WaterViz STEAM Program for Students with Visual Impairments: A Multisensory Approach to Understanding Water Cycle & Climate Data

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Image description: WaterViz art showing trees in a forest, the soil layer, a stream, decorative musical notes, and a line graph. In later slides, this image is marked as decorative.

Slide 2: Session Objectives

Participants will

- Identify three benefits of using **creative and multisensory methods** for representing scientific data.
- Identify three strategies for increasing the **engagement** of students with visual impairment in analyzing, interpreting, understanding, & explaining scientific data.
- Identify at least one way they could use the **WaterViz curriculum** with their students.

Slide 3: Partnerships

Image 1 description: Logo, South Carolina Commission for the Blind

Image 2 description: Logo, Project INSPIRE

Image 3 description: Logo, National Federation of the Blind South Carolina

Slide 4: Summer Teen Overview

- SCCB is a vocational rehabilitation agency
- Pre-Employment Transition Services (ETS)
- 5 service categories
    - Job exploration

- Work based learning experiences
- Counseling on post-secondary education
- Workplace readiness training
- Self-advocacy

Slide 5: WaterViz STEAM Camp Overview

Students have opportunities to

- Learn about the collaboration of artists, musicians, and scientists to create the multidisciplinary WaterViz project.
- Analyze, interpret, and build 3-D scale models to represent real scientific data.
- Design and construct their own creative data representations of real environmental data.
- Complete field investigations using accessible tools & sensors.
- Learn about climate trends and identify ways to take action.
- Further develop skills in each of the Expanded Core Curriculum areas.

Slide 6: WaterViz STEAM Camp Participants

- Teens who are blind, have low vision, or are deafblind
- Two in-person week-long summer camps
- One virtual 6-week long Saturday morning program for braille readers

Image description: Group photo of 21 teens at the Summer Teen WaterViz STEAM Camp 2023.

Slide 7: A Deep Dive into the Water Cycle

- Team-Building Activities
- Draw a Scientist
- Water Cycle BINGO
- Water Cycle Basketball
- Transpiration Experiment

Image 1 description: Photo of the Fruit Ninja team sitting at an outdoor table.

Image 2 description: Graphics of a Mickey Mouse scientist (Scienteer), Smarties candies, and a smiling crab

Slide 8: Using Games to Spark Interest & Engagement

Water Cycle BINGO

Image 1 description: Photo of a student using wiki sticks to mark boxes on his braille Water Cycle BINGO card. The student is seated beside a student who is using a large-print BINGO card.

Water Cycle Basketball Tournament

Image 2 description: Graphic of a 4-team basketball bracket and a Water Cycle Basketball Champion 2024 trophy. Two teams compete in Game 1 and two other teams compete in Game 2. The winners of Games 1 and 2 compete in the Championship Game.

Slide 9: Engaging Students with Hands-on Learning

- Measuring transpiration in nature
- Choosing experimental variables to investigate
- Using accessible labeling strategies & tools
- Weighing by difference
- Troubleshooting experimental challenges

Image 1 description: Photo of a student at a bush carefully closing a Ziplock bag around several leaves.

Image 2 description: Photo of a Ziplock bag closed around a flower and a few leaves. The bag is labeled “Carson Plant 1.” Beside the plant is a sign that reads, “Transpiration in Progress. Please do not disturb!”

Slide 10: Using Accessible Tools to Build Confidence

- Accessible labels
    - Large print
    - Braille
    - Talking
    - Tactile
- Talking digital scales
- Talking calculators

Image 1 description: Reizen Talking Label Wand voice labeling system.

Image 2 description: Photo of a student holding two Ziplock bags labeled with tactile bump dots to indicate plant 1 and plant 2. Transpired water is present in the bags.

Image 3 description: Photo of a digital scale under an improvised draft shield made from a plastic storage container. A Ziplock bag containing transpired water is being weighed on the scale.

Slide 11: WaterViz Explained

Hubbard Brook Experimental Forest

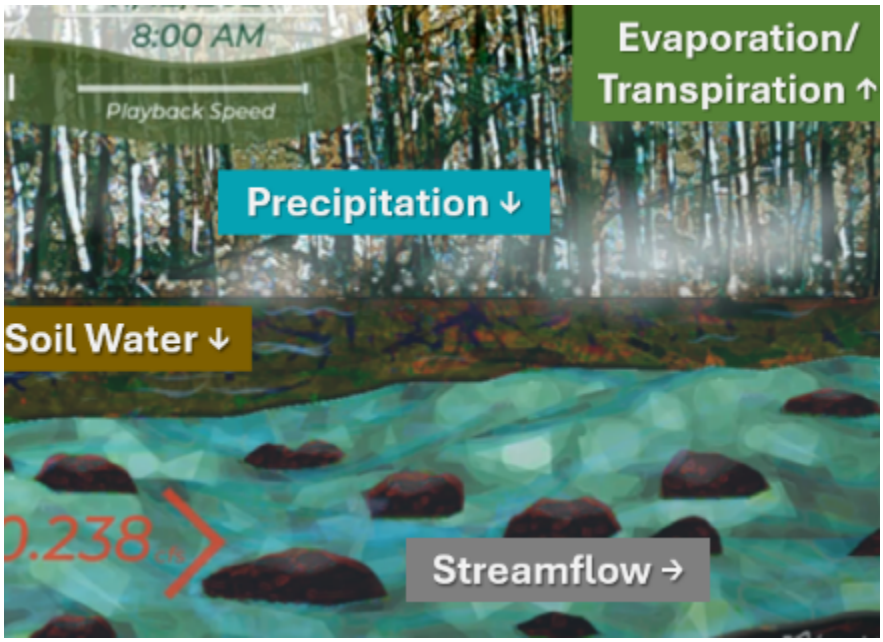
Image 1 description: Map of the Hubbard Brook Experimental Forest showing the locations of high frequency radios transmitting data to a base station computer. The list of data collected includes precipitation, streamflow, air temperature, relative humidity, snow depth, evaporation, and transpiration.

