Chesapeake Bay Program
Science. Restoration. Partnership.

Climate Resiliency Workgroup
June 20, 2024

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SCIENTISTS SERVING COMMUNITIES

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EARTH SYSTEM SCIENCE INTERDISCIPLINARY CENTER

DEPARTMENT OF ATMOSPHERIC & OCEANIC SCIENCE

DEPARTMENT OF GEOLOGY

DEPARTMENT OF GEOGRAPHICAL SCIENCES

Addressing Climate Challenges for a Sustainable Earth unifies the expertise of UMD's scientists with the immediate requirements of Maryland's decision-makers to address the complexities of climate change

. **Coproduction Approach to Delivering Actionable Information to User Communities**
Developing predictive decision support capabilities requires a coproduction approach that brings together scientists, software developers, extension experts, and stakeholders (*Meadow et al. 2015, Prokopy et al. 2017*)

HYDRONET
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MEES
MARINE ESTUARINE ENVIRONMENTAL SCIENCES GRADUATE PROGRAM

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Our Complete Project Team

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(CMNS/GEOL)

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(BSOS/GEOG)

Sumant Nigam
(CMNS/AOSC)

Project Coordination and Liaison Team:

Mike Maddox, Research and Stakeholder Coordination
Louis Uccellini, Senior Research Professor
Cazzy Medley, Communications and Coordination
Jennifer Collins, Experiential Learning Coordinator

Key Investigators:

AOSC: **Russ Dickerson; James Hyde,** MESONET
GEOL: **Karen Prestegaard; Sujay Kaushal; Mong-Han Huang**
GEOG: **Mike Humber; Kara Mobley**

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Project Focus & Structure

75 interns across 3 programs in 2023-2024

Experiential Learning

Coastal Impacts
AOSC/MEES

Climate Resilient Agriculture
GEOG

Land, Water & Air
GEOG/AOSC

Stakeholder Engagement

Ferry Cove Shellfish

Maryland Department of the Environment

Resilience Authority of Charles County, Maryland, Inc.

MARACOOS
Ocean Information for a Changing World

Montgomery County GreenBank
Your partner for clean energy

Maryland Department of Natural Resources

RC&D

University of Maryland Center for Environmental Science Integration and Application Network

Mattawoman Creek Environmental Education Center
Charles County Public Schools

Keep Charles County Beautiful

Sea Grant Maryland

University of Maryland Center for Environmental Science Integration and Application Network

The Nature Conservancy

The Resilience Authority
Of Annapolis and Anne Arundel County Inc.

NOAA Air Resources Laboratory
Investigating processes in the Earth's Boundary Layer

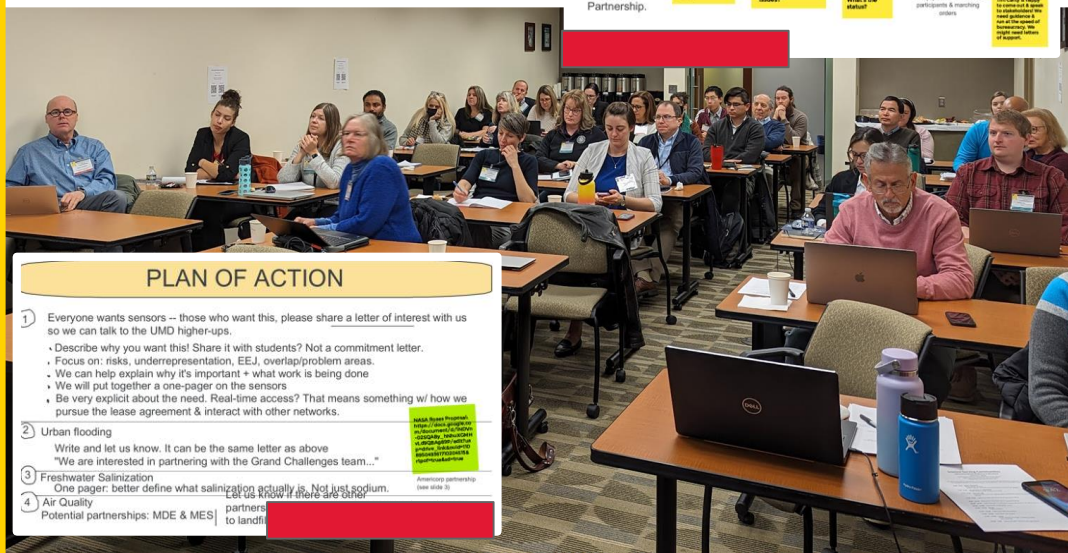
Stakeholder Workshop - 1/5/24

Science Serving Communities:

Advancing Climate Resilience in Maryland

cmns.umd.edu/news-events/news/ESSIC-advancing-climate-resilience-maryland

- Hosted at ESSIC
- Nearly 50 participants, including
  - ESSIC project team
  - Local - Anne Arundel, Charles, Mont. Counties
  - Agencies - DNR, NOAA, Maryland Environmental Service, USFWS
  - Academia - UMCES, St. Marys
- Series of lightning talks on our focus areas, then open discussions



Key Outcomes

- Stakeholders were immediately interested in installing water sensors, conducting air quality tests, participating in citizen science
- Solicited letters of support & tentative funding ideas
- Potential NASA ROSES letter of intent

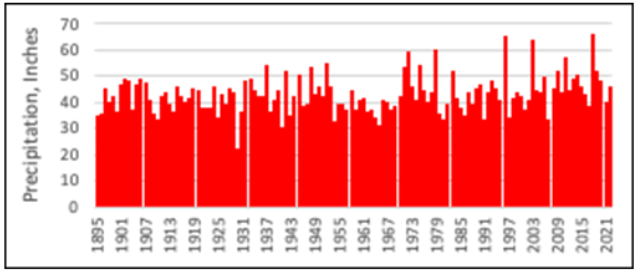
Project Progress: Effects of Climate Change on Streams, Floods and Water Resources

Problem: Many Maryland communities rely on small streams or groundwater for water resources. Impact of climate change is causing increased clustering of precipitation - more dry and wet periods. *Impacts water resources significantly - groundwater/wells, agriculture, runoff, erosion.*

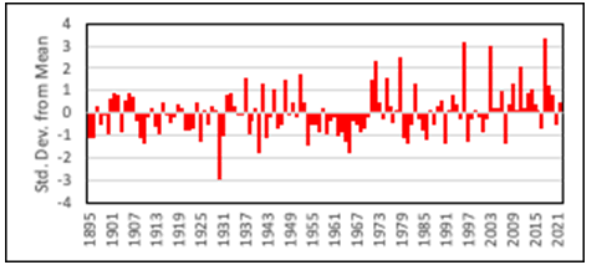
Actions:

- **Quantify trends** in precipitation, stormflow, baseflow, groundwater recharge, and other water balance components In targeted Maryland watersheds, e.g. Frederick County.
- Use USGS and UMD stream gauge data to examine runoff partitioning and how variations in land-use, geomorphology, and soil thickness affect stormflow, and baseflow, and evapotranspiration.

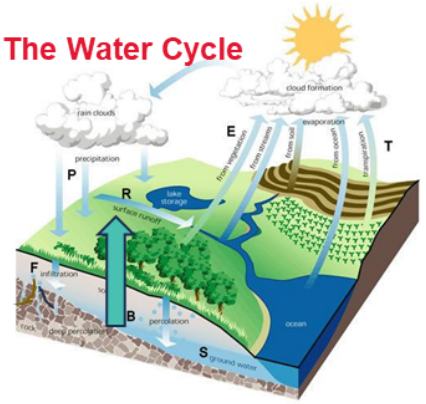
Trends - Relatively Flat

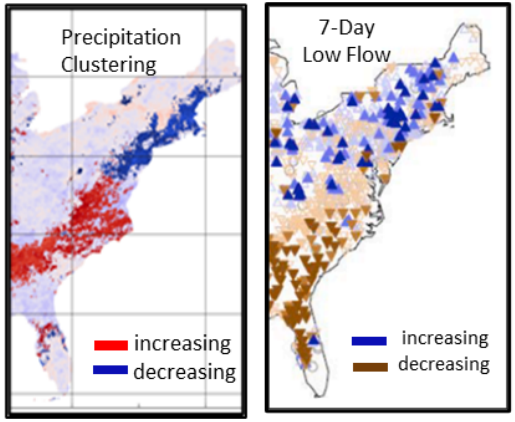


Variability - Increasing!



