RisingEMOTIONS: Bridging Art and Technology to Visualize Public's Emotions about Climate Change

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ABSTRACT

In response to the threat posed by sea-level rise, coastal cities must rapidly adapt and transform vulnerable areas to protect endangered communities. As such, raising awareness and engaging affected communities in planning for adaptation strategies is critical. However, in the US, public engagement with climate change is low, especially among underrepresented populations. To address this challenge, we designed and implemented RisingEMOTIONS, a site-specific collaborative art installation situated in East Boston that combines public art with digital technology. The installation depicts the impacts of sea-level rise by visualizing local projected flood levels and the public's emotions toward this threat. The community's engagement with our project demonstrated the potential for public art to create interest and raise awareness of climate change. We discuss the potential for continued growth in the way that digital tools and public art can support equitable resilience planning through increased public engagement.

CCS CONCEPTS

• **Human-centered computing → Human computer interaction (HCI)**.

KEYWORDS

Art installation, climate emergency, public engagement

1 INTRODUCTION

In the U.S., sea-level rise can affect and potentially displace up to 13.1 million people by 2100 if no adaptation measures are set in place [19]. Coastal cities, such as Boston, are in need to rapidly transform their shorelines in order to increase their resilience to the multiple effects of the climate emergency [9]. In this paper, we use the term climate emergency, as opposed to climate change, to

reflect the growing trend by governments, scientists, and media to better communicate the urgency and risk of the phenomenon to humanity. To achieve equitable resilience, it is imperative to engage the vulnerable communities in the planning and implementation of adaptation strategies. However, public engagement with climate planning issues is low, making climate adaptation planning more difficult due to lack of public support [12].

Traditional public engagement methods are often limiting due to the amount of time and resources the participants have to commit [22, 39]. Furthermore, factors such as social dynamics, education, economics, and shyness might also impact public participation [20, 29]. As such, traditional public engagement methods may inhibit widespread participation and lead to an ineffective collection of public-generated data [20, 22, 26, 29, 39]. Digital civics is an emerging cross-disciplinary area that has arisen from concerns with traditional public participation methods, such as lack of inclusiveness and scalability in face-to-face meetings. Digital civics explores ways to utilize technology for promoting democratic participation to bridge the gap between the public and policymakers [28]. Research shows that social computing can enhance the public's access to civic issues and enable broader participation [27]. However, civic technology is often limited to only those who have access to it.

To communicate the effect of the climate emergency to the general public, researchers have designed various interactive digital visualizations [13, 33, 40]. However, research shows that people might have difficulties accessing and/or interpreting such visualizations [8, 23]. Alternatively, public art installations could present an accessible and engaging way to communicate the impacts of climate emergency to the general public. Often sited in public spaces, public art installations could remove barriers of admission that may be associated with visiting art inside cultural institutions. As such, public art has the potential to be used as a tool for public engagement with climate emergency planning [8]. Furthermore, public and participatory art practices have the potential to foster emotional connections, a major determinant of risk perception, which can invoke a sense of urgency [25, 37] and increase salience with issues of the climate emergency [8, 37].

In this work, we sought to increase public engagement in planning efforts by piloting an approach bridging two fields of study: digital civics and public art. We created an art installation called RisingEMOTIONS, where we captured the emotions of the affected communities through an online survey and then encoded their responses into tangible physical artifacts in the form of a public art installation. The goals of this project were to create (1) a unique physical art installation depicting the impact of sea-level rise and expressing the emotions of the affected community, (2) to explore
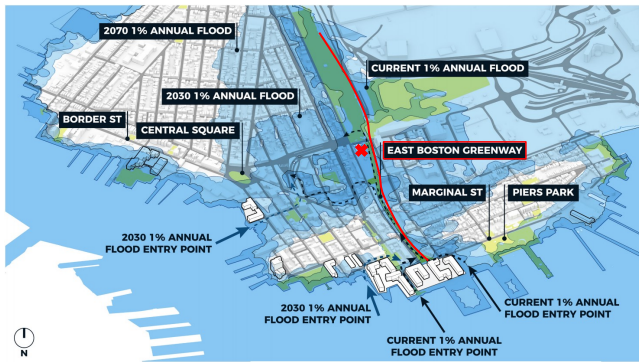
Figure 1: This map shows how the annual chance of flood changes as sea-level rises. The blue gradations show the changes in 1% annual chance flood extent. The arrows demonstrate the flood entry points and pathways with current sea levels with 9 inches of sea-level rise by 2030s and 36 inches of sea-level rise by 2070s [3], making East Boston an extremely vulnerable neighborhood. We highlighted the East Boston Greenway, and the site of our installation (X) on this map.

alternative ways to communicate the threats of flooding due to sea-level rise, and (3) to create a hybrid participatory experience enhancing the sense of community, and a venue to connect with current planning efforts. This project could constitute a scalable model for continued test and implementation as part of climate planning processes.