Image 2 description: Graphic of an individual’s brain with the reasoning, auditory, and visual centers highlighted.

Slide 12: WaterViz Data Visualization and Sonification

Image description: WaterViz animated art screen capture dated 11/21/2021, 8:00 AM. Water cycle component data labels indicate the location in the art where the data for each component are displayed through art animations. The streamflow value is included on the bottom left of the image and begins at 0.238 cfs (cubic feet per second). A detailed description of the artwork is provided at the end of this document. The following water cycle labels are shown:

- Precipitation: particles moving down from the top of the screen.
- Soil Water: little waves moving in the soil layer between the trees and the stream.
- Streamflow: particles moving from left to right at the bottom of the screen.
- Evaporation/transpiration: white and green mist rising up from surfaces and towards the top of the screen.



[WaterViz Website]

https://hubbardbrook.org/waterviz/

Slide 13: Investigation 1: Analyzing a Summer Rain Event

- Students read a news article about a 2-week summer rain event at the Hubbard Brook Experimental Forest.
- Each team becomes an expert on the changes in one water cycle component through reading, discussing, and charting their understanding.
- Teams share their charts at the Gallery Walk and learn about the changes in each of the water cycle components.

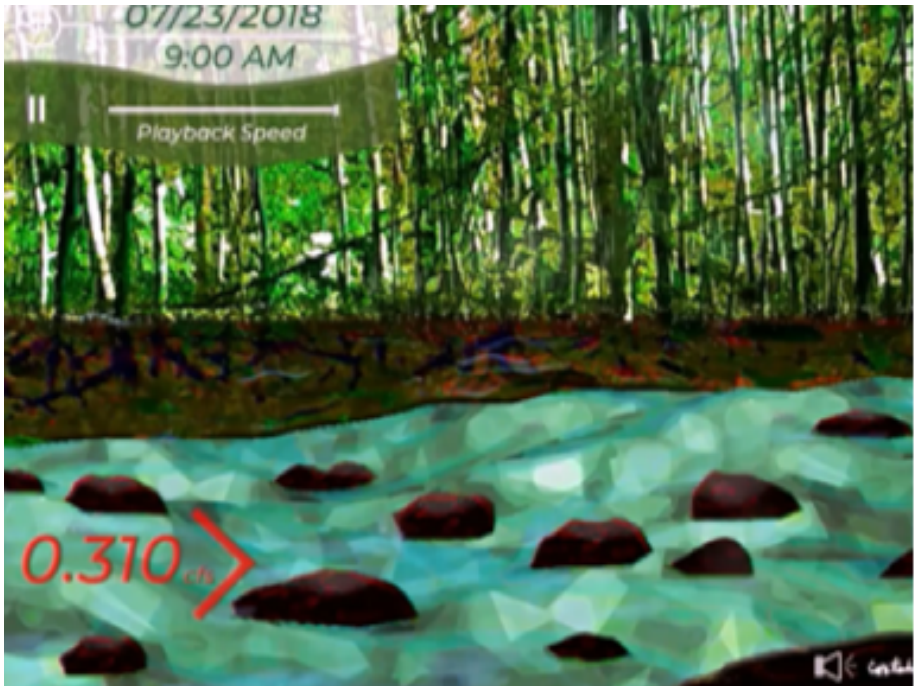
Image description: Photo of teams of students collaborating and preparing charts to share at the Gallery Walk that explain the changes in their water cycle component.

Slide 14: Gallery Walk

Image description: Two Gallery Walk charts are shown: Streamflow and Soil Water. The Streamflow team created a tactile roller coaster called *The Best Streamcoaster* using pipe cleaners, wiki sticks, and foam blocks. Changes in streamflow were shown as changes in the height of the *Streamcoaster* tracks and streamflow values were written in print and braille. The Soil Water team created a pictograph and made the connection between precipitation and soil water. They used tactile bump dots to indicate the amount of rainfall and pipe cleaners to represent the amount of water stored in the soil during the 2-week rain event. Soil water values were reported using print and braille labels.

Slide 15: Investigation 2: Water Cycle Data Presented as Animated Digital Art

Image description: WaterViz animated art screen capture dated 07/23/2018 at 9:00 AM. The streamflow value on the bottom left of the image is 0.310 cfs (cubic feet per second).



Students match each WaterViz Animated Art description to a water cycle component.