The Water Cycle





Lastner and Prestegaard, 2023, summer flow Levels are dropping in areas where precipitation clustering has increased.

Project Progress: Freshwater Salinization

Information to Stakeholders: High resolution monitoring of salt concentrations helps Montgomery County to develop and quantify effects of road salt reduction strategies and provides Washington Suburban Sanitary Commission with information regarding sources of drinking water contamination.

Future Expansion: Methods are applicable to mapping coastal saltwater intrusion into streams. Leverage existing NSF grants; engage with AA and, Charles County, etc.

Experiential Education: Grad and undergrad student participation in field monitoring, sampling, laboratory measurement, data analysis, and engagement with stakeholders.

Goals for 2024:

- Longitudinal sampling survey along Watts Branch to tracking salt sources to drinking water intake
- Installation of high-frequency conductivity sensor at Watts Branch
- Engage and involve one underrepresented minority female PhD student in project
- -Communication of results to stakeholders (Montgomery County, WSSC, EPA, etc.) in meetings

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Advancing Near-Surface Geophysics (NSG) for subsurface Hydrology

Problem: Direct and extensive measurement of bedrock depth and groundwater table along steep hillslopes is not feasible. We seek using multiple NSG to jointly constrain deep rock structures and moisture content at different landscapes. *Diminishing groundwater affects well water which is relied upon in rural areas.*

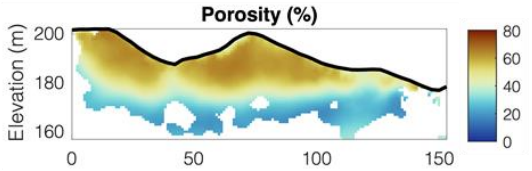
Approach: Employ multiple geophysics techniques including active source seismic refraction, electrical resistivity, and LiDAR to image subsurface rock structure, moisture content and how it changes in time.

Training: Method tested at sites in MD, CA, Puerto Rico with undergrad and grad students. Newly established site at the Central Maryland Research & Education Center.

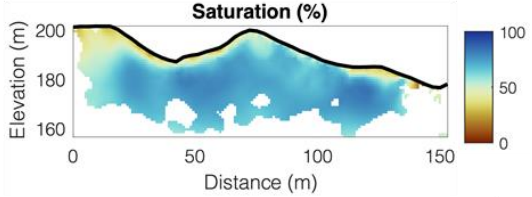
Stakeholders: USGS landslide hazard group and Maryland DNR

Goals for 2024:

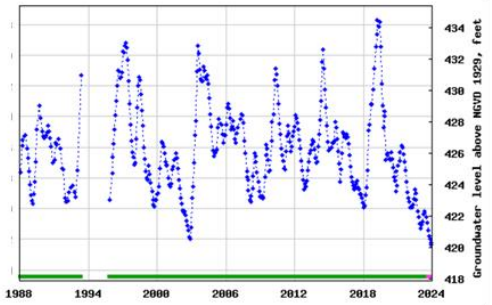
- Repeat NSG survey at t selected sites; monitor changes over time
- One MS student is working on the project and one UMD undergraduate student will join in the summer
- Testing this NSG surveys and studying subsurface moisture dynamics at sites with different geologic settings



Example of porosity and saturation estimates using multiple NSG methods in Utuado, Puerto Rico.



Students practicing NSG deployment and operation



Future groundwater calibration site at the Maryland Research & Education Center. Chart shows water level time series.

