OLD DOMINION UNIVERSITY
Resilience Collaborative

Sea Grant Virginia

Flood Resilience Community Outreach Using the ASERT Framework

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Introduction

The Old Dominion University Resilience Collaborative team of faculty Michelle Covi, Wie Yusuf, Carol Considine, Gail Nicula, Afi Anuar, and student Makayla Brown developed a program for public engagement meetings using their ASERT (Action-oriented Stakeholder Engagement for a Resilient Tomorrow) framework to solicit resident input into the City of Virginia Beach's *Comprehensive Sea Level Rise and Recurrent Flooding Analysis and Planning Study*.

The meetings were designed to:

- Provide an inclusive and engaging process that allowed residents to participate in the resilience efforts in Virginia Beach.
- Provide information about community and household resilience in an environment that encouraged social learning, including curiosity and reflection, and to promote behavioral change that resulted in improved resilience.
- Allow residents to give real-time perceptions of risk and feedback about resilience activities in Virginia Beach.
- Collect data related to residents' risk perceptions, levels of knowledge and extent of preparedness, to allow for targeted follow-up.

The community meetings took the form of a "Flood Resilience Game Night" with five stations in which residents could participate in activities to earn stamps on a game card. The stations included an introductory station that gathered anonymous demographic information about participants and two stations designed to collect information about perceptions and preferences using a computer tablet (or paper survey). The Flood Tolerance station collected perceptions about the feasibility of driving on flooded roadways or the comfort level with flooding on residential properties. The Adaptation Actions station guided residents through possible approaches that the community or individual property owners might take to prevent flooding and then asked about their preferences for these different actions or approaches. Mapping stations included a Travel Disruption station with a large-format printed map of the City that allowed residents to note places where travel had been disrupted and the WeTable station which featured an interactive electronic map that allowed residents to both pinpoint areas that had been challenged by flood or other related problems and note community assets that might be threatened.

In addition to these stations, other opportunities to interact with staff from the City of Virginia Beach, The Miles Agency and Dewberry were also available during Flood Resilience Game Nights. City staff provided floodplain and emergency management information and helped guide residents to better understand their neighborhood challenges using maps, provided by Dewberry, of current and potential future floodplains due to sea level rise.

Seven evening meetings (Game Nights) were conducted in December 2017 and January 2018 in public schools located in seven different sub watersheds of the City. One meeting was hosted

on a Saturday afternoon in March at a Virginia Beach public library, taking the form of a Flood Resilience Fun Afternoon. The events were attended by 10-50 people each.

Details of the Virginia Beach Flood Resilience Game Nights and Fun Afternoon are as follows:

- December 4, 2017 at Kempsville High School. Targeted at watersheds 2, and 17 through 22 (the Elizabeth River Watershed). Estimated attendance: 50.
- December 6, 2017 at Cox High School. Targeted at watersheds 5, 6 and 7 (the Eastern Lynnhaven area, bounded to the east by First Colonial Road; the south by Princess Anne Road; and the west by Rosemont Road and Little Neck Road). Estimated attendance: 50.
- December 11, 2017 at Cooke Elementary School. Targeted at watersheds 8, 29 and 30 (Oceanfront beach district and the Lynnhaven east of Great Neck Road). Estimated attendance: 45.
- January 22, 2018 at Kellam High School. Targeted at watersheds 9, 10, 11, 16 and 23 through 28 (Oceanfront beach district and the Lynnhaven east of Great Neck Road). Estimated attendance: 30.
- January 26, 2018 at Princess Anne High School. Targeted at watershed 3 and 4 (Western Lynnhaven area north of Princess Anne Road, bounded to the east by South Rosemont Road and Little Neck Road)
- January 29, 2018 at Bayside High School. Targeted at watersheds 1 and 31 (Little Creek area to the east where Shore Drive intersects Northampton Blvd). Estimated attendance: 20.
- January 30, 2018 at Landstown High School. Targeted at watersheds 12 through 15 (Stumpy Lake/North Landing River Area to the southwest of Princess Anne Road, bounded to the north by Kempsville Road). Estimated attendance: 15.
- March 24, 2018 at Virginia Beach Public Library. City-wide event with showing of the film *Tidewater: Water is Rising, Land is Sinking and the Military Is Here to Stay.* Estimated attendance: 10.

(Note: Throughout this report the term Game Night will be used to refer to the Flood Resilience Game Nights and the Fun Afternoon).

Figure 1 shows images of participants and the stations during the Game Night and a sample flier distributed to the community.

Community participation was also available in an online format (an online survey and web mapping portal) for Virginia Beach residents unable to attend the live Game Night events. Information about the online format was available to Virginia Beach residents on the city's 'Comprehensive Sea Level Rise' website (https://www.vbgov.com/government/departments/public-works/storm-water/Pages/pw-slr-8-2015.aspx) and was also shared with residents in a Letter to the Editor published in The Virginian-Pilot (https://pilotonline.com/opinion/letters/article_565bbdc7-475c-5ace-b052-e37c8990beed.html). Eighty-one Virginia Beach residents participated in the online survey and the web mapping portal was accessed 154 times. This report summarizes the results from both Game Night and online participants.

Figure 1. Game Night participants, stations and a sample flier

(a) Introductory presentation

(b) Introductory presentation

(c) Flood Tolerance station

(d) Adaptation Options station

Flood Resilience 'Fun Afternoon' & Interactive Community Event

Where: Virginia Beach Central Library

When: Saturday, March 24, 2018 starting at 1:30 p.m. (until 4 p.m.)

Showing of the film *'Tidewater: Water Is Rising, Land Is Sinking, and the Military Is Here to Stay'* @ 2 pm
(with introduction by Rear Admiral (Ret.) Ann Phillips)

- Come out to this family friendly event - Be part of the process for long-term resiliency planning for Virginia Beach.
- Information you provide will help the city and engineers understand what the public feels is important about existing flood risk, possible changes in the future, and possible flood risk management and adaptation options.

This film explores the challenge of sea level rise in the Tidewater region of Virginia and North Carolina, encompassing Hampton Roads, arguably the region whose vulnerability most affects our overall national security. *Directed and produced by Roger Sorkin and the American Resilience Project* [illegible]

Participate in interactive activities:
- Mapping and understanding risks
- Assessing vulnerabilities and tolerances to flooding
- Adaptation and flood proofing options

WIN PRIZES FOR PARTICIPATING!

Sponsored by: City of Virginia Beach, Public Works Engineering, and the ODU Resilience Collaborative

(e) Sample flier

Characteristics of Participants

Game Night and online participants were asked to complete a participant questionnaire. 185 Game Night participants and 81 online participants answered these questions. Combined across Game Night and the online formats, the gender of the participants was evenly split at fifty percent. In terms of race, 87.5% of participants were White, while 3.2% reported being Black/African American, 1.1% Asian, 1.8% Hispanic, 2.8% Multiracial and 3.6% Other.