WaterViz Animated Art	Water Cycle Component
Particles move from top to bottom	Precipitation
Mist rises up from surfaces	Evaporation/Transpiration
Waves move in the layer below the trees	Soil Water
Particles flow from left to right	Streamflow
Not shown in art	Temperature

Slide 16: Setting the Stage for Investigation 3

Learning about pitch

Image 1 description: A photo of a student playing the guitar and demonstrating how changes in pitch sound.

Musical instruments for data sonification

Image 2 description: A photo of toy instruments used to represent musical instruments used in the WaterViz Symphony including: flute, xylophone, French horn, cymbals, and guitar.

Slide 17: Investigation 3: Water Cycle Data Presented as Music

A video is shown and described by the presenters.

Image description: WaterViz animated art screen capture dated 07/23/2018 at 9:00 AM. Labels are positioned throughout the artwork to indicate the water cycle component represented by the art animation in that area of the image. The following water cycle components are included: precipitation, soil water, streamflow, and evaporation/transpiration.

Students match each WaterViz musical instrument to a water cycle component.

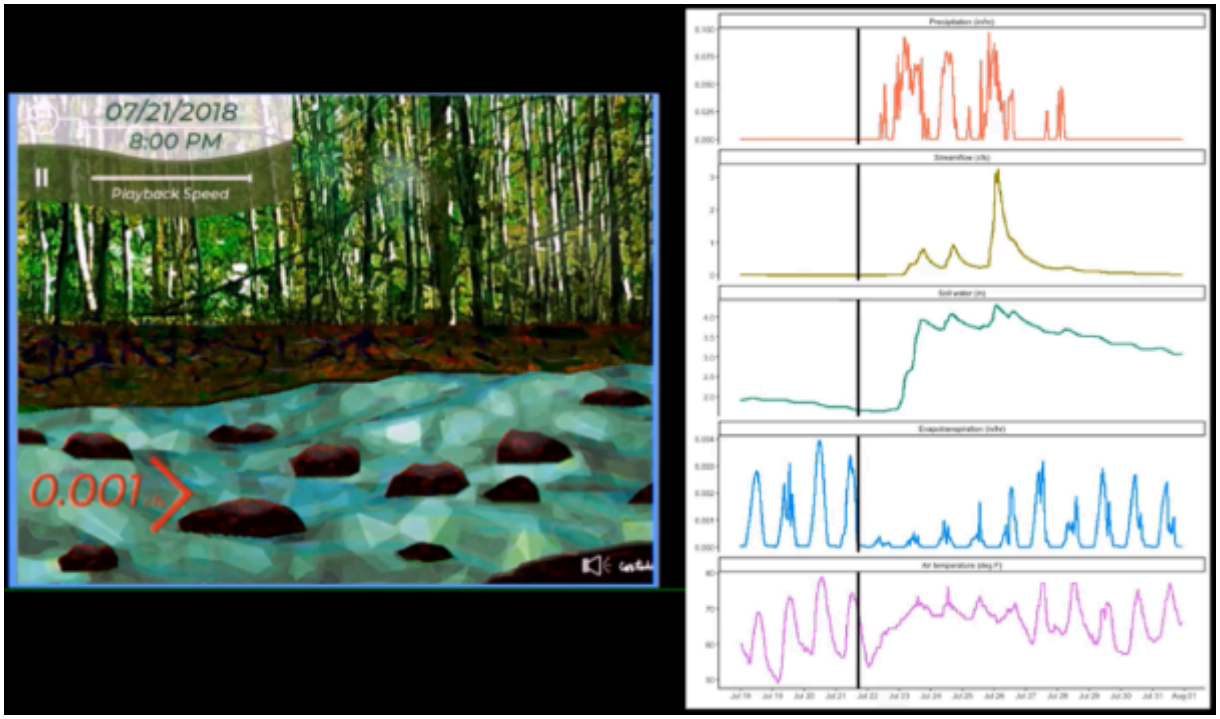
WaterViz Music	Water Cycle Component
Cymbals	Precipitation
Bass Guitar & French Horn	Streamflow
Marimba	Evaporation/Transpiration
Guitar	Soil Water
Flute	Temperature

Slide 18: Investigation 4: Finding and Interpreting Patterns in Water Cycle Data

A video is shown and described by the presenters.

- Students analyze & interpret data from line graphs.
- Each water cycle component is matched to a graph.
- Teams select an appropriate title and y-axis unit for each graph.

Image description: WaterViz animated art screen capture dated 07/21/2018 at 8:00 PM. To the right of the artwork is a set of five line graphs displayed vertically. Each graph represents the data for one water cycle component during the 2-week July 2018 rain event. Detailed descriptions of each graph are provided at the end of this document.



Slide 19: Student Reflections on Data Representations

Data Representations

- News article
- Animated digital art with descriptions
- Musical data sonifications
- Large print and tactile graphs

Reflection Questions

- What data representation did you like best?
- What made the most sense to you?

Image description: Photo of a student and instructor smiling as they are working on a 3D data model.