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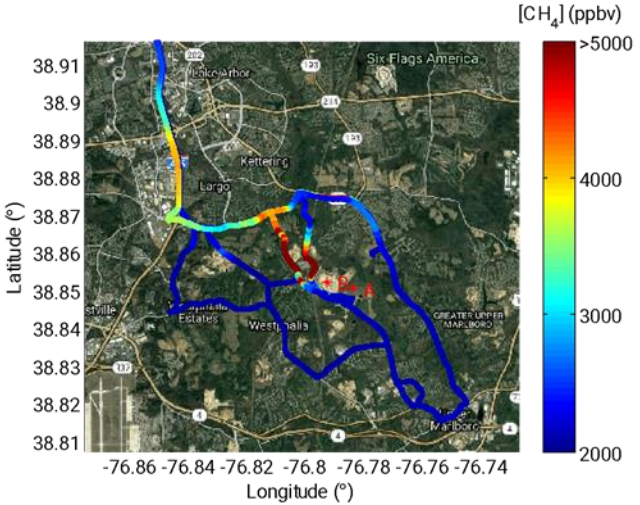
Air Quality

Need #1: Methane emissions (Landfills, wastewater, ecosystem health/restorations, infrastructure)

UMD Capabilities: Mobile surveys (air and land), Models, Novel methods to attribute emissions and guide effective mitigation through information about hidden sources and inventories.

Need #2: Air quality impacts on communities (Black Carbon (soot) in areas of truck traffic, air pollutants, aerosols etc….)

UMD Capabilities: Mobile surveys of BC and trace gases to identify sources and chemical techniques to fingerprint sources aid mitigation and in turn improve quality of life for residents.



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Project Progress: Climate-Resilient Agriculture

Integrated various GIS data and EO to create detailed maps and models highlighting climate risk to agricultural areas in Maryland.

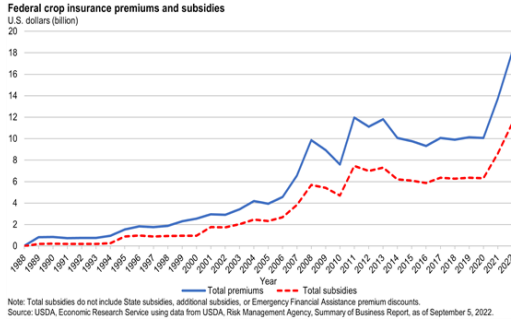
Creating an interactive dashboard that provides a user-friendly interface for accessing and interpreting the data and serves as a central repository for project findings

StoryMaps to explain the map visualizations and analysis results, ensuring that the information is comprehensible and actionable for all stakeholders, from policymakers to farmers.

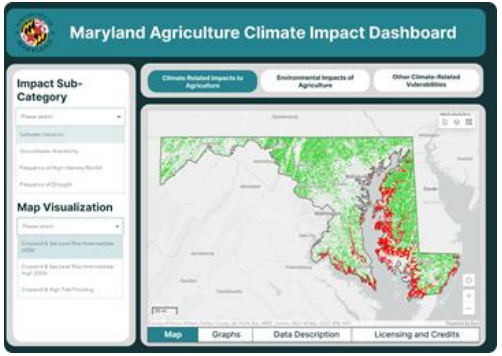
Successfully completed its first semester of a Citizen Science Competition

- engaged all GEOG undergraduate students in field data collection
- competition provided experiential learning opportunities
- Students collected field observations and delineate field boundaries using mobile applications and web tools

The data collected will be used to train models and validate crop type and cropland extent mapping throughout Maryland



Federal crop insurance premiums and subsidies derived from 2022 USDA Cropland Data Layer (CDL)