Table 1 provides a summary of participants by age. The number of participants for each age group is listed with the percentage shown in parentheses. Over three quarters (77.86%) of the participants were over 45 years of age. The age group 25-44 years had a greater proportion of online participants (30.77%) compared to Game Night (15.22%).

Table 1. Age categories

	Game Night	Online	Total
18-24 years	4 (*2.17%*)	2 (*2.56%*)	6 (*2.29%*)
25-44 years	28 (*15.22%*)	24 (*30.77%*)	52 (*19.85%*)
45-64 years	75 (*40.76%*)	39 (*50.00%*)	114 (*43.51%*)
65 years and over	77 (*41.85%*)	13 (*16.67%*)	90 (*34.35%*)

Participants were highly educated, for both the Game Night and online formats (see Table 2). Three quarters (75.18%) of the participants completed a bachelor's or graduate degree. Under a quarter (21.66%) of the participants reported being affiliated with the military.

Table 2. Highest level of education completed

	Game Night	Online	Total
High school diploma/GED or less	5 (*2.49%*)	2 (*2.47%*)	7 (*2.48%*)
Trade/professional school/ Associates degree	15 (*7.46%*)	7 (*8.64%*)	22 (*7.80%*)
Some college	28 (*13.93%*)	9 (*11.11%*)	37 (*13.12%*)
Bachelor's degree	81 (*40.30%*)	32 (*39.51%*)	113 (*40.07%*)
Graduate degree	68 (*33.83%*)	31 (*38.27%*)	99 (*35.11%*)

Table 3. Residential tenure in Hampton Roads

	Game Night	Online	Total
5 years or less	14 (*8.81%*)	5 (*6.17%*)	19 (*7.92%*)
6 to 10 years	7 (*4.40%*)	9 (*11.11%*)	16 (*6.67%*)
11 years or more	138 (*86.79%*)	67 (*82.72%*)	205 (*85.42%*)

Participants were overwhelmingly (85.42%) long-term residents of Hampton Roads, defined as having lived in the area for 11 years or more. Only 7.92% of participants had lived in the region for five years or less. An additional 6.67% had lived in the region between 6 and 10 years.

Vulnerability to and Perceptions of Sea Level Rise

The majority of participants clearly perceived themselves to be vulnerable to flooding and experienced the impacts of SLR. Participants were asked the question 'How would you rate your personal vulnerability to flooding due to sea level rise?' and were given the option to rate their vulnerability from a low of 0 to a high of 35. The vulnerability rating was divided into five groups: extremely low (0-7), somewhat low (8-14), neither high nor low (15-21), somewhat high (22-28) and extremely high (29-35). The results are listed in Table 4. Over half (59.65%) of the participants rated their personal vulnerability to be somewhat or extremely high.

Table 4. Rating of personal vulnerability

	Game Night	Online	Total
Extremely low	27 (*13.04%*)	11 (*14.10%*)	38 (*13.33%*)
Somewhat low	15 (*7.25%*)	5 (*6.41%*)	20 (*7.02%*)
Neither low nor high	46 (*22.22%*)	11 (*14.10%*)	57 (*20.00%*)
Somewhat high	46 (*22.22%*)	19 (*24.36%*)	65 (*22.81%*)
Extremely high	73 (*35.27%*)	32 (*41.03%*)	105 (*36.84%*)

These participants also perceived that sea level rise would have a more immediate impact on Hampton Roads. Slightly half (51.19%) of the participants reported that sea level rise was having an impact now, while an additional 19.44% indicated that the impacts would be in one to five years (see Table 5). Participants at Game Night recorded a higher percentage of sea level rise having an impact now at 58.25% compared to 27.59% for online survey participants.

Table 5. When SLR will have an impact on Hampton Roads (number of years)

	Game Night	Online	Total
Now	113 (*58.25%*)	16 (*27.59%*)	129 (*51.19%*)
1 to 5 years	33 (*17.01%*)	16 (*27.59%*)	49 (*19.44%*)
6 to 10 years	20 (*10.31%*)	11 (*18.96%*)	31 (*12.30%*)
11 to 25 years	12 (*6.18%*)	8 (*13.79%*)	20 (*7.94%*)
26 to 50 years	9 (*4.64%*)	3 (*5.17%*)	12 (*4.76%*)
51 or 100 years	7 (*3.61%*)	4 (*6.90%*)	11 (*4.36%*)

Game Night participants did not believe they were well-informed about increasing flooding in Hampton Roads and the causes of such flooding. More than half (55.39%) of the participants considered themselves not at all or not well informed about increasing flooding and its causes. Approximately 29% of participants indicated they were well informed or very well informed (see Table 6). This question was not asked in the online survey.

Table 6. How well informed about increasing flooding and causes in Hampton Roads

	Game Night
Not at all informed	35 (*17.16%*)
Not well informed	78 (*38.23%*)
Neither uninformed nor informed	32 (*15.69%*)
Well informed	51 (*25.00%*)
Very well informed	8 (*3.92%*)

Note: Question was not asked in the online survey.

A majority (92.20%) of participants either owned their home or were in the process of buying a home. Over half of the participants (52.11%) reported not having flood insurance through the federal government's National Flood Insurance Program (NFIP). 43.3% of participants had NFIP flood insurance policy and 4.58%% did not know if they had flood insurance.

Flood Tolerance

At the Flood Tolerance station participants were asked to indicate their tolerance for flooding in two contexts. The first context was when they were traveling to work, school or an appointment and they encounter flooded roadways. In the second context, participants were asked to react to flooding on their residential property. For each, participants were shown low, medium, and high scenario pictures of flooding. Participants were then asked to respond whether they would be willing to drive through the flooded roadways shown in the pictures and whether they would be comfortable with the level of water shown on the residential property in the pictures.

Flooded Roadways

Participants were presented with three scenarios representing different levels of roadway flooding – low, medium, and high – as shown in Figure 2. They were asked to respond to the following prompt: When traveling to school, work, or an appointment, I would be willing to drive through the flooded roadways shown in the picture.

Figure 2. Three scenarios of roadway flooding

Flooded roadway tolerance results for the 183 Game Night participants are shown in Figure 3. For the low scenario, 114 (62%) of the 183 Game Night participants were comfortable with this level of flooding, as they recorded strongly agree or somewhat agree responses. Forty-three (23%) participants disagreed with the statement while 26 (14%) remained neutral. For the medium and high scenarios, 46 (25%) and 7 (4%) participants were comfortable with this level of flooding, respectively. More participants indicated disagreement with the statement for the medium and high scenarios, with 134 (72%) and 175 (96%) disagreeing, respectively.

