near enough to the OWLs to overhear conversations but far enough to not cause interference prevented this. Thus, most of the observational periods were 'hosted observations' where observers were near the OWLs and engaged in conversation with passers-by and OWL users when approached, but simply observed if not approached.

Participant Observation in a Facilitated Community Dialogue

Project participants who signed up on the www.here-now-us.org website and Marin County residents who had previously attended a County meeting were invited to a community dialogue on sea level rise and local adaptive responses on October 8th, 2015. Promotion of the event through local email lists brought additional participants to the event. Project partners Climate Access and Susanne Moser facilitated the evening event.

The overall purpose of the event was to mark the launch of a community/county-wide adaptation journey with an open dialogue on what the community is already experiencing in terms of impacts and what residents want from the adaptation process. Approximately 100 individuals attended the community dialogue to talk about sea level rise related risks, implications for the County, and possible responses (Figure 11). Participation was voluntary; there was no pre-selection or limitation on the number of participants; and no compensation other than food and beverages was offered to participants. The large number of dialogue participants was greater than in most previous sea level rise and adaptation-focused community meetings. While publicly launching concerted sea level rise adaptation efforts in the county, for the OWL project it served as the culminating event.[8]

Figure 11: More than 100 Marin County residents participated in a community dialogue to discuss sea level rise risks and adaptation options.
Source: Susanne Moser

The dialogue was introduced by Supervisor Kate Sears, followed by presentations from Marin County staff, and lead researcher Dr. Susanne Moser. These presentations included the basics of climate change and sea level rise risks and the County's vulnerability assessment and adaptation planning process. Additionally, a presentation of preliminary findings from the OWL data collection period (June-September 2015) was offered.

For the dialogue portion of the event, the large number of participants were organized into groups of 7-8 individuals– by Marin County subregion – around round tables. Each group included a "table captain" to facilitate and take notes. Table captains had been previously trained by County staff in dialogue facilitation and were briefed prior to the event on specific goals and approaches. Project staff also joined tables to observe the dialogue among participants.

The dialogue emphasized respectful listening to and engaging with other participants' points of view so as to allow all viewpoints to surface. The dialogue was not meant to result in consensus or a decision, but rather produce a sense of what the attitudes and preferences in the community are.

Over the course of the three-hour dialogue session, participants shared their existing understanding and perceptions of the problem and risks, and their preferences, reasoning and underlying beliefs and values regarding response options. Specific questions to prompt the dialogue were developed in collaboration with project partners based on the insights gained from the OWL project. The facilitated dialogue constituted the main portion of the evening. Given the multiple dialogue tables, creative ways of report-back

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[8] Sea level rise planning is actively continuing throughout the county.

and debriefing periods occurred throughout, and an informal synthesis concluded the session.

Prior to closing, dialogue participants were asked to complete a brief exit survey, which was meant to assess their motivation to attend the dialogue event, what participants learned in the dialogue, the impacts the dialogue had on participants concern about climate change risks and desired levels of further engagement in adaptation planning, as well as to obtain information about prior OWL use. About half of the attendees (n=51) completed the survey (albeit response rates varied by question). Appendix G shows the questions included in the exit survey.

Media, Social Media and Web Tracking

The project team tracked media coverage over the course of the project, including local TV, radio and print coverage and national and online coverage (see the listing in Appendix D). Ongoing sea level rise media coverage served as important "background buzz," in and of itself raising awareness of climate change risks and adaptation, but also creating motivation to visit the OWLs and/or the project website. In fact, while the www.here-now-us.org website averaged over 1,000 page views each month with approx. 95% of all web traffic new visitors, one of the largest spikes in web traffic to the www.here-now-us.org website occurred just after July 31st, when the project was featured on NPR's *Science Friday* show, which reaches over 1million listeners across the United States. On that day alone, the website registered ca. 200 page views. The project was also featured in the August edition of *Marin Magazine* and was covered by *Bloomberg BNA*, *Autodesk* and *Scientific American*.

Ongoing sea level rise media coverage created motivation to visit the OWLs and the project website.

More than 100 people followed the project Facebook page which allowed people to share photos of their OWL use and project partners to share information about project related efforts and events. The most popular post was the project being featured by the *Bloomberg BNA* blog in August (reaching 459 people), followed by the project being written up in *Scientific American* (reaching 326 people). The majority of the Facebook traffic came through clicking on a link at the www.here-now-us.org website, followed by Google and Bing search results. The busiest week for the Facebook page was the OWL Project Launch Week, when 875 people were reached.

More than 100 people signed up to be on the project mailing list at www.here-now-us.org. The email sign–up form did not ask whether the registrant had been to the OWL installation. About 35% of dialogue attendees had visited the OWLs but only 4% of dialogue participants who answered the exit survey had been to the project website. It is unknown whether they provided their email there or were brought to the dialogue through another channel. These data suggests that Marin County's direct email lists were more effective in getting people to attend the dialogue session than the project website and related email list.

Data Analysis

As the above section suggests, a large amount and diversity of data were collected in the course of this project. Table 2 (next page) provides a summative overview of the type and source of data collected through the described approaches.

Table 2: Data Gathered for this Project by Type and Source

Data Sets	Source	Type	Notes
OWL user responses (survey questions on risk, solution preferences)	OWL	quantitative	Concern about sea level rise related risks prior to and after exposure to visualizations; interest in response options, further engagement; age
OWL user responses (engagement with visualizations)	OWL	quantitative	Length of engagement at OWL
OWL user responses (audio recordings)	OWL	qualitative	Spontaneous oral reactions to visualization scenarios (emotional responses to scenarios and OWL technology)
Onsite observations of OWL use	OWL	qualitative	Length of engagement by individual users, use patterns, use behavior, visible/audible responses, group vs. individual use, non-engagement with OWL (i.e., passers-by)
Web visits	Website	quantitative	Web traffic statistics of individual visitors
Web visitor actions	Website	quantitative	Web tracking statistics of people clicking on available actions
Web visitor email addresses	Website	nominal (confidential)	For follow-up encouragements to go to website; participate in community forum
Web visitor actions	Twitter	quantitative	Tweets sent to special twitter account, urging County action on sea level rise
Dialogue participation	Dialogue event	quantitative	Number of individuals attending
Dialogue participants' climate change concern	Dialogue event	qualitative/ quantitative	Observations, notes, exit survey responses
Dialogue participants' learning at event	Dialogue event	qualitative/ quantitative	Exit survey responses
Dialogue participant desire for further engagement	Dialogue event	qualitative/ quantitative	Expressions of intent to undertake certain actions, and – if possible to track – actions taken after the community dialogue event

The collected data was qualitatively and quantitatively analyzed for trends, patterns, correlations, length and degree of engagement with the visualizations, and follow-on activity patterns. Details on these analyses are provided below.

OWL Survey Analysis

The survey responses recorded in the two OWLs were analyzed, first, using basic descriptive statistics related to the key variables explored through the survey questions:

- Concern about existing flooding risks ("pre-concern")
- Concern about flooding risks associated with 3 feet of sea level rise ("post-concern")
- Interest in learning more about different adaptation options
- Desired level of further engagement
- Age of the OWL user

Moreover, the OWLs were designed to track start and end time of user sessions as well as time spent between clicks moving the viewer to the next scenario. Thus, from the background tracking, we could also ascertain:

- Duration spent with the OWL per user
- Duration spent on each question
- Time of day and day of the week when a user engaged with the OWL.

From these observations, we could determine drop-off rates from question to question, average attention spans, and other engagement patterns. These descriptive statistical insights were summarized in histograms (i.e., frequency distributions) to uncover any patterns or trends over the 14-week viewing period.

Subsequently, pre- and post-concern levels were more closely analyzed with a Wilcoxon Matched Pairs Test to determine if there was a statistically significant change in the level of concern moving from the first to the second risk scenario. This non-parametric statistical test is generally used with ordinal data to compare two matched samples (i.e., the pre- and post-concern levels of the same individual). This test only indicates whether there is a change in concern and how large it is, but does not indicate whether the level of concern is increasing or decreasing. The rejection level for the hypothesis testing was set at $p = .05$, with smaller values indicating that there is a change in concern.

In a first analysis, we included the entire subset of the user population that answered both questions one and two on pre-and post-concern (n=2,111). In a second analysis, we considered only those users who answered "Not at all", "Not very" and "Somewhat" for pre-concern levels (n=1,077). Finally, we analyzed only the users that answered "Not at All" and "Not very" for pre-concern levels (n = 556). These progressively less concerned subsets of the entire user population were analyzed independently to answer the question whether the visualization of higher sea levels affected them differently: do those coming in with lower levels of concern about current flood risks change their concern any differently than those who come in with a higher level of concern?

Subsets of the user population were analyzed independently to answer the question whether the visualization of higher sea levels affected them differently: do those coming in with lower levels of concern about current flood risks change their concern any differently than those who come in with a higher level of concern?

In order to evaluate if the change of concern was increasing or decreasing, and by how many levels, we created a histogram of change of concern levels, ranging from -4 to 4. These numbers represented the theoretically possible shift in concern from the level of pre-concern to post-concern a user could make. For example, a user selecting "Not very concerned" in response to Question 1 and "Very" in response to Question 2, shifted +2 levels; a user answering "Very concerned" to Question 1, and "Not at all" to Question 2, shifted -3 levels. A 0 would indicate no shift in pre- and post-level of concern. These figures on direction and amount of shift do not indicate from which level of concern someone shifted away. Thus, if a user had a high pre- and post-concern without any change, or if a user had a low pre- and post-concern without any change, both would be marked as 0. It is for this reason, that different sub-groups were analyzed independently.

Finally, different sets of variables were correlated and tested for statistical significance using Chi-square tests. These analyses allowed us to examine relationships between variables, e.g., age and concern, age and desired level of engagement, or the desired level of engagement in the adaptation process (dependent variable) and pre-, post-, and change in the level of concern, respectively (independent variables). For the first of these, i.e., to test if there was a correlation between pre-concern and desired level of engagement, we used the sub-sample of the population (n= 1,405) that answered both Question 1 (pre-concern) and Question 4 (desired level of engagement). For the second, we examined the subsample of the population (n= 1,411) that answered both Question 2 (post-concern) and Question 4 (desired level of engagement). To determine the change in level of concern, we examined the subsample of the population (n = 1,301) that answered both Question

1(pre-concern) and Question 2 (post-concern) and correlated the result with the respondents' answers to Question 4 (desired level of engagement). For age and level of engagement, we used the subsample of the population (n=1,372) that answered both Question 4 (desired level of engagement) and Question 5 (age range). Then we examined the subsample population (n=1,252) that answered Question 5 (age range) along with Question 1 (pre-concern). We followed this with examining the subsample population (n=1,356) that answered Question 5 with Question 2 (post-concern) to see if there was a difference in the correlation between age and pre- versus post-concern.

The null hypothesis was that the variables are unrelated and the rejection level for the null hypothesis for all of these analyses was set at $p = .05$. Anything less than .05 would indicate that the null hypothesis could be rejected and, thus, that the variables are in fact related.

The intent behind these various analyses was to determine where a) there were differences among age groups in concern and desired level of engagement; b) concern relates at all to the level of desired engagement in the adaptation process; c) seeing the visualizations of sea level rise motivated people to get more involved; and d) the magnitude in the shift of concern itself had an impact on the desired level of further engagement.