We collaborated with community representatives and organizers to develop a bilingual low-barrier online survey accessible from any device with an internet connection. The survey was disseminated using social media, through posters and business cards distributed throughout the neighborhood, and via educational activities in a nearby high school. Over 165 residents responded to the online survey during a two-week period. Their responses were inscribed by hand by community volunteers into fabric bands that were used in the physical public art installation. The installation consisted of steel frames at the height of the projected 1% annual chance flood for this specific location in 2070 as predicted by the University of Massachusetts-Boston Sustainable Solutions Lab. In this paper, we focus on describing the design and implementation process of our approach as a pilot project, the challenges faced, and lessons learned that can inform future work seeking to pursue the intersection of public art and technology to facilitate public engagement with inclusive planning processes related to climate adaptation.

2 BACKGROUND

2.1 Sea-level rise and Projected Flood

Coastal cities, such as Boston, must implement different adaptation strategies [11] to mitigate the economic impact that flooding will produce along the 825km of its coastal shoreline, especially along residential and highly developed areas. To address these challenges, the City of Boston created the Climate Ready Boston initiative as a way to integrate climate preparedness into city planning. The

Climate Ready Boston report [9], contained updated projections for the climate emergency, vulnerability assessments, and district-wide adaptation strategies for neighborhoods at higher risk of flooding, such as East Boston.

East Boston, composed of over 46,000 residents, has the largest number of buildings, land area, and population at risk from coastal flooding of all Boston neighborhoods [3]. The median household income is $52,000, with 25% of families with children and 20% of elders living below the official poverty line [2].

Particularly vulnerable areas include flood pathways — low-lying areas that serve as entry points for coastal flooding. One of the major flood pathways in East Boston is a portion of land in the southwest that connects the waterfront to the Mary Ellen Welch Greenway (MEWG). This flood pathway would allow water to enter the Greenway distributing floodwaters to the interior of the neighborhood (Fig. 1). As a result, the Greenway could effectively become a 3-mile vector for floodwaters.

2.2 Public Engagement through Art Installation

Municipal planning agencies, non-profit and community groups are currently seeking alternative forms of communication and engagement to increase awareness around issues of the climate emergency [8]. Among these tools are public and participatory art practices—which have been identified as having the potential to foster emotional connections, localizing information, and increasing the salience of the effects of the climate emergency [8, 37]. Often sited in public spaces, art installations can be experienced by a wide range of the public without the barriers of admission that may be associated with art inside cultural institutions [8].

Furthermore, art practices present alternative forms of communication about the effects of climate chance, which is usually presented through climate visualization (tables, charts, maps, etc.), aimed at reducing the cognitive challenge of gaining information on complex data sets [24]. However, this information delivery mode may not be best aligned to maximize public understanding [15, 32]. The comprehension of such visualization requires having a certain level of numeracy skills which the general population in the U.S. may not have [16]. A study conducted by Kain and Covi [23] showed that people have difficulty interpreting graphs, maps and photographs, with graphs being the most difficult (almost half of respondents were not able to interpret the information), followed by maps (which were successfully interpreted by 2/3 of the readers), while photographs were most successful as they are the closest form of representation to reality and do not require the same level of interpretation demanded by graphs and maps. The need for making climate visualization more accessible to lay audiences has evolved to include interactive digital visualizations that provide personal interactions with large data sets through scalable customizable information and 3D simulation environments [13, 33, 40]. However, these visualizations are detached from the experience of physical place and may not be accessible to underserved populations without access to these technologies [8].

2.3 Public Art to Visualize the Effect of the Climate Emergency

The use of the term "climate change" has recently evolved to include terms like "climate emergency, crisis or breakdown" to better reflect the urgency of the problem. News media like The Guardian and Scientific American have changed their style recommendations to replace "climate change" to "climate emergency", because they found the term "climate change" inappropriate to describe the implications of the risk to humanity to [4, 7]. Changes to the terminology could also have a legal significance in the U.S. By declaring a climate "emergency" more than 100 presidential powers could be unlocked [5]. To date, 1,859 jurisdictions in 33 countries have issued climate emergency declarations covering more than 820 million people. In December 2020, U.N. Secretary-General Antonio Guterres pleaded for every nation to declare a "climate emergency" [6] to call for attention to the adverse effects of climate change and take actions.