Similar results were obtained from the 76 participants of the online survey (see Figure 4). Almost half (37 participants or 49%) were comfortable with the low flooding scenario while 16 (21%) and three (4%) participants were comfortable with the low, medium and high flooding scenarios, respectively (see Figure 4). Thirty-five (46%), 56 (74%) and 70 (92%) disagreed that they would be willing to drive through the low, medium and high flooding travel scenarios, respectively. Four (5%), four (5%) and three (4%) participants remained neutral for the different scenarios.

Figure 3. Willing to drive through the flooded roadways - Game Night

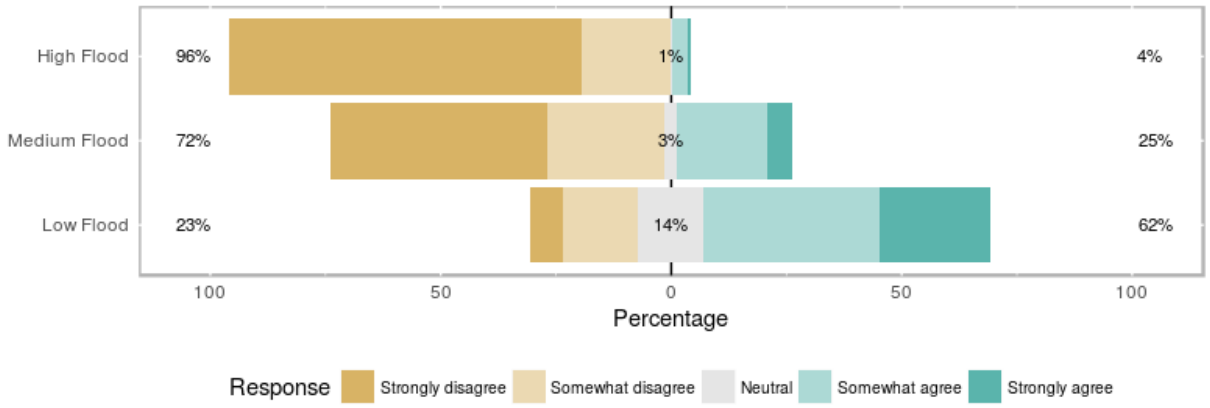
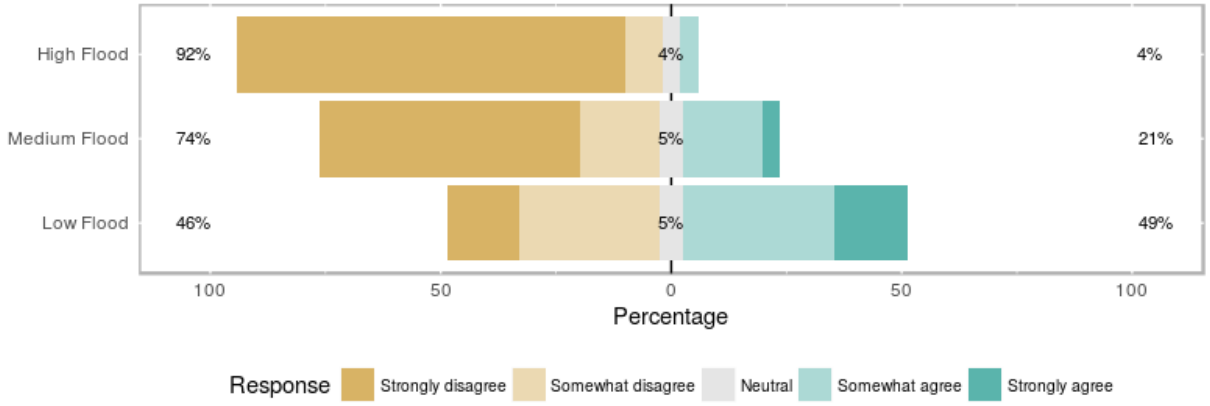


Figure 4. Willing to drive through the flooded roadways - Online



In general, as the level of flooding on the roadway increased, so did the disagreement with the statement about being willing to drive through the flooded roadways.

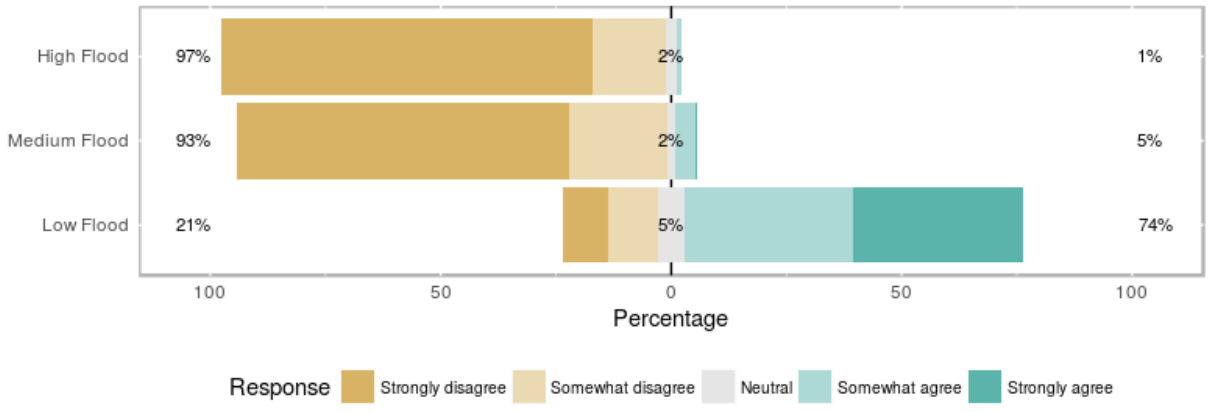
Flooding on Residential Property

Participants were presented with three scenarios representing different levels of flooding on residential property – low, medium, and high – as shown in Figure 5. They were asked to respond to the following prompt: When it comes to my residence, I would be comfortable with the level of water shown in the picture.