OWL Audio Recording Analysis

A total of 121 recorded audio messages were available for further qualitative analysis. In this pilot study, where both technological issues and research possibilities had to be worked out, no attempt was made to match survey responses to recordings (although this is technically possible). Rather, the messages were inductively coded for content and emotional expression to obtain a richer picture of people's OWL user experience. The messages ranged from brief, but heartfelt reflections on what viewers had just seen, to expressions of concern about climate change more generally, to calls for action and comments on the OWL experience. The following categories of comments were coded:

- Emotional expressions
- Local flooding experience
- Global warming beliefs
- Questions about climate change
- General comments about acting on global warming
- Adaptive solutions
- Reasons for preferring a particular adaptation scenario
- OWL experience
- OWL technology
- Self-identification
- Other

The usable audio recordings allowed unambiguous distinction of gender and age (categorical distinction between children and adults). The "self-identification" category captures individuals saying that they are local residents or from out-of-town. A significant number of children left messages related to the OWL experience per se, but many also used the opportunity to tape unrelated messages (categorized under "Other" as jokes, fun or just playing with the technology.

Community Dialogue Exit Survey Analysis

The exit surveys were distributed, completed and collected from dialogue participants at the end of the event and analyzed using descriptive statistics for the following variables:

- Motivation to attend the dialogue event
- Extent of learning at least one new thing at the dialogue event
- Most significant source of learning
- Experience of the OWLs or the website prior to attending the dialogue event
- Change in level of understanding of climate change risks
- Change in concern about climate change risks as a result of the dialogue event
- Change in understanding of Marin's adaptation planning process

Chi-square tests were initially attempted to test the relationship between prior visualization exposure (at the OWL or on the website) and the level of concern expressed in the exit survey. The intent was to see whether those dialogue participants who had been to the OWL or who had visited the website showed any greater concern about sea level rise than those who had not experienced the visualizations prior to the event. Given the small number of responses in each of these categories, results must be viewed with care. In some instances, there were >5 observed data points to enter in the data table. The conventional rule of thumb is to not employ the Chi-square analysis if the observed values are 5 or less.

4 Research Findings

This project aimed to test the effectiveness of visualizations in an experiential setting to increase public concern and to motivate greater engagement of citizens in a local adaptation process. The multi-method approach used to examine the role of visualization and dialogue in climate change engagement produced significant new insights from a scientific standpoint and advanced the application of such methods in community outreach. Below we detail the research findings specific to concern and engagement.

Visualizing Climate Change Impacts in the OWLs

Can 3D visualization of climate change impacts and adaptation options- using the OWL technology - increase viewers' level of concern, and the desire to engage in the local adaptation process? The overarching answer is a resounding yes, with interesting details and caveats revealed by the statistical analysis.

Flood-Risk Concerns and Changes in Concern

The survey first produced a profile of the OWL user population and their level of concern about current flood risks. Figure 12 depicts an OWL user population that – by majority – is already "very" or "extremely" concerned about existing flood risks (47%), although the single largest segment of this population falls into the middle of the distribution with rather modest concern. Just over a quarter of all OWL users (28%) were "not very" or "not at all" concerned.

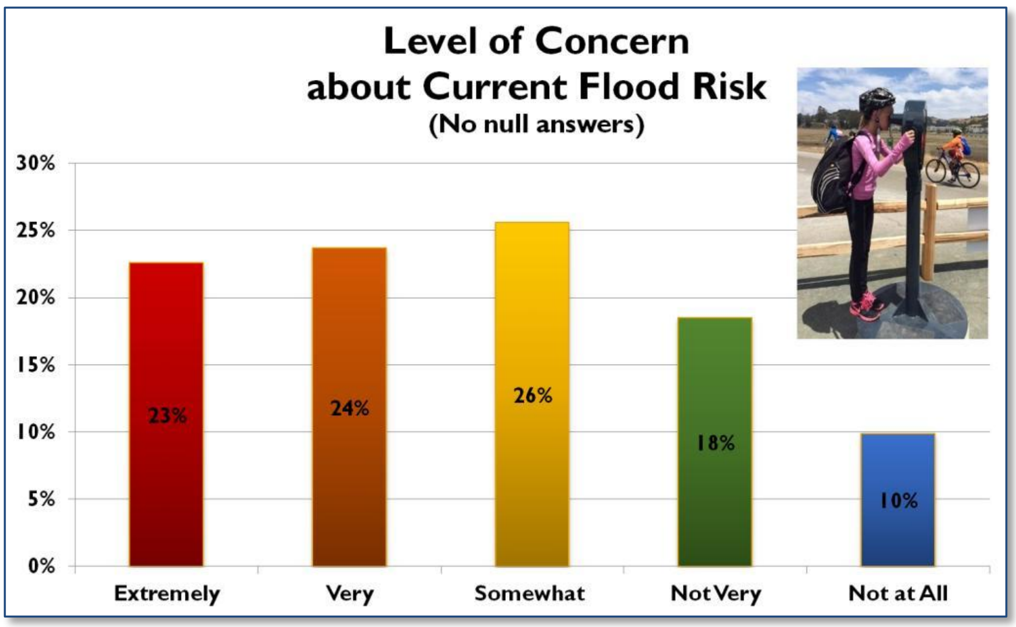

Figure 12: A majority of OWL users is quite concerned already about existing flood risks.
Photo: Leslie Alden

Given that these answers were given prior to seeing the sea level rise visualization, these responses reflect the levels of concerns of local residents and other passers-by, presumably many from the Bay Area. Memories of local flooding was triggered in the audio narrative accompanying the visualization. Moreover, press coverage of sea level rise has been in the news quite frequently over the past five years in the Bay Area. Thus, the expression of concern leaning toward higher levels of concern even just for current flooding risks is not surprising and consistent with expectation.

Our findings indicate clearly that the 3D visualization of greater flooding risk, as a result of sea level rise, did indeed further increase user concern. Figure 13 shows this increase particularly in the increase in the "very concerned" category, and a commensurate decline in the "somewhat concerned" category.

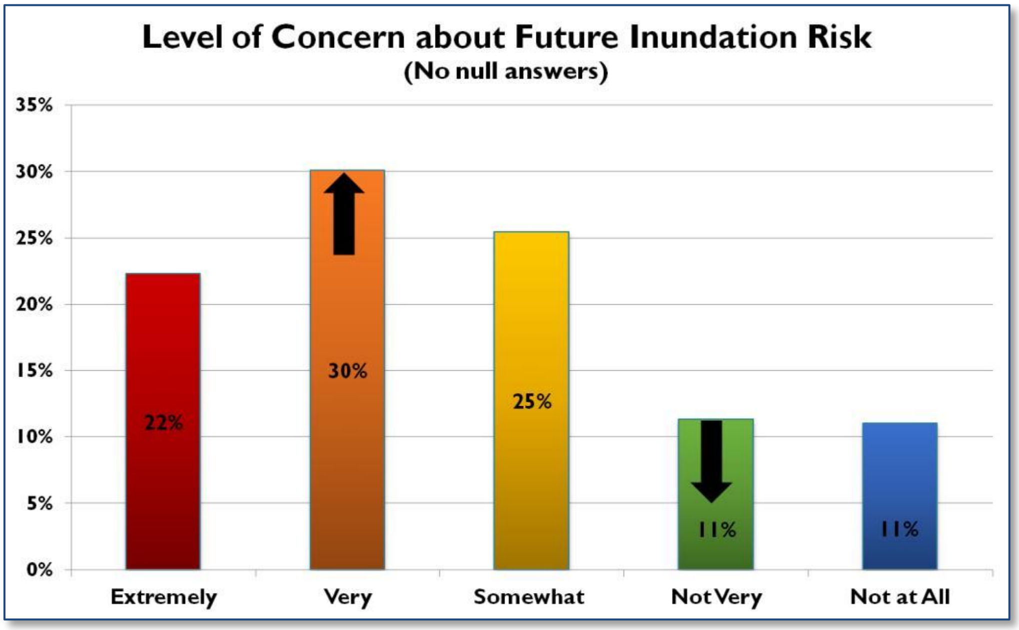

Figure 13: OWL users' concern increased when they looked at a visualization of the greater flooding risks that can be expected under 3 feet of sea level rise.

The statistical tests undertaken revealed important additional details hidden beneath this overall pattern. Examining pairs of responses where users answered both questions related to concern about existing flooding risks and increased risks due to sea level rise, we observed that those OWL users who initially expressed a low level of concern (answering “not at all” and “not very”), experienced a highly significant shift toward higher levels of concern: an average of two two levels. Notably, 75% of the population that came in with low to no concern indicated that they felt more concerned after viewing the future sea level rise scenarios. By contrast, those who initially showed a higher level of concern were either more likely to stay at same level after viewing the sea level rise visualization or moved to yet a higher level (if possible). Very few OWL users shifted to a lower level of concern upon seeing the sea level rise visualization – a shift that either suggests emotional numbing, skeptical views about climate change influencing their responses, or an inadvertent selection of an unintended answer.

Interest in Adaptation Options

Next, OWL users were shown two adaptation options – the seawall and the eco-berm (or horizontal levee). After viewing both options they were asked about their interest in learning more about either or additional options. Figure 14 below reflects their level of interest in these options.

A clear pattern emerged: The smallest segment of OWL users (13%) answering this question were not interested in any further information on adaptation, suggesting that the large majority of OWL users is already or can be mobilized to engage further on this issue. The next segment, similarly small (14%), wanted to learn more about the seawall option shown first, while 26% – nearly twice as many – wanted to learn more about the eco-berm option. The largest segment (27%) wanted to learn more about both options, and a significant portion (20%) wanted to learn more about these two and additional options.

Arguable, those who were interested in learning more about additional options may be viewed as significantly cognitively engaged at this stage, as their curiosity and desire to learn goes even beyond what was depicted.

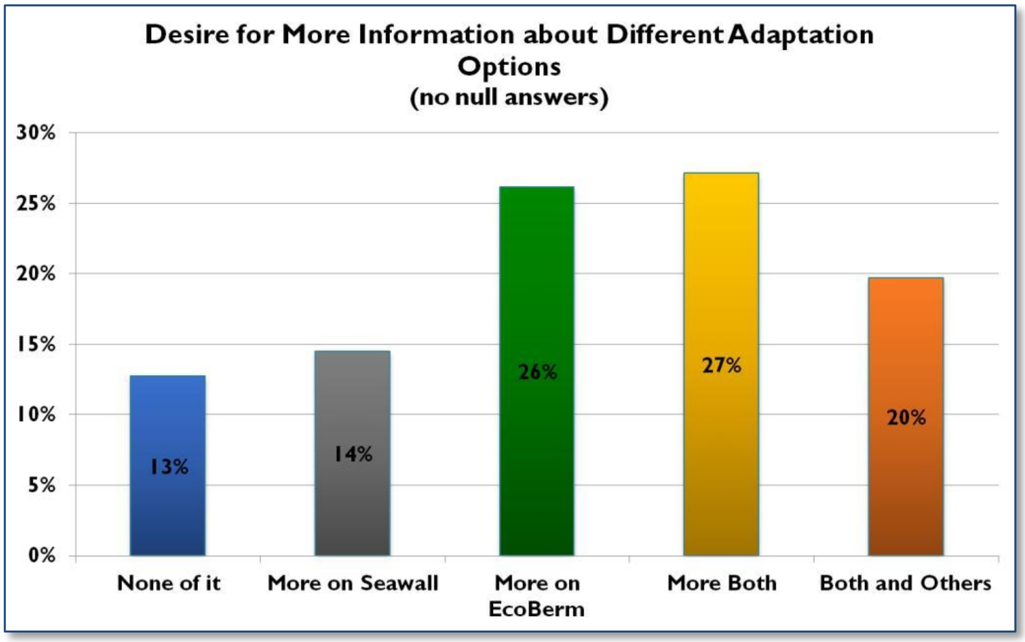

Figure 14: A clear majority of OWL users wanted to learn more about the eco-berm, about both the eco-berm and seawall options, or about additional options to deal with local sea level rise risks.

