



IMPACT PLANNING • EVALUATION • AUDIENCE RESEARCH



SUMMATIVE EVALUATION

CLIMATE CHANGE AND RESILIENCY

Prepared for
Science Museum of Virginia
Richmond, VA

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SUMMARY AND DISCUSSION

This report, prepared by RK&A, Inc., presents results from a summative evaluation of five climate change and resiliency programs at the Science Museum of Virginia (SMV). The summative evaluation is the culmination of a three-year grant from the National Oceanic and Atmospheric Administration (NOAA)—front-end and formative evaluations were completed in the two years prior. The five programs tested in the summative evaluation include the Digital Dome’s “Cosmic Climate Cookbook” video; the Extreme Event Challenge; Science on a Sphere; Ready Rowhomes “Preparing for a Wetter, Hotter Virginia” program; and the Climate Connections Lecture Series. The goal of this evaluation is to test the extent to which these programs achieved the intended visitor outcomes defined in SMV’s Impact Framework (summarized below).

SMV IMPACT FRAMEWORK

AWARENESS/KNOWLEDGE/ UNDERSTANDING

Increase participants’ awareness and understanding of:

- Climate change science
- The relationship between natural and human-induced heat-trapping gasses and climate change
- The concept of resiliency relative to climate change impacts in Virginia.

ENGAGEMENT/INTEREST

Increase participants’ interest in:

- Using scientific data to inform personal actions they may take to increase personal and community resiliency.

ATTITUDE

Help participants recognize that:

- Climate change is impacting their lives now and will continue to impact Virginia in the future
- They can do something about becoming ready and resilient to climate change impacts in Virginia.

BEHAVIOR

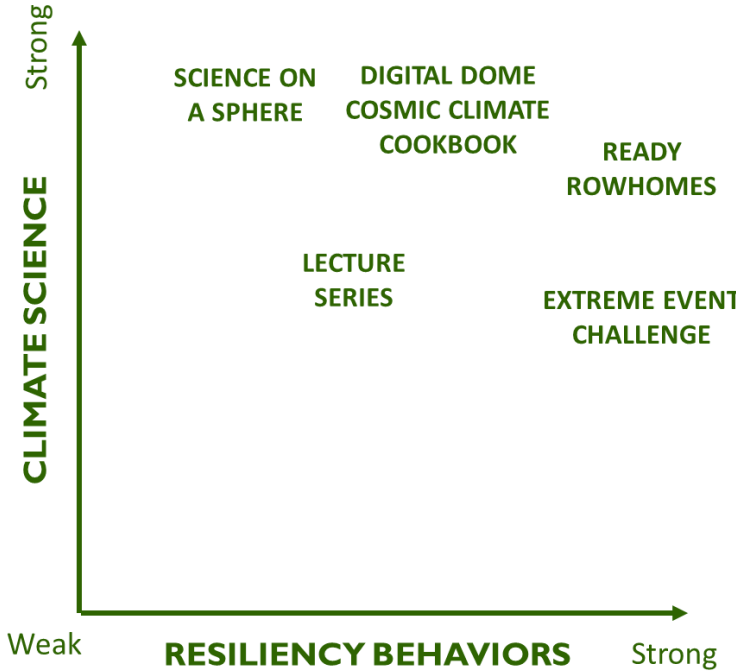
Help participants:

- Make informed decisions and take steps to become more resilient to the effects of climate change in Virginia (thereby increasing the overall resiliency of communities across the Commonwealth)

RK&A conducted observations of each program evaluated, interviewed 52 program participants about their experiences, and interviewed five SMV staff to better understand internal perspectives about the successes and challenges of the programs evaluated. Results indicate SMV has made significant strides in its climate change and resiliency programming over the course of the front-end, formative, and now summative evaluations. As staff explained in interviews, they revised the programs significantly over time to help strengthen the connection between climate change and resiliency for visitors. SMV discontinued some programs (Challenge Lab Water Filtration Activity and the Eco Lab Solitary Bee Nest Activity) when formative evaluation showed that these programs were not contributing to visitors achieving their intended outcomes, and revised others (the Digital Dome Cosmic Climate Cookbook, Extreme Event Challenge, and Science on a Sphere) to strengthen their messaging based on recommendations from the past evaluations.

Overall, summative results indicate that the programs evaluated are largely successful in achieving their intended outcomes, with a few limitations. The Digital Dome video and Science on a Sphere presentation were particularly effective in communicating climate science by translating complex concepts with clear language and data visualizations, while the Extreme Event Challenge and Ready Rowhomes programs were successful at increasing awareness of and interest in climate resiliency behaviors. The Lecture Series demonstrated the reality of climate change through data-driven presentations, although some of these were too academic for a general museum audience. Together, the suite of climate change and resiliency programming offered by SMV provides a complementary balance of climate science and resiliency concepts (see graphic on the following page, and heat maps in Appendix B). One area for continued growth for SMV is working to battle the sense of hopelessness that sometimes accompanies addressing a problem at the scale of climate change. In particular, visitors need help to understand the value of individual action in making an impact on climate change.

PROGRAM STRENGTHS REGARDING CLIMATE SCIENCE AND RESILIENCY¹



In the discussion below, we explain in detail how each of the programs fared in light of the visitor outcomes identified in SMV’s Impact Framework. The framework is guided by the National Science Foundation’s Framework for Evaluating Impacts of Informal Science Education Projects categories of awareness/knowledge/understanding; engagement/interest; attitude; and behavior; and we discuss each program with this framework in mind.

The findings presented here are among the most salient. Please read the body of the report for a comprehensive presentation of findings by methodology.

¹ SMV’s Impact Framework outcomes generally supported concepts of climate science and/or resiliency behaviors. Considering each program’s achievement of its intended outcomes for visitors (as presented in the heat maps in Appendix B, programs were plotted into the graph to reflect the extent to which the program supported climate science and/or climate resiliency concepts for visitors.

DIGITAL DOME COSMIC CLIMATE COOKBOOK

Visitors responded quite positively to the Cosmic Climate Cookbook video shown in the Digital Dome theater, particularly noting its clear presentation of complex scientific information and its striking visuals displayed on a larger-than-life screen. Both visitors in adult-only groups and groups with children felt the video took a complicated subject like climate science and translated it into terms they could understand by visualizing the data and showing trends over time. As a result, the majority of visitors come away with the understanding that humans have contributed significantly to climate change, one of the intended outcomes from the Impact Framework. Almost one-half of visitors understood that there are certain key elements of the Earth’s atmosphere that make it habitable (compared to other planets, like Mars), and that a delicate balance needs to be maintained to keep Earth as a livable planet. Although few visitors used the terms “recipe” or “cookbook” when talking about these ideas, the presentation of this information through the lens of a cookbook appears to have been an effective approach. Notably, staff also expressed a great sense of pride in the production of the Cosmic Climate Cookbook, with one describing it as “the biggest undertaking the museum has ever done,” in terms of creating a fully-produced, 30-minute media piece.



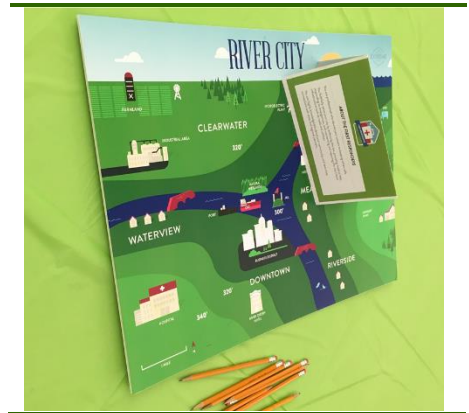
While the video is effective in communicating key climate science concepts, it also generated concerns for some visitors. Based on feedback from the formative evaluation, the museum added additional content about actions people can take to mitigate the effects of climate change, such as recycling and buying local foods. Responses indicate many more visitors came away with ideas about changes they could make to their daily lives to respond to climate change. However, a few visitors said they felt “hopeless” and skeptical that these actions would not have a significant impact. Similarly, information about the effects of climate change, such as rising temperatures and sea levels, made some visitors concerned about what environmental issues future generations will face. Generating a certain level of concern about climate change is necessary, given the urgency of the issue, but climate science communicators also face the challenge of balancing concern with a sense of agency and empowerment that individuals can make a difference.² We know from the front-end and formative evaluations that convincing individuals that their actions matter is a recurring hurdle because climate change is such a monumental challenge to address. As we discuss later, it may help for visitors to have an opportunity to observe the potential impacts of their behavior in order to understand the value of their actions, as became clear in the Ready Rowhomes activity when participants were inspired by the clear impact of adding green infrastructure in the extreme heat and rain simulations. In the context of the Digital Dome, perhaps adding examples of small-scale individual or community initiatives that have seen measurable results in mitigating humans’ effects on the environment could serve a similar function—local examples would have the added benefit of making climate change feel like a personal issue rather than a “far away concept.” It may not be

² Chadwick, Amy. “Climate Change Communication,”

feasible to change the Cosmic Climate Cookbook video, but a supplementary discussion with slides following the video could be one way to deliver this additional information to visitors.

EXTREME EVENT CHALLENGE

Findings indicate the Extreme Event Challenge is a fun and social experience for visitors that raises awareness of the many challenges that come into play when responding to an extreme weather event. The presentation before the activity, which provided foundational knowledge on weather, climate, and climate change, helped visitors make the connection between climate change and extreme weather events. This is promising growth, since the formative evaluation of the Extreme Event Challenge found that visitors were struggling to make this connection when the activity was paired with the Science on a Sphere presentation. In interviews, staff discussed an intentional shift to using the word “resiliency” many times during the presentation and discussion, and making explicit the direct links between climate change and extreme weather.



Moreover, both the Extreme Event Challenge activity and the group discussion afterwards helped visitors recognize the importance of emergency preparedness in advance of extreme weather events, both at an individual and community level. For example, assigning various roles to participants (e.g., local government officials, emergency responders, community members) allowed them to understand some of the decision-making around managing resources in an emergency. The discussion afterward provided time for visitors to reflect on the importance of building relationships for strong lines of communication during an emergency.

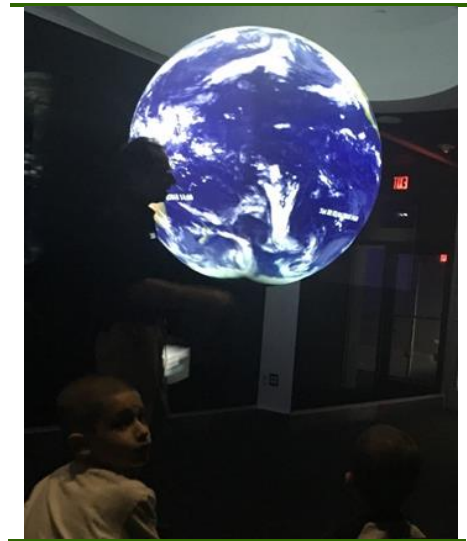
Many said the choice of using a flooding event made the activity feel relevant to the Richmond area because the city is located on a river, another area of growth from the formative evaluation. The current program has added climate data specific to Richmond and explicitly asked visitors to keep in mind that the extreme weather situation could potentially happen to Richmond in the future. By spelling out the local connections, most visitors were able to recognize ways climate change might impact their lives, whether through creating a preparedness kit for an extreme event, advocating for leadership that values environmental sustainability and emergency preparedness, or anticipating how flooding might impact their property.

The Extreme Event Challenge was an enjoyable and enriching experience for those who attended the program—the museum’s biggest challenge is generating interest in participating in the program. For example, during the April program, only about one-half of those who signed up to participate in the program actually attended, even with the incentive of receiving a free tree to take home with them. During staff interviews, one voiced frustration with marketing efforts within the museum (or lack thereof) for the program. The museum has discussed the potential for marketing the Extreme Event Challenge as a team-building opportunity for local

organizations and businesses—we recommend pursuing this avenue, as participants valued the social, team-building, and problem-solving aspects as highlights of the program.