Slide 20: Investigation 5: Building a Model of Long-Term Water Cycle Data

- Teams analyze data tables
- 60 years of water cycle data collected at the Hubbard Brook Experimental Forest
- Use scale factors and accessible measuring tools to build 3D models of the data

Example data table:

Decade	Average Annual Temperature (°F)
1960-1969	41.2
1970-1979	41.5
1980-1989	42.3
1990-1999	42.8
2000-2019	44.3

Slide 21: Accessible Tools

- Braille and large print rulers
- Braille & digital large print calipers

Field Investigation

- Talking tape measure
- Talking air temperature sensor
- Large print digital surface temperature sensor
- Talking calculator

Image 1 description: Photo of a metric braille caliper and an APH toss-away large print–braille ruler.

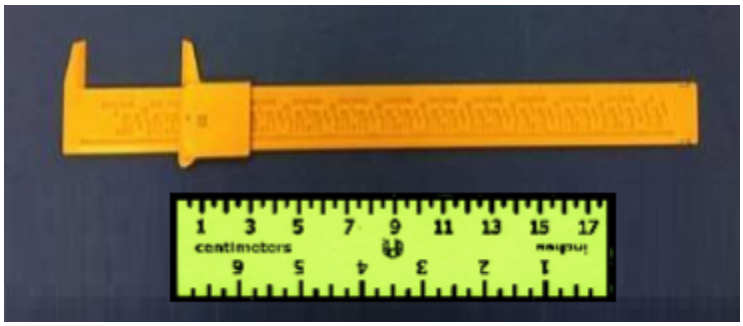


Image 2 description: Photo of 3 talking devices: tape measure, air temperature sensor, and calculator.

Slide 22: Climate Data Scale Models

Image 1 description: Photo of 3D climate data models built with paper straws inserted into foam blocks. The models include 60 years of Hubbard Brook data for temperature, precipitation, streamflow, and evaporation/transpiration.

Image 2 description: Photo of a 3D climate data wall hanging created with paper straws and a foam block. The model includes 60 years of Hubbard Brook data for streamflow, temperature, precipitation, and evaporation.

Image 3 description: Photo of two climate data models. The top model was created with pipe cleaners on paper and shows 60 years of Hubbard Brook precipitation data. The bottom model was created with wiki sticks on paper and shows 60 years of Hubbard Brook temperature, precipitation, and streamflow data.

Slide 23: Fireside Chat with Dr. Lindsey Rustad

The WaterViz project lead shared about

- her work as a research ecologist
- experimental forests
- conducting experiments in nature
- the importance of collecting short-term and long-term water cycle data

Groups discussed observed climate trends and their environmental, societal, and economic impacts.

Image 1 description: Photo of Dr. Rustad listening as a team explains the 3D climate data model they created using Hubbard Brook data.

Image 2 description: Photo of Dr. Rustad speaking to a group of students.

Slide 24: Local Resources for Field Investigations

Teams of campers

- Rotate through 5 stations at the Swan Lake Iris Gardens in Sumter, SC.
- Conduct multisensory field measurements and investigations to collect experimental data.

Image description: Group photo during the Summer 2024 Field Investigation at the Swan Lake Iris Gardens in Sumter, SC.

Slide 25: Field Investigation Station 1: Talking Tree Trail

Teams visit 9 stations to learn interesting facts about each type of tree & collect items from nature.

Image 1 description: Photo of a student feeling the bark of a tree.

Image 2 description: Photo of a student smiling and sitting on a tree branch.

Image 3 description: Photo of a student laughing and hugging the trunk of a large tree.

Image 4 description: Photo of an instructor and students feeling leaves from a magnolia tree.

Image 5 description: Photo of a student smiling and holding a bag of items collected on the Talking Tree Trail, including leaves, seed pods, and cones.

Slide 26: Field Investigation Station 2: Camellia Island Bridge Measurements

- Teams use accessible tools to measure streamflow.
- Teams identify challenges associated with making measurements in nature.

Image 1 description: Photo of a student sitting on the bridge. He is using a long PVC pipe to feel the bottom of the stream to determine if it is muddy or rocky.

Image 2 description: Photo of students measuring the width of the bridge using a talking tape measure and recording the time for an object to travel in the stream from one side of the bridge to the other.

Slide 27: Field Investigation Station 3: Braille & Chocolate Gardens

- Teams use their senses of touch, sight, and smell to explore flowers, plants, & trees in the gardens.
- Teams estimate & then measure the length of a 120 ft tree.

Image 1 description: Photo of students exploring the features of a hydrangea bush.

Image 2 description: Photo of students looking at and feeling bright yellow flowers.

Image 3 description: Photo of an instructor and student feeling an orange flower shaped like a cone.

Slide 28: Field Investigation Station 4: Chocolate Tasting

- Teams compare and contrast scents, tastes, & textures of 4 types of chocolate.
- Teams learn about the cacao tree, the locations where it grows, & the climate it needs to thrive.

Image 1 description: Photo of a camp counselor smiling as she displays the 4 types of chocolate bars: white, ruby, milk, & dark.

Image 2 description: Photo of students holding their nose as a piece of chocolate begins to melt on their tongue.

Image 3 description: Photo of another group of students holding their nose as they place a piece of chocolate on their tongue.

Slide 29: Field Investigation Station 5: Cypress Boardwalk Measurements

- Teams learn about the science of sound in nature using underground & underwater listening probes.
- Teams learn about working in outdoor laboratories and use sensors to make environmental measurements.