DESIRED LEVELS OF FURTHER ENGAGEMENT

Next, OWL users were asked about their desired level of further engagement in the adaptation process. The five options were: "I will not get involved"; "I am interested but not likely to participate"; "I would like more information and updates on the process"; "I would like to attend more meetings as the planning gets underway"; "I would like to know how to take an active role in my community". Figure 15 shows the responses of those OWL users answering this question, with the level of active engagement growing from left to right.

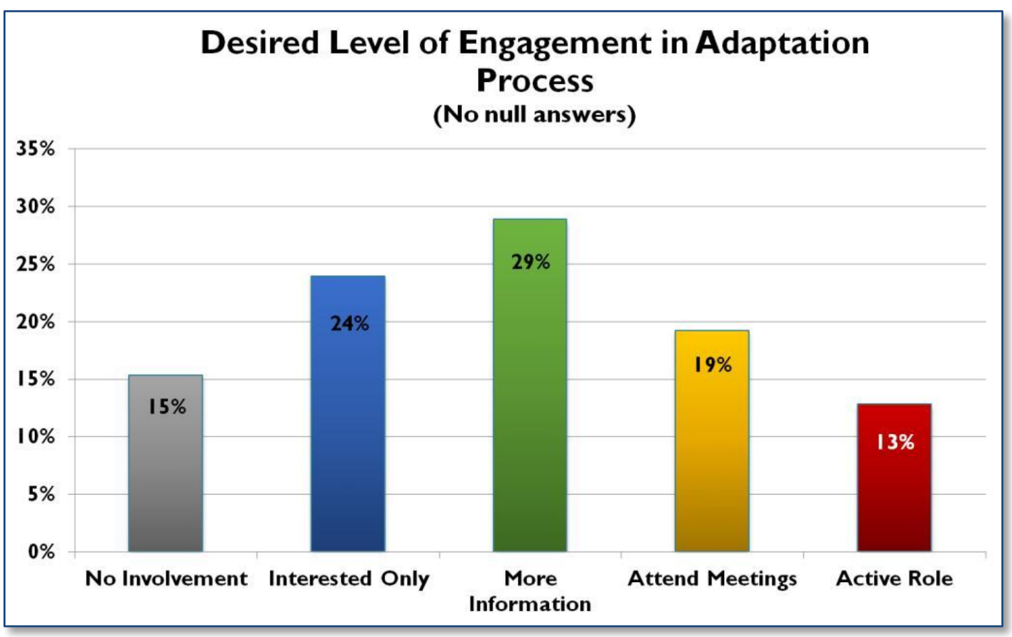

Figure 15: A notably large number of OWL users (32%) is willing to participate in an adaptation related public meeting or take an active role in their community around this issue.

Consistent with the distribution of levels of concern and expressed interests in learning more about different adaptation options, 15% of OWL users answering this question wished no further involvement in the adaptation planning process. Nearly a quarter expressed a generalized interest, but did not think they wanted to be involved any further. The largest number of respondents (29%) indicated they would like more information about the process, another 19% said they would attend a meeting, and the smallest number of respondents (13%) said, they would like to take an active role in their community. The latter two groups combined (32%) constitute a surprising large proportion or community members who could be mobilized for civic engagement.

Relationship Between Concern and Engagement

In order to test whether OWL users' level of concern is related to their desired level of further engagement in the adaptation process, we undertook a series of Chi-square tests, as described above. The results indicated that, indeed, there was a relationship between the level of concern and the motivation for further engagement. Specifically, the test revealed that the higher the level of concern, the higher the desired level of engagement. This relationship was strongest between concern about future sea level rise and engagement, followed by the relationship between existing concern of flooding and engagement, and least strong, but still highly significant for the relationship between change in level of concern and desired level of engagement.

The higher the level of concern about flooding and sea level rise, the higher the desired level of engagement in the adaptation process. But those with fervent opposing views also are strongly motivated to be engaged.

Interestingly, and consistent with expectation, those who suggested they are "not at all concerned" also showed a desire for higher levels of engagement. In other words, those with fervent opposing views also feel strongly motivated to be engaged. The Chi-square test only uncovers if there is a relationship between the variables, but does not indicate specific differences in what was observed versus expected. We evaluated the residuals/ differences in order to shed insight into the relationships uncovered. In the analysis of the change of level of concern and post-concern condition, there was a distinct progression toward greater observed values than expected levels of engagement the higher OWL users' levels of concern. The converse was also true: as concern decreased or the change in levels of concern decreased, levels of engagement decreased as well.

Age Differences

Marin County partners were particularly interested in whether or not there are discernible age differences in levels of concern, adaptation interests and motivation to engage in the adaptation process. And indeed, our analysis found distinct patterns.

To recall, the population of OWL users answering the last – age-related – question showed a spread across all age groups (see Figure 5 above), with 21% under 15 years of age (Gen Z), 18% Millennials (18-35 years old), 26% between 36-50 years old (Gen X), and another 26% in the 51-72 age group (Baby Boomers), and, finally, a smaller group (10%) of individuals more than 72 years of age (Matures, sometimes also called Silents).

Between these five generational groups, there were significant differences in concern. Figure 16 and 17 (next page) show the levels of concern about existing flooding risk and about future sea level rise related risks, respectively. Given the uneven size of the generational population segments, the figures show percentages of the total in each age group, so that they are more easily comparable.

Figure 16 (concern about current flooding risk by age group) shows the greatest concern in the Gen X and Mature segments in terms of the largest number of "extremely" and "very" concerned individuals, followed by the Millennials and Baby Boomers. The youngest generation is the least concerned judging from the percentage of "extremely" and "very" concerned individuals. Interestingly, however, the two oldest population segments also have the greatest percentage of individuals "not at all" concerned about current flood risks.

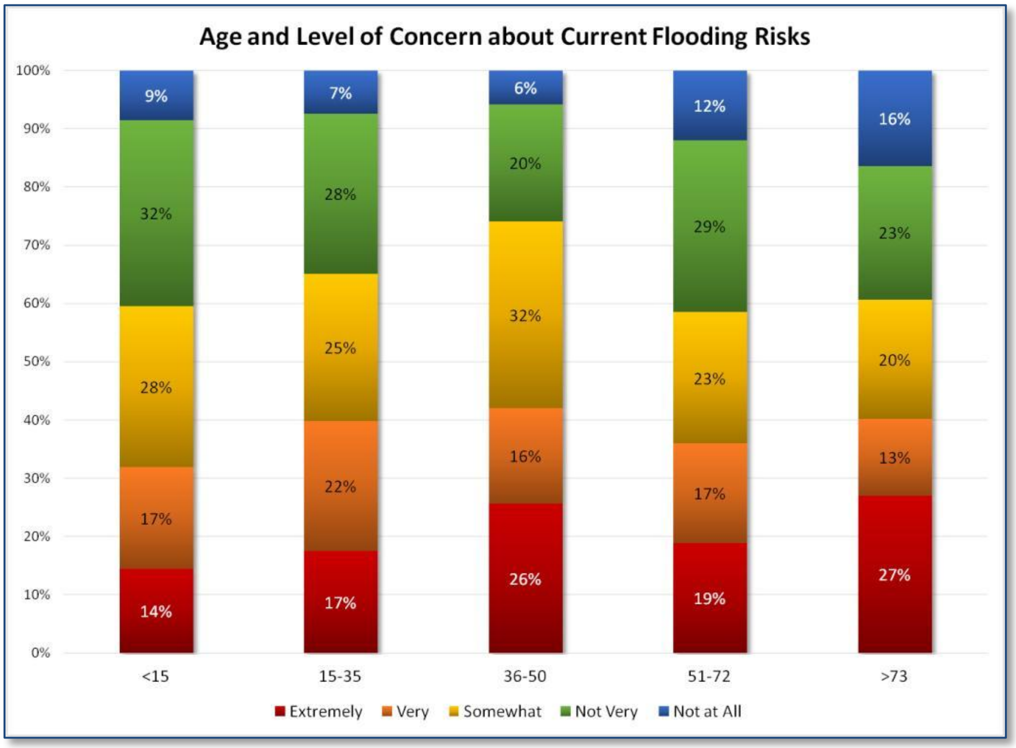

Figure 16: The Matures and Gen X are most concerned about existing flooding risks, but the older age groups also have the largest percentage of "not at all" concerned individuals.

How does this concern change when OWL users see the sea level rise visualization? Figure 17 illustrates the shifts.

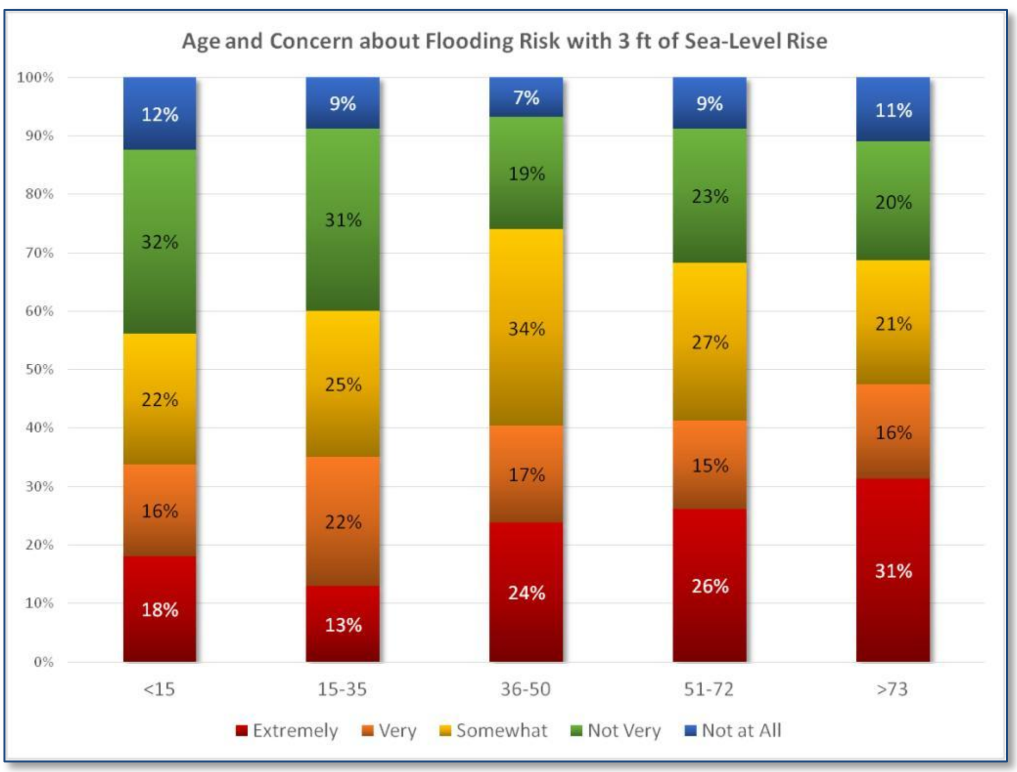

Figure 17: The Matures, Baby Boomers and Gen Z shift most significantly toward greater concern, producing an overall pattern wherein being "very" or "extremely" concerned about future sea level rise is correlated with age. However, the oldest and youngest also have the greatest number of "not at all" concerned.