While there is general enthusiasm about the potential for art to serve as a catalyst for change [30, 31], not all forms of climate art are as effective. As noted in Climate Change as Social Drama, Global Warming in the Public Sphere [41], high end climate art can be elitist, usually fails to attract audiences, and often does not engender meaningful dialogue, in ways that preclude it from achieving its purpose. In this paper, we discuss the value of accessible and easily interpretable public art, which by its nature has a higher potential to be participatory and engaging. This is informed by previous works which have shown how visual art can be useful to engage people by making data more accessible [21] and support collaboration and reflection [42, 43]. Our approach is informed by prior works that emphasized the value of data visualization through public art to engage the public in critical discourses around the climate emergency along with the associated issues and challenges. For instance, InterANTARCTICA was a publicly displayed museum-based visualization to engage non-experts in discussions towards challenges involving climate emergency [17]. Another example is Particle Falls, which provided an artistic interpretation of air-quality data by projecting the data onto a public building to display the air quality in real-time. The objective of Particle Falls was to raise awareness about air pollution and its impact on health [1]. Garden of Eden visualizes the impact of air pollution in different cities involved growing lettuce in sealed boxes filled with air that matched the air pollution level in various cities [34]. Climate Prisms: The Arctic took an artistic approach on explaining and providing information around climate emergency issues, especially in the arctic to engage people and motivate change [38]. Chemicals in the Creek was another approach that experimented with situated data physicalization and public participation to have meaningful engagement with open data [36].

2.4 Digital Civics for Broadening Public Engagement

Public opinion gathering is heavily dependent on in-situ public data collection methods including public meetings, town halls, and forums [14, 22, 28]. However, constraints such as fixed physical locations along with the lack of time and resources often limit the efficacy of these face-to-face processes to collect public-generated data effectively [20, 22, 26, 29, 39]. Furthermore, social dynamics such as education, economic background, shyness etc. can inhibit participation [44]. Digital civics is an emerging cross-disciplinary area exploring new ways to utilize technology as a means to promote democratic participation [18, 35, 45]. For instance, online public engagement platforms have proven to be effective in accessing a broader population and quickly collecting critical information without the restrictions of fixed time and place [10, 27]. While such technologies are proven to be effective for reaching a broader range of the public [28], they are still inherently limited in scalability to those who have technical literacy and access to technology. In this work, we explore the potential of utilizing a physical art installation with digital civics technologies to address this limitation.

3 METHODS

3.1 Planning and Organization

The concept for RisingEMOTIONS grew through brainstorming sessions between the academic team about the potential for digital civics and public art to work together to create novel forms of engagement. This led to the idea of gathering and visualizing public's emotions in addition to depicting sea-level rise. The project sought to explore the potential for overlaying perceived binaries: the digital and the physical, as well as the rational and the emotional, through a unique blend of participatory and artistic practices. Furthermore, RisingEMOTIONS sought to bridge academia, art, civic institutions, local residents and youth, to expand opportunities for multiple groups to come together around the topic of flood vulnerability. The community of East Boston was identified as a desirable location for the implementation of RisingEMOTIONS due to its high vulnerability to climate impacts. In particular, its Greenway as a public landscape and major flood pathway was considered an ideal setting to publicly display the impacts of sea-level rise.

3.2 Stakeholders and Collaborators

Multiple organizations collaborated in refining the concept and aided in the implementation of RisingEMOTIONS. This collaborative effort is the result of several years of relationship building between the first author and local organizations, including the Boston Society of Landscape Architects, an organization that promotes landscape based solutions for resilience in the Boston area. Based on their recommendations, we started conversations with the Boston Planning & Development Agency (BPDA) to ensure that the project did not distract from ongoing planning activities but rather enhanced outreach efforts around resilience in the neighborhood. The BPDA was supportive of the project and helped us connect with the local public library branch manager. They also provided us with comments on the drafts of the survey used to collect the feelings of the community members and other communications. The relationship with the library manager was instrumental to the project in getting access and permission to use to the site and building facilities. Other critical collaborators included the Friends of the Mary Ellen Welch Greenway; grassroot organizations like Harborkeepers and GreenRoots; and administrators and teachers of the Excel Academy, a neighboring charter high school. RisingEMOTIONS had to undergo the approval process for public art by the Boston Art Commission, ensuring that all stakeholders, especially

Figure 2: This figure depicts the survey website and different forms of dissemination we used to spread the word about RisingE-MOTIONS and the survey. A) Landing page of the website hosting the survey. B) The front face of a business card. The back of the card includes survey and contact information. C) The poster we distributed primarily at and near the library as well as the adjacent high school. D) A signage used alongside the art installation to provide information regarding survey data.

the Boston Library and the nearby Boston Logan Airport were in agreement with the project, that there would be no risk to public safety. An interdisciplinary group of nine graduate and undergraduate students developed the project where they contributed to all aspects of RisingEMOTIONS, including graphics visualization of the installation, prototype and material testing, survey creation and dissemination, community engagement, construction, and installation of the artwork.