Image 1 description: Photo of students using hand-held digital surface temperature sensors to measure the temperature of the boardwalk.

Image 2 description: Photo of Dr. Rustad and a student using a listening probe to listen to the natural sound scape.

Image 3 description: Photo of a student using a hand-held digital surface temperature sensor to measure water temperature.

Slide 30: Draw a Scientist

- Student perceptions of who scientists are and the work they do
- Accessible art supplies
- Tactile pictures
- Word pictures
- Drawings

Image 1 description: Photo of a group of students using art supplies and braille writers to create pictures of scientists. One student is dictating a word picture to a scribe who is using a braille writer.

Image 2 description: Photo of a student drawing on swell paper and another student feeling the raised images.

Slide 31: Draw a Scientist Photos

Image 1 description: Photo of student artwork created with wiki sticks. A man is in a lab, wearing goggles, holding a flask with fumes coming out, and moving toward a disposal bin. The caption reads: “This stuff stinks, I better get rid of it.”

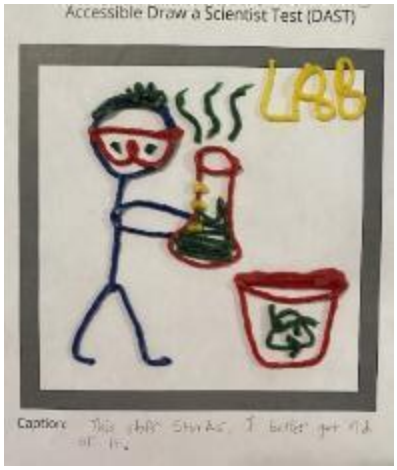


Image 2 description: Photo of student artwork created using a variety of tactile materials. The multi-media collage depicts a female scientist.

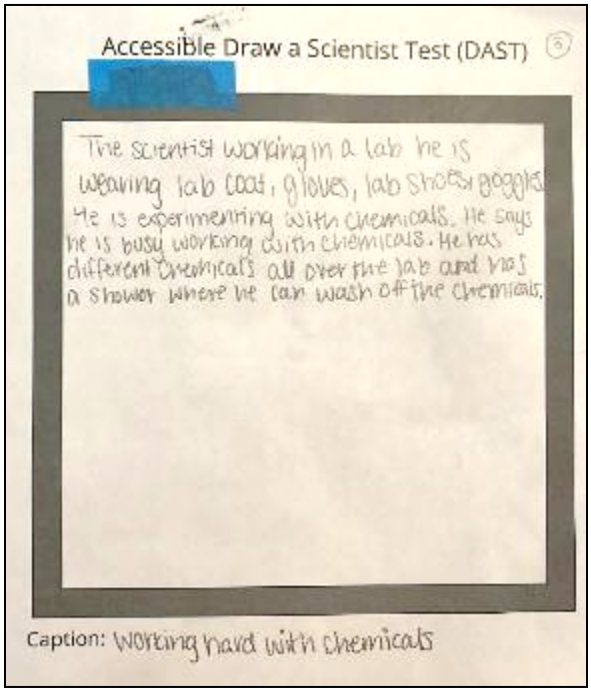
Image 3 description: Photo of student artwork created using swell paper, markers, and tactile bump dots. A man is using a large digging tool to dig for dinosaur bones buried in the ground. The caption reads, “Hi, my name is Bob and I am looking for dinosaur bones.”

Slide 32: Draw a Scientist: Before & After the Field Investigation

BEFORE

- Dictated a word picture to a scribe.
- Caption: Working hard with chemicals.

Image 1 description: Accessible Draw a Scientist Test (DAST). The student dictated a word picture that reads, “The scientist working in a lab he is wearing a lab coat, gloves, lab shoes, goggles. He is experimenting with chemicals. He says he is busy working with chemicals. He has different chemicals all over the lab and has a shower where he can wash off the chemicals.”



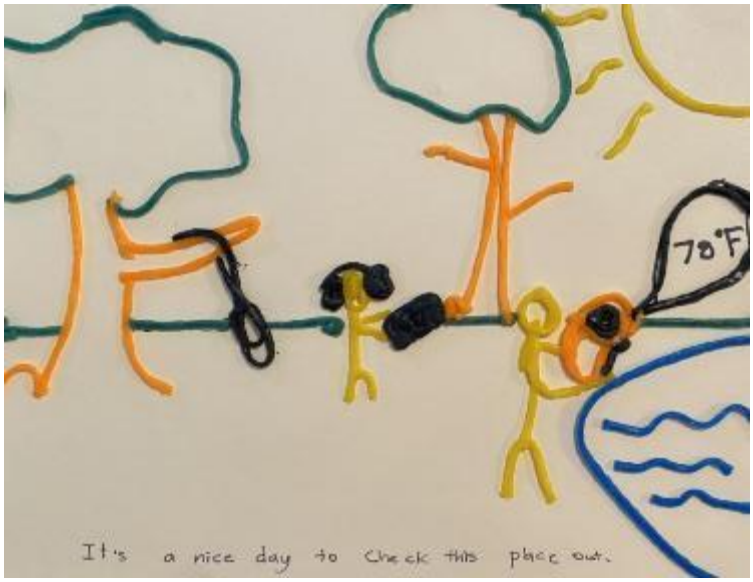
AFTER

- Drew a picture of a field investigation.
- Caption: Studying nature is fun.