Overall, there are more people across all age groups who are "extremely or "very" concerned (40% average) about future sea level rise, than there are people who are "not at all" or "not very" concerned (35% average). Looking more closely at the patterns by age group, majorities in all age groups remain in the “somewhat” or “not very” concerned categories, and proportionally, both the youngest and the oldest age groups have the greatest number of "not at all" concerned. The Matures, Baby Boomers and Gen Z shift most significantly (at least four points) toward greater concern (individuals marking "extremely" concerned), whereas a smaller proportion than before among the young adults and Gen X are "extremely" concerned about future sea level rise. Overall, however, the older adults emerge as the most (i.e., "very" and "extremely") concerned groups regarding their concern about future sea level rise, suggesting there is a positive correlation between age and concern about future sea level rise. A Chi-square test revealed that this relationship is statistically significant.

A distinct age-related pattern was also found among interests in the adaptation options (Figure 18). An overarching take-home message from Figure 18 is that the overwhelming majority of OWL users is interested in learning more about adaptation options (more than 90% in all but one age group), with a surprisingly large number among the oldest age group standing out as wishing to not learn any more about any of the adaptation options. By contrast, the majority of the under 15 year-olds is interested to learn more about the seawall option, while a strong majority of the Gen X wants to learn about the seawall and the eco-berm options. Millennials and Baby Boomers want to learn more about both of these and additional adaptation options.

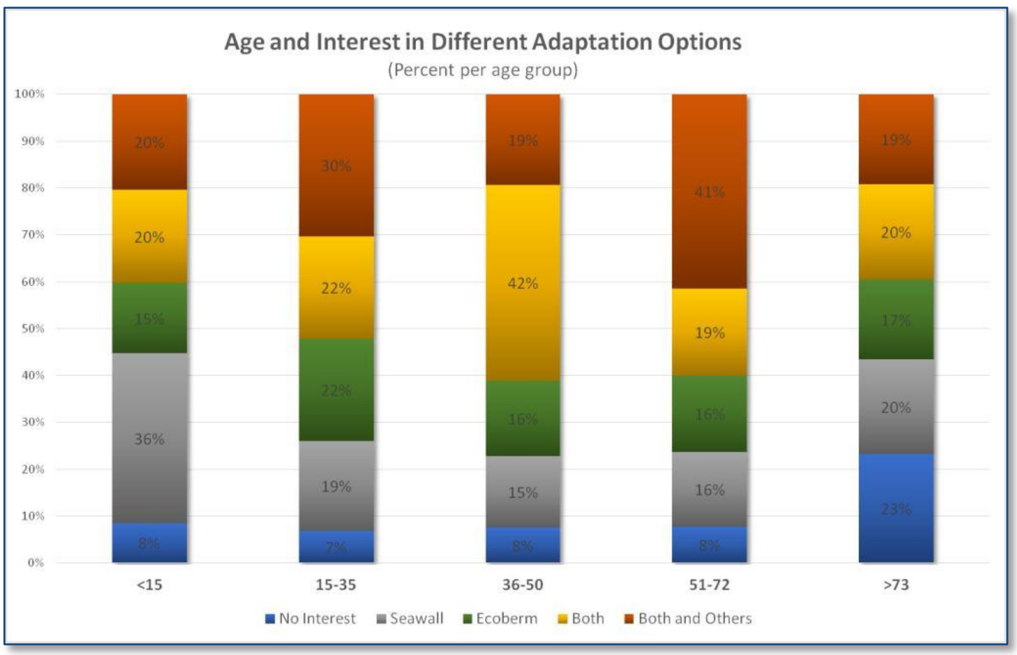

Figure 18: The overwhelming majority of OWL users is interested in learning more about adaptation (more than 90% in all but one age group).

This interest in learning more about different adaptation options is even more accentuated in the desired level of being further engaged in Marin's adaptation process.

Figure 19 (next page) depicts age-related differences in the engagement level. The Chi-square test uncovered the statistically most significant correlation of all analyses done for this project between age and engagement level: the older in age, the higher the desired level of engagement. The youngest group included the greatest number of individuals wishing no further involvement in the adaptation process while older adults wished to attend a meeting or take an active role in the community. Reflective of common patterns of civic engagement in the U.S. at this time, but also reflective of life stage and time availability, a plurality of the Matures wish to take an active role in their community, and Baby Boomers – by majority – would be willing to attend a meeting on adaptation. Almost half of the Gen X OWL users would like to receive more information about the adaptation process, whereas more than half of the two younger generational cohorts are either not at all interested in getting involved or are interested but unlikely to do so. However, a notable 20% even in those two groups would be willing to attend a meeting and a small number would also like to take a more active role.

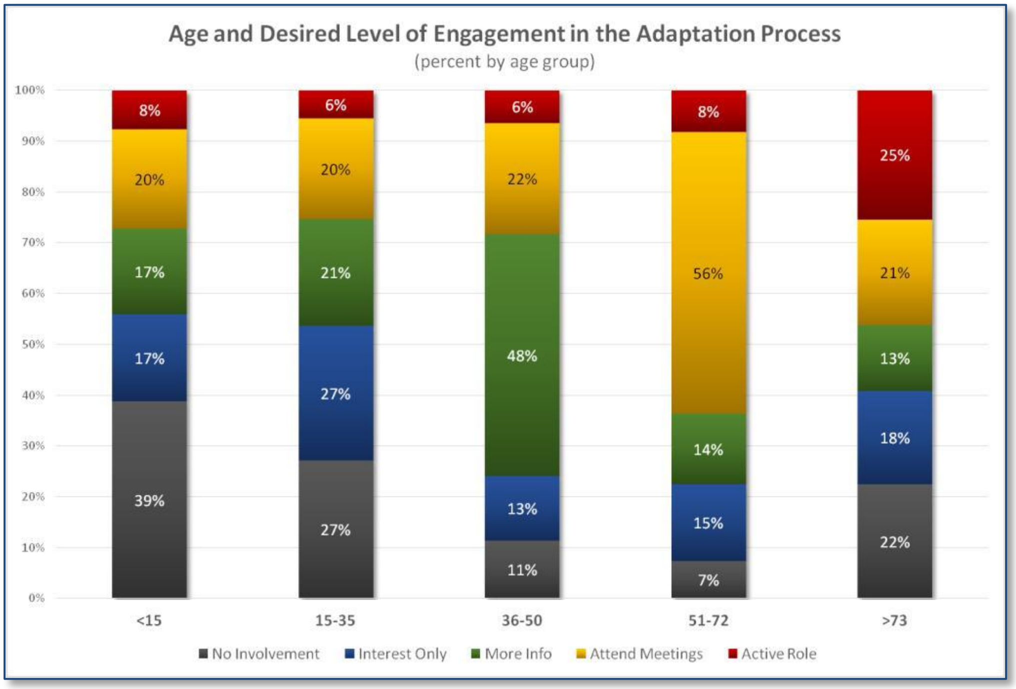

Figure 19: There is a distinct relationship between age and desired level of engagement, with the youngest wishing no further involvement in the adaptation process and older adults wishing to attend a meeting or taking an active role in the community.

Audio Recordings

Additional insights could be gleaned from the qualitative analysis of the 121 usable audio recordings. As reported above, both adults and children used the opportunity to leave audio messages at surprisingly large rates (321 recording attempts (or 21%) of the 1,532 individuals receiving the recording prompt). Nearly 40% of the recordings were usable for further analysis.

Considering the ratio between children (operationalized here as OWL users <15 years of age) and adults (all remaining OWL users >15 years of age) (21% to 79%), about 25% of all messages were expected to be from children. Instead, 61 (or just over 50%) of the usable recordings were from children, while 60 were left by adults. Even with the non-serious messages by children subtracted, still ca. 40% of all audio messages are from the youngest viewers. This makes clear that children used this interactive option far more frequently than numerically expected and suggests, that the OWL technology may be particularly attractive and useful for youth engagement.

Several notable observations stand out based on the frequency with which certain issues were mentioned (Figure 20, below). The most common message from the recordings was related to viewers' preference for the eco-berm option, closely followed by people's gratitude for doing the OWL project. The playful but unrelated messages from children and greetings to the project team aside (set apart in pink in Figure 20), this was reiterated by people saying that they really liked the OWL project and how it helped them see what sea level rise means in their community. Further reinforcement of this sentiment came from the many emotive expressions of how "cool", "fascinating", "interesting" or "fantastic" the visualizations were.

OWL users also took the opportunity to express their feelings about climate change impacts – most commonly sentiments of concern, worry, and fear (in one case, crying). A number also offered additional sea level rise adaptation solutions beyond those shown in the OWLs, and they spoke of their familiarity or experiences with local flooding.

Many other comments were recorded (items in each of the categories listed below occurred between 1-5 times), including

- other emotions than concern (anger, hope),
- general global warming beliefs (by majority in agreement with the scientific consensus, but also several skeptical voices),
- general calls or support for acting on climate change (both mitigation and adaptation) and for protecting the environment,
- general comments about the need for adaptation, and comments or questions about approaches to adapt specific locales in the county,
- questions about global warming and impacts, and several confused questions about the relationship between the (ongoing) drought and flooding, and
- comments about the OWL technology.

Commenters also articulated why they preferred a particular adaptation scenario, in most instances why they liked the eco-berm option better than the seawall: the predominant reason for preferring the horizontal levee was its aesthetic quality, closely followed by its multi-use concept, and its effectiveness for keeping the water out, while still allowing a view to the Bay. Figure 20 summarizes the most common expressions documented in the audio recordings.

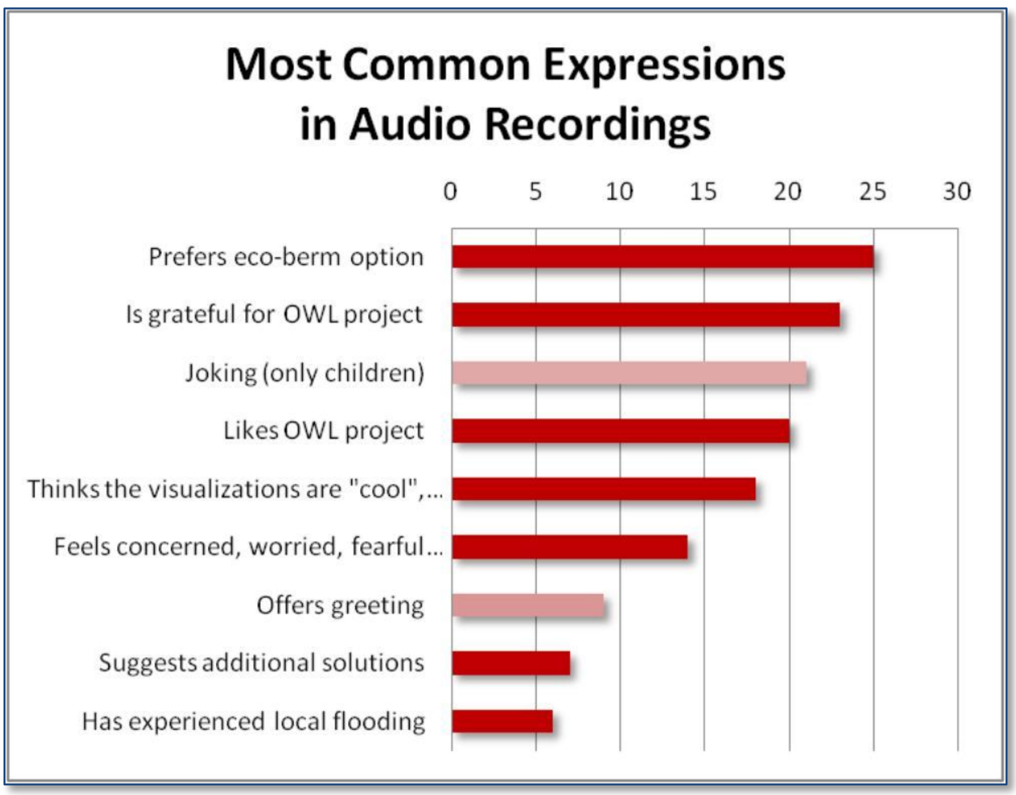

Figure 20: OWL users who left audio recordings most commonly spoke of their preference for the eco-berm option, their appreciation for the OWL project and the "cool" visuals, and their concerns about climate change.