SCIENCE ON A SPHERE

Similar to the Digital Dome, Science on a Sphere offers a highly visual way to communicate to visitors about climate science. Visitors find the sphere an engaging format and said the animations displayed on the sphere make climate change concepts easier to understand. Notably, many visitors said they thought about the evidence scientists use to understand climate change as they viewed the Science on a Sphere presentation, and how climate change science is supported by many different data sets. This is encouraging, as sometimes presenting data to the public can make them feel overwhelmed or confused. Instead, the presentation gave visitors the sense that the data was all building toward scientific consensus around climate change. This supports our findings from the formative evaluation, that effective visualizations like those used in Science on a Sphere can communicate complex ideas and information about climate change and the science behind it by presenting this information in a more easily digestible way. Additionally, the museum strengthened the Science on a Sphere program’s messaging around Virginia’s climate since the formative evaluation, with many more visitors recalling information about Virginia or Richmond’s climate in the summative interviews. Visitors also universally praised the Science on a Sphere facilitator(s) for making the information feel accessible by being approachable and willing to answer any questions the audience had.



Findings indicate that while the Science on a Sphere presentation was effective in communicating climate science, communicating about the personal effects climate change and climate resiliency remains challenging—this supports our findings from the formative evaluation. In particular, participants either did not recall hearing about resiliency behaviors, or, similar to the case with the Digital Dome’s Cosmic Climate Cookbook, they were skeptical that the solutions offered to mitigate the effects of climate change would make a “meaningful” impact on the problem. The Science on a Sphere presentation is brief, so it seems unlikely that adding more content on resiliency would be feasible or an effective use of time. Instead, this recurring theme of “hopelessness” about individual impact speaks to a larger issue with climate change and resiliency communication. More research may be needed to understand the most effective ways to communicate to the public about the significance and impact of individual and community action on climate change.

Finally, another challenge of the Science on a Sphere program revealed in the observation and staff interviews is increasing attendance, and then keeping visitors through the whole presentation. The location of the Science on a Sphere program is somewhat tucked away, and

some visitors said it was difficult to find, which may be leading to low program attendance. Furthermore, one staff member said the presentation seems to work best with young professionals and retirees, but can be too complex for families with young children (who made up the majority of the audience during the observed program). As a result, young families sometimes leave before the presentation is over, and thus, miss out on most of the discussion about resiliency behaviors. The museum may want to consider ways to raise visitors' awareness of the location of the Science on a Sphere program, and, if young families are an intended audience for this presentation, think about ways to make the presentation more accessible to children.

READY ROWHOMES

Interviews with participants in the Ready Rowhomes program, “Preparing for a Wetter and Hotter Virginia,” indicate the program clearly communicates climate science and resiliency concepts. In particular, responses indicate that the presentation at the beginning of the program provided key foundational knowledge about climate change using data points specific to Richmond, as well as identifying some characteristics of urban environments that make them more susceptible to flooding (e.g., a concentration of paved surfaces) and heat islands (e.g., lack of tree canopy). The maps of Richmond showing heat islands were memorable for participants, and a few vividly recalled hearing about how these heat island areas also overlap with areas with higher instances of health vulnerabilities.



The Ready Rowhomes activity using model homes to test the effects of green infrastructure on extreme rain and heat events provided “convincing” evidence to participants of the benefits of adding green infrastructure to buildings. Participants appreciated the hands-on nature of the activity, the clear and observable results, and the fact that they could easily apply these concepts in their own homes and communities. In this way, the Ready Rowhomes activity stands out because participants felt empowered that they could take and apply the actions they heard about to make a difference they felt was meaningful—something that the Digital Dome program and Science on a Sphere struggled to do. Staff posit, and we agree, that “doing and seeing” (i.e., participants simulating climate resiliency actions and immediately observing the stark results those actions could have) helped drive home the impact personal actions can have and was a convincing motivator for behavioral change.

While the results of the Ready Rowhome program were promising, it should be noted that the interview sample size is small and participants of the program were members of an Urban Gardener program at Lewis Ginter Botanical Garden—a program that fosters community organization around urban greening and beautification—rather than the general museum visitor population. Individuals in the Urban Gardener program are already taking action toward

environmental projects in the community, and thus may be predisposed to adopt other resiliency actions. Museum visitors may not have the same enthusiasm as the participants interviewed, but nevertheless, the program seems to have a high potential for communicating the impact of climate resiliency behaviors, like adding green infrastructure, on the environment.

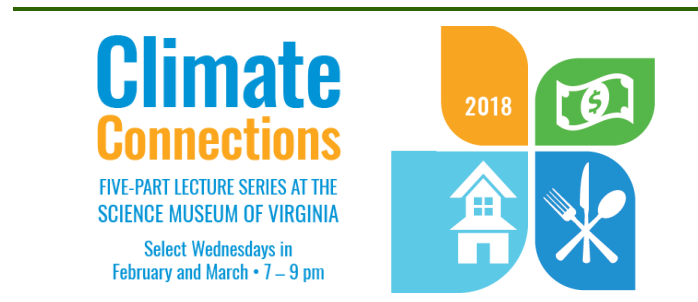
CLIMATE CONNECTIONS LECTURE SERIES

Visitor response to the lecture series was positive overall, with some caveats. Interviews indicated that visitors enjoyed the use of data in the lectures because it grounded the presentations in facts, and data visualizations made concepts easier to understand. Many visitors underscored that the information they heard during

the lecture reiterated that climate change is “real” because it was supported by data—a key outcome in the Impact Framework. Findings from the lecture series (and other programs evaluated in this report) indicate presenting data is important, particularly when communicating to climate change skeptics, because it helps to assuage concerns that a presenter is just “being political” or pushing an “agenda.” A few visitors pointed out that presenting data allows visitors to draw their own conclusions, rather than trusting in someone else’s interpretation.

It is also promising that many visitors made connections to how climate change affects Virginia, with flooding being the most commonly cited effect on the local environment. It is not surprising that flooding was top of mind for visitors, not only because one of the lectures was specifically about flood hazards in Virginia, but also because we know from the front-end and formative evaluations that flooding is one of the effects of climate change visitors are already more conscious of (likely due to Virginia’s coastal location). However, findings indicate the lectures also communicated other effects of climate change on Virginia, such as effects on local fish populations and farming.

Inclusion of data in the lectures was a strength, but also a distinct weakness of some of the lectures. Visitors complained that certain presenters sometimes got “too far down in the weeds” with the details of the data and communicated at a technical level above that of the general public they were presenting to. When the lectures went into too much detail, visitors tended to lose sight of why the information should matter to them. Conversations with staff after the observed lecture indicated they agreed that lecture was not as accessible and relevant to visitors as they anticipated. One visitor made a valuable suggestion that the museum may want to provide more explicit guidance to presenters about considering their audience and the information the museum wants visitors to leave with, such as “Why is this information important to me?” Science communication is not easy, especially when focusing on a complex and politically-charged issue like climate change. Striking a balance between providing data and keeping the information accessible is a constant challenge, but an important one for helping



visitors feel like they are shaping their own conclusions about the reality of climate change and its impact on their lives.

STUDY BACKGROUND

The Science Museum of Virginia (SMV) contracted RK&A to conduct a summative evaluation of its NOAA-funded climate change and resiliency programming. The goal of the evaluation is to test the extent to which each program achieved the intended impacts as articulated in the Education Outcomes Impact Framework.

The Education Outcomes Impact Framework was developed using the National Science Foundation's Framework for Evaluating Impacts of Informal Science Education Projects (see Appendix A).³ Using the framework as a guide, this evaluation explores the extent to which each program meets the following intended outcomes:

AWARENESS/KNOWLEDGE/ UNDERSTANDING

Increase participants' awareness and understanding of:

- Climate change science
- The relationship between natural and human-induced heat-trapping gasses and climate change
- The concept of resiliency relative to climate change impacts in Virginia.

ENGAGEMENT/INTEREST

Increase participants' interest in:

- Using scientific data to inform personal actions they may take to increase personal and community resiliency.

ATTITUDE

Help participants recognize that:

- Climate change is impacting their lives now and will continue to impact Virginia in the future
- They can do something about becoming ready and resilient to climate change impacts in Virginia.

BEHAVIOR

Help participants:

- Make informed decisions and take steps to become more resilient to the effects of climate change in Virginia (thereby increasing the overall resiliency of communities across the Commonwealth)

³ See SMV's April 2015 NOAA grant application, page 5.

METHODOLOGY

RK&A observed five SMV programs related to climate change and resiliency between February and October 2018 and conducted telephone interviews with program participants. At each event, a data collector circulated a sign-up sheet to collect contact information from individuals 18 years and older who were willing to participate in a telephone interview. Within two weeks of each program, data collectors contacted participants via email to set up a telephone interview. Data collectors sent up to three emails to participants who signed up for an interview but did not respond to the initial email outreach. As a final step, data collectors tried contacting participants by phone to set up an interview. All participants were offered two free tickets to the Digital Dome in appreciation for their participation in an interview. Despite these efforts, data collection efforts were challenged by low response rates to outreach, and for some programs, a limited pool of participants to recruit from due to low participation in the programs themselves after bad weather impacted program attendance.

Data collectors conducted open-ended interviews about each program using an interview guide and asking probing or clarifying questions to better understand visitors' experiences. Data collectors typed notes during each interview, recording responses as close to verbatim as possible. RK&A conducted 52 interviews with participants who attended SMV climate change and resiliency programming—Digital Dome's "Cosmic Climate Cookbook" video (17 interviews); the Extreme Event Challenge (10 interviews); Science on a Sphere (7 interviews);⁴ Ready Rowhomes "Preparing for a Wetter, Hotter Virginia" program (5 interviews); and the Climate Connections Lecture Series (13 interviews).

In September 2018, RK&A conducted interviews with five SMV staff who have been a part of the core development team for the museum's climate change and resiliency programming to better understand internal perspectives about the successes and challenges of the programs evaluated.

⁴ Note that the Science on a Sphere program is a short (10-15 minute) drop-in program, unlike the other four programs evaluated, which were longer (30 minutes or more) scheduled events where advanced registration or reservations were encouraged. This likely impacted recruitment for interviews, as participants may have felt less invested in the program and/or less confident about providing program feedback.

DATA ANALYSIS AND REPORTING

The data are qualitative, meaning that results are descriptive. In analyzing the data, the evaluator studied the observation and interview notes for meaningful patterns and grouped similar responses as patterns and trends emerged. The objectives of the study, as well as our professional experience, informed the analysis. Findings are reported in narrative, supplemented with exemplary quotations from participants. Keep in mind that interviews were not audio-recorded and transcribed verbatim, and instead represent the data collectors' notes from the conversation.

Trends and themes in the data are presented from most- to least-frequently occurring. When describing the findings, this report uses qualitative data terms such as “most” and “several,” as is appropriate for the sample size and the type of data collected. Proportions, such as one-half or one-third, are used where appropriate. Such descriptive language is intended to provide readers with a sense of the general trends. For programs with a sample size of less than ten interviews, findings report the actual number of participants who provided a particular response. For some questions, participants mentioned more than one idea in their response, and thus, proportions may exceed 100 percent.

DIGITAL DOME INTERVIEW FINDINGS

RK&A observed a showing of “The Cosmic Climate Cookbook” video in the Digital Dome on April 2, 2018, and conducted 17 telephone interviews with participants about their experience.⁵ During “The Cosmic Climate Cookbook,” visitors watched a 30-minute video where visualizations of space, climate, and weather data were projected onto the large concave dome theater ceiling.