Image 2 description: Student drawing with pencil on paper. The outdoor scene includes the sun, trees, flowers, animals, water, and fish. A person is wearing headphones and holding a sound sensor that is in the water. The caption reads, “Studying nature is fun.”

Slide 33: Draw a Scientist AFTER the Field Investigation

Image description: Photo of student artwork created with wiki sticks. An outdoor scene shows two scientists making measurements in an area with trees and water. One is wearing headphones and holding a sound sensor. The other is holding a surface temperature sensor and measuring 78 °F. The caption reads, “It’s a nice day to check this place out.”



Post-camp Survey Question:
Do you think people who have a visual impairment can be a scientist?
100% said “yes”

Slide 34: Water Showcase

Teams create & present their own creative representation of water cycle data.

A video will be shown and described by the presenters.

Slide 35: Student Reflections

Water Cycle knowledge pre & post camp

- Water cycle components & their relationships
- Impacts of the water cycle & our changing climate on human, animal, & plant life

What was your favorite part of WaterViz?

- 69%: Field investigation
- 25%: Art or music
- 6%: Fireside chat with Dr. Rustad

Image 1 description: Photo of 2 students wearing their WaterViz t-shirts, smiling, and standing in front of a lake.

Image 2 description: Photo of 3 students standing on a bridge over water.

Slide 36: Promoting Mentoring Relationships

- Peer mentors
- STEM professionals
- Community resources
- State & national resources

Slide 37: Benefits for Students

- Learn about experimental forests & explore creative ways to represent scientific data.
- Build critical thinking & data analysis skills.
- Actively participate in solving problems & using accessible measuring tools.
- Enhance & refine ECC skills.
- Build self-confidence & relationships while having FUN with SCIENCE!
- Opportunities to become peer mentors.

Image description: Expanded Core Curriculum Hub: Compensatory Access, Sensory Efficiency, Assistive Technology, Orientation & Mobility, Social Interaction, Recreation & Leisure, Independent Living, Self-determination, Career Education.

Slide 38: WaterViz Contributors

- Research Ecologist & Project Lead: Lindsey Rustad
- Scientists: JP Ganon, Michael Casey, Mark Green, Amey Bailey
- Artist & Musician: Xavier Cortada, Marty Quinn
- Technology Developers: Mary Martin, Jussi Rasinmaki, Ivaylo Dzhedzhev
- Educators: Sarah Garlick, Joanne Goelzer, Karmen Korut, Mariella Mannino, Dan Scarpati, Mutiara Syifa, Sarah Thorne

Image 1 description: Dr. Lindsey Rustad standing beside her life-sized 3D printed statue at the Smithsonian.

Image 2 description: Logos for: (1) IF/THEN An Initiative of Lyda Hill Philanthropies, (2) USDA Forest Service Department of Agriculture, (3) Hubbard Brook Research Foundation, and (4) National Science Foundation (NSF)

Slide 39: Questions?

WaterViz Curriculum

Image description: The 2024 Summer Teen WaterViz STEAM Camp team of instructors and camp counselors. Individual photos of Niki Outen and Susan Osterhaus are included below the group photo.