COMMUNITY DIALOGUE

The 3D visualization project concluded in the fall of 2015 with a community dialogue hosted by the project partners. The objective of the dialogue was to engage participants in a deeper exploration of sea level rise-related risks to Marin County coastal areas and assets and of different adaptation options. Of the more than 100 participants who attended the event, 51 completed an exit survey at the end of the dialogue that revealed insights about the particular benefits of the deliberative conversation.

Attendees came to the event for a number of reasons, but their generalized concern about climate change and the desire to be engaged in finding solutions dominated the motivations. Wanting to learn more about the County's sea level rise adaptation planning process was also a key reason, followed by a general interest in environmental issues. Notably, the central theme of the visualizations – sea level rise – and its impacts on local residences and businesses were not the leading reasons, nor was the central feature of a dialogue event, namely to connect with one's neighbors on a certain issue (Figure 21).

Figure 21: Marin County residents came to the dialogue event mainly because of their concerns about climate change and their desire to be engaged in finding solutions.

When asked whether the dialogue helped them learn at least one new thing, the vast majority (88%) said they did. The remainder did not think so or where not sure (3% each). When asked about who the dialogue participants learned most from, 50% said they learned most from other dialogue participants, i.e., people like themselves, whereas 30% thought they learned most from the presenters, and 20% from the facilitators. This reflects both the time spent in different engagement modes (the majority of the time was spent in dialogue, after brief upfront presentations and short facilitation interventions throughout), and also the potential of dialogue as in-depth educational engagement method.

The exit survey specifically asked about dialogue participants' change in the level of understanding about climate change risks. Half indicated that they had a "somewhat" (40%) or "a lot" (5%) better understanding of the risks following the event. No one felt their understanding decreased. Similarly, participants were asked to self-assess whether they understood Marin's adaptation planning process better after the event than before they came. More than two thirds felt their understanding had increased "somewhat" (49%) or "a lot" (19%). Thirty percent felt their level of understanding was unchanged and 2% felt they understood it less after the event than before. These findings underscore again the potential of dialogue as an educational engagement approach.

Exit survey respondents also rated whether they experienced any change in the level of concern about climate change risks due to the event. The majority (52%) felt their concern was unchanged (possibly reflecting the high level of concern with which dialogue participants entered the event), while 34% felt their concern went up "a little" and another 11% felt it went up "a lot." Only 2% felt their concern decreased "a little," but the brief survey did not allow for further inquiry into why their concern changed one way or the other. Thus, the increased concern could be due to what more they learned about climate change risks, the personalization of that risk through the flood experience stories exchanged among dialogue participants, or due to a lowered confidence in what is being done about these risks. Overall, however, the dialogue also serves well as a method for deeper affective engagement, even for already concerned individuals.

Finally, the exit survey inquired about dialogue participants' experience with the OWLs. Of those who answered the exit survey, 74% had heard of or experienced the OWLs. Interestingly, the majority had heard of them and wanted to go see them but did not get around to doing so (35%); 29% had gone to see the visualizations at the OWLs; 6% said they went but the OWLS didn't work so they did not get to see the visualizations before that evening; and another 4% percent had gone to the project website. Slightly more than a quarter of survey respondents (27%) had never heard of the OWLs prior to the dialogue event. These findings allow the careful conclusion that while the project website and related email sign-up may have not been as effective in bringing people to the dialogue event (as discussed above), the media outreach was influential in creating a local "buzz" and generating a desire to go see the OWLs. The experience itself was motivational at least in so far as to pay attention to emails from the County inviting residents to the dialogue event.

The findings underscore the potential of dialogue both as an educational and affective engagement approach that helps deepen people's understanding and concern.

In summary, dialogue attendees may be described as a highly motivated subset of County residents, as indicated in their actual event attendance and in the motivations they articulated for coming (predominantly, their climate change concern, an affective form of engagement, and the desire to be engaged in finding solutions, an active, civic form of engagement).

5

Discussion

The OWL project yielded a large amount of valuable information and unprecedented insights into the use and impact of in-situ visualization of climate change impacts and of deliberative dialogue. Below we discuss them in light of the prior understanding of these communication methods and other contextual information. As a pilot study, the work reported here also yielded critical insights into the practical side of using the OWL technology. We discuss these technical and methodological constraints first to place the findings in the appropriate light.

Technical and Methodological Constraints

OWL Placement & Signage

The OWLs were placed on Miller Avenue in Mill Valley, CA at the Almonte Boulevard entrance to the Mill Valley/Sausalito multi-use path. While there is high pedestrian and bicycle traffic on this path, along which it was reasonable to expect a mixed (i.e., demographically diverse; local, transit and visiting) population, the site itself is a recreation pathway. On-site observation revealed that most people actually passed by (walking, running or biking) the OWL without stopping because their primary intent was to engage in recreational activities or in commuting. Thus, logging more than 3,700 user sessions was a considerable achievement. A location where people – by design – linger longer (e.g., parks, bus stations) may increase the user number even further or induce people to engage with the technology longer.

Figure 22: Passers-by of all ages engaged with the OWL. Signage should clearly indicate that use is free.
Photo: Leslie Alden

The OWLs were placed directly next to the multi-use path in an area enclosed by a small fence. Signage explained the project, listed the sponsors, and invited passers-by to explore the visualizations and the accompanying website. Given the semblance of the OWLs to the old-fashioned, coin-operated viewers in vista locations, it would have been useful to mention that the use of the OWLs is free and does not require coins. Again, on-site observation, and interaction between potential viewers and hosts, revealed that recreationists often do not carry money while biking or running. Thus, not visibly announcing that OWL use is free may have dissuaded some from stopping to explore the visualizations.

Technical Challenges

The OWLs were placed in the ground one day prior to the official launch of the project. This short pre-launch period proved insufficient to work out technical (hardware and software) issues that only emerged once the OWLs were in the ground. Due to the malfunction and resulting questions about data validity, all survey responses prior to June 9 and all responses collected on June 26, 2015 were eliminated from the final analysis.

While the OWLs are designed to automatically report malfunction, some issues were only discovered through on-site observation, suggesting that having early and occasional observational periods is an important additional way to ensure functionality.

Certain technical challenges affected only the audio recordings, particularly on the ADA-compliant, short OWL, resulting in a significant number of audio files being unusable. The ability to record for longer periods of time would also have resulted in a yet-richer database.

Problematic elements of the OWL design have since been addressed. But, clearly, additional in-situ testing prior to the official launch would have improved the user experience and resulted in even more usable data.

Web Design and Research Constraints

The research team originally wanted to compare the responses to the OWL survey with those to the web-based survey to explore whether there are significant differences in viewers' experiences in-situ versus on a computer. However, the web design (using Nation Builder) could not exactly mirror the OWL experience. OWL survey questions were sequenced in such a way that researchers could trace the influence of a particular visualization to particular responses. This was not possible with the web design chosen (essentially, viewers could see all visualizations before they would be prompted to answer any survey questions). Not only did this set-up create a much lower incentive to respond to the survey questions, resulting in inadequate response rates, but people's responses also could not be traced to a particular visual experience, thus making the survey responses ambiguous, and not allowing valid interpretation. The idea of comparing web and in-situ survey results therefore had to be abandoned in this study.

Advances in Scientific Understanding

The Use of Visualization in Climate Change Communication

Visual depiction of the climate system, causes of climate change, and impacts is increasingly well understood as a powerful tool and augmentation of other forms of communication, such as written or spoken words. Short of the actual experiencing of such impacts, visuals may be among the most impactful tools to "bring climate change home" and alive for audiences. Not surprisingly, a growing body of literature has emerged in the last five years testing and promoting the use of iconic visuals and computer-based visuals to foster greater understanding and concern among different audiences (see literature review and Appendix A).

The OWL technology and underlying development of images combines state-of-the art visual design, with 360-degree photography and scientifically accurate sea level rise modeling in a 3D landscape. Moreover, the viewing device is located in the depicted landscape and invites active, free-choice user engagement (360 degree movement of the viewer, clicking to provide survey answers, and audio recording). These features make it considerably more powerful as a visualization device than a 2D graphic or static computer-screen depiction of climate change impacts. In fact, the OWL comes closest to what social scientists have recommended for the use of visualizations in climate communication: realism, immediacy, personal relevance, human experience, and tangible future consequences (see discussion in the literature review above).

To our knowledge, using the OWLs in this way constitutes the first-ever experiment undertaken in which viewers could see climate change impacts in 3D in the very locations in which the shown impacts are expected to occur.

The OWL experience is at once cognitive, affective, and physical – an arousing experience more likely to be retained in memory.

An integrative view of the insights gained from on-site observation of OWL use, the strong affective responses documented through the audio recordings, and the statistically robust findings on levels of concern – and changes in that level of concern – suggest the profound impact that the OWL visualizations have had on viewers in Marin. While this study did not allow for a direct comparison of the OWL experience with the web-based visualization experience, the findings from the audio recordings and on-site observations are particularly telling: people displayed spontaneous expressions of being wowed, surprised, astonished, amazed, possibly even shocked, awed, or incredulous. Thus, the

OWL experience is far more than an educational or explanatory communication tool, but rather a tool that creates an experience at once cognitive, affective, and physical – in short, it is an arousing experience that is more likely to be retained in memory.

In a world of constant information input, and increasingly information overload, having such a memorable, visceral experience has a far better chance than non-arousing information to stand out, be noticed, and be impactful on the recipient.

Three quarters of all Americans – traditionally the most difficult to mobilize audience segments – constitute a primary target for the OWL experience.

In fact, the OWLs proved particularly effective with viewers who initially showed no or only little concern about current flooding risks: their level of concern rose the most when shown the sea level rise scenario. Most likely, these are viewers who had little prior experience with flooding and/or who had spent little time thinking about what sea level rise could mean to them locally. Thus, the OWL visualizations may be particularly effective in engaging those members of the public who are at present relatively unconcerned about and disengaged from the climate change issue. According to the bi-annual surveys conducted by Leiserowitz et al. (most recently in late 2015), roughly three quarters of all Americans fall between the highly-engaged Alarmed segment of the population (i.e., those most concerned, most convinced that human-caused climate change is occurring and that it is a serious problem) and the equally engaged Dismissive (i.e., those most convinced that climate change is not occurring, not human-caused, and not worth worrying about). This middle portion of the population – traditionally the most difficult to mobilize audience segments – thus constitutes a primary target for the OWL experience.