Of the participants interviewed:

- ◆ **Gender:** Most are female, and a few are male.
- ◆ **Age:** Participants range in age from 26 to 71 years old. The median age is 43.
- ◆ **Visit history:** All had visited SMV in the past, prior to attending “The Cosmic Climate Cookbook” video. Several are SMV members, and two volunteer at the museum.
- ◆ **Group composition:** Many attended the Digital Dome with other adults, and several attended with children (ranging in age from 2 to 15 years). Two attended alone.
- ◆ **Likelihood of future program participation:** Most participants said they were “very likely” to attend a future activity or workshop (at SMV or somewhere else) to learn about how to become more resilient to the impacts of climate change. A few said they were “somewhat likely” to attend a future activity, and one said they are “not at all likely” to do so.



⁵ 37 participants provided contact information during the event to participate in a telephone interview after the program. RK&A contacted all participants who provided contact information via email up to three times and once by phone attempted to set up interviews. 17 participants completed an interview, for a participation rate of 46 percent.

MOST ENJOYABLE

Participants were asked what they liked most about what they experienced during “The Cosmic Climate Cookbook” video. A few shared multiple ideas in their responses.

- ♦ **Clearly communicated complex topic:** One-half said they enjoyed how the video communicated a complex topic in a “clear, transparent way”—for example, defining scientific terms using language that is easy to understand. In particular, one said the way the information was organized (introducing a topic, explaining it, and then reiterating key points) made the concepts easier to understand.
- ♦ **Learning new information:** Several said they most enjoyed learning new information about Earth. A few shared details about Earth’s atmosphere, the ozone layer, and the elements required for life.
- ♦ **Visuals:** Several said they enjoyed the “vibrant” visual display, and said the Digital Dome setting felt immersive and interactive.⁶ A few said the graphics made the video easy to follow because they could visualize the scientific data.
- ♦ **Human connection to climate change:** Two said they liked that the video showed how Earth’s climate is “really affected by what we do.” They said they appreciated the end of the video describing actions individuals can take to respond to climate change, such as reducing plastic use and engaging in political advocacy.

AREAS OF CONFUSION/SUGGESTED CHANGES

Participants were asked if there was anything confusing about the video, or anything they would change about their experience with “The Cosmic Climate Cookbook” video.

- ♦ **Nothing:** Most said they found nothing confusing about the video.
- ♦ **Alternative theories of climate change:** Three said the video did not accommodate alternative beliefs about climate change. These participants perceived the video as “one-sided,” particularly regarding Earth’s age and origin, the natural factors involved in climate change, and the true level of impact humans have on Earth’s climate. Two of these said they would have preferred a “more balanced view” on climate change, or emphasis that human’s impact on the climate is “only one theory.”
- ♦ **Sense of hopelessness:** Two said the information about Earth’s environmental problems, such as melting ice caps and rising temperatures, felt “very depressing.” One said the information at the end of the video about actions they could take to mitigate the effects of climate change (e.g., recycling) was not enough to overcome this feeling.

⁶ A few reported feeling “motion sickness” from the presentation in the theater.

MAIN MESSAGE

Participants were asked what they thought was the big idea that SMV wants to communicate to participants through “The Cosmic Climate Cookbook” video. Many mentioned more than one main message in their response.

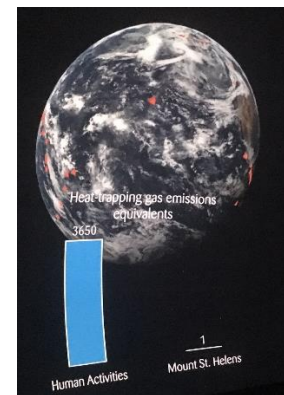
- ◆ **Human behavior affects climate change:** Two-thirds said the video’s main idea is to communicate that human behavior has an impact on climate change. Many of these said the video showed how humans have significantly contributed to climate change (e.g., through carbon emissions). Many of these also talked about how humans can “do our part” to reduce our impact; however, most spoke generally about “conservation” and “how we can do better to help the climate” but did not recall specific examples of actions they could take.
- ◆ **Earth’s delicate balance:** Nearly one-half said the main idea of the video was to communicate the factors that make Earth a livable planet and how small changes in these factors might make Earth uninhabitable. Few recalled the specific “ingredients” (energy, atmosphere, and liquid water) that make Earth habitable, but they recognized that there is a balance of factors or conditions that make Earth habitable.
- ◆ **Climate change is real:** One-quarter said the video communicated that climate change is “real, not fake,” and it is happening now. Most cited scientific data from the video, such as the graph showing the spike in carbon dioxide levels in recent history. As one participant put it, “It showed that climate change is something that is identifiable by scientific data...the graphs told a story.”

HUMAN IMPACTS ON CLIMATE

“[The main idea was] that we need to be, as human consumers, aware of climate change and that man is a contributing factor, and that we can all do our part to make the Earth live longer for future generations.”

KEEPING EARTH HABITABLE

“We need to be conscientious of what we do in our day to day lives and the way it affects the environment around us, especially as it relates to CO₂ levels and green house effects...[The video] talked about how Mars and Venus both had water at one point, and maybe had sustainable life. And though Earth is going through similar changes, the charts really showed the difference in CO₂ levels, and we’re accelerating the rate Earth is heating.”

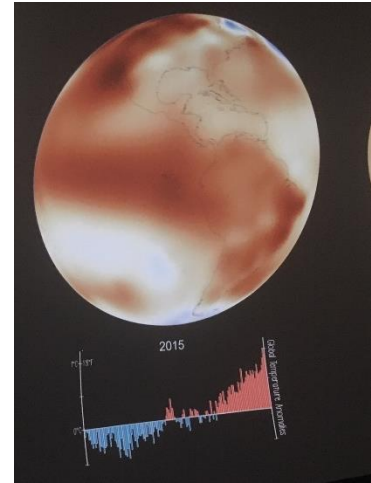


Output of heat-trapping gas caused by humans versus volcanic eruption.

PERSPECTIVES ON CLIMATE

Participants were asked how, if at all, the program made them think about the Earth's climate.

- ◆ **Better understanding of climate science:** One-half said they thought about some aspect of climate science, such as specific causes and effects of climate change and the relationship between rising temperatures and extreme weather. Several cited specific visuals from the video that made them think about the Earth's climate—for example, one said “looking at the image showing the change in global temperature over time...going from a mix of blue and red to mostly red, indicating an increase in temperature.”
- ◆ **Worry about Earth's future:** Three said the video made them uncertain about what Earth's climate will be like in the future. One said images of pollution from the video made them wonder about what kind of environment their grandchildren will inherit. Another said the solutions presented at the end of the video seem unviable, and thus made them think climate change will continue to get worse.
- ◆ **Earth's climate unique from other planets:** Two said the video made them think about Earth's “unique climate in relation to other planets,” such as Mars and Venus. This made them think about the importance of protecting Earth to keep it habitable.
- ◆ **Skeptical of Earth's fragility:** One said the video only focused on human causes of climate change, as opposed to natural causes, and overemphasized how fragile Earth's climate is. He said there are “many more factors” that affect climate change and that he felt the video was imbalanced.



Data visualization of rising global temperatures

UNDERSTANDING CLIMATE SCIENCE

“It made me think about the climate in terms of... it made more sense as to why we're having more extreme weather. It explained the fact that because ice is melting things are getting hotter overall. Hotter oceans cause more storms. And same thing with the winters, too. Typically, we wouldn't have the cold coming down this far for so long, but it's the whole planet and how things are changing that's causing all that. It's connected.”

CLIMATE CHANGE DATA

Participants were asked what, if anything, “The Cosmic Climate Cookbook” video made them think about the information scientists use surrounding climate change.

- ◆ **Did not think about this:** One-third said they couldn’t remember seeing or hearing anything in the video that made them think about information scientists use to understand climate change. One said this idea is something they wondered about during and after the video.
- ◆ **Climate data is reliable:** Over one-quarter said they thought about scientific data as a reliable source to understand our climate. A few talked about scientific consensus (i.e., that the data is “vetted” by many scientists) and how different strands of data support each other, such as data about rising sea levels paired with data about coastline change. However, a few of these said while they trust the data presented, they may not fully understand it.
- ◆ **Skeptical of climate data:** A few said they were not entirely convinced about the information presented in the video. One said there was “controversy” about how climate data is presented—for example, one explained, “I’ve heard a lot of statistics, and I go to YouTube and someone who isn’t supportive of climate change flips that statistic around to show how it might not really show what we think.”
- ◆ **Scientific technology:** One said it was interesting to think about the technology scientists use to gather their data (such as water levels and changing coastlines).

SCIENTIFIC CONSENSUS

“I felt what they used was thorough and reliable. They are getting their data from federal agencies, not just individual scientists gathering data. Once data gets to that point, you know that it has been vetted by many scientists and it is reliable.”

HOW CLIMATE CHANGE MAY AFFECT MY LIFE

Participants were asked how, if at all, the program made them think about how climate change might affect their life.

- ◆ **Concern for future generations:** One-third said the video made them think about how climate change might affect their children and grandchildren. Most of these also said they thought about the things they could do to mitigate climate change, in hopes of preserving the Earth for their children and grandchildren.
- ◆ **Did not think about this:** A few said the video did not make them think about how climate change might affect their lives.
- ◆ **Will not affect my life:** A few said they did not think climate change would significantly affect their lives. For example, one said they were skeptical that after “so many billions of years, then all of the sudden this can happen in the next 30 years.” Another said he had observed increased severe weather, but it had not directly affected him.
- ◆ **Developing or reinforcing resiliency behaviors:** A few said the video made them think about what they can do to counter the effects of climate change. Most spoke about conservation actions, such as recycling, reducing carbon emissions, installing solar panels, and collecting rainwater.
- ◆ **Effects of climate change:** A few described potential effects of climate change on their lives in detail, such as how rising sea levels and warming temperatures will change the shoreline’s geography or how extreme weather could impact Virginia.

CONCERN FOR FUTURE GENERATIONS

“It made me think a lot about it. I’m a new grandmother. What will my grandson be left with? It made me think of things I can do effect change, like my carbon footprint, the energy I use at home, walking rather than driving, recycling.

LIMITED PERSONAL EFFECTS OF CLIMATE CHANGE

“[Nothing] other than more severe disruptions in weather. So, between fire, temperature, storms...Those disruptions are disastrous for some and not for others. We live in an area where it’s not currently disastrous.”

PROGRAM IMPACTS ON BEHAVIOR

Participants were asked how, if at all, the video made them think about what they or their community can do to respond to, or be prepared for, the future effects of climate change. Participants were also asked if there were any actions they heard about during the video which they planned to adopt.

- ◆ **Adopt resiliency behaviors:** Many said the video made them think about making changes to their daily lives to respond to climate change—such as reducing single-use plastics, reusing grocery bags, driving a hybrid car, and taking shorter showers—or already do so. Many of these said they already knew about these measures before the video, but the video “started the conversation” again or reminded them of actions they could take. A few said they felt a renewed “sense of urgency” to take action within their spheres of influence.
- ◆ **Did not think about this/not concerned:** Several said the video did not make them think about this idea, or they could not remember any specific actions mentioned in the video for how individuals can respond to climate change.
- ◆ **Climate change conversations:** A few said the video encouraged them to talk about climate change with others, including family, friends, neighbors, and politicians. These participants noted that resiliency behaviors will have greater impact if more people adopt eco-friendly behaviors.
- ◆ **Engage children in resiliency behaviors:** A few spoke about the importance of involving children in understanding and responding to climate change. They described sharing resiliency actions with their children, or working together as a family to reduce waste and carbon emissions. One, who is an SMV member and attended the Digital Dome with her six-year-old child, tied their discussion of the video to a prior SMV exhibit involving animals sculpted from plastics found in the ocean.