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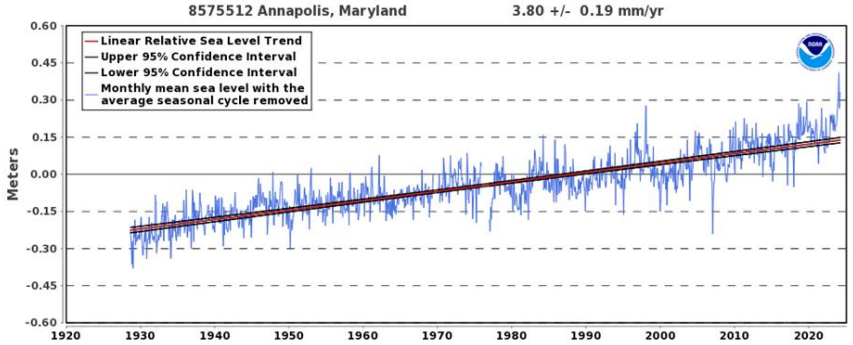
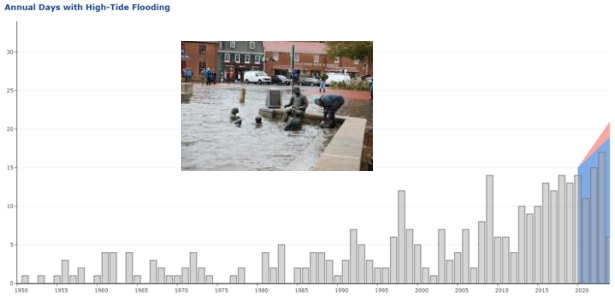
“Climate Change Is Here, And We Are Ground Zero”

Matt Fleming, The Resilience Authority of Annapolis And Anne Arundel County





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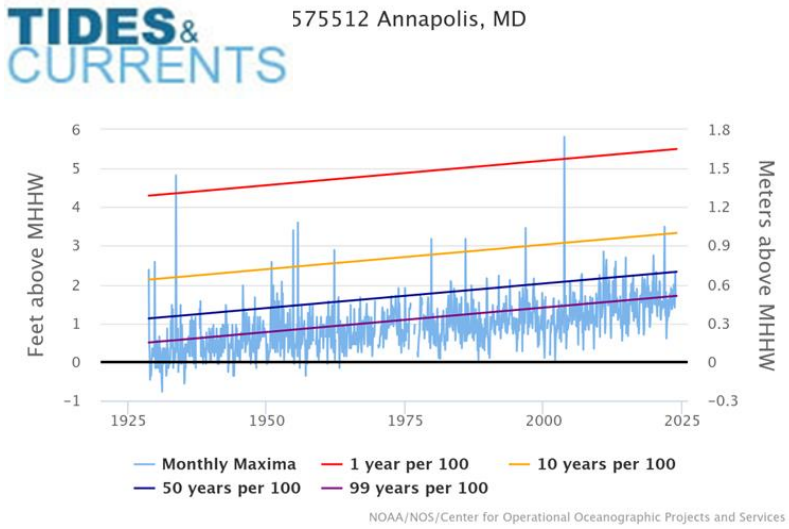
1.3 - 5.2 feet

Predicted rise of Bay waters over the next 100 years

https://www.chesapeakebay.net/issues/threats-to-the-bay/climate-change



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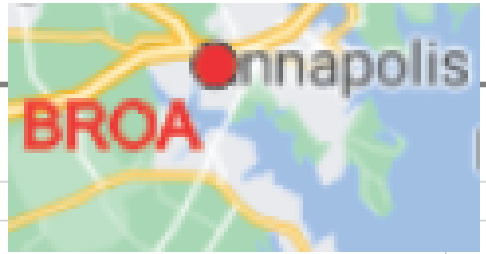
Land Subsidence Monitoring