Figure 5. Three scenarios of roadway flooding

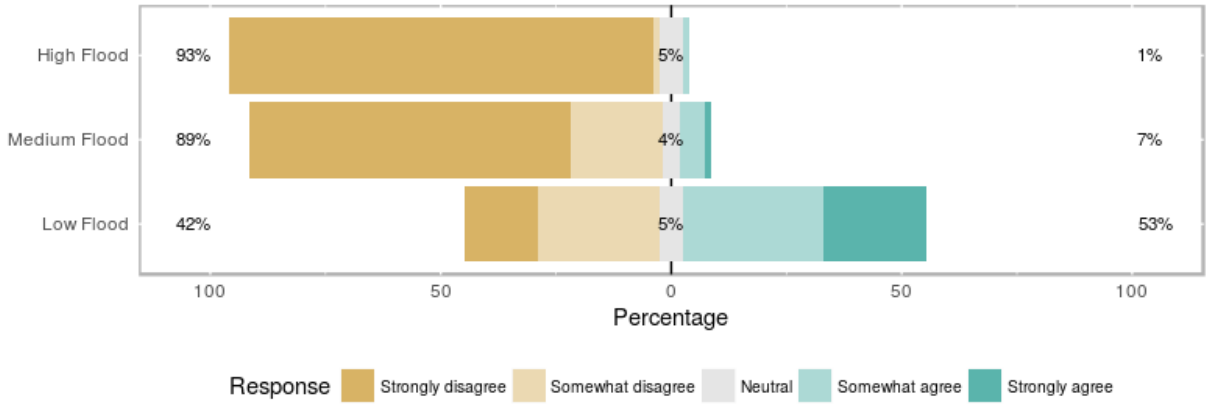
Under the low scenario, 135 (74%) Game Night participants were comfortable with this level of flooding, as they recorded strongly agree or somewhat agree responses, as shown in Figure 6. Thirty-eight (21%) participants disagreed with the statement while ten (5%) remained neutral. For medium and high scenarios, nine (5%) and two (1%) participants were comfortable with this level of flooding, respectively. One hundred seventy-one (93%) and 171 (97%) Game Night participants disagreed with the medium and high scenarios, reflecting 93% and 97% respectively.

Figure 6. Comfort with level of flooding on residential property - Game Night



Results of the online survey revealed that 40 (53%), five (7%) and one (1%) participants were comfortable with the low, medium and high flooding scenarios, respectively (see Figure 7), while 32 (42%), 68 (89%) and 70 (93%) disagreed with the low, medium and high flooding scenarios, respectively. Four (5%), three (4%) and four (5%) participants remained neutral for the different scenarios.

Figure 7. Comfort with level of flooding on residential property - Online



In summary, as the level of flooding increased during travel or near a residence, tolerance levels decreased substantially.

Adaptation Options

Game Night participants were asked three questions about their preferences for adaptation options to pursue. Two questions focused on adaptation options and approaches that the city should pursue. The first question focused on what options the participants preferred their local government invest in, and the second question focused on the planning and management approaches that their city focus on. A third question focused on individual actions that participants could take to improve their resilience.

Local Government Investment

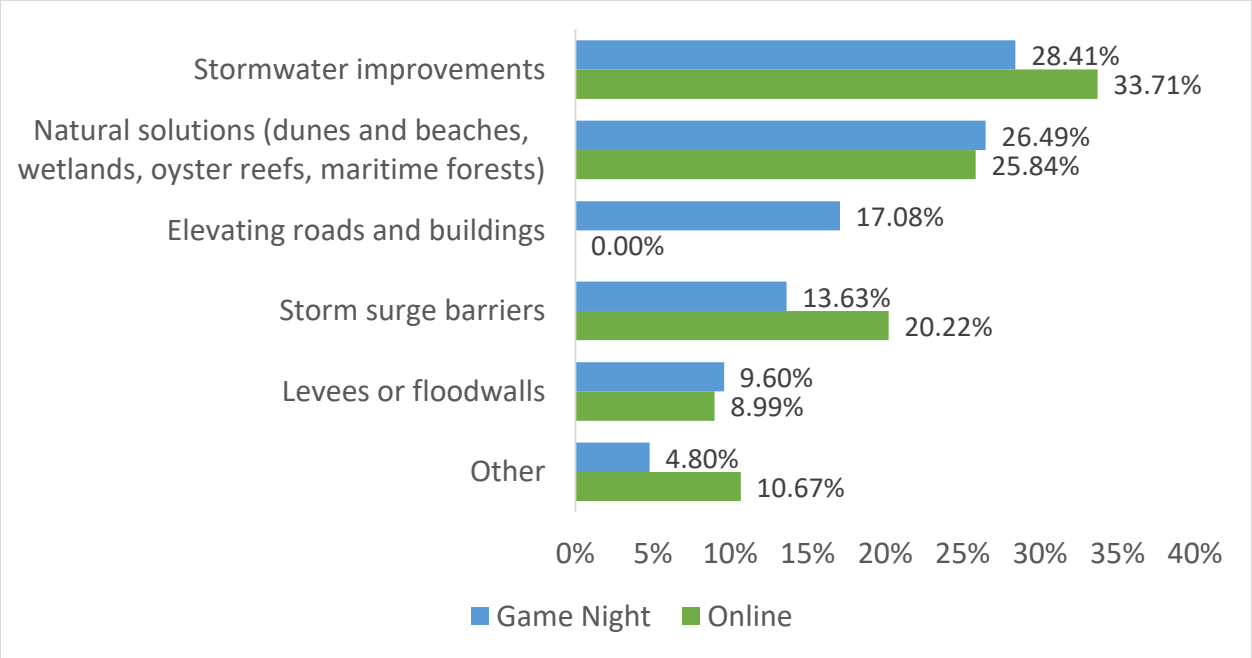
Participants were asked “Given a limited amount of public funding, which of the following options would you prefer your local government invest in?” They were given the following options: Stormwater improvements; natural solutions (dunes and beaches, wetlands, oyster reefs, maritime forests); elevating roads and buildings; storm surge barriers; levees or

floodwalls; and other. They were instructed to select the top three options and had the opportunity to add their own option under the "other" category.

Game Night participants preferred stormwater improvements (28%) and natural solutions (26%) as the top adaptation options for the city. Constructed solutions of elevating roads and buildings (17%), storm surge barriers (14%) and levees and floodwalls (10%) were also selected. Participants that chose "other" (5%) provided a range of comments. Some comments fell within the adaptation options provided above, but other adaptation categories included urban planning/zoning (limiting development, and retreat), establishing city budget priorities to address existing problems, and dredging. The dredging comments were based on the misconception that dredging would somehow lessen the impacts of sea level rise. Interestingly, while online participants chose similar top preferences, stormwater improvements (34%) and natural solutions (26%) for adaptation options, their constructed solutions were limited to storm surge barriers (20%) and levees and floodwalls (9%). Online participants did not perceive elevating roads and buildings (0%) as an option.

Responses to this question are summarized in Figure 8.