RECYCLING PLASTICS

“[The video] talked about plastic and how plastic is a huge factor as something we could recycle. We talk a lot in our house about not buying single use plastics and recycling them...my daughter is very concerned about animals and sea life so we talk about how people not recycling means things end up in the ocean, and that hurts marine life. We tied that into an exhibit the science museum had last year, about all of the plastics from the ocean. They had turned [the plastic] into sculptures and things like that.”

WANTED MORE INFORMATION ON RESILIENCY ACTIONS

“I would have liked to see a little more detail. Especially since it's geared for kids, I would have liked to have seen more around what kids can do, how they can think about their daily lives, not wasting things, thinking about recycling, composting, all those types of things.”



Example of using reusable grocery bags instead of plastic

SHARING ABOUT THE PROGRAM WITH OTHERS

Participants were asked if they talked about their experience at the Digital Dome with others. Most said they had discussed their experience with someone else, either a friend, family member, or colleague. When asked what they said about their experiences, responses were mostly general.

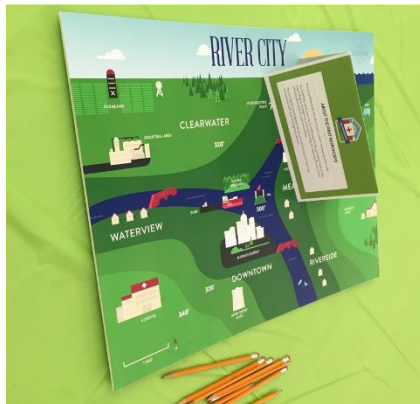
- ◆ **Enjoyed the video:** Over one-third said they talked to others about the video, and shared general information (e.g., that they watched the video at SMV and enjoyed it).
- ◆ **Key takeaways:** Several said they discussed a main takeaway from the video, including the importance of understanding climate change, information about Earth’s climate, or humans’ impact on the environment. A few also shared about resiliency actions that others could adopt, including reducing waste and carbon emissions and using rain barrels.
- ◆ **Invited others to visit SMV:** Several said they encouraged others to visit the museum or recommended others see “The Cosmic Climate Cookbook.”
- ◆ **Did not discuss:** Three did not discuss the video with anyone afterwards.

EXTREME EVENT CHALLENGE INTERVIEW FINDINGS

RK&A conducted 10 in-depth telephone interviews with individuals who participated in an Extreme Event Challenge event.⁷ The Extreme Event Challenge is a program where visitors participate in a natural disaster simulation scenario where they are assigned to neighborhood teams and have to try to prepare for and react to an extreme weather event by managing and coordinating their resources with other teams. Programs were hosted on April 4 and July 11, 2018.

Of the participants interviewed:

- ◆ **Gender:** More than two-thirds are female; less than one-third are male.
- ◆ **Age:** Participants range in age from 28 to 66 years old. Median age is 37 years.
- ◆ **Visit history:** Almost all had visited SMV in the past, prior to the program.
- ◆ **Group composition:** Most participants attended the program with a coworker, friend, or family member. Two attended alone.
- ◆ **Likelihood of future program participation:** All participants said they were “very likely” to attend a future activity or workshop (at SMV or somewhere else) to learn about how to become more resilient to the impacts of climate change.



⁷ 36 participants provided contact information during the event to participate in a telephone interview after the program. RK&A contacted all participants who provided contact information via email up to three times and once by phone attempted to set up interviews. 10 participants completed an interview, for a participation rate of 28 percent.

MOST ENJOYABLE

Participants were asked what they liked most about what they experienced during the Extreme Event Challenge.

- ◆ **Teamwork/social interaction:** Several participants said they liked working in a team during the Challenge because it encouraged them to work together to accomplish a goal and because they liked meeting new people at the event.
- ◆ **Problem-solving:** A few enjoyed practicing problem-solving during the Challenge. They said the unpredictability of the simulation and limited resources for each team forced them to think about “what would be most beneficial” during an emergency situation.
- ◆ **Fun:** A few said the Challenge was a “high-energy” and fun experience.
- ◆ **Learning new information:** Two participants said they appreciated learning new things during the Challenge. One spoke generally about “learning a lot,” while another said they learned about rain gardens and are now planning to build one on their property.



Teamwork during the Challenge

AREAS OF CONFUSION/SUGGESTED CHANGES

Participants were asked if there was anything confusing about the program, or anything they would change about their experience in the Extreme Event Challenge.⁸

- ◆ **Game instructions/logistics:** Several participants said communication between the program staff and participants could have been improved in some way. Two specified that it was sometimes difficult to hear instructions from SMV staff above the noise of other participants during the Challenge. One suggested adding visual cues as part of the slideshow to help explain the parts of the Challenge, such as the emergency events, as they happened. Another participant said more explanation of the available resources for each team would have improved the experience.
- ◆ **Nothing:** Several said they were not confused and would not change anything.

⁸ One participant suggested having more vegan and vegetarian options for refreshments.

MAIN MESSAGE

Participants were asked what they thought was the big idea that SMV wants to communicate to participants through the Extreme Event Challenge.

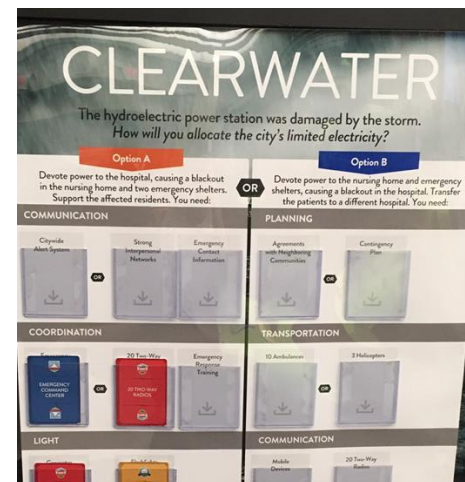
- ♦ **The importance of emergency preparedness:** Almost all participants said the Challenge was meant to communicate the importance of being prepared for extreme events. Most said the simulation helped them feel better prepared for what could happen “in real life” during an extreme event and raised their awareness of what kinds of resources are important to have and which local agencies would support the community during an extreme event. A few said the discussion after the Challenge also communicated this message.
- ♦ **Cooperation:** One-half said the museum wanted to demonstrate the importance of cooperation. These participants said the simulation showed how cooperation between neighbors, agencies, and governments was crucial, both during the Challenge and in the real world.
- ♦ **Climate change awareness:** Two participants said SMV was trying to communicate climate change awareness through the Challenge. They said helping participants understand climate change and the effects humans have on the environment could prepare them for an extreme event. Both said the presentation at the beginning of the program communicated this idea.
- ♦ **Advocacy:** One said the Challenge helped them better understand the importance of advocacy in encouraging local, state, and federal officials to prioritize emergency preparedness for an extreme event. They said the discussion following the Challenge helped communicate this message.

CONNECTING CLIMATE CHANGE TO EXTREME EVENTS

“When we started off and had the talk about weather and climate change, it was giving us a deeper understanding of what’s really happening in the environment, and getting us ready for the simulation of event that could happen. And the [simulation] was a demonstration of what could actually happen in real life. It was a great segue from straight information, to examples, to a learning experience.”

EMERGENCY PREPAREDNESS

“Just showing people that these events that we hear about all the time do have real world implications, and really how to see from a city-planning level down to a very personal level, how to react and what to expect in these situations.”



Simulating flooding event and resource management

PERSPECTIVES ON CLIMATE

IN GENERAL

Participants were asked how, if at all, the program made them think about the Earth's climate.

- ◆ **Extreme weather:** Many participants said the Challenge made them think about extreme weather events (five of these thought about flood events; two thought about rising temperatures). Most of these said they had observed increased extreme weather events, but a few did not know much about the “technical” reasons behind them before.
- ◆ **Preparing for the effects of climate change:** A few said the program reminded them there are things they can do to prepare for extreme events (e.g., preventing erosion during extreme rain events by planting rain gardens or having an action plan for weather emergencies).
- ◆ **Climate change is fact-based:** Two said the program showed how climate change is based on facts and data, particularly shown in the slide presentation at the beginning of the program.
- ◆ **Climate science basics:** Two said they were already familiar with many of the climate concepts discussed, but noted that the program communicated basic information about climate science (such as the difference between weather and climate) in an easily understandable way for participants.

RISING TEMPERATURES

“I have my own theories about the climate changing, but I didn't know all the technical things about climate. I've had my suspicions about climate, that it's been getting hotter each year and staying hot longer. This confirms my suspicions and makes me aware.”

CLIMATE CHANGE IS FACT-BASED

“Right now, a lot of this stuff is being politicized, but putting that information in front of people makes it clear that this is just facts. People say things to try to hide the truth, but this is raw data, it's fact. And if people that were there [at the Challenge] were on the fence about whether climate change was a hoax, that would have really helped them understand.”

IN VIRGINIA

Participants were also asked how, if at all, the program made them think about Virginia's climate.

- ◆ **Extreme events in Virginia:** Many said the discussion following the Challenge gave them a better understanding of the possible extreme events which could occur in Virginia, specifically in the Richmond area. They spoke about flooding, erosion, and pollution in the area, particularly in Shockoe Bottom. Interestingly, three of these participants said they had recently moved to Richmond and this discussion helped them feel more familiar with the geography and history of Richmond, as well as feel prepared for possible extreme events.
- ◆ **Data about extreme events:** A few participants said seeing data and examples during the lecture and slideshow prior to the Challenge helped them understand possible extreme events in Virginia, particularly flooding in Richmond.
- ◆ **Less volatile than other places:** Two said while there are indeed changes in the climate, Virginia is a "good place to live" because it has fewer extreme changes compared to other states.

EXTREME FLOODING EVENTS

"I'm relatively new to Richmond, I moved here about four years ago, but I've heard a lot about the flooding problems. I've seen photos of flooding. It's a place that can suffer a serious flood, especially places like Shockoe Bottom. This [simulation] is perfect because it's something we might really encounter."

HOW CLIMATE CHANGE MAY AFFECT MY LIFE

Participants were asked how, if at all, the program made them think about how climate change might affect their life. When responding, most spoke about extreme events rather than climate change, implying that they understood that extreme events are caused by, or at least connected to, climate change.

- ◆ **Extreme event preparedness:** A few participants said the Challenge made them think about how to be prepared for a real extreme event. Participants said they realized they needed a plan and emergency supplies in case a flood or other event occurred in Richmond.
- ◆ **Personal property:** A few spoke about possible effects of extreme events to their personal property, such as flooding and erosion. These participants talked about wondering whether their current home or future property could be located in a flood plain, and ways they can add specific types of plants on their property to mitigate erosion, absorb water, and reduce runoff.
- ◆ **Advocacy and city infrastructure:** A few said they were inspired to advocate to local officials for additional extreme event preparedness measures. These participants said it was important to know which groups or politicians support environmental sustainability, and to support them to continue that work to create city infrastructure that can better manage an extreme event.
- ◆ **Concern for future generations:** Two said they were concerned for future generations due to the extreme events caused by human impact on climate.
- ◆ **Not concerned:** One participant said they were not “overly concerned” about the effects of climate change on their life.

PREPAREDNESS AND PLANNING FOR EXTREME EVENTS

“The thing it made me think about is emergency preparedness and planning. I’m new to Richmond so it made me focus my attention on things I might need to know as a new resident. Knowing who my local politicians are. I’m looking to purchase a new home, so knowing where its situated in the flood zone or not. Thinking about flood insurance and the cost associated with that.”

PROGRAM IMPACTS ON BEHAVIOR

Participants were asked how, if at all, the program made them think about things they or the community can do to respond to, or be prepared for, the future effects of climate change. Participants were also asked if there were any actions they heard about during the program which they planned to adopt.