Raising Concern – Fostering Engagement

The OWLS also proved highly effective in not only raising concern, particularly among the previously unconcerned individuals, but in stimulating a desire to get more engaged. OWL survey findings showed that the desired level of further engagement in Marin's adaptation process was positively correlated with the respondents' level of concern: the higher the concern, the more actively involved respondents wanted to be. Particularly notable here was the significant increase in concern among older adults, that segment of the population traditionally more likely to be civically and politically active, particularly in terms of voting (Bump, 2016; DeSilver, 2014; Madland & Teixeira, 2009; Pew Research Center, 2014; Smith, 2013).

What research in social and political trends shows is that adults of all ages are civically active, but their preferred means and venues differ. Older adults (Silents and Baby Boomers), for example, are more likely to vote and attend public meetings, whereas younger adults (Millennials and Gen X) vote less, but often are very active online. To the extent older individuals' reduced work obligations after retirement allow, that generation may simply have more time than younger working adults to take on community roles or participate in public meetings. And, in fact, the OWL survey results in age-differentiated levels of desired engagement showed that it is precisely this oldest segment of OWL users, who made the greatest shift in their level of concern about current and future flooding risks, and who showed the greatest desire to take on an active role in the community. Thus, the OWLs illustrate the potential to mobilize this particular segment of the community for active climate change engagement.

OWL survey results showed that more than half of Millennials, by contrast, were not at all interested in further involvement or interested but unlikely to get involved. About one fifth of that group wished for more information and another fifth said they would attend a meeting, but only 6% could see themselves taking on a more active role in the community. The next older age group, the Gen X, included about a quarter of respondents who were not interested in getting involved and nearly half who just wanted more information. Similarly low numbers, as among the Millennials, wanted to attend a meeting or take on a more active role.

While these levels of desired engagement are broadly consistent with more generally observed civic and political engagement across age groups in the US (see above cited references) – thus providing confidence in the validity and generalizability of the OWL survey findings – the implications of who comes to the political table and who does not are important to consider for adaptation leaders. Political and ideological leanings, as well as the types of concerns and interests brought to the table differ in important ways (Figure 23). Thus, who gets mobilized and who does not through engagement efforts like the OWL project, affects who sits at the political table and thus has an opportunity to help shape the debate and the solutions.

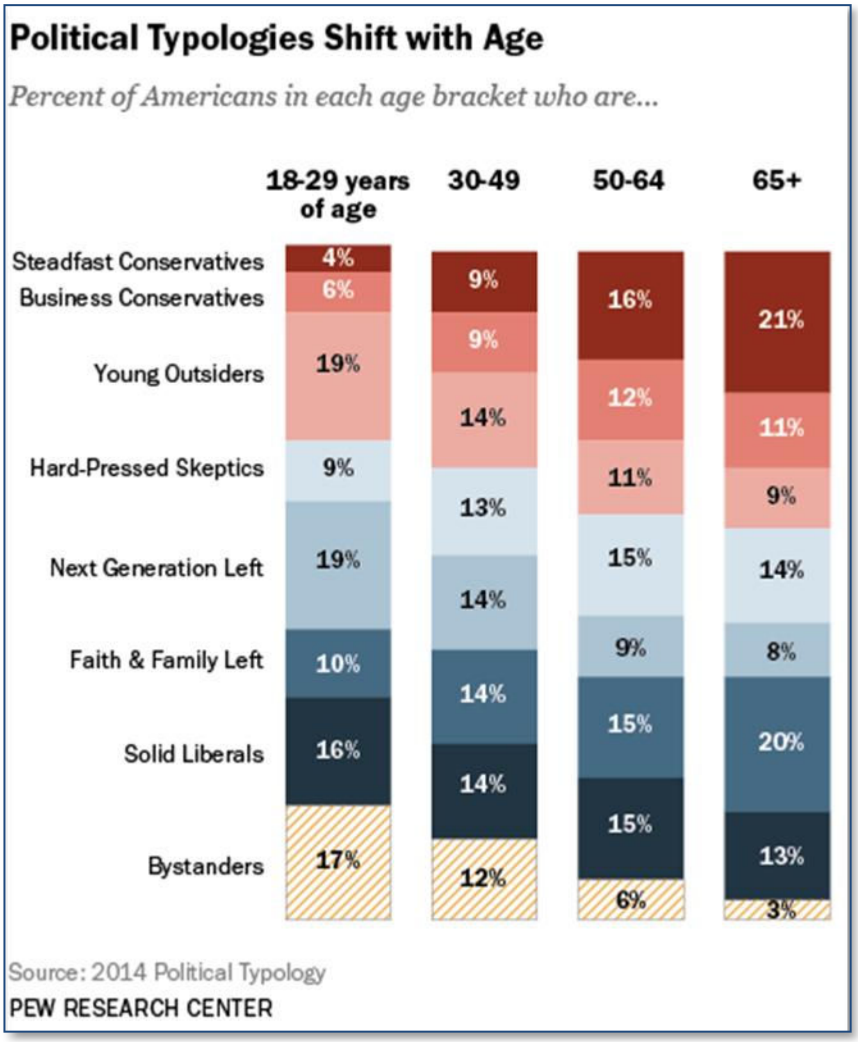

Figure 23: The distribution of political orientation among the American public varies by age. Thus, who gets mobilized and who does not through engagement efforts like the OWL project, affects who sits at the political table and helps shape the debate and the solutions.
Source: Smith (2014)

FROM INTENT TO ACTION

In this pilot study, the OWL survey was largely used to examine whether visualizations could shift levels of concern, raise interest in adaptation, and motivate a desire to get more engaged in the Marin adaptation planning process. It did not ask people to "vote" for particular adaptation option preferences, nor did it focus on or track the translation of the raised concern and motivation into real action.

That said, recording an audio message could be viewed as an immediate follow-on action, as could later project website visits and attendance of the community dialogue. While website visits and Owl visits by one and the same person could not be linked, the high rate of attempted audio recordings (21%) and the familiarity of the OWL project among dialogue participants (74%) are indicative of the OWLs ability to not just raise concern but mobilize people to action. Numerous audio recordings conveyed messages that called on governments in Marin County and at other levels of government to take action; others indicated their own readiness to act and be part of the solution. Similarly, many community dialogue participants wanted to see immediate and strong adaptation action; several viewed the community as already behind in taking the necessary steps. A clear sense of impatience, even fatalism, emerged among some participants about the advanced stage of climate change and sea level rise, given the in-built global momentum and difficulty in reversing trends. Thus, at least among the most engaged participants in this project, the desire and readiness for action was palpable.

To what extent the OWL motivated individuals to take personal action (either related to greenhouse gas emission reductions or preparedness/adaptation), however, could not be judged from this study. Future studies will have to make the links between OWL visits and a series of different action options more direct and apparent to be able to trace the OWL's potential for mobilization toward action.

6 Conclusions and Recommendations

The OWL project set out with the overarching scientific objective to examine the role of visualizations in climate change engagement. More specifically, it aimed to answer three key research questions. The conclusions from this study are summarized vis-à-vis each of these questions, leading to a set of recommendations for future research and modifications to the use of the OWLs.

Research Question 1: What are the specific benefits and challenges of using the OWL technology in climate change engagement?

The answers to this question pertain to the implementation of this project over the course of several months, and focus primarily on the technical and logistical aspects of using this technology, rather than the scientific results.

As described in the previous section, the OWL is one of the most advanced technologies currently available for visualizing climate change impacts. Most visualization approaches use 2D, computer-based visuals viewed indoors, rather than interactive, 3D, in-situ visual experiences. This produces visuals that score highly on all recommended dimensions for effective visualizations emanating from prior scientific research: realism, immediacy, relevance, human experience and the clear link between human choice and future consequences. The resulting visual experience is cognitively and emotionally arousing, and through the interactive nature of the device – also physically engaging, thus able to generate more impactful and more memorable experiences in the viewers.

No other technology currently available in the market (much less in widespread use in climate change engagement) combines the OWL's technological, design, and scientific strengths, and none is as impactful in terms of the viewing experience.

To our knowledge, no other technology currently available on the market (not to speak of widespread use in climate change engagement) combines the technological, design, and scientific strengths of the OWL, and none is as impactful in terms of the viewing experience.

At the time of this pilot study, the particular OWLs used were a novel prototype that revealed a number of technical (hardware and software-related) shortcomings, which were not entirely worked out prior to the official unveiling and project launch. This caused frustration among project partners, viewers, and resulted in the loss of a considerable amount of data. Improvements were made as issues arose, allowing for the collection of a large set of data. Given these adjustments and lessons learned, future projects are likely to face less challenges, but will need to build in a safety buffer of time to ensure proper functioning from the start of a project.

Regardless of the technical issues, the particular OWL experience the project team designed included the survey element – a feature that can be included or left out. Given prior experience with the OWL, and previously observed lengths of engagement with the OWL, it was clear that the survey had to be simple, and there could only be a maximum of five questions to not risk excessive viewer fatigue and disengagement. Still, the internal tracking showed that there was a significant overall drop-off rate (59%), with the greatest number dropping off after the early questions (19%, 17%, 17%, 4% and 2% from question to question, respectively). While the number of survey responses after a 14-week viewing period were sufficient for robust analysis, an OWL experience without a research component may be even more impactful from an emotional engagement perspective. The project team thought the trade-off was worth it, however, given the rich insights this research generated.

Research Question 2: What are the broader benefits of using 3D visualizations in interactive, immersive educational environments for public engagement on climate change?

Data collected at and in the OWL resulted in key advances over existing scientific understanding. The large number of survey responses collected allowed for robust statistical analysis and revealed patterns consistent with prior and independent research. Importantly, however, the project's scientific objectives could be achieved through a multi-method design, whereby independent, quantitative and qualitative data sources could be integrated for internally consistent and compelling findings. The size of the data sets, the statistically significant findings, the validity of constructs, and well established underlying theory on risk perception and motivation, as well as the triangulation among different data sets make for robust answers to the following research questions:

A. Do the 3D visualizations increase concern about flooding risks?

The research showed unambiguously that the OWL-based 3D visualizations raise concern in OWL users. The visualizations were particularly effective with populations that initially showed no to little concern about current flooding risks, i.e., with viewers who had either no prior or only limited experience with flooding and/or had not thought much about sea level rise risks before. This subgroup of the viewing population shifted on average two levels up as a result of viewing the sea level rise-related flooding visual. Those OWL users who came in with moderate or high levels of concern about current flood risks also moved to yet-higher levels when shown the sea level rise scenario, but their shift in concern was less prominent.

Figure 24: The OWLs helped overcome the psychological distance many still experience when hearing about climate change: it is indeed something that can happen here, now, to us.
Photo: Jack Liebster

Overall, then, the visualizations helped overcome a significant hurdle in climate change communication and engagement, namely the psychological distance many people experience when thinking or hearing about climate change. Despite overwhelming scientific evidence, many still believe that climate change is a problem that is far away in time and space, will happen to other species and to people in other countries or communities, and is therefore not something they need to be concerned with here, now, and for themselves. By localizing sea level rise in the very place in which it is expected to occur, and experiencing it quite viscerally, the visualizations helped increase awareness and understanding of localized climate change risks.

By design, the selected scenarios did not only show climate change risks, but also two adaptation options. The intent behind this choice was to avoid "scaring" people only with the risk scenarios and leaving them without an equally imaginable, visceral experience that "something can be done about it." Overwhelming risks without an adequate response tend to foster hopelessness, despair, and emotional numbing. Thus, by showing two visually very different in-situ solutions, viewers could remain cognitively and emotionally engaged in the experience.