Figure 8. Preferences for adaptation actions for the City to invest in

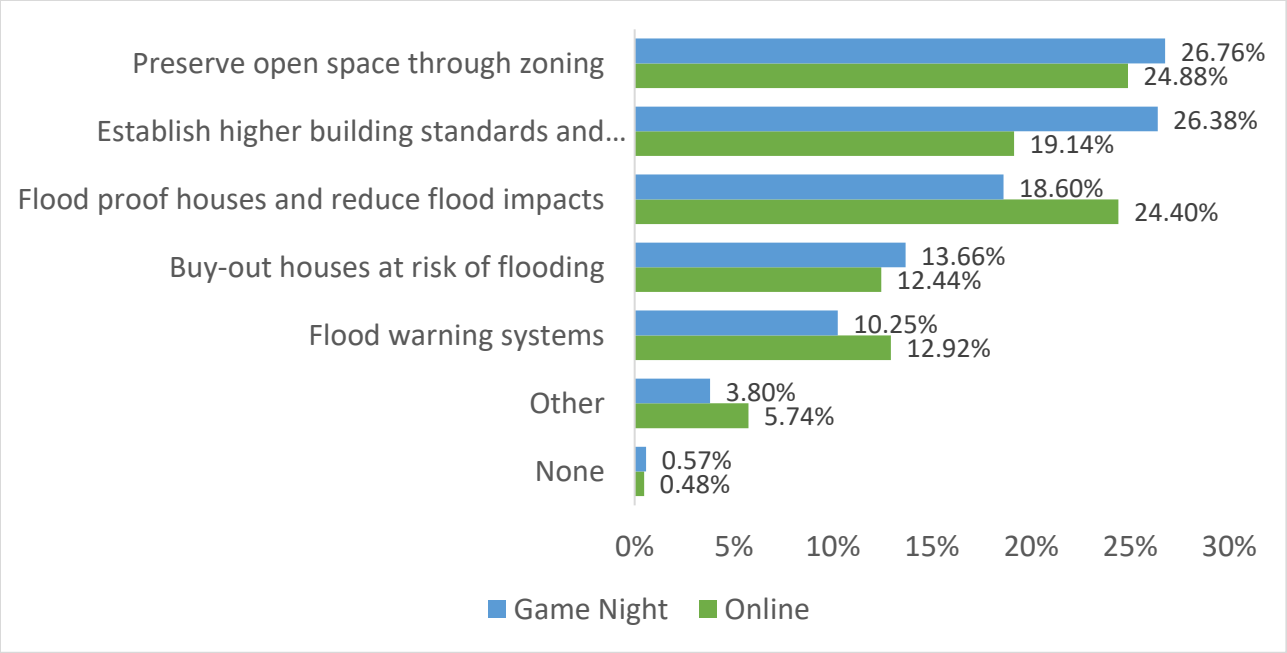


(N=521 Game Night and N=178 Online. Participants could select up to three responses)

Planning and Management Approaches

Participant were as the question: "Which planning and management approaches do you prefer your city to focus on?" They were given the options of: Preserve open space through zoning; establish higher building standards and codes; buy-out houses at risk of flooding; flood warning systems; flood proof houses and reduce flood impacts; and other. Again, they were instructed to select the top three approaches and had the opportunity to add their own option under the "other" category. The summary of responses is provided in Figure 9.

Figure 9. Preferences for planning and management approaches for the City



(N=527 Game Night and N=209 Online as participants could select up to three responses)

Game Night participants preferred preservation of open space through zoning (27%) and establishment of higher building standards and codes (26%) almost equally as the top planning and management approaches for the city. Flood proofing houses and reducing flood impacts (19%), buying out houses at risk of flooding (14%), and putting in place flood warning systems (10%) were also selected.

Interestingly, while online participants choose preserving open space through zoning (25%) as a top preference, their second top preference was flood proofing houses and reducing flood impacts (24%). Lower preferences were for the options of establishing higher building standards and codes (19%), buying-out houses at risk of flooding (13%), and utilizing flood warning systems (13%).

Participants who chose the "other" category (4%) provided a range of comments. Most of the comments fell within the planning and management approaches provided above, but repair and management of the stormwater system received a large number of responses in the "other" category.

Individual Actions

Participants were asked "Which of these actions would you take to improve your flood resilience?" The following options were given: Install cisterns and rain barrels; install rain-gardens or other landscaping; invest in home flood-proofing; buy flood insurance; talk to public officials; talk to my family and friends; other; and none. Responses to this question are summarized in Table 7.

Table 7. Actions participants would take to improve flood resilience

	Game Night	Online	Total
Talk to public officials about allocating resources for implementing adaptation	109 (*20.49%*)	38 (*17.59%*)	147 (*19.68%*)
Install rain-gardens or other landscaping designed to hold stormwater	107 (*20.11%*)	45 (*20.83%*)	152 (*20.35%*)
Invest in home flood-proofing	84 (*15.79%*)	40 (*18.52%*)	124 (*16.60%*)
Buy flood insurance	82 (*15.41%*)	37 (*17.13%*)	119 (*15.93%*)
Install cisterns and rain barrels	71 (*13.35%*)	29 (*13.43%*)	100 (*13.39%*)
Talk to my family and friends about how to become more resilient	58 (*11.09%*)	15 (*6.94%*)	73 (*9.77%*)
Other	18 (*3.38%*)	10 (*4.63%*)	28 (*3.75%*)
None	2 (*0.38%*)	2 (*0.93%*)	4 (*0.05%*)

Participants at the Game Night events selected talking to public officials (21%) and installing rain-gardens or other landscaping (20%) as their top actions. Other high priority actions included investing in home flood-proofing (16%), buying flood insurance (15%), and talking to family and friends (11%). A few participants chose "other" (3%) and "none" (less than 1%).

The online participants chose installing rain-gardens or other landscaping as their top action (21%), investing in home flood proofing (19%), talking to public officials (18%), and buying flood insurance (17%) as other high priorities.

For this question, very few of the "other" category responses fell into the action categories provided as part of the question. Responses for the "other" category included: Taking physical

action (move to higher ground) and taking political action (stormwater improvement advocacy and making voting choices based on their priorities).

Game Night participants were also asked 'What would you like to know more about?' They were allowed to select multiple responses and were given the following choices: What the city is doing to address increasing flooding; understanding the impacts of increased rain and storms; what I can do to adapt and prepare; the causes of sea level rise and flooding; nuisance flooding and minor flooding; flood insurance; and other. Responses to this question are summarized in Table 8.

Participants at both the Game Night events and online agreed that they were most interested in knowing what the city was doing to address increasing flooding (29% and 33%, respectively). The participants at the Game Night events were also very interested in understanding the impacts of increased rain and storms (19%), what they could do to adapt and prepare (14%), the causes of sea level rise and flooding (13%) and nuisance flooding and minor flooding (11%). Online participants were also interested in what they could do to adapt and prepare (18%), the causes of sea level rise and flooding (14%) understanding the impacts of increased rain and storms (13%), and nuisance flooding and minor flooding (11%). Both Game Night and online participants were less interested in flood insurance (8% and 7%, respectively). Responses in the "other" category ranged from general comments like "think outside the box" to specific information about the "canal in my backyard", funding, stormwater improvement planning, planning and preparation, and information on impacts and city priorities.