- ◆ **Personal preparation:** Several participants said the Challenge and the following discussion made them think about ways they can personally be better prepared for an extreme event. Some spoke generally about having a plan in case of an extreme event. Others talked specifically about packing important materials in waterproof containers, planning a chain of communication between friends and family, and having medical supplies and food in an accessible storage location.
- ◆ **Personal property:** A few spoke about changes to personal property they planned to make as a result of participating in the program. These participants all spoke about installing rain gardens in their yard or planting native species which could help absorb more water than grass in a flood situation. One participant was also researching how to install solar panels on their home as an alternative source of energy.
- ◆ **Concern for disadvantaged community members:** Two participants expressed concern for disadvantaged community members who may be more susceptible to the effects of climate change and extreme events. They said the Challenge and following discussion made them think about specific resources needed for elderly and low-income community members.
- ◆ **Knowing neighbors:** Two participants highlighted the importance of knowing their neighbors, or more generally others in the community, to look for support in the case of an extreme event.

PREPAREDNESS AT HOME

“Making my own survival kit at my home, making sure my supplies are in a go-bag, knowing I have stuff to take with me, first aid kits. Playing the game and realizing that not everybody had the resources they needed made me reflect on whether I have the basic necessities: bottled water, flashlight. Thinking about things like if people were trapped in the schools, how that would affect my family?”

SHARING ABOUT THE PROGRAM WITH OTHERS

Participants were asked if they talked about their experience at the Extreme Event Challenge with others. Nine out of ten said they had discussed their experience with someone else, either a friend, family member, or colleague. When asked what they said about the program, responses were mostly general.

- ◆ **General information about the program:** Several said they described the simulation, the lecture, and discussion.
- ◆ **Key takeaways:** Several said they discussed the main takeaways from the program, including the importance of having an emergency plan and certain plant species which absorb moisture and reduce erosion. Two of these said they posted about their experience on Facebook.
- ◆ **Fun:** Two said they told others about the fun experience they had participating in the Challenge.
- ◆ **Invited others to a future program:** Two said they invited friends or family members to join them at a future Extreme Event Challenge.
- ◆ **Did not discuss:** One did not discuss their experience at the Challenge with anyone afterwards.

SCIENCE ON A SPHERE

RK&A conducted seven telephone interviews with individuals who attended a drop-in Science on a Sphere presentation between April and October 2018. The Science on a Sphere presentation is a 20-minute presentation on climate change and resiliency, using weather patterns and data visualizations projected on a globe, paired with a PowerPoint slide presentation.

Of the participants interviewed:

- ◆ **Gender:** Five are female, two are male.
- ◆ **Age:** Participants range in age from 29 to 53 years.
- ◆ **Visit history:** Five had visited SMV in the past. Two had never visited before.
- ◆ **Group composition:** All attended the program in a social group of friends and/or family. All were adult only groups except one visit group with a 10-year-old child.
- ◆ **Likelihood of future program participation:** Four said they were “very likely” and three said they were “somewhat likely” to attend a future activity or workshop (at SMV or somewhere else) to learn about how to become more resilient to the impacts of climate change.



MOST ENJOYABLE

Participants were asked what they most enjoyed about the Science on a Sphere presentation and why. Many participants named more than one thing they liked about the presentation.

- ◆ **Visual appeal:** Most said their favorite part of the presentation was seeing the animations on the globe. Some liked the globe because it was unusual (not a flat screen) and others talked about how it was an effective way to show information about weather and climate. For example, one recalled watching the paths of hurricanes displayed on the globe.
- ◆ **Asking questions:** Four said they appreciated the chance to ask questions of the presenter at the end of the program—they described the presenter as knowledgeable and open to answering a wide variety of questions. For example, one said, “[the presenter] was very approachable and my 10-year-old son even asked questions, which is very unusual.”
- ◆ **Climate change information:** One said she liked hearing the information about climate change, and found it very convincing—particularly because there were examples of data from Richmond for context. She said, “It was an eye opener. I always thought global warming was a hoax. But now I think there may be some truth to it.”

AREAS OF CONFUSION/SUGGESTED CHANGES

Participants were asked if there was anything confusing, or anything they would change about the Science on a Sphere program:

- ◆ **Nothing:** Four said nothing was confusing or needed to be changed.
- ◆ **Awareness of program:** Two said they just happened to wander in to the program, and wondered if many people knew the program was there. Both of these said they enjoyed the presentation a lot and hoped others weren’t missing out on it due to lack of awareness that the program is offered.
- ◆ **Tailor to audience:** One said the program they attended only had four people in the audience, and all knew quite a bit about climate change already. She said the presenter could have tailored the presentation with this in mind to skip over simpler concepts and “differentiated for a group of people who already know a lot about climate science.”

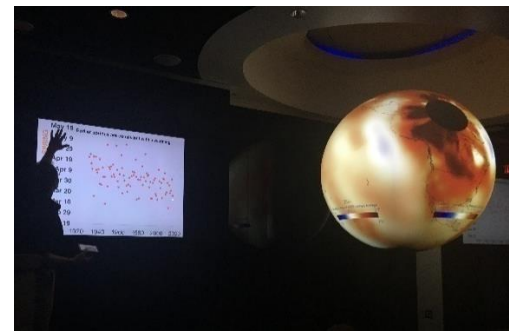
MAIN MESSAGE

Participants were asked about their perception of the “big idea” that the museum hoped to communicate through the Science on a Sphere program, and what prompted them to think of those ideas. Some participants shared more than one main idea.

- ♦ **Causes and effects of climate change:** Three talked about the main message of the presentation in terms of causes and effects of climate change. Two of these mentioned specific effects of climate change—changing weather patterns and rising sea levels—and said they thought about things they could do to mitigate climate change (suggesting they recognize that human behavior impacts climate). One spoke more generally about “being aware of what we’re using, energy-wise, to respect our planet.”
- ♦ **Climate change is fact-based:** Three said the main message they took away was that climate change is “real,” “fact-based,” and supported by “many scientists.”
- ♦ **Science is accessible:** One said their main takeaway was that “science is for everyone, not just scientists.” They described the presentation as “accessible” and “interactive” in a way that made the information understandable in “layman’s terms.”

CONNECTING CLIMATE CHANGE TO EXTREME EVENTS

“[The presentation] was about how the consensus among scientists is that the earth is getting warmer and to show the difference between weather and climate... One thing that stuck out to me was a time lapse of average temperature of the Earth over time and whether each year was hotter or colder than the average. So, he showed it was close to the average until the industrial revolution, and then every single year was hotter in the last 15 years, except during the polar vortex. Seeing all that red on the globe was striking.”



Globe shows above average temperatures in red over time.

PERSPECTIVES ON CLIMATE

IN GENERAL

Participants were asked how, if at all, the program made them think about the Earth's climate.

- ◆ **Evidence of climate change:** Five said they thought about the evidence (or data) used to understand climate change. These participants used words like “data,” “time-lapse” and “comparison graphs” when talking about the information they saw in the presentation to support the reality climate change. However, one said thinking about the limited history of weather data collection made him question whether the changes that have been documented are truly indicative of a shift, or if things are just “always changing, and there is no constant.”
- ◆ **Sea level rise:** Two said the presentation made them think about the issue of sea level rise specifically. One of these said she would not consider moving to a coastal town after the presentation, and the other said it made her think about regions around the world that “could be under water in the near future.”

IN VIRGINIA

Participants were asked how, if at all, the program made them think about the Virginia's climate specifically.

- ◆ **Coastal flooding:** Four said the presentation made them think about the effects of rising sea levels on the coast of Virginia. They talked about potential flooding in the Chesapeake Bay, Hampton Roads area, and Richmond as a result of sea level rise and extreme weather events like hurricanes.
- ◆ **Blurring of seasons:** One said she recalled the presenter talking about how Richmond is beginning to “lose its seasons” due to climate change.
- ◆ **Energy consumption in Virginia:** One said she recalled seeing information about levels of energy consumption in Richmond and Virginia and how that might be connected to climate.
- ◆ **Evidence of climate change:** One said he remembered the presenter talking about changes to Virginia's climate “from a statistics point of view” but could not recall specific effects on Virginia.

SEASONAL CHANGES IN VIRGINIA

“I've lived in Richmond most of my life, and I used to remember the four seasons as being very clear. We looked at some of the data from the hottest summers, and I can verify that data with my own memory. That was really interesting to compare these memories with the data about the last 15 summers that were the hottest on record.”

CLIMATE CHANGE DATA

Participants were asked how, if at all, the program made them think about the information scientists use to understand climate change.

- ♦ **Multiple points of data:** Five said that scientists use many different sources of information to understand climate change. A few of these said that because climate change is based on many data points, such as ice cores, hurricane frequency, temperature data, and fossil fuel use, the argument for climate change is stronger and less likely to be “made up.” As one said, “I already knew this, but came away with a stronger sense that it is a mass of data that is all saying the same thing.”
- ♦ **Presentation made data accessible:** Two said the way the data was presented made it easy to understand for “non-scientists.” The visualizations and the time at the end for questions and discussion contributed to making the data feel approachable.

HOW CLIMATE CHANGE MAY AFFECT MY LIFE

Participants were asked how, if at all, the program made them think about how climate change might affect their life.

- ♦ **Future generations:** Three said they thought there would be limited effects in their own lifetime,⁹ but worried about how climate change may affect future generations. One of these said he didn’t feel like the climate change is at a “critical mass” yet to where it would affect his life significantly.
- ♦ **Voting:** Two said the presentation reinforced for them the need to elect politicians who value climate change as an important issue.
- ♦ **Mitigation behaviors:** Two said they thought about actions they could take to slow climate change. One cited reducing their energy consumption, while the other spoke generally about “protecting the environment and the Earth for future generations.”
- ♦ **Moving out of Virginia:** One said attending the program sparked a conversation in her family, and as a result they are considering moving out of Virginia up to Vermont. She said her family dislikes the humidity in Virginia already, and it will only get worse over time with climate change.

MOVING AWAY FROM VIRGINIA HUMIDITY

“[The program] actually made a big difference. My family is considering moving up to Vermont, based on some of the graphs he showed, because of temperature change, weather change. It sparked a conversation for us. We are so tired of the humid and heat. It seems like it started back in February, and now it is October and we haven’t had cool fall weather yet. So, yeah, it has had a big influence.”

⁹ These participants were in their late 20s and early 40s.

PROGRAM IMPACTS ON BEHAVIOR

Participants were asked how, if at all, the program made them think about what they or their community can do to respond to, or be prepared for, the future effects of climate change. Participants were also asked if there were any actions they heard about during the presentation which they planned to adopt.

- ◆ **Solutions were not convincing:** Three said they heard about some actions they could take to respond to, or be prepared for, the effects of climate change; however, they were skeptical of whether these actions would truly make any difference. For example, one said even if the United States made changes, other countries like China would still be producing a lot of pollution. Another said she remembered hearing about reducing electricity, but said the presentation “didn’t give us examples of how to make a difference meaningfully.”
- ◆ **Did not recall:** Three said they didn’t recall any actions that would mitigate the effects of climate change from the presentation.
- ◆ **Voting:** One said she remembered hearing that it was important to elect officials who care about climate change. She also said having conversations with friends and encouraging them to vote for climate change could make a difference.

SHARING ABOUT THE PROGRAM WITH OTHERS

Participants were asked if they talked about their experience with the Science on a Sphere program with others.

- ◆ **General information about the program:** Three said they described the program to friends and family in general terms (e.g., described the sphere and enjoying the program).
- ◆ **Key takeaways:** Three said they shared key takeaways from the presentation with coworkers and family, such as the urgency of climate change and actions their family could take to reduce their impact. Two of these had concerns about bringing up climate change with others, and therefore talked around the subject instead—for example, one said “I said we have changing weather...I don’t want to bring up climate change [to my coworkers], so I let them take away from it what they want.”
- ◆ **Did not share:** One said they did not talk about the program with anyone else.