3.3 Survey Design and Dissemination

The survey was first conceived during a brainstorming session with our team of graduate and undergraduate students and then refined with stakeholders' input. We created a website to engage the public with the subject matter and raise awareness. Fig. 2(A) shows the landing page of the website where the survey was hosted. The website had two major components. First, the website contained information including an introduction of our project, the vulnerabilities of East Boston due to sea-level rise, and about current planning and grassroot organization efforts on resilience. Second, the website contained an interactive survey created in two languages - English and Spanish. In the survey, we asked the participants to share their feelings towards the climate emergency and its impact on their neighborhoods in one of the five categories - Concerned, Optimistic, Sad, Angry, and Other. We also asked them to leave their comments on the survey to elaborate on their shared feelings. The participants were free to decide which questions to answer. We color coded the emotion categories where Concerned was expressed in teal, Optimistic as yellow, Sad as dark blue, Angry as red, and Other as green. Based on the response to the question about the participants' feelings towards the climate emergency, we created a bar chart visualization that depicted statistics of the emotions from all participants who participated in the survey to provoke thoughts on the community's perception on the climate emergency and its effects. Furthermore, we also asked participants which neighborhood they belonged to, and whether they wanted to get involved in future the planning for resilience processes. If they

agreed, we collected their email to connect them to the local climate emergency resilience planning and other grassroot organizations.

Our team of students originally developed the content of the website. Then we iteratively edited and improved the website through direct feedback from the senior resilience planner and communications director from the BPDA, a local active community member, and the project manager from the Friends of the Mary Ellen Welch Greenway. We also worked with community representatives to crystallize the emotion categories. To increase the chances of success with the survey, on which the project was entirely dependent, we explored multiple forms of dissemination. The dissemination ranged from low-cost posters and business cards with a QR code linking to the project website and survey, a Public Service Announcement with a local radio station, social media postings through institutional, group and personal accounts, as well as postings in social networking sites like Facebook, Twitter, and Reddit. Fig. 2(B) and Fig. 2(C) present the business card and poster design that we disseminated. We also used a signage alongside the art installation Fig. 2(D) to provide more information about the details of installation to the attendees. We used the posters primarily within the library building and the adjacent high school building. We placed a copy of the poster and business cards on the circulation desk of the library. The high school students of the Excel Academy used the posters within their building to call attention to the projected flood levels by taping them along the corresponding flood elevations. During working sessions with our team, the high school students distributed business cards to their friends. Additionally, active community members with access to other neighborhood organizations helped us to distribute postcards and posters.

The online survey was operational for two weeks in November of 2019. 165 participants took part in the survey. An overwhelming majority (147 out of 165, 89%) of the participants chose to remain anonymous while 18 participants shared their contact information who wished to receive updates to get connected with the grassroot effort and participate further during the installation and display of the art installation. Out of 165 participants, 51.63% shared their feeling of being concerned, 16.34% felt optimistic, 13.73% were sad,
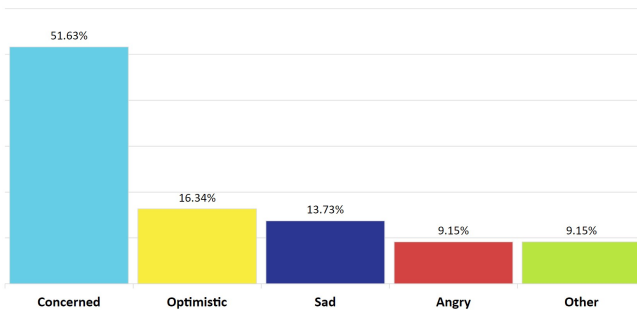
Figure 3: This figure shows a bar chart of emotions collected from the survey where out of 165 participants, 51.63% were concerned, 16.34% felt optimistic, 13.73% were sad, 9.15% were angry while another 9.15% had other feelings.

and 9.15% were angry while another 9.15% felt differently in various other ways. Fig. 3 depicts the distribution of the shared emotion from participants with the majority of them feeling concerned. The participants were also asked to leave their comments on the survey to elaborate on their shared feelings. In Table 1, we present some examples of feelings shared by the participants who took part in the survey.