Table 8. Issues participants would like to know more about

	Game Night	Online	Total
What the city is doing to address increasing flooding	136 (*29.37%*)	61 (*33.33%*)	197 (*30.50%*)
Impacts of increased rain and storms	86 (*18.57%*)	24 (*13.11%*)	110 (*17.03%*)
What I can do to adapt and prepare	64 (*13.82%*)	32 (*17.49%*)	96 (*14.86%*)
Causes of sea level rise and flooding	59 (*12.74%*)	25 (*13.66%*)	84 (*13.00%*)
Nuisance and minor flooding	51 (*11.02%*)	20 (*10.93%*)	71 (*10.99%*)
Flood insurance	35 (*7.56%*)	12 (*6.56%*)	47 (*7.28%*)
Other	32 (*6.91%*)	9 (*4.92%*)	41 (*6.35%*)

Community Assets and Challenges

Game Night participants were able to identify community assets and community challenges using two different approaches. In the first approach, participants were asked to think about community assets as physical places in the Hampton Roads region such as favorite beaches, surfing areas, airports, nature parks or preserves, botanical gardens, libraries, houses of worship, pumping stations, shopping centers, government buildings, and the like. They were also asked to think about challenges such as streets, roads, highways, bridges, and intersections that were considered impassable, or passable with some degree of risk, because of periods of heavy or sustained rain, nuisance flooding, wind-driven flooding, or flooding from storms such as hurricanes or northeasters. The interactive station that afforded participants the opportunity to identify these assets and challenges was a WeTable, which uses Wii™ technology, a light pen, and map projection on large tables (see Figure 10).

Figure 10. WeTable station

(a) (b)

Game Night participants had a second option to identify and locate travel disruptions at each of the community resilience game nights. Using a large-format laminated map of Virginia Beach (supplied by Dewberry), participants were able to locate their neighborhoods and travel routes, and place plastic [sticky] tabs with short descriptions of one or more areas in the city where they experienced travel disruptions (see Figure 11). The facilitator at this map station explained to participants that they could place sticky tabs anywhere on the map where they had experienced flooding to the extent that they were not able to reach their desired destination(s).

Figure 11. (a) Travel Disruption station and (b) City of Virginia Beach staff available to answer questions about maps with sea level rise projections

(a)

(b)

These two stations, the WeTable station and the large format map Travel Disruptions station, gave participants two different ways to take action to identify the city's challenges. The challenges ranged from descriptions such as "clogged storm drains" to "heavy rain episodic" to "tidal flooding." Community members who used the WeTable identified assets such as Bayville Farms Park, the Church Point Manor Historic B & B, and the Thoroughgood Road Post Office. The assets, challenges and flooding locations that were identified by the participants were plotted on maps as shown in Figure 12.

Figure 12. (a) Assets, (b) Challenges and (c) Flooding locations

(a) Assets

(b) Challenges

(c) Flooding locations

Analyses

Up to this point, this report has focused on the data that were collected during Game Night and through the online format. This section discusses some of the analyses that were performed using the data collected.

Flood Tolerance and Perceptions of Vulnerability

To measure participants' tolerance to flooding, a flood tolerance index was developed and calculated, with a high index value indicating a high tolerance to flooding. To calculate the index value, participants' responses to questions about flooded roadways and flooding on residential property were combined. Responses to these questions were assigned numerical values and the flooding scenarios were assigned weights. The response for *strongly disagree* was assigned a value of one and *somewhat disagree* was assigned a value of two. A neutral response was assigned a value of three. *Somewhat agree* and *strongly agree* were assigned values of four and five, respectively.

Weight was also assigned to the different flood scenarios, with the low, medium and high flooding scenarios assigned weighting values of one, three and five, respectively.

The flood tolerance index for each participant was calculated as the weighted sum of the participants' responses for the different flood scenarios. The formula to calculate the flood tolerance index is shown below.

$$\text{Flood tolerance index} = \sum_{i=1}^{6} x_i y_i$$

where x = response to the flooding questions
y = weight for flooding scenario
i = flooding scenario

Figure 13 shows a sample calculation for the flood tolerance index. For the three flooded roadways scenario the participant responded with *strongly agree* (low flooding scenario), *somewhat disagree* (medium flooding scenario) and *strongly disagree* (high flooding scenario). The values for the participant's response to the flooding scenarios are shown in blue circles and the weights for the three flooding scenarios are shown in the green diamonds. For flooding on residential property, the same participant responded with *neutral* (low flooding scenario), *somewhat disagree* (medium flooding scenario) and *strongly disagree* (high flooding scenario).

Figure 13. Flood tolerance index sample calculation

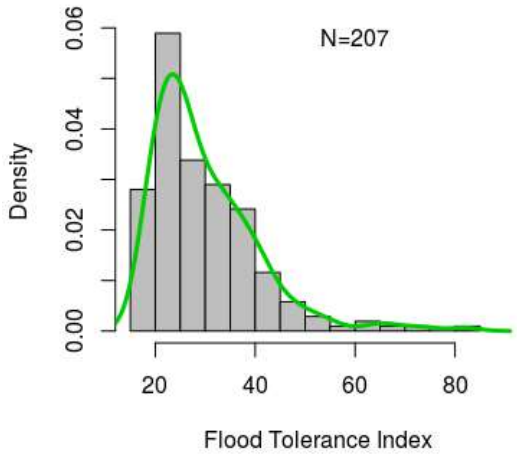
Roadway Flooding			Residential Flooding		
Low 1	Medium 3	High 5	Low 1	Medium 3	High 5
Strongly agree	Somewhat disagree	Strongly disagree	Neutral	Somewhat disagree	Strongly disagree
5	2	1	3	2	1

The flood tolerance index for this participant was calculated as:

$$(5 \times 1) + (2 \times 3) + (1 \times 5) + (3 \times 1) + (2 \times 3) + (1 \times 5) = 30$$

The flood tolerance index was calculated for each participant (from Game Night and the online survey, N=207). The minimum flood tolerance index was 18 and maximum was 82 with an average of 30 and a median of 27. The distribution of the flood tolerance index is shown in Figure 14. From this figure, a majority (87%) of the participants have a flood tolerance index of 40 or lower.

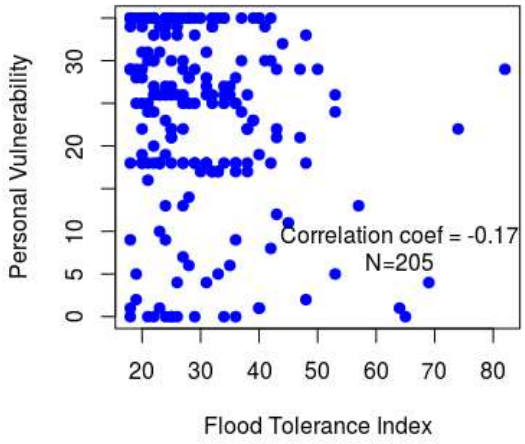
Figure 14. Distribution of flood tolerance index



The flood tolerance index was used to better understand if and how participants' tolerance levels were related to their perceived vulnerability and preferences for different adaptation options. Analysis was conducted to determine the correlation between personal vulnerability and the flood tolerance index. Figure 15 is a plot showing the relationship between the two. As

can be seen in this figure, most data points are clustering in the upper left quadrant. Statistically the correlation coefficient between the flood tolerance index and personal vulnerability was –0.17 with a *p*-value of 0.013. This indicates that there is a negative relationship between flood tolerance and perceived personal vulnerability. Those who perceive themselves to be personally vulnerable also indicate having low tolerance for flooding.