READY ROWHOMES

RK&A conducted five telephone interviews with individuals who attended a Ready Rowhomes workshop as a part of an Urban Gardener program at Lewis Ginter Botanical Garden.¹⁰ The Ready Rowhomes program, called “Preparing for a Wetter and Hotter Virginia,” aims to help participants understand how to leverage design, engineering, and natural landscapes to make houses more resilient to extreme heat and rain events by simulating these events using a model rowhome. Before the activity, a slide presentation introduced foundational information about climate science, urban heat islands, and extreme weather events, with examples from local data.

Of the participants interviewed:

- ◆ **Gender:** Three are female, two are male.
- ◆ **Age:** Participants range in age from 26 to 53 years.
- ◆ **Visit history:** Four had visited SMV in the past. One has never visited.
- ◆ **Group composition:** All participated as part of the Urban Gardeners program offered through the Lewis Ginter Botanical Garden.¹¹
- ◆ **Likelihood of future program participation:** Two said they were “very likely” and three said they were “somewhat likely” to attend a future activity or workshop (at SMV or somewhere else) to learn about how to become more resilient to the impacts of climate change.



¹⁰ Nine participants provided contact information during the event to participate in a telephone interview after the program. RK&A contacted all participants who provided contact information via email up to three times and once by phone attempted to set up interviews. Five participants completed an interview, for a participation rate of 56 percent.

¹¹ The Urban Gardener program teaches citizens not only how to garden, but also how to lead large-scale projects and coordinate volunteers. Trainees envision urban greening and beautification projects, learn how to develop and maintain them, and can then apply for local funding to carry the project out.

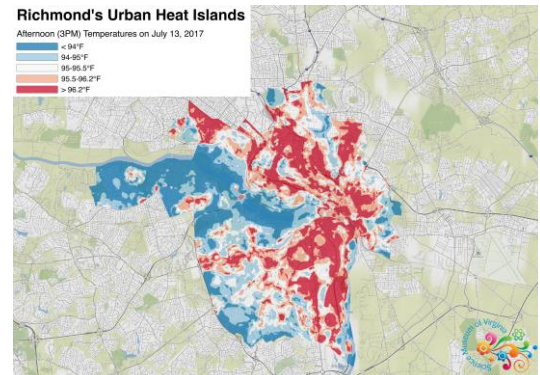
MOST ENJOYABLE

Participants were asked what they most enjoyed about the Ready Rowhomes program and why.

- ◆ **Observable results:** All said they liked the activity because it provided an alternative, “hands-on” way to illustrate the concepts introduced in the slide presentation at the beginning of the activity, with clearly observable results before and after adding green infrastructure to the model homes (e.g., reduced water levels in the sewer after adding rain gardens and rain barrels to the model rowhome). The activity was “to the point,” “solidified” their understanding of what they heard about in the presentation, and was “convincing” in showing the benefits of adding green infrastructure to buildings. For example, a heat gun showed a 20-degree difference in temperature between the light and dark roof materials when exposed to high heat, and participants greatly reduced the water that made it into the model home sewer after adding the rain barrels and sponges representing rain gardens.
- ◆ **Examples of mitigation:** Two said they liked that the activity provided concrete examples of things they can do to mitigate the effects of extreme heat and rain events. One said she came away knowing “changes I can make today,” like installing a rain barrel or planting a roof garden.

DATA VISUALIZATION

“I really appreciated a hands-on explanation for the urban heat island effect, which I understand on a conceptual level, but that really solidified, this is exactly what we’re talking about... it was an opportunity to understand something better and I walked away with applicable changes I can make today. Sometimes you learn things [about climate change], but you walk away and think this feels so big, how can I do anything. It feels overwhelming. This was broken down in a way I could walk away and know what to do, to start me on that journey.”



Heat map showing Richmond's urban heat islands

AREAS OF CONFUSION/SUGGESTED CHANGES

Participants were asked if there was anything confusing or anything they would change about the Ready Rowhomes program.

- ◆ **Nothing:** All said there was nothing confusing about the activity. They said the instructions were “simple and easy” and the “hands-on experience” was better than learning about something from a video.
- ◆ **Different building types:** One suggested that it would be interesting to see the effects on different building types, not just rowhomes.

MAIN MESSAGE

Participants were asked about their perception of the “big idea” that the museum hoped to communicate through the program, and what prompted them to think of those ideas.

- ♦ **Impacts of green infrastructure:** All said their main takeaway that adding green infrastructure—such as adding vegetation, lighter colored roofing, and rain barrels—has a large impact on addressing the effects of extreme heat and rain events. One said, “the differences were really stunning” when comparing the model rowhomes with and without green infrastructure. Another added that the activity also showed how you could “extrapolate that if this is happening at your home, it is happening at most homes...[and] individual decisions affect the community.”
- ♦ **Health impacts of heat islands:** One said a second main takeaway was that areas affected by heat, such as areas with a lot of concrete and few trees, make you more susceptible to health issues. He recalled the heat island maps of Richmond showing how some areas are more affected by heat waves than other areas.

GREEN INFRASTRUCTURE MAKES A BIG IMPACT

“Making small changes can make a big difference. With the models, I just put the sponges somewhere. As we were pouring the water over the tip on the roof...just being able to manipulate those and see how [adding the sponges] affects everything was cool. And the second part, where we had the heat lamps on the models, looking at the difference [in temperature] between a dark and a light roof, just seeing even small difference and thinking about how something might be chosen because someone likes the aesthetic, but individual decisions affect the community.”



Heat lamp simulates effects of high heat on building materials

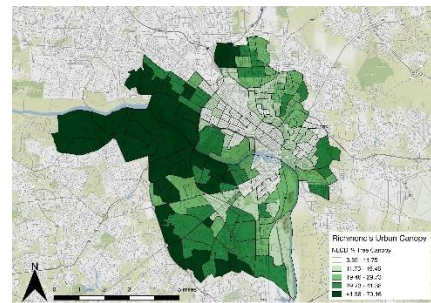
PERSPECTIVES ON RICHMOND'S CLIMATE

Participants were asked how, if at all, the program made them think about Richmond's climate.

- ♦ **Disparity of greenspaces across Richmond:** Four said it made them think about how little greenspace there is in the downtown area versus suburban areas further from the downtown core, and the way this affects how people living in these areas experience Richmond's climate. Two connected this idea to personal experiences—for example, one recalled how her car was parked downtown during Hurricane Isabel and the car flooded, whereas her parent's neighborhood, which has more vegetation to soak up rain, did not flood. Another talked about the health disparities that arise for people living in areas that amplify the heat during heatwaves, recalling maps showing how heat islands aligned with areas that had more health issues.
- ♦ **Short-term mitigation:** One said the program made him think about ways to mitigate the effects of climate change in the short-term, but did not offer a long-term climate change solution.

URBAN VS. SUBURBAN CLIMATE EXPERIENCES

"It made me think about the fact that I was in a more suburban area, so I wasn't realizing how dramatically different the experience of a hot day could be for someone in an area with less green matter in it. I love to think of Richmond as a beautiful green natural place with a river through the middle and parks, but it really made me think of people living in a community that is different than where I live."



Heat map showing Richmond's urban tree canopy

HOW CLIMATE CHANGE MAY AFFECT MY LIFE

Participants were asked how, if at all, the program made them think about how climate change might affect their life.

- ♦ **Mitigation actions:** Four talked about climate change's effect on their life in terms of mitigating actions they may take to reduce those effects and "contribute to a solution," such as planting trees, reducing use of fossil fuels, participating in the Urban Gardening program, and using rain barrels and gardens to "mop up rainfall" before it overwhelms the sewer systems and causes flooding.
- ♦ **Extreme weather:** Three gave examples of how extreme weather events have affected their lives already, or may affect them in the future, such as heat waves and hurricanes.
- ♦ **Allergies:** One said changes in Richmond's climate have extended the pollen season throughout the year, which aggravates his allergies for a longer period of time.

INDIVIDUAL AND COLLECTIVE CHANGE

"Certainly [I'm affected by] the real-world effects of climate change and changing weather patterns. Fortunately, Richmond wasn't hit that hard in the hurricane, but there are places that were devastated. That won't change, it will continue to happen. So, in general it makes me think in a larger way about how do I reduce my own consumption...things that can be done on an individual level maybe won't change the large trajectory, but if everyone is more conscious of how they are living their lives, it's a collective change. In general, I think that the Urban Gardening program and this [Ready Rowhomes] experiment has changed my perspective. I'm less inclined to just accept things as they are."

PROGRAM IMPACTS ON BEHAVIOR

Participants were asked how, if at all, the program made them think about what they or their community can do to respond to, or be prepared for, the future effects of climate change. Participants were also asked if there were any actions they heard about during the presentation which they planned to adopt.

- ◆ **Rain barrels:** Three said they had installed, or planned to install, a rain barrel they constructed through their Urban Gardener program at their house.¹²
- ◆ **Adding greenspace:** Three said they work on projects adding greenspace around the city through the Urban Gardener program they participate in. Two of these also said they had added plants around their house recently to help with absorbing storm runoff as a result of the activity.
- ◆ **Community education:** Two said the program made them think about the importance of educating the community on issues of climate change and the importance of green infrastructure. Both of these suggested starting by educating children about climate issues so that its importance is instilled at a young age.

SHARING ABOUT THE PROGRAM WITH OTHERS

Participants were asked if they talked about their experience with the Ready Rowhomes program with others.

- ◆ **Key takeaways:** Two said they shared key takeaways from the program with coworkers and family, such as the importance of capturing and reusing rainwater, and how climate and health are interconnected.
- ◆ **Applications in schools:** Two are teachers and said they talked about how they could apply the Ready Rowhomes activity or concepts they learned about in the activity in their classrooms.
- ◆ **Did not share:** One said they did not talk about the program with anyone else.

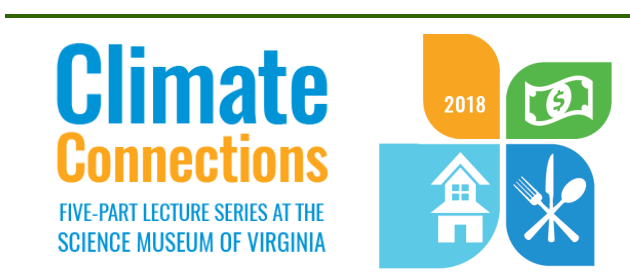
¹² Constructing a rain barrel was an activity completed on the same day as the Ready Rowhomes presentation during the Urban Gardeners meeting.

CLIMATE CONNECTIONS LECTURE SERIES

RK&A conducted 13 telephone interviews with individuals who attended at least one of the following evening lectures in the five-part Climate Connections lecture series: “Is Climate Change Making Me Sick?” (March 14, 2018) and/or “Climate Change—Are We Ready?”¹³ (March 21, 2018).¹⁴ The Climate Connections lecture series aimed to connect visitors with relevant and relatable information about resiliency and climate science topics.

Of the participants interviewed:

- ◆ **Gender:** Over one-half are male; less than one-half are female.
- ◆ **Age:** Participants range in age from 37 to 75 years. Median age is 57 years.
- ◆ **Visit history:** Almost all had visited SMV in the past, prior to attending a lecture. One was a first-time visitor.
- ◆ **Group composition:** Several attended the lecture with other adults, and a few attended alone. Two attended the lectures with children (one with a 16-year-old, and one with a 6-year-old).
- ◆ **Lectures attended:** Nearly all attended the “Climate Change—Are We Ready?” lecture, and a few attended “Is Climate Change Making Me Sick?” Most attended one lecture, a few attended multiple lectures, and one attended all five lectures.
- ◆ **Likelihood of future program participation:** Most participants said they were “very likely” to attend a future activity or workshop (at SMV or somewhere else) to learn about how to become more resilient to the impacts of climate change. Two said they were “somewhat likely.”