3.4 Art Installation Process

After defining the concept for the artwork–one of visualizing emotions and sea-level rise simultaneously, we developed the early design implementations. We explored several ideas to identify ways to easily assembled structures that could serve as a framework to hold and display the ribbons. From the early stages of design, we identified key components: the ability to install and de-install the artwork easily; to enable the visitors to read the texts of the art piece; ease of construction so that community members and/or school age children could be involved; and the ability to have significant visual impact while working with a very limited budget. Furthermore, we considered issues of structural stability and public safety. We intentionally avoided structures requiring ground penetration, or elements of the installation that could potentially affect or damage the physical structure of the building and premises of the property. These measures helped us to simplify the permitting process.

One of the first issues that we needed to resolve was selecting the projected height for flooding in the particular site location since the height had significant implications on the design of the sculpture. If the height was too high, it would require significant structural stability for the artwork, and make reading the comments by the survey participants too difficult. To establish an appropriate flood level to display, we reached out to the UMass Boston Sustainable Solutions Lab (SSL) responsible for the latest flood models for the city. The SSL estimated an elevation of approximately 3.7 feet based on their latest model, which represents the 1% chance flood for 2070 was selected. The 1% chance flood, previously known as the 100-year flood, has become a common way to communicate about climate risk, as it determines thresholds by which planning policies are developed to protect communities at risk.

Once the elevation was determined, we began to conceive different ways to visualize the information obtained through the surveys. An important element of the design became the steel frames which could hold a lightweight structure which would contain the data. Due to budget constraints, the team decided to reuse the steel framework that used in a previous project, modifying it to match the new installation. A benefit of this steel framework was that it had integrated concrete pavers as footings, allowing for structural stability without having to insert poles into the ground. For configuration, we explored several arrangements and decided on a linear form that would span parallel to the front facade and entry of the library, spanning over both sides of the path that connects the Greenway to the building.

For materials, originally the team considered using gardening nets to hold a weaving of ribbons. Due to budget and labor constraints, we replaced this idea and opted for using cut fabric instead. The next important development of the design included extending the installation beyond the top of the frames. To increase the visual impact of the artwork, and enhance the notion of "flooding," the artwork was extended to encompass a larger part of the site. To achieve this, the colored ribbons on the steel frame were extended and connected onto the grassy lawn. The lines of color were then continued by duct tape over pavers and removable vinyl strips on the library windows (Fig. 5).

The tight time-frame between the distribution of the survey and the execution of the project also posed challenges. The team had to estimate the number of ribbons that would be needed for each of the colors, and manufacture additional ribbons to ensure that we could represent the answers accurately. Overall, 65 yards of fabric were cut into 250 strips that were 2 in. by 20 ft. long. We sewed a loop with each strip of fabric in order to be able to attach to the metal structure. This manual process was done in the studio, afterwards the team took the ribbons to the site and used them during two community making sessions at the East Boston branch of the Boston Public Library.

We selected the color for the fabrics, and thus the ribbons, to accomplish two goals: (1) tie the project visually to the notion of water, and (2) to represent emotions to colors that would resonate with the public. As such, we selected teal as a shade of blue that could signify water, to represent "concerned," which the team anticipated to be the majority of the responses. We selected red to represent anger, blue for sadness, yellow for optimism, and green for "other" which encompass other emotions not represented by the former choices.

Once survey response collections was complete, the team gathered once again inside the East Boston Library to assemble the tops of the metal frames and weave the different colored ribbons. During this time, we made an aesthetic choice: to randomize the distribution of colors so as to create a visually dynamic field, rather than grouping the colors. After the panels had their ribbons inserted, the team took them outside and placed them atop the metal posts. The team then attached the ribbons to the ground using landscape staples. Simultaneously, the team and volunteers, installed the matching colored duct tape on the stone pavers, and the removable vinyl on the library windows. The vinyl was also designed to match the top of the frames as a representation of the 1% chance flood level for 2070 in this location. The process of installation of the

Table 1: This table presents some example emotions we collected from the survey. These quotes were inscribed by the local community on ribbons and served as the major component of RisingEMOTIONS.