Figure 15. Correlation between personal vulnerability and flood tolerance index



During the survey participants were also asked "Given a limited amount of public funding, which of the following options would you prefer your local government invest in?" These preferences were compared in terms of the flood tolerance index. The results of the analysis are shown in Figure 16. The mean flood tolerance index values were consistent across the different adaptation options (ranging from 27.9 to 33.4), suggesting that preferences for adaptation options did not vary with flood tolerance values. Specifically, there were no adaptation options that were overwhelmingly preferred by participants with higher or lower flood tolerance levels.

A similar analysis was conducted comparing perceived personal vulnerability across different adaptation options as shown in Figure 17. The mean personal vulnerability values were consistent across the different adaptation options (ranging from 22.4 to 24.8, where values in the 22-28 range are categorized as somewhat high ratings of personal vulnerability). This suggested that preferences for adaptation options did not vary with personal vulnerability. There were no adaptation options that were overwhelmingly preferred by participants with higher or lower vulnerability to flooding. One exception, however, was for those participants who indicated they were not vulnerable to flooding. Participants who indicated no adaptation

actions needed to be taken (N=33) all rated their personal vulnerability to flooding as 0 (the lowest value that could be selected).

Figure 16. Comparison of flood tolerance index values across different adaptation options

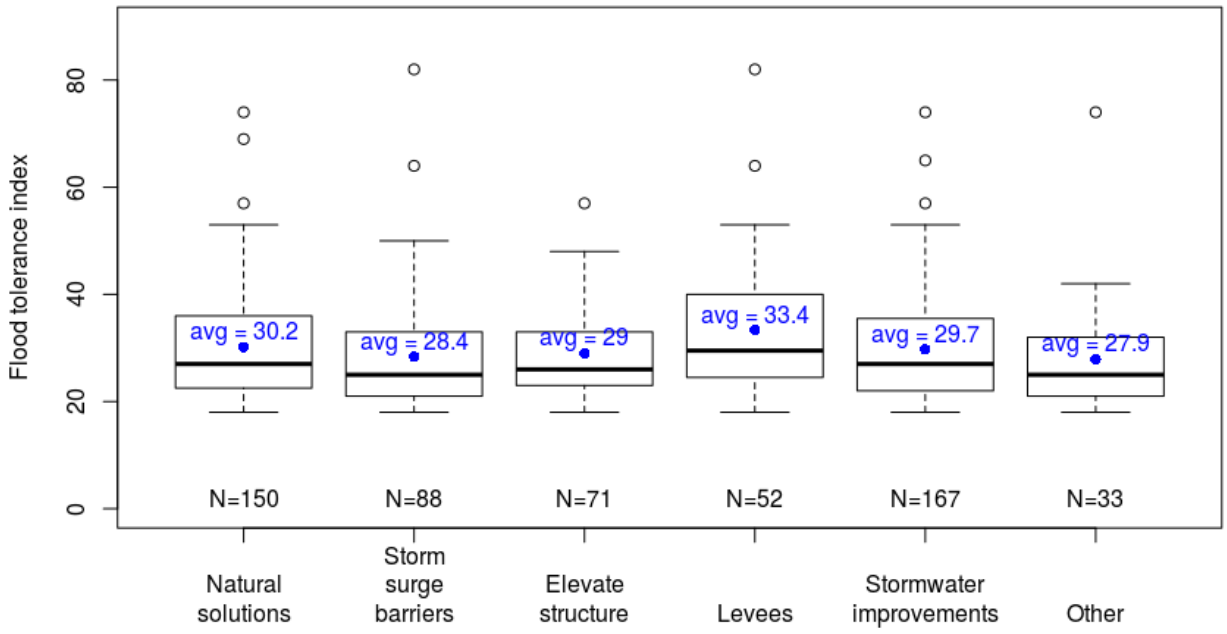
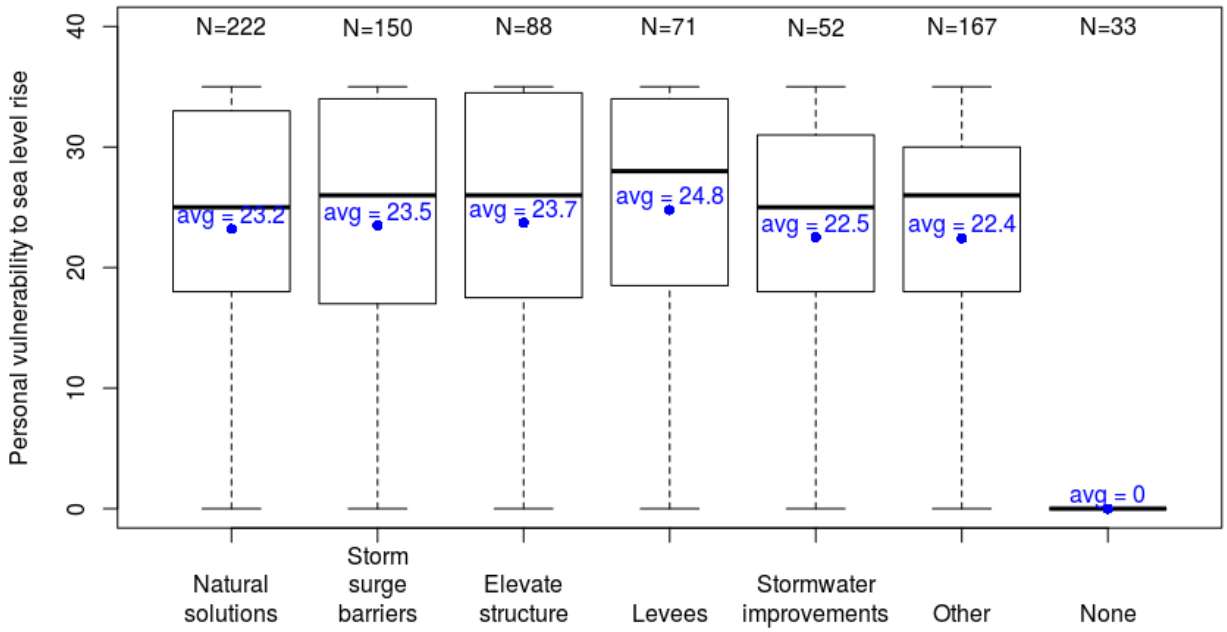