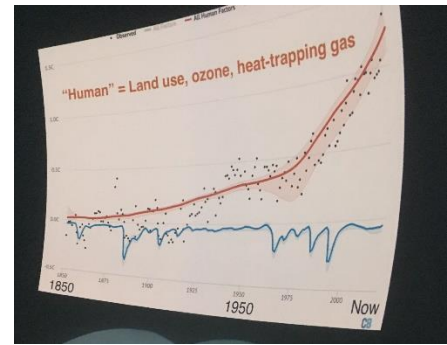
¹³ RK&A observed this lecture.

¹⁴ 46 participants provided contact information during the event to participate in a telephone interview after the program. RK&A contacted all participants who provided contact information via email up to three times and once by phone attempted to set up interviews. 13 participants completed an interview, for a participation rate of 28 percent.

MOST ENJOYABLE

Participants were asked what they most enjoyed about what they saw and heard at the lecture(s), and why.

- ◆ **Use of data:** Most said they liked the way SMV and the lecturers approached talking about climate change through data and visualizations (e.g., changes in temperature, shipping and flight patterns, and sea level rise). Two said seeing these data projected in the Dome Theater was impressive and engaging in general. Two said that presenting data not only made the topic more “believable,” but also allowed for participants to draw their own conclusions about climate change from the evidence.



Data visualizations of climate change

- ◆ **Institutional commitment to climate change:** A few said they liked that the museum offered a series of lectures focusing on real-world issues relevant to Virginia, because they felt it demonstrated SMV’s commitment both to sharing knowledge and inspiring participants to learn how to care for themselves, others, and the planet in response to climate change.
- ◆ **Passionate lecturer:** One said a lecturers’ presentation conveyed passion, which made the participant more interested in the topic.¹⁵
- ◆ **New perspective on climate change:** One said “Is Climate Change Making Me Sick?” prompted them to think about how subtle environmental changes affect people, such as causing asthma and lung irritation, which they did not previously attribute to climate change.
- ◆ **Audience discussion:** One liked that participants could answer each other’s questions when the discussion shifted to topics of audience interest.

DATA VISUALIZATION

“It’s stellar because you think of ‘living in a global village’ and they show you the shipping lane patterns in particular, the flight patterns and the number of flights that travel over the globe during the day, then lay them over in the dome over your head. It’s ‘Wow, this is unbelievable,’ and can really hit home just how extensive it is. More so than you could possibly do on a smaller scale.”

¹⁵ The participant did not specify which lecturer.

AREAS OF CONFUSION/SUGGESTED CHANGES

Participants were asked what, if anything, was confusing about the lecture(s), or what they would change about the experiences. Responses include:

- ♦ **Too much detail:** Many said the lecturers relied on technical details to support their arguments, which was overwhelming or hard to understand. For example, a few said some of the lectures got “too far down in the weeds” or required some prior knowledge (e.g., knowledge of the medical field for “Is Climate Change Making Me Sick?”). In some cases, this obscured why the issue mattered to Virginians or action steps the audience could take to prepare for climate change. A few participants suggested ways to make the lectures easier to follow, such as using a laser pointer to draw the audience’s attention to relevant data points on visualizations and using bullet points to summarize key points for the audience.
- ♦ **More audience engagement:** A few said the lecturers could have asked more open-ended questions and let discussions be guided by audience interest. For example, one said the lecturer for “Is Climate Change Making Me Sick?” seemed to dismiss audience questions about how farming practices affect Virginians’ health because the topic was unrelated to the speaker’s expertise in medicine.
- ♦ **Logistics:** One group was confused about where to meet for the lecture, and another did not like the steep incline in the theater.

TOO DETAILED

“I thought the first presenter went into far too much detail. He went into a depth that I would have struggled with at an academic conference. Too far down in the weeds. The museum could have given the lecturers a question to answer for the audience they were talking to about—like, “Why is this important to me?” The lecturers went too deep, and I didn’t know why this should matter to me. If that had been more explicit, I think people would have gotten more out of it. Maybe the museum could have provided more direction to the lecturers.”

MAIN MESSAGE

Participants were asked to describe their perception of the “big idea” that the museum hoped to communicate through the lecture(s) they attended, and what prompted them to think of those ideas.

- ◆ **Climate change is real:** Many said the lecture series’ main idea is that climate change is “real.” Many said the scientific data shared by lecturers, such as the increasing regional temperature and its impact on sea level rise, showed that climate change is not “just an emotional or gut feeling.” One said that seeing both global and regional data together connected climate change ideas to Virginia.
- ◆ **Climate change impacts Virginia:** Nearly one-half said the lecture they saw communicated climate impacts specific to Virginia, including rising temperatures, sea level rise, the fish population, flooding, and farming. Furthermore, some described connections among different climate change effects in Virginia. For instance, one connected the rising global temperature to warmer ocean temperatures, which in turn drives certain fish populations native to the Virginia coast further north.
- ◆ **Climate change preparedness:** A few said it is important to prepare for the effects of climate change, including conducting or supporting research, responsive city planning, and self-education.
- ◆ **Science education:** A few said the main takeaway is that SMV is playing a role in science education and sharing information about climate change. They see the museum as a “science communicator,” connecting laypeople with the knowledge required to understand and prepare for climate change.
- ◆ **Climate change is inevitable:** One said that, while scientists can measure climate change, there is “not so much we can do about it.”

CLIMATE CHANGE IS REAL

“The big idea was to make people more aware that things are really changing, and you can’t brush this off as fake science or conspiracy. All of the lectures added together, that was the takeaway. One lecture talked about fish species moving farther north, so now you don’t find them in the same places they used to be—that’s something people don’t think about, but it’s happening. Each speaker had their own reasons why [climate change] is happening, and it was an accumulation of a lot of different data saying, ‘Don’t push this under the rug.’”

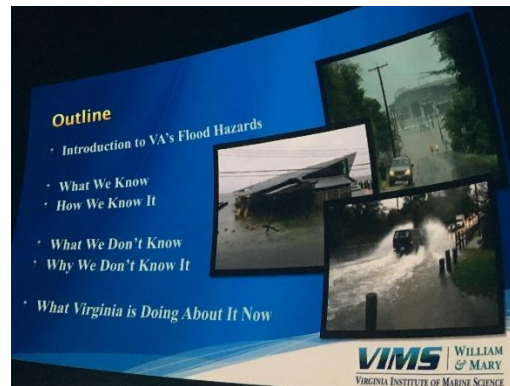
VIRGINIA'S CLIMATE

Participants were asked to describe how the lecture(s) made them think about Virginia's climate, and were invited to share examples from the lecture(s) that prompted them to think about this idea. Nearly all recalled specific details from the lectures, and several thought deeply about how climate change impacts Virginia. Responses include:

- ◆ **Evidence of climate change's impact on Virginia:** Most said the lectures made them think about how climate change affects Virginia, and a few further noted that climate change affects different parts of the state in different ways. All of these provided specific evidence from the lectures describing signs of climate change's impact on the region. The most commonly cited issue was flooding (e.g., how flooding impacts infrastructure, and should thus influence state decision-makers' approach to building in flood zones, especially along the coast), but rising temperatures were also mentioned by a few. Participants recalled seeing maps and photographs that communicated these ideas.
- ◆ **Climate change is real:** A few said the lectures supported what they already knew about Virginia's climate—that it is real and has imminent impact. One said the lecture they saw supported that scientists' predictions about climate change have “come true.” Another, a farmer, said they think about Virginia's climate “all the time, because we can see it happening in the crops we plant and how they adapt.”

CLIMATE CHANGE EFFECTS ACROSS VIRGINIA

“Virginia is in the thick of this. Virginia has as much to lose as any other place, maybe more, because of the wide temperature range, from sea level all the way to the mountains all in the same state...They showed photos of Norfolk after a storm, and houses that had been there for years that previously did not have flooding problems. They showed pictures—after a good storm, we are talking about a foot of water in those houses.”



Images of Virginia flood events

HOW CLIMATE CHANGE MAY AFFECT MY LIFE

Participants were asked how, if at all, the lecture(s) made them think about how climate change might affect their lives, health, or plans for the future. Participants shared a variety of responses, including:

- ♦ **Call to action:** One-half said hearing about the consequences of climate change encouraged them to prepare for climate change personally and in their communities. For instance, a few described political actions, such as understanding legislature, voting, and meeting with local officials. One joined a waiting list for Solar United Neighborhoods, a solar energy co-op. Another described a commitment to eating less meat and seafood.
- ♦ **Flooding and sea level rise:** One-half said issues related to flooding or sea level rise most affected them now or would in the future. A few considered sites that could disappear from the coast line, including residential properties, military bases, and historic forts in Virginia and along the southeastern coastline. A few cautioned against buying property close to the ocean, or criticized municipalities for allowing construction along the coast.
- ♦ **Food supply:** A few said climate change affects livestock and farming in Virginia. Two explained the meat and seafood industries' carbon footprint, which contributes to climate change. Two others talked about how climate change would have a negative effect on the food supply because of threats to pollinating insects and farming challenges due to salination of water sources.
- ♦ **Inheriting “a mess”:** A few said they worry about ensuring a safe environmental future for their children and grandchildren. As one put it, “It makes me worry that it’s all going to snowball faster than before.”

IMPLICATIONS FOR FUTURE GENERATIONS

“It reinforces the need to communicate better with people who don't ‘get it.’... how can I help translate this information into a way that people will understand? I have an 8-year-old daughter too, so I'm thinking about how I cannot leave her with the biggest mess for the next generation. How can I affect the decision makers? And, how that will affect my daughter's life, more than mine.”

PROGRAM IMPACTS ON BEHAVIOR

Participants were asked to describe how the lectures prompted them to consider things they or their communities can do to respond to (or be prepared for) the future effects of climate change. Furthermore, participants were asked if there were any actions they heard about during the lecture(s) that they plan to adopt, and what inspired them to make that change.

- ◆ **Climate change advocacy:** Several said the lecture series made them want to spread awareness about climate change, or to get involved with other groups who do so (such as SMV). For example, one said that the lecture series empowers her to “speak from a point of knowledge, rather than just feeling” in such advocacy efforts. Two described political actions they could take, such as electing politicians who “establish and enforce the policies that we need to prepare” for climate change.
- ◆ **Changes in consumer habits:** A few said the lectures inspired them to think about changing their consumer behavior, including use of energy (the importance of buying local goods to reduce carbon footprints), transportation (reducing carbon emissions by biking instead of driving), and food (eating less beef because of the carbon cost of the beef industry).
- ◆ **Already working to prepare for climate change:** A few said they were already taking some of the actions they learned about in the lectures to prepare for or respond to climate change. Some of these actions included making their yards more sustainable by planting native plants and grasses to help mitigate the effects of heat and drought, participating in watershed cleanups, recycling, and gardening.
- ◆ **Nothing:** A few said there is nothing meaningful they can do to prepare for or respond to climate change. In particular, participants who attended “Is Climate Change Making Me Sick?” said there were no actions they heard about during the lecture that they planned to adopt. One, who attended “Climate Change—Are We Ready?” said that, while scientists have the tools to learn about how climate change impacts us, there is “not much” people can do about it.

IMPLICATIONS FOR FUTURE GENERATIONS

“It makes me want to be a part of a movement and a problem-solving network that the Science Museum is part of. Because I think there are lots of things the average citizen of Richmond can do or be part of, but people turn off because it seems gloom and doom. Whether it's planting paths and walkways with native plants rather than non-native, that can make it more sustainable.”

SHARING ABOUT THE PROGRAM WITH OTHERS

Participants were asked if they had talked about their experience at the lecture with others, and if so, who they talked to and what information they shared. A few trends emerged:

- ♦ **Climate change awareness:** Nearly one-half promoted general climate change awareness to friends and family. For instance, one told neighbors and her adult children “that the situation is real, and when someone says it’s not, they’re misinformed.” A few encouraged friends or family attend another Climate Connections lecture.
- ♦ **Sharing specific facts and information:** A few shared specific details from the lectures with others. For instance, one discussed changing EPA regulations with friends, and another shared information from one lecturer’s research with a friend who works for a satellite company that deals with erosion and sea level rise.
- ♦ **Didn’t share:** Three said they did not discuss the lecture with anyone else.
- ♦ **Lecture was not interesting:** Two shared with a partner or friend that they were disappointed by the lecture because it was not engaging; one of these said they believe the museum “has potential for good lectures,” but that the lecture they attended did not interest them.