Emotion Category	Collected Quotes
Other	*It is weird because it was so warm.*
Angry	*Disappointed the city is allowing development on the waterfronts rather than natural spaces to buffer floods and storms.*
Optimistic	*There is still hope and we must come together.*
Optimistic	*I don't care. It will be fine.*
Sad	*I am afraid that my home will flood, and I'll lose my life savings. I'm afraid the city will case less because we are not an affluent community.*
Sad	*I just hope it won't be too late before we start taking actions instead of discussing what should be done.*
Concerned	*It's scary. We need to look to the future and take actions now.*
Concerned	*Having lived here my whole life, it would be sad if something bad happened.*
Concerned	*Is the community enough to take care of such a huge challenge?*
Concerned	*There has been very little planning and action in this regard. It makes me wonder if anyone even cares or not.*
Concerned	*I am worried that the neighborhood will be wiped out.*
Concerned	*Es preocupante ver como el clima esta cambiando y no se ve que se esta haciendo al respecto!*

Figure 4: This figure chronicles the fabrication process by the student team, and community members during making sessions and the installation of RisingEMOTIONS in an engaging and collaborative way. From left to right: Cutting and sewing fabric strips by the team; a 'making' session at the library with community members; volunteers contributing to the installation of the artwork.

artwork was a collaborative effort between the team, library staff, the Excel Academy high school students, and the community at large (Fig. 4). An aspect that facilitated the involvement of different groups was the relative ease of handling of the parts which allowed each participant to contribute to the completion of the installation day, which took less than one day.

4 ART EXHIBITION

Through our project, we connected with different groups of people including the members of the community, dignitaries, attendees of the library, and environment conservationists. Involvement of the community members in the making sessions where they inscribed the digitally collected emotions enabled us to humanize and demystify the planning, engagement, and collaboration process. We observed a general enthusiasm around the project where community members were interested to learn more about climate emergency and its effects. The location of the installation played a crucial role in the engagement of community members. The head librarian mentioned that the library branch serves as a community

hub where all members of the community are free to visit and socialize. The front porch of the building where the installation was displayed separates the library with a walking garden frequented by locals. An installation in an open space encouraged more engagement with the project compared to a display situated inside the building, which might lead to a sense of barrier to entry [8]. Furthermore, the installation was approachable and accessible enough for attendees to easily engage without prior knowledge about the installation or public art pieces in general.

While RisingEMOTIONS was on display, we observed people from all age groups engage with the installation in their own unique ways. For instance, the children who came to visit with their parents turned the installation into a playground where they ran around under the frames to play (Fig. 6). Members of the elderly population actively participated in the making process by bringing their own equipment to set up the frames, inscribing the ribbons with quotes from the survey, and engaging with the teenagers and high-school students in conversations around the climate emergency. For many of these teenagers and high-schoolers, RisingEMOTIONS
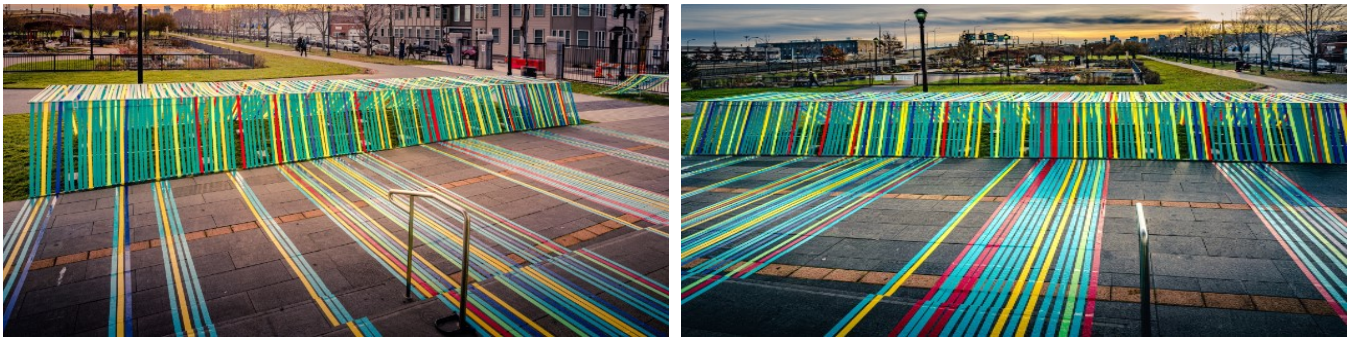
Figure 5: RisingEMOTIONS (©Carolina Aragón, 2019), a collaborative public art installation situated in front of the the Boston Public Library, East Boston branch. (©Matt Conti, 2019)

was their first exposure with the danger of the climate emergency (Fig. 6). They showed keen interest in learning more about climate change, the sea-level rise and the imminent threat towards their neighborhood and the world from attending climate scientists and researchers. Many of them wanted to learn more about the ongoing grassroot efforts and get involved to fight the effect of climate emergency. This demographic also made up the majority of the population who inscribed the survey quotes on to ribbons that sparked spontaneous discussions among themselves around the feelings of survey participants.