B. Does higher concern increase the motivation to engage further?

The research also clearly demonstrated that the higher levels of concern correlated positively with an interest to learn more about the various adaptation options and with higher levels of desired engagement.

The overwhelming majority of OWL users was interested in learning more about adaptation (more than 90% in all but one age group). Moreover, those who expressed high levels of concern about current flooding risks, those who expressed high levels of concern about future sea level rise, and those who made the greatest shifts toward greater concern all express a desire to engage in the more intensive forms of engagement, such as attending a meeting or taking an active role in their communities.

The OWLs succeeded in generating a motivation to learn more about adaptation options, and they were effective in generating a larger-than-expected level of desired further engagement.

That said, the higher levels of engagement were not the dominant choices among OWL users. More common were expressions of generalized interest without a desire of getting more actively involved or the desire to get more information and to be kept abreast of public meetings on the topic. Expecting any more, however, may be unrealistic. What is notable among OWL users is that the level of desired further active engagement is far larger than commonly found. Differently put, the OWLs succeeded in generating a motivation to learn more about adaptation options, and they were effective in generating a larger-than-expected level of desired further engagement. This was reiterated through the audio recordings and in the attendance at the community dialogue: 21% of OWL users recorded an audio message and 74% of participants in a community dialogue held nearly three months after the removal of the OWLs had some level of familiarity with the OWL project, suggesting the OWLs played some role in inspiring them to come. The combined impact of repeated media coverage and email outreach, as well as the OWL experience itself, created a buzz and motivation to actually deliver on the intentions expressed in the OWL survey.

The research could not trace conclusively, however, how people's expressed interest in learning more about adaptation or their intentions to be further engaged in the adaptation process translated into realizing these intentions in real action. Thus, the potential of the OWLs for moving people to action remains somewhat uncertain. Future projects (currently being planned for San Mateo County and San Francisco) will need to improve the tracing of concern and motivation to action, and attention must be paid to offering a variety of actions that correspond with people's readiness to actively engage.

Post-OWL installation debriefs with County staff reiterated this point: any effort to raise climate change concern and motivate engagement must be followed directly with opportunities to turn that elevated concern and motivation into practical action. In this pilot study, more emphasis was placed on the visualization and understanding their immediate impact on viewers than on prompting people to take action. Thus, future OWL projects must offer a variety of immediate and delayed action options, which would also allow researchers to explore whether elevated concern and motivation can be traced directly to further action.

C. Do these benefits differ by age or incoming levels of concern?

While a comprehensive demographic profile of OWL users is not available, the last question in the OWL-based survey asked viewers for their age. This allowed the differentiation of findings by age, at least of the user group that stayed through all five questions, i.e., the most engaged OWL user segment. About half of those fell into the Gen X (26%) and Baby Boomer (26%) generations; another 21% were under 15 years of age (Gen Z), 18% self-identified as Millennials, and the smallest group (10%) were the Matures.

The different generations, showed significant differences in their levels of concern, interest to learn more about adaptation, and in their desired level of engagement. For example, the Matures and Gen X were most concerned about existing flooding risks, but the two older age groups also had the largest percentage of "not at all" concerned. When shown the sea level rise scenario, the Matures, Baby Boomers and Gen Z shifted most significantly toward greater concern, producing an overall pattern of higher concern levels about future sea level rise being positively correlated with age. But the oldest and the youngest age group also had the greatest number of "not at all" concerned.

While the age groups showed varying interests in different adaptation options (e.g., the youngest were most interested in the seawall option), the notable finding was that large majorities (more than 90%) in each group was interested to learn more about at least one of them. The exception was the oldest generation with the largest group of "not at all" interested individuals.

The research further revealed a distinct positive correlation between age and desired level of further engagement, with the youngest more commonly wishing no further involvement or simply interest without active engagement in the adaptation process while older adults more often wished for more information, were willing to attend a meeting, or take on an active role in the community.

Interestingly, the interaction with the OWL technology also showed somewhat of an age signature. As expected, the tall and short OWL showed greater majorities of adults vs. children, respectively, but a detailed look revealed the predominance of children in the audio recordings. Proportionately, children left nearly twice as many messages as expected based on their percentage of the total OWL user population. This makes clear that children used this interactive option far more frequently than numerically expected and suggests, that the OWL technology may be particularly attractive and useful for youth engagement.

Project findings suggest the OWL technology may be particularly attractive and useful for youth engagement.

That said, while 20% of the youngest age group said they would be willing to attend a meeting, no children or youth attended the community dialogue. Thus active engagement must be made age-appropriate, accessible and attractive.

Research Question 3: To what extent do visualizations, followed with a deliberative dialogue process, help increase awareness and efficacy of localized climate change risks and solutions options?

The research findings from this project largely confirm the importance of dialogic deliberation as a way to foster deeper engagement with the climate change issue. Given the high level of motivation and concern of dialogue participants as evidenced in their attendance, the dialogue made only modest contributions to further increase concern about climate change. But it did serve as an effective way to increase people's understanding of climate change risks and of Marin's adaptation planning process. A large majority of dialogue participants said that they learned at least one new thing that evening, and – as it should be – a majority said they learned most from other dialogue participants, rather than from the presenters and facilitators. While few were motivated to join the event because they wanted to connect with their neighbors, inevitably, the dialogue connected them more with each other. Write-in comments indicated how much participants enjoyed learning the views and exchanging ideas with other participants.

The dialogue turnout for the event was larger than for most previous adaptation-related events and included residents from across the county. When asked directly, participants stated their general concern about climate change and their desire to be involved in finding solutions as the leading motivations to attend the event. Moreover, about three quarters of those who responded to the exit survey said they had heard of, had intentions to see, or actually visited the OWLs. Thus, the extensive media coverage and email outreach via project and particularly County-owned distribution lists, as well as the OWLs seemed to have played a role in motivating people to attend.

Whether the dialogue event increased people's efficacy, i.e., their sense of control or ability that they can effectively do something about the climate change risks, is difficult to infer. While exit survey respondents said they learned more about how the County's planning process, write-in comments hinted at some level of frustration with the slow pace of that process, participants' impression of inadequate cross-agency, and cross-level of government coordination, and lack of state and federal support. Thus, while many respondents were grateful to learn about what was underway, and that something was being done at all (factors that could increase their sense of efficacy), others felt impatient with the pace of implementation (a factor that could decrease a sense of efficacy). Such differences in opinion should be expected and do not indicate a weakness of the dialogue process itself. They do, however, suggest that follow-up after a dialogue event to provide process updates and keep people engaged in the process on a regular basis is an important follow-up. Such continued engagement over time itself will build social capital, understanding of the governance process, and adaptive capacity in a community.

Recommendations

A number of recommendations for how to build and improve upon, and advance the use of the OWL technology and 3D visualizations, as well as deliberative dialogues, in climate change engagement follow from the findings of this study.

1. **Future research**: The OWL technology was an effective means to obtain a large amount of data on the public's level of concern, interest, and desire to engage. While the number of survey questions may be constrained, the type of questions that could be asked are wide open. For example, other aspects of public perceptions of risk and solutions could be explored in future projects (e.g., direct inquiry into the emotional experiences of viewing certain scenarios). In addition, rather than just asking about people's interest in learning more about adaptation options, the OWLs could be used as a tool to assess preferences, i.e., allowing potential solution options to be presented, explored and then voted on. Finally, creatively combining the use of the OWL technology with social media and other traceable actions would allow future studies to come to more conclusive answers about the OWL's ability to motivate action. To learn whether the in-situ visualizations have a different impact on viewers than web-based ones, future projects should either work with a different website design to enable direct comparability or aim to create the best possible Owl and the best possible web experience and compare how effective the two formats are in raising concern and mobilizing individuals to action.

2. **Improvements in the OWL technology**. A number of technical issues emerged once the OWLs were installed at the site. As a prototype, this can be expected and improvements are already being implemented. Some of these pertain to the functionality of the hardware, others pertained to the audio script accompanying the viewing experience, yet others to the audio recording reliability. Ongoing technological development and improvement must improve on these issue to avoid user frustration and loss of valuable data.

3. **OWL installment timing and site.** The time allowed to install and test the OWLs and ensure functionality prior to the public launch was insufficient. Future projects must ensure a longer testing period before the installation is opened to the public. Similarly, the placement of the OWL must be carefully considered not just vis-à-vis potential climate change risks, but also how diverse and interesting the depicted viewshed is and how visually different the risk and solution scenarios can be. Moreover, OWL placement must be evaluated from the perspective of natural

behavior of individuals around the OWL (e.g., foot traffic, lingering in the location versus commuting or recreating). Ideally, future projects would have a high level of slow-moving foot traffic that invites people to pause for longer engagement with the OWL installation.

4. **Moving from concern to action**. The OWLs proved highly effective in raising concern and motivating people to become further engaged. It is important to bank on this elevated readiness to engage by providing OWL users immediately with something meaningful to do, preferably multiple, but not an overwhelming set of, options. Similarly, engagement events like the dialogue should also be followed up with updates, direct actions, and further opportunities to stay meaningfully involved in the community's adaptation process.

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APPENDICES

A. VISUALS AND VISUALIZATIONS IN CLIMATE CHANGE COMMUNICATION: FURTHER READINGS

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B. IRB Protocol: Participant Protection and Research Ethics

Guidance on social science research involving human subjects requires – at a minimum – that the research protocol ensures the safety, ethical treatment, and protection of confidentiality of participating individuals. To ensure this is so, the research protocol was submitted to the Antioch University Internal Review Board (IRB) for review and compliance with all federal laws and human subjects ethics principles. This is a legal requirement for all federally funded research (which applies here, given FEMA funding).

The signage near the OWL – and identical text used on the project website – mentions in a minimalist fashion that the project involves research and who is leading it. It also mentions that the Antioch University IRB approved the project (approval was obtained at the time of the official project launch). While it is impractical to obtain written or verbal consent, people using the OWL or engaging with the web-based visualizations were only informed of their research participation. However, participation was entirely voluntary.

The relevant portion of the signage read as follows:

"The *Here-Us-Now* Project is a public-private-community partnership to test the use of visualizations and community engagement on climate change risks. This is a temporary, 12-week research installation approved by Antioch University. Survey and audio data collected via the viewer will remain anonymous and confidential, kept separate from email addresses that viewers provide to *Here-Now-Us*. Dr. Susanne Moser is overseeing the research. Data & responses will be collated, analyzed and reported to FEMA and in scientific publications. For more information, please visit the website."

C. Background on OWL Technology

Aaron Selverston, CEO of Owlized, led the design and production of the OWL digital viewfinder from proof-of-concept to prototype to production. The OWLs utilize immersive 3D visualization that allows the users to view the location they are standing in in real-time. Designed for city planning departments, property developers, corporate marketers, historic sites, and parks, OWL offers an immersive "time goggles" visualization experience that helps everyday people connect deeply with their surrounding environment.

Owlized worked closely with the City of San Francisco's Department of Public Works to pilot test the OWL as a medium for civic engagement. The OWL was loaded with various design options being considered by city planners for the Better Market Street project—the City's effort to revitalize the entire stretch of Market Street. During the test, the OWL was installed at the corner of 6^{th} and Market Streets for one week, reaching more than 500 people, of whom nearly 40 percent had never heard of the Better Market Street project, despite well-publicized public meetings that were held a few months prior. 85 percent of OWL users responded that they felt the device was helpful for visualizing the Better Market Street designs, and 99 percent indicated that they would like to use an OWL again in the future to visualize future city project design options.