HAVE YOU TALKED ABOUT YOUR EXPERIENCE AT THE LECTURE WITH OTHERS?

“Yes, [I talked about it with] family and friends. We talked about the [Is Climate Change Making Me Sick?] program with them quite a bit because, at our age [71], we talk about health quite a bit, so it comes up in our conversations. We usually say, “I heard on NPR,” but now I might say, “I heard at this SMV lecture...””

APPENDIX

APPENDIX A: EDUCATION OUTCOMES IMPACT FRAMEWORK

Impact Category	Impact Statement	Indicators
Awareness, knowledge, or understanding	The Museum's climate change and resiliency-themed programming will increase guest and viewer awareness and understanding of climate change science, the relationship between natural and human-induced heat-trapping gasses and climate change, and the concept of resiliency relative to climate change impacts in Virginia.	Participants and listeners will be more likely to state that <u>climate change science is evidence-based and ever-changing</u> .
		Participants and listeners will be more likely to <u>name current causes and effects of climate change, both natural and manmade</u> , and explain the science behind them.
		Participants and listeners will be more likely to <u>explain the ways that climate change impacts Virginia and identify the signs and data</u> that indicate that we are currently experiencing these effects across the Commonwealth.
		Participants and listeners will be more likely to <u>know what it means to be resilient</u> to the effects of climate change in Virginia.
Engagement or interest	Engaging Museum guests in interactive and/or project-based climate change and resiliency-themed programs and activities (e.g. Art Lab, Challenge Lab, Extreme Events Challenge scenario workshops, community preparedness events) will increase participants' interest in using scientific data to inform personal actions they may take to increase personal and community resiliency.	Participants will be more likely to indicate an <u>interest in knowing how climate change data is collected and interpreted</u> .
		Guests will state that participation in a program helped <u>develop or increase their interest in what resiliency means and how they and their community can increase resiliency</u> to the impacts of climate change in Virginia.
		Participants will be more likely to <u>indicate an interest in participating in subsequent activities or workshops</u> designed to increase personal and/or community resiliency.
		Guests who participate in a program will be more likely than those who do not to <u>share their knowledge with others in why resiliency is important and how to become resilient</u> to impacts of climate change in Virginia.
Attitude	The Museum's climate change and resiliency-themed SOS, Dome, educational programming, and digital media campaign will help guests recognize that climate change is impacting their lives now and will continue to impact Virginia in the future, and empower them to feel that that they can do something about becoming ready and resilient to climate change impacts in Virginia.	Participants will be more likely to <u>state a belief that climate change is real</u> and that it is currently happening throughout Virginia in different ways.
		Participants will be more likely to <u>state a belief that it is important to take steps</u> to increase personal and community resiliency to the effects of climate change.
		Participants will be more likely to <u>state a belief that their personal choices affect climate change and that individually, each person can do something</u> about climate change and its impacts in Virginia and can protect themselves and their families by being prepared.
Behavior	The Museum's climate change and resiliency-themed programming will help guests make informed decisions and take steps to become more resilient to the effects of climate change in Virginia, thereby increasing the overall resiliency of communities across the Commonwealth.	Participants will be more likely to <u>state an intention to change their long term behaviors</u> by taking steps to protect themselves and their families from the impacts of climate change in Virginia; guests will cite participation in the program as their motivation.
		Participants will be more likely to <u>engage in up to five new behaviors that increase their personal or community resilience</u> to the impacts of climate change in Virginia; guests will cite participation as the motivation for at least two of these behaviors.

APPENDIX B: OUTCOME ACHIEVEMENT HEAT MAPS

Program-specific heat maps were developed by reviewing the evaluation data (observations and interviews) against each intended outcome and assigning an outcome achievement rating of high, moderate, low, or not applicable (N/A) if the outcome was not intended for a particular program. Outcome achievement ratings are somewhat subjective, but reflect the evaluator’s intimate understanding of the interview data, program observations, and the evaluator’s professional experience. After mapping all the program-specific outcomes, the results were compiled into a summary heat map showing the results of the summative evaluation across all programs evaluated.

Note that the Science on a Sphere program is a short (10-15 minute) drop-in program, unlike the other four programs evaluated, which were longer (30 minutes or more) scheduled events where advanced registration or reservations were encouraged. Thus, outcomes achievement for this program should be considered taking into account what can realistically be accomplished in a short drop-in program.

DIGITAL DOME OUTCOME ACHIEVEMENT

Achievement	Outcome	Influencing program factors
High	I’m more aware of/understand relationship between natural and human-induced heat-trapping gasses and climate change	The video provided convincing examples comparing human versus natural contributions to climate change
	I’m more aware of/understand climate change science	The video used simple language and clear data visualizations
Moderate	I can do something about becoming ready and resilient to climate change impacts in VA	The video provided many examples of resiliency actions, some believe these actions are not “enough”
	Climate change is impacting my life now and will continue to impact VA in the future	The video continuously cited/presented data showing climate change is “real,” but some persist in seeing it as a future issue
	I’m interested in using data to inform my future actions to increase personal and community resiliency	The video used data to explain how climate change will affect people and the importance of taking action, but most did not cite data as informing their actions.
	I will take steps to become more resilient to the effects of climate change in VA	The video mentioned steps to take, and a few said they intended to follow through on those steps; others were already doing the things mentioned
N/A	I’m more aware of/understand the concept of resiliency relative to climate change impacts in VA	Not a primary focus of the program

EXTREME EVENT CHALLENGE OUTCOME ACHIEVEMENT



Achievement	Outcome	Influencing program factors
High	I can do something about becoming ready and resilient to climate change impacts in VA	Role-playing and wrap-up discussion helped participants think about resiliency on a local and personal level
	Climate change is impacting my life now and will continue to impact VA in the future	Local data in presentation and flooding example were relevant to Richmond
	I'm more aware of/understand the concept of resiliency relative to climate change impacts in VA	Used term "resiliency" and discussed examples throughout presentation and discussion
Moderate	I will take steps to become more resilient to the effects of climate change in VA	Several participants stated intentions to make changes based on what they heard in the activity and discussion afterwards
	I'm more aware of/understand climate change science	Presentation before activity provided foundational climate science knowledge
Low	I'm interested in using data to inform my future actions to increase personal and community resiliency	Presentation before activity included climate data, but participants did not cite data as informing their future actions
N/A	I'm more aware of/understand relationship between natural and human-induced heat-trapping gasses and climate change	Not a primary focus of the program

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SCIENCE ON A SPHERE OUTCOME ACHIEVEMENT



Achievement	Outcome	Influencing program factors
High	I'm more aware of/understand climate change science	Participants recognized the program draws on multiple data sources supporting climate change
	I'm more aware of/understand the concept of resiliency relative to climate change impacts in VA	Examples of Richmond/Virginia data and climate change impacts and the need to take action (broadly)
Moderate	I'm more aware of/understand relationship between natural and human-induced heat-trapping gasses and climate change	Sphere presents evidence of climate change (e.g., extreme weather/temps) but less emphasis on humans as the primary cause
	Climate change is impacting my life now and will continue to impact VA in the future	Examples show some imminent local impacts (e.g. allergies, coastal flooding), but some still see climate change as an issue in the future
Low	I'm interested in using data to inform my future actions to increase personal and community resiliency	The program presented data evidencing climate change, but few participants indicated applying this information to their lives
	I will take steps to become more resilient to the effects of climate change in VA	The actions mentioned during the program did not motivate many to take steps toward resiliency
	I can do something about becoming ready and resilient to climate change impacts in VA	Resiliency actions were not a memorable or did not seem like they would make a meaningful impact

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READY ROWHOMES OUTCOME ACHIEVEMENT



Achievement	Outcome	Influencing program factors
High	I'm interested in using data to inform my future actions to increase personal and community resiliency	Heat/ flooding measurements from the activity clearly demonstrate potential of personal/ community impacts
	I can do something about becoming ready and resilient to climate change impacts in VA	Heat maps with Richmond climate data and the activity with clear applications to personal life
	Climate change is impacting my life now and will continue to impact VA in the future	Heat maps with Richmond climate data and the activity with clear applications to personal life
	I will take steps to become more resilient to the effects of climate change in VA	The actions demonstrated in the activity motivated participants to make personal changes (e.g., planting to absorb storm runoff)
	I'm more aware of/understand climate change science	The presentation and activity explained how and why heat islands and urban flooding occur
Moderate	I'm more aware of/understand the concept of resiliency relative to climate change impacts in VA	Resiliency as a term was not emphasized, but the program broadly emphasized why and how resiliency is important to Virginia
N/A	I'm more aware of/understand relationship between natural and human-induced heat-trapping gasses and climate change	Not a primary focus of the program

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LECTURE SERIES OUTCOME ACHIEVEMENT



Achievement	Outcome	Influencing program factors
High	I'm more aware of/understand climate change science	Lectures were grounded in climate science data and participants recalled specific examples
	Climate change is impacting my life now and will continue to impact VA in the future	Data communicated that climate change is "real" and Virginia-specific examples showed the state and local impacts
Moderate	I can do something about becoming ready and resilient to climate change impacts in VA	Examples of climate impacts in Virginia felt like a "call to action" to prepare for the effects of climate change
	I'm interested in using data to inform my future actions to increase personal and community resiliency	Some cited data they heard in the lecture when talking about potential resiliency actions they may take
	I will take steps to become more resilient to the effects of climate change in VA	Hearing about the consequences of climate change motivated a few visitors to take action, and others thought about things they might do.
	I'm more aware of/understand the concept of resiliency relative to climate change impacts in VA	Although lecturers did not emphasize the term "resiliency," they gave examples of preparing for/responding to climate change in Virginia
N/A	I'm more aware of/understand relationship between natural and human-induced heat-trapping gasses and climate change	Not a primary focus of the lectures

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SMV IMPACT FRAMEWORK OUTCOME ACHIEVEMENT

PROGRAM	READY ROWHOMES	EXTREME EVENT CHALLENGE	DIGITAL DOME "COSMIC CLIMATE COOKBOOK	LECTURE SERIES	SCIENCE ON A SPHERE
Increase participants' awareness/ understanding of climate change science	High Achievement	Moderate Achievement	High Achievement	High Achievement	High Achievement
Help participants recognize that climate change is impacting their lives now and will continue to impact Virginia in the future	High Achievement	Moderate Achievement	Moderate Achievement	Moderate Achievement	Moderate Achievement
Help participants make informed decisions and take steps to become more resilient to the effects of climate change in Virginia	High Achievement	Moderate Achievement	Moderate Achievement	Moderate Achievement	Moderate Achievement
Increase participants' interest in using scientific data to inform personal actions they may take to increase personal and community resiliency	High Achievement	Moderate Achievement	Moderate Achievement	Moderate Achievement	Moderate Achievement
Help participants recognize that they can do something about becoming ready and resilient to climate change impacts in Virginia	High Achievement	Moderate Achievement	Moderate Achievement	Moderate Achievement	Moderate Achievement
Increase participants' awareness/understanding of the concept of resiliency relative to climate change impacts in Virginia	Moderate Achievement	High Achievement	High Achievement	High Achievement	High Achievement
Increase participants' awareness/understanding of the relationship between natural and human-induced heat-trapping gasses and climate change	High Achievement	High Achievement	High Achievement	High Achievement	High Achievement

Key: High Achievement Moderate Achievement Low Achievement Not Applicable