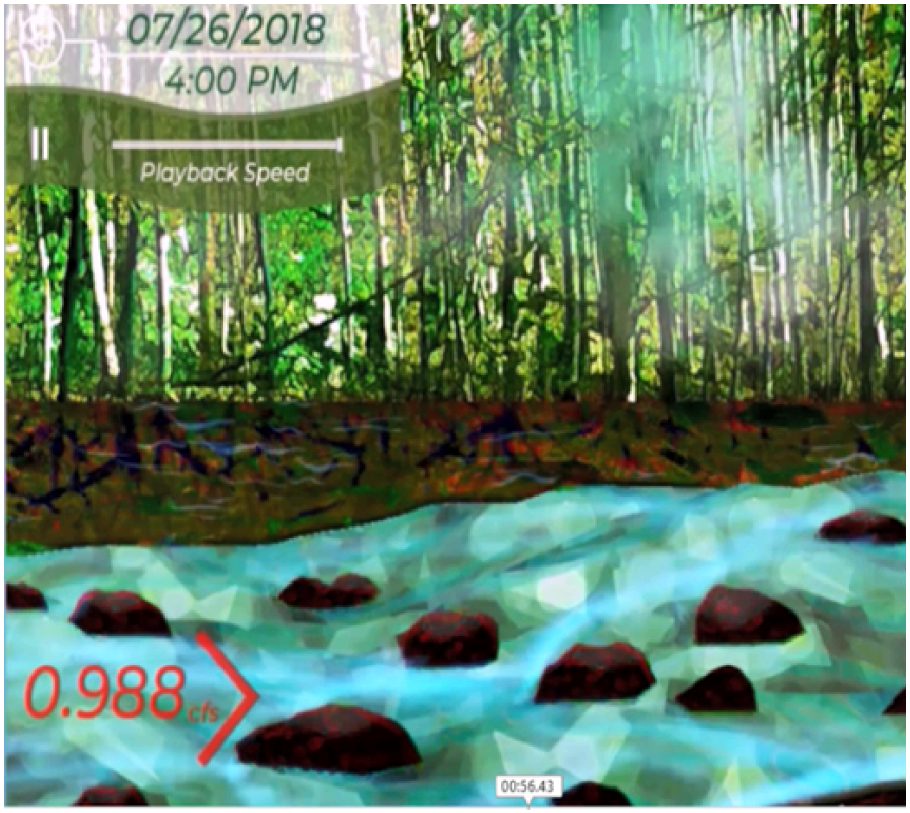
Additional Resources

Description of WaterViz Animated Art

The background image of WaterViz is an original painting by artist Xavier Cortada, with sections for each component of the water cycle. Each section is animated by moving particles. The number of particles and the speed of their movements are directly proportional to the data generated by environmental sensors at the Hubbard Brook. For example, as stream flow increases, the number of particles in the stream increases and they ‘flow’ faster.

Beginning at the top, the animated graphic shows a forest of trees that change in appearance based on the season. For example, in summer, green foliage is shown on the trees. In winter, the trees do not have foliage. Below the trees, roots extend down into a layer of soil. In some winter images, a layer of snow is shown above the soil. At the bottom, stream water flows from left to right. The red number on the bottom left of the screen shows the amount of stream water passing a specific point each second (cubic feet of water per second, cfs). The following animated particles are shown in the graphic to represent different components of the water cycle:

1. Particles move from top to bottom to represent rain or snow falling.
2. Waves move in the soil layer to show the amount of water stored in the soil.
3. Particles flow from left to right in the stream.
4. A hazy green mist rises from the surface of the plants and a hazy white mist rises from the stream and soil.

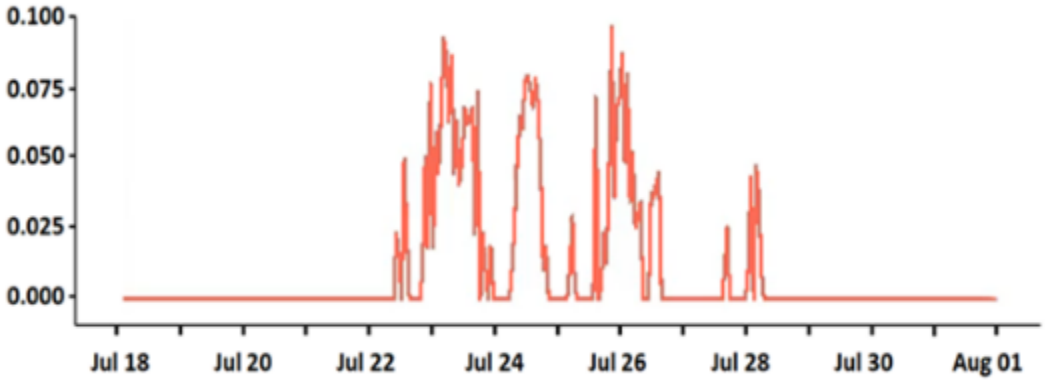


Descriptions of WaterViz Graphs

For all graphs, the following dates are labeled on the x-axis: July 18, July 20, July 22, July 24, July 26, July 28, July 30, August 01.

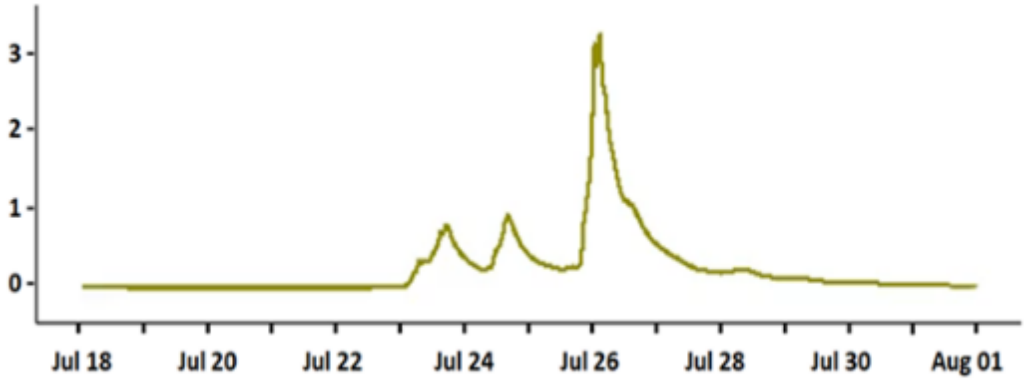
Graph 1. The following values are labeled on the y-axis: 0.000, 0.025, 0.050, 0.075, 0.100. Data are plotted with a red line. From July 18 to July 22, the graph remains at 0. The curve then sharply increases to 0.050 and then returns to zero between July 22 and July 23. From July 23 to July 27, the graph fluctuates between 0 and values between 0.050 and 1.00. It returns to 0 on July 27. On July 28 there are a few more peaks up to 0.025-0.050 before the graph returns to 0 until August 01.