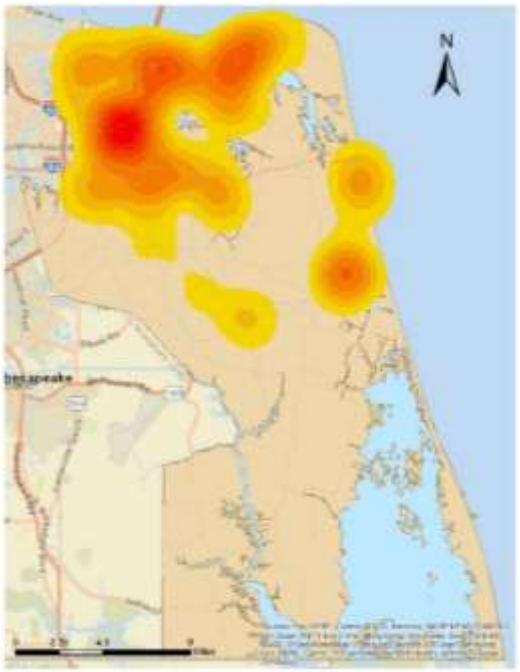
Figure 17. Comparison of personal vulnerability across different adaptation options



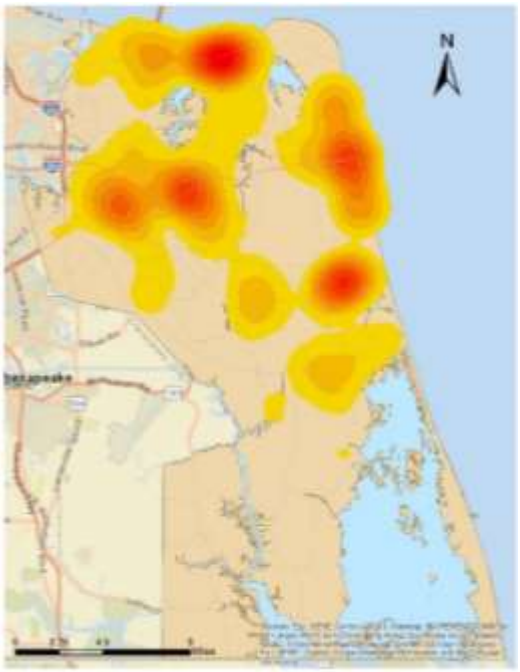
Heat Maps

Heat maps were created to provide a spatial representation of community assets, challenges and flooding locations identified by participants (see Figure 18). The heat maps use a color-coding system to represent the density. Areas with a high number of points (more dense) are represented as a darker color, slowly tapering off as the number of points are reduced.

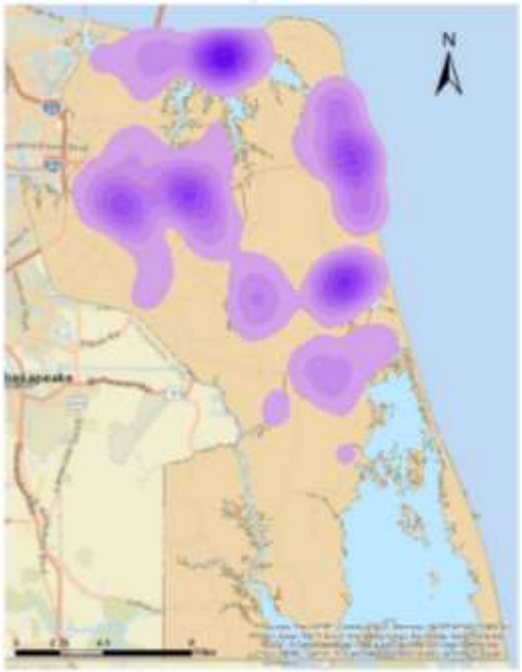
Figure 18. Heatmaps of (a) Assets, (b) Challenges and (c) Flooding



(a) Assets



(b) Challenges



(c) Flooding

Conclusion

The community engagement events and online participation for the Flood Resilience Community Outreach in Virginia Beach, Virginia accomplished the goals they were designed for:

- Provided an inclusive and engaging process that allowed residents to participate in the resilience efforts in Virginia Beach.
- Provided information about community and household resilience in an environment that encouraged social learning, including curiosity and reflection, to promote behavioral change that could result in improved resilience.
- Allowed residents to give real-time perceptions of risk and feedback about resilience activities in Virginia Beach.
- Collected data related to residents' risk perceptions, levels of knowledge and preparedness, to allow for targeted follow-up.

The results and findings from these live and online engagement events can be used by the city to validate the assumptions used in the comprehensive sea level rise planning process and other related planning and policy processes.

Despite efforts by the City and The Miles Agency to promote the Flood Resilience Game Nights to improve participation beyond the typical turnout for public meetings, participation of residents was low with a total participation of less than 1% of residents. The characteristics of participants who completed demographic questionnaires were almost equally split by gender (female 47%, male 53%), but they were mostly white (90%), older than 45 years of age (77%), highly educated, with 75% reporting earning at least a bachelor's degree, and long-term residents of Hampton Roads (85% having lived in Hampton Roads 11 years or more). While the engagement efforts were not able to reach a representative group of Virginia Beach residents, the live Game Night and online formats were able to capture a fairly wide group of concerned residents.

Most of the participants clearly perceived themselves to be personally vulnerable to flooding and have experienced the impacts of sea level rise. The majority (55%) also believed that they were informed about increasing flooding and causes in Hampton Roads.

Flood tolerance was evaluated in the context of road flooding encountered during travel to work, school or an appointment and in the context of flooding on residential property. In the context of road flooding, participants were less willing to drive through a flooded roadway as the level of flooding in the roadway increased. A similar result was found in the context of flooding on residential property; as the flooding level increases, comfort levels decreased substantially.

When considering adaptation to flooding, top preferences for adaptation options given the limited amount of public funding were for stormwater improvements and natural solutions.

There was also some preference for the constructed solutions of elevating roads and buildings, storm surge barriers, and levees/floodwalls. The planning and management approaches in which participants expressed the most interest were preservation of open space through zoning, establishing higher building standards and codes, and flood proofing of houses and reduction of flood impacts. There was lower preference for buy-out of houses at risk of flooding and implementing flood warning systems.

The top individual actions participants were most willing to take included talking to public officials, installing rain-gardens or other landscaping, and investing in home flood-proofing. Purchasing of flood insurance, and talking to family and friends were lower priority actions based on participant responses.

Participants indicated that they were very interested in knowing more about what the city is doing to address flooding. They also were interested in understanding the impacts of increased rain and storms, what they can do to adapt and prepare, the causes of sea level rise and flooding, and nuisance flooding and minor flooding.

Participants were very interested in identifying community assets and community challenges, including identifying travel disruptions. Over 300 regional assets have been located on the Community Resilience Map and travel disruptions identified will be valuable to the city in future planning.