This project was the first time OWL technology was used to visualize climate change impacts and solutions.

D. OWL Project Media Citations

Headline	Outlet	Link
Virtual Reality Viewfinders Show Sea Level Rise and What to do About it	Scientific American/ Climatewire	http://www.scientificamerican.com/article/virtual-reality-viewfinders-show-sea-level-rise-and-what-to-do-about-it/
Beyond Renderings: Using augmented reality to communicate a vision of climate change	Autodesk blog	http://bimontherocks.com/beyond-renderings-using-augmented-reality-to-communicate-a-vision-of-climate-change/
Climate Impacts: Here, Now, Us	Bloomberg BNA	http://www.bna.com/climate-impacts-us-b17179934674/
Eye Sea	Marin Magazine	http://www.marinmagazine.com/August-2015/Eye-Sea/
A Device to Visualize Your Climate Change Future	NPR Science Friday	http://www.sciencefriday.com/segment/07/31/2015/-a-device-to-visualize-your-climate-change-future.html
On the Rise: A digital version of an old fashioned tool helps see the future - under water	Landscape Architecture Magazine	http://au.zinio.com/reader.jsp?issue=416345791&o=ext
Focusing and planning ahead for sea level change	Marin Independent Journal	http://www.marinij.com/opinion/20150627/marin-voice-focusing-and-planning-ahead-for-sea-level-change
Poor Lessons in Governmental Funding	Marin Independent Journal	http://www.marinij.com/opinion/20150606/dick-spotswood-poor-lessons-in-governmental-funding
A Glimpse of Marin's Future Through the OWL	CMCM TV	https://youtu.be/ggris51y4Ao
The Augmented Reality Viewers That Let Us See the Future Under Climate Change	Vice Motherboard	http://motherboard.vice.com/read/augmented-reality-binoculars-show-you-the-future-under-climate-change
MARIN COUNTY: High-tech 'OWL' viewer to show impact of climate change on water levels	KTVU	http://wn.ktvu.com/clip/11510104/marin-county-high-tech-owl-viewer-to-show-impact-of-climate-change-on-water-levels
Visualize sea level rise with time goggles	Triple Pundit	http://www.triplepundit.com/2015/01/behold-future-visualizing-sea-level-rise-owlized/
Sea Level Rise (part 2)	KCBS Radio	https://drive.google.com/file/d/0B9dnWp0euXXgdm1ObGlVbUo3NGtZNVFYcjl4dXBzYi1oNzFn/view?usp=sharing

Headline	Outlet	Link
Sea Level Rise (part 1)	KCBS Radio	https://drive.google.com/file/d/0B9dnWp0euxXgLXBCUnZTbDBKZmpMMnM2S29KZDNKSDdOenVz/view?usp=sharing
Marin climate change program puts face on sea level rise	Marin Independent Journal	http://www.marinij.com/marinnews/ci_27157794/marin-climate-change-program-puts-face-sea-level
Marin to Get High-Tech Visuals of Sea level Rise	Patch	http://patch.com/california/sananselmofairfax/marin-get-high-tech-visuals-sea-level-rise
Viewfinders Will Teach Mill Valley Residents About Sea Level Rise	KGO Radio	http://www.kgoradio.com/common/page.php?pt=Viewfinders+Will+Teach+Mill+Valley+Residents+About+Sea+Level+Rise&id=101181&is_corp=0
Upfront: Rain check on climate action?	Pacific Sun	http://www.pacificsun.com/news/upfront-rain-check-on-climate-action-plan/article_94bbea26-7101-11e4-af26-af7f3d21c456.html
New Virtual Reality Installation Reveals How Sea level Rise Will Affect Bay Area Shoreline	San Francisco Public Press	http://sfpublicpress.org/news/2014-11/new-virtual-reality-installation-reveals-how-sea-level-rise-will-affect-bay-area-shoreline
Can jaw-dropping visuals change the climate conversation?	GreenBiz	http://www.greenbiz.com/blog/2014/05/28/climate-resiliency-visualization

E. OWL Survey Questions

1. Quickly, before you go on to the next visual: How concerned are you about these current risks from this combination of present sea level, high tides and storms? Click the left button to choose the answer that best matches your level of concern.

   RESPONSE OPTIONS: Extremely Concerned; Very Concerned, Somewhat Concerned; Not Very Concerned; Not at All Concerned.

2. Before looking at two different response options: How concerned are you about these future risks from additional sea level rise, as shown in this visualization? Again, click the left button to choose the answer that best matches your level of concern.

   RESPONSE OPTIONS: Extremely Concerned; Very Concerned, Somewhat Concerned; Not Very Concerned; Not at All Concerned.

3. In addition to the adaptation options shown here, Marin County is carefully studying which areas are most vulnerable to sea level rise and what response options or combinations of options are best suited and feasible to protect different stretches of the shoreline. Please tell us which options you'd like to learn more about. Click on the left button to get to the answer that comes closest to what you're most interested in.

   RESPONSE OPTIONS: To learn more about the sea-wall; To learn more about the eco-berm; To learn more about both options; To learn about these and other options; I am not particularly interested in any of this.

4. You've seen two images of flooding in this location and two images of different ways to adapt to reduce flooding risk. As Marin County continues to assess these flooding risks and response options, please tell us how likely you are to get involved in this process? Click on the left button to get to the answer that best captures how much you'd like to be involved.

   RESPONSE OPTIONS: I will not get involved; I am interested but not likely to participate; I would like more information and updates on the process; I would like to attend more meetings as the planning gets underway; I would like to know how to take an active role in my community.

5. Great, thanks! Finally, you can leave an audio message about what you think about these flood risks and response options. Before you do that, tell us quickly: what is your age? Click the left button to get to the right age range.

   RESPONSE OPTIONS: Under 15; 16-35; 36-50; 51-72; Over 72. (These age ranges correspond to common delineation of different generations: Gen Z, Millennials, Gen X, Baby Boomers, Silents).

F. DATA STORAGE AND SECURITY, VANDALISM, AND PROTECTION

Data Storage and Security

Data storage and security are essential is a project where data collection occurs at unmanned, public sites. Below, we list how collected data were stored and secured.

Protection against Vandalism

The OWL head is an extremely secure, essentially military grade aluminum vault that is locked tight, only accessible with a key. If somehow a thief got into the OWL head and stole the tablet, the thief would still need to discover the password-protected files on the tablet and know how to open them. A thief with access to the tablet, could access the audio files, but they would all be anonymous recordings.

Protection against Data Manipulation

An algorithm was programmed into the OWL (and tested prior to the data collection period) to automatically recognize data manipulation (e.g., an entry of the same survey responses by a single OWL user tens to hundreds of times). The data was analyzed with data that did not meet the standards discarded and not used in the analysis.

Secure Data Storage

Survey data at the OWL was collected and stored in .XML files, and audio recordings were stored as .mp3 files and frequently uploaded to a secure Data Cloud Storage site.

Observations of OWL use were made by trained observers and entered by hand on paper sheets. The data files were transcribed and uploaded to the secure online Dropbox that was only accessible to the research team.

Responses of website visitors exploring the scenarios and responding to survey questions were tracked with Google analytics and stored by NationBuilder. Data was also uploaded at intervals to the secure Dropbox.

Observations of the community dialogue were hand-written notes and collected by Amy Huva, transcribed, digitized, and stored in a secure office location and uploaded to the Dropbox. Since the community dialogue is a public meeting, participants are not anonymous to each other.

Data Confidentiality

Data collected at the OWL, the website, or in the community dialogue were collected without any personal, unique identifying information. If participants wished to be further involved in the project, they voluntarily gave their emails but this information was unconnected to their survey responses. All data was analyzed and reported collectively without identifying information.

Data Accessibility to Analysts

Data will be accessible to the technical and research teams. The former need access to ensure data security and for checking whether data are correctly tracked and stored (i.e., to identify and rectify any potential malfunction); the latter will conduct the analysis.

G. Community Dialogue Exit Survey

1. We would like to know what motivated you to come to the dialogue event tonight (please check 1-3 responses that reflect your primary motivations for coming)

   RESPONSE OPTIONS: My general interest in environmental issues; My general concern about climate change; My worries about how sea level rise will affect local businesses; My worries about how sea level rise will affect local residences; My desire to be engaged in finding solutions; My questions about what Marin County is planning to do about sea level rise; My desire to connect with my neighbors on the issue; Other (describe)

2. Before I came to the dialogue vent, I went to "the OWLs" (view finders temporarily placed at the Mill Valley-Sausalito Multi-Use Path and looked at the different sea level rise scenarios and response options. (please pick only one answer)

   RESPONSE OPTIONS: Yes; Yes, but the OWLs didn't work right, so I didn't see anything; No, but I wanted to go there; No, but I visited the Here-Now-Us (OWL project) website; I never heard about the OWLs before tonight; Can't recall

3. Please tell us how much this dialogue event helped you in understanding the risks from sea level rise related flooding to Marin County (please choose the one response that best matches your personal learning)

   RESPONSE OPTIONS: Compared to before I came tonight, I now understand the sea level risks to Marin – A lot better; somewhat better; about the same; even less; a lot less

4. During the dialogue event I learned at least one new piece of information (Please circle the one response that is true for you):

5. RESPONSE OPTIONS:
   A. Yes (go to "B"); NO; Not sure
   B. If yes, I learned the most from: Presenters; Facilitators; Other dialogue participants

6. Please tell us in just a few words what the most important thing is that you learned during the dialogue event tonight:

   RESPONSE OPTIONS: Open ended question

7. Next we would like to know whether the dialogue event affected how concerned you are about these risks, compared to your level of concern before you came tonight (Again, please pick the one response that best matches your level of concern.)

   RESPONSE OPTIONS: Compared to before I came tonight, my concern about sea level rise relate flood risks has – Increased a lot; increased a little; is unchanged; decreased a little; decreased a lot.

8. Please tell us whether the dialogue event helped you in understanding about how Marin is going about planning and preparing for sea level rise. (Please choose just one response that best matches your personal learning.)

   RESPONSE OPTIONS: Compared to before I came tonight, I now understand how Marin is planning for sea level rise – A lot better; somewhat better; about the same;

even less; a lot less.

9. Please tell us your thoughts about this dialogue event – what you enjoyed, what you didn't enjoy; anything you would like to see changed if such events were held again in the future:

   RESPONSE OPTIONS: Open ended question.

10. We would like to know how you learned about this dialogue event. (Please circle all that apply):

    RESPONSE OPTIONS: I signed up at the Here-Now-Us website; I heard about it from a friend/colleague/neighbor; I got an invitation from Marin County; I got an invitation from Climate Access; I can't remember; Other (please specify).

11. Would you like to stay engaged as Marin works to find workable solutions to prepare for and adapt to sea level rise along its shorelines? (Please circle one answer)

    RESPONSE OPTIONS:
    A. Yes (go to "B" and "C"); Not sure (Go to "B" and "C"); No
    B. I would be willing to be interviewed by phone about my views on sea level rise for research purposes YES; NO
    C. Please provide an email so we can add you to the contact list. This email will be stored separately from your answers here, and it will only be used to alert you to events like this where you can learn about sea level rise, adaptation, and offer your input going forward.

12. My email: (open ended)