WaterViz Graph 1



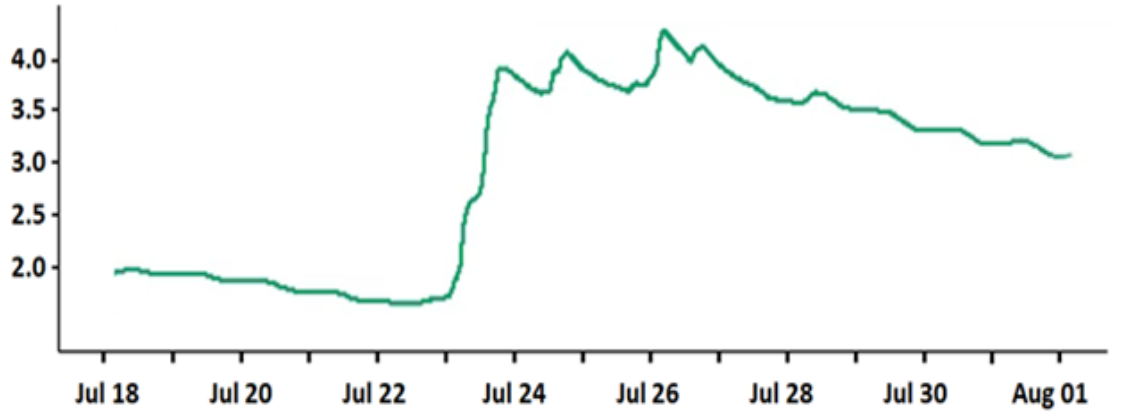
Graph 2. The following values are labeled on the y-axis: 0, 1, 2, 3. Data are plotted with a golden-brown line with a y-axis value of 0 from July 18 through July 23. The curve increases and peaks at a y-axis value of 1 on July 24. It then declines to nearly 0 and then peaks at 1 on July 25 before declining to nearly 0 until July 26, when a sharp increase to 3 occurs. The graph then declines sharply and returns to nearly 0 from July 29 through August 01.

WaterViz Graph 2



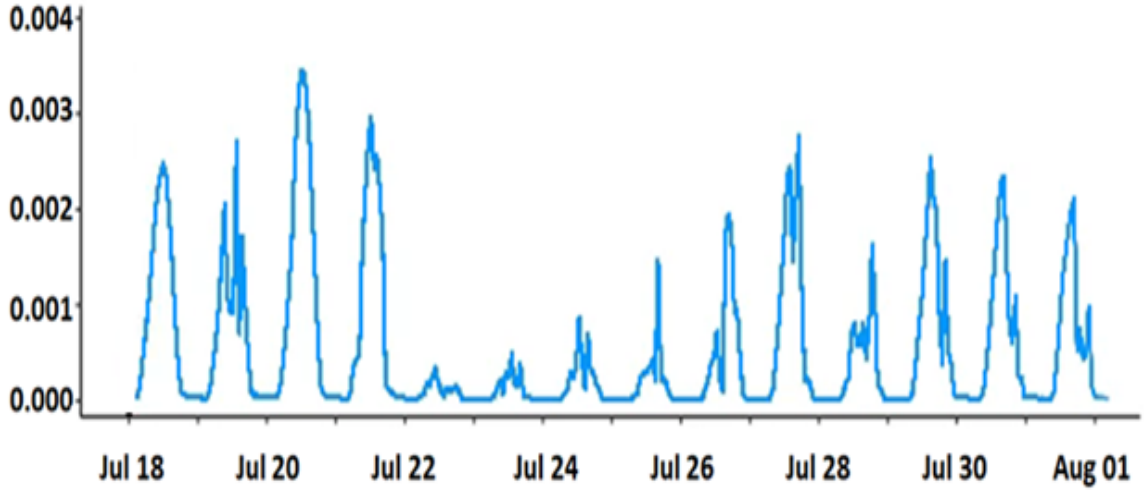
Graph 3. The following values are labeled on the y-axis: 2.0, 2.5, 3.0, 3.5, 4.0. Data are plotted with a teal line beginning on July 18 with a y-axis value of 2.0. Between July 18 and July 23, the graph goes down slightly and then sharply increases to 4.0. It remains above 3.5 until July 28 when it starts to gradually decline to around 3.0 on August 01.

WaterViz Graph 3



Graph 4. The following values are labeled on the y-axis: 0.000, 0.001, 0.002, 0.003, 0.004. Data are plotted with a blue line beginning on Jul 18 with a y-axis value of 0.000. Between July 18 and July 19, it rises to a value of 0.003 and then returns to baseline. This pattern is repeated with daily increases and decreases. Peak heights range from 0.003-0.004 on July 18 through July 21. The period from July 22 through July 27 shows a daily increase, but the peak heights range from less than 0.001 to 0.002. From July 26 through August 01, daily peak heights are between 0.002 and 0.003.

WaterViz Graph 4



Graph 5. The following values are labeled on the y-axis: 50, 60, 70, 80. Data are plotted with a purple line beginning on July 18 with a y-axis value between 50 and 60. Between July 18 and July 19, the graph rises to a value of nearly 70 and then goes down to 50. A similar pattern, with daily increases and decreases, is repeated for the rest of the graph.

WaterViz Graph 5