The installation was also visited and inaugurated by local dignitaries including state representatives. One senator (S1) mentioned, *"We in East Boston are really susceptible to sea-level rise, climate change and storm surge. We have to approach this issue and bring awareness to the problem of climate change through different mediums. Now, folks walking by that use the Greenway or the library will immediately be hit with this visual impact that shows sea-level rise is very real for us living in East Boston."* They also highlighted how the overwhelming feeling of concerns in people's emotions can help raise awareness, saying *"Some of these writings are very striking. There's a lot of concerns but one thing is for certain that an art installation like this raises awareness."* Another senator (S2) mentioned the key takeaway from this project, saying *"The visual makes people think and when people think they talk. And when people talk, taking action is not far behind."* The spokesperson for the mayor's Office of Arts and Culture who attended the inauguration mentioned, *"The city as a whole is generally very devoted to addressing the climate change crisis in East Boston, specifically because it's such a high-risk neighborhood for coastal flooding."*

5 DISCUSSION AND FUTURE WORK

Increasing engagement by integrating public art and digital civics. RisingEMOTIONS provided several opportunities for learning about the potential for integrating art and social computing technologies to create novel forms of connecting with the public and potentially increasing engagement with planning issues. In particular, the project demonstrated a model capable of informing the public about future risks, while simultaneously providing a platform for emotional expression that operated at the individual level and potentially at the neighborhood scale.

As such, it provided a tangible, non-threatening point of access to information about sea-level rise, but also an opportunity for residents to reflect on their response to this vulnerability in a public manner. The latter offers not only an opportunity for self-expression in a way that is anonymous and non-judgemental, but that seeks to spark dialogue. The messages embedded in the artwork serve not only to inform or assess the public's feelings about future flooding but also serve as a prompt to invite a "chorus" response. Such responses are critical, yet often missing from visual artworks about the climate emergency [41].

Bridging scientific data with emotions (rational and affective). Perhaps the most unique aspect of this project is the bringing together of scientific data about future flooding with the public's emotions. The overlay of the personal over the scientific may be an effective tool to create a memorable and relatable experience capable of increasing salience. By visualizing a group of responses, the artwork also provided a unique opportunity for the individual to join a collective, visually representing a dialogue about a very difficult and often elusive subject. To do this in the form of an art installation, is also particularly effective, as installations are per se designed to create environments of heightened sensory awareness. In this case, the experience contains bodily awareness–that of measuring the flood waters against the body), visual awareness of the colors and emotions they represent, and finally emotional connections which may be triggered by reading community member responses.

Trade-off between artistic visualization and accurate data representation. The aesthetics of the project, the materials and techniques used in its construction were key to the perceived success of the project. The colorful ribbons, and playful nature of the work, created an attractive interface which called attention to the project and provided a colorful play space for young children to run under (Fig. 6). However, aesthetic choices may have minimized the effect of the visualization. The randomized mixing of colored ribbons, purposely chosen to create visual interest, may have minimized the legibility of the information. This would have been more noticeable if the same color fabric strips had been grouped together to better reveal the hierarchy in the responses (Fig. 5). It is unclear whether this approach would

Figure 6: The community actively engaged in the making of RisingEMOTIONS. For many teenagers and high-school students in the community, RisingEMOTIONS was their first exposure to the climate emergency and its imminent threats. Many of them decided to participate in installing RisingEMOTIONS. Other members participated in inscribing the feelings collected from the community members via the survey. The children who visited the public art installation enjoyed running around and playing under the installation. However, their playfulness highlighted a contrast to the grim reality of the projected flood level of 3.7 feet by year 2070. (©Matt Conti, 2019)

have diminished the appreciation and enjoyment by the public, or whether it would have had any effect on people reading the text of the ribbons. While the potential dissonance that results from a visually engaging aesthetic against the grim projections from the effects of the climate emergency is not lost, it was clear that the visual quality of the artwork was perceived in a positive way by most participants, thus suggesting that similar approaches could be implemented in the future. Another positive characteristic of the project was the lightweight and varied nature of the materials used for its implementation. Fabric, as opposed to heavier materials which may require power tools, was easily cut, sewn, woven into the frames, and finally connected to the ground using landscape staples. Likewise, duct tape and vinyl were elements that volunteers, including children, could participate in installing. The use of multiples (in this case a 2" fabric ribbon, piece of tape or vinyl) allowed for multiple participants to work simultaneously to achieve the final goal. Designing artworks that are made of lightweight, human-scale materials that can be easily handled by a wide variety of people, in the manner similar to craft, is an effective way to maximize opportunities for participation.

Challenges around engaging affected populations. RisingE-MOTIONS demonstrated the utility of combining the usage of digital technology with physical approaches such as public arts to engage a broader population. Having a digital data collection platform enabled us to disseminate the survey over digital media using social media and online channels, as well as physical media via posters and business cards to reach more people. RisingEMO-TIONS suggests the importance of developing a strong in-person presence in the local community, even when employing digital technologies. We found that while digital dissemination helped increase immediate attention towards the survey, participation in the online survey was also benefited by the special events that took place at the high school and the library. In these events, the team not only distributed the business cards and posters with QR codes, but also spoke about the project, and showed several participants how to use a QR code, creating a deeper sense of engagement. The physical presence of posters and business cards at

the library, school, and other businesses helped amplify awareness of the project and build anticipation for its construction. As such, the hybrid approach can increase the depth of engagement by in-person engagement with the community and increase the breadth of engagement by having online data collection modalities for a more convenient access and reachability via social media and online platforms. Other factors positively affecting participation rose from the relationship that had been previously established by the team with community members and organizers, who then personally distributed the survey link through their networks.

Challenges around physical installation. The low budget and short time-frame for the installation proved to be limiting factors. The budget, although subsidized by academic grants and other funding sources, severely limited the choice of materials to be implemented, and relied heavily on volunteer labor. An example was the cutting of the fabric, which provided a significantly less expensive cost as a raw material versus having pre-cut ribbons. The short time-frame between inception and implementation also challenged the coordination between the survey distribution, data collection and text transcription onto the fabric strips. Additionally, the time in which the installation took place was also challenging: RisingEMOTIONS was exhibited between late November and mid-January at the peak of winter season in Boston. While originally it was scheduled to be exhibited earlier, the project was delayed due to the limitations of scheduling approvals by the Boston Art Commission. Due to the severity of the winter weather, the installation had to be repaired several times.

Future directions. RisingEMOTIONS offers suggestions for future work interested in increasing public engagement. A major aspect to be explored is the potential for a hybrid model involving public art and social computing to provide continuous or real-time visualizations containing public opinion about issues affecting communities, through site-specific, physical displays in public space. Projects using a model similar to RisingEMOTIONS could be utilized to call attention to local issues, engage participants through accessible

digital platforms, and then translate results into physical representations. Additionally, the hybrid online and physical model may prove to be beneficial as part of participatory projects developed during pandemic conditions which limit social interaction. Participants can engage online and projects can be built incrementally in outdoor environments.

Future projects interested in gaining an in-depth understanding of the impact of various communication modalities in public engagement could benefit from conducting pre and post surveys, as well as longitudinal studies to assess the impact of the projects. Important questions such as the ones listed below could inform future work: (1) how might the combination of social computing methods and public art increase participation? (2) How can we leverage this combination to broaden outreach to marginalized and underrepresented populations? (3) How can we utilize the collected public input to design and develop computational approaches capable of analyzing and understanding qualitative public input to accelerate the decision making process?

6 CONCLUSION

Coastal cities are at the risk of flooding due to the threat posed by sea-level rise caused by climate emergency. While the affected community's participation is critical for effective resilience and adaptation planning, engagement with them is still low. In this work, we piloted a concept of raising public awareness towards the climate emergency by blending public art with digital technology with a specific focus on gathering and communicating affected neighborhood's emotions towards sea-level rise. We used a low-barrier bilingual online survey to gather the emotions of community members' from East Boston. These emotions were then transformed into physical artifacts and were used in the art installation, RisingE-MOTIONS. The aftermath of this multidisciplinary collaborative endeavor between climate scientists, artists, and digital civics researchers suggest the potential value of this hybrid approach towards public engagement. This project showed the potential for public art installations to engage a wide range of community members and the potential for affective data to evoke people's feelings towards critical issues such as climate emergency. We discuss the challenges and trade-offs involved with artistic choices and data representation and dissemination of online resources to general public. We also suggest future directions to adopt such hybrid model to increase public engagement.

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