BROA Benchmark -- ITRF2014

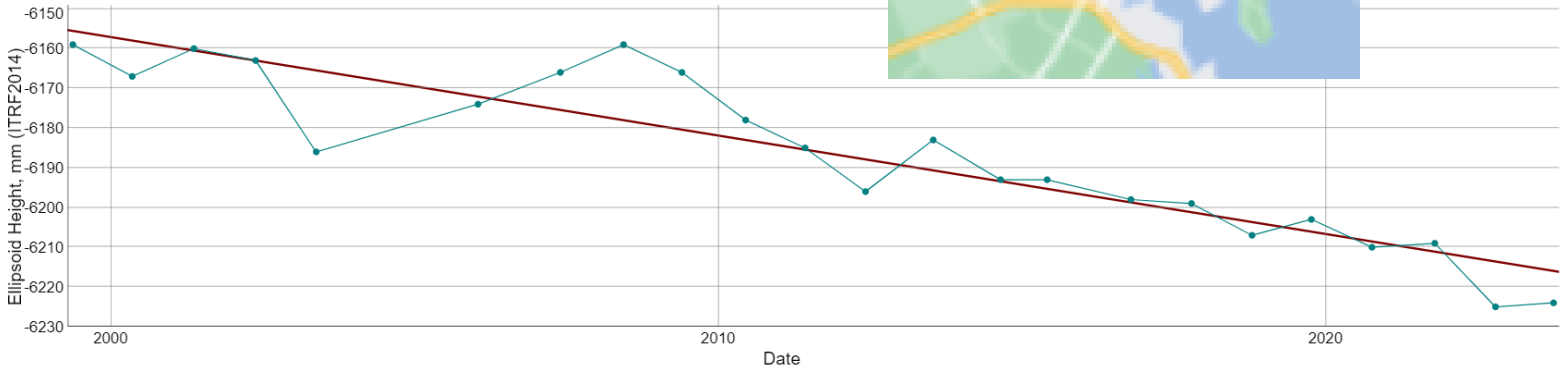
MARYLAND GEOLOGICAL SURVEY

Surveyed annual elevation data with trend analysis

To change the graph scale, click and drag mouse vertical or horizontal. To reset graph scale, double click on the graph.



Benchmark: BROA
Location: Broad Creek Water Treatment Plant



Simple Regression | Clear Regression Line

Slope (mm/yr): **2.48**

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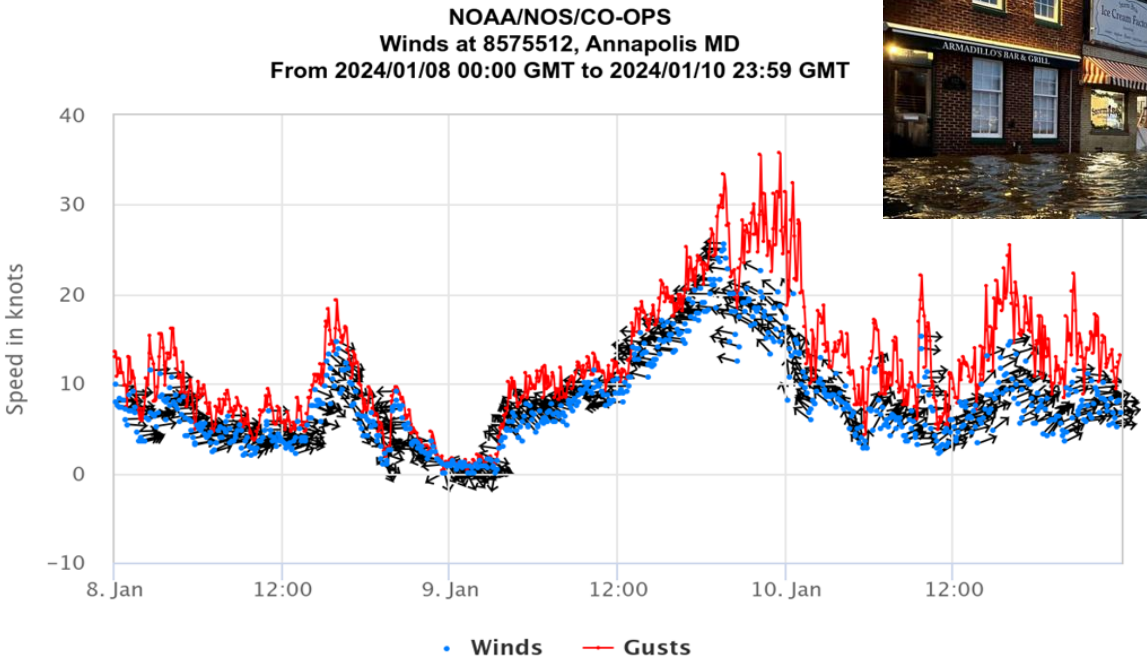
January 9-10, 2024



"…relative sea level rise and accelerating instances of coastal nuisance flooding are having a tangible negative impact on economic activity and infrastructure in Annapolis, Maryland"

Davies, A. R. et al. 2022

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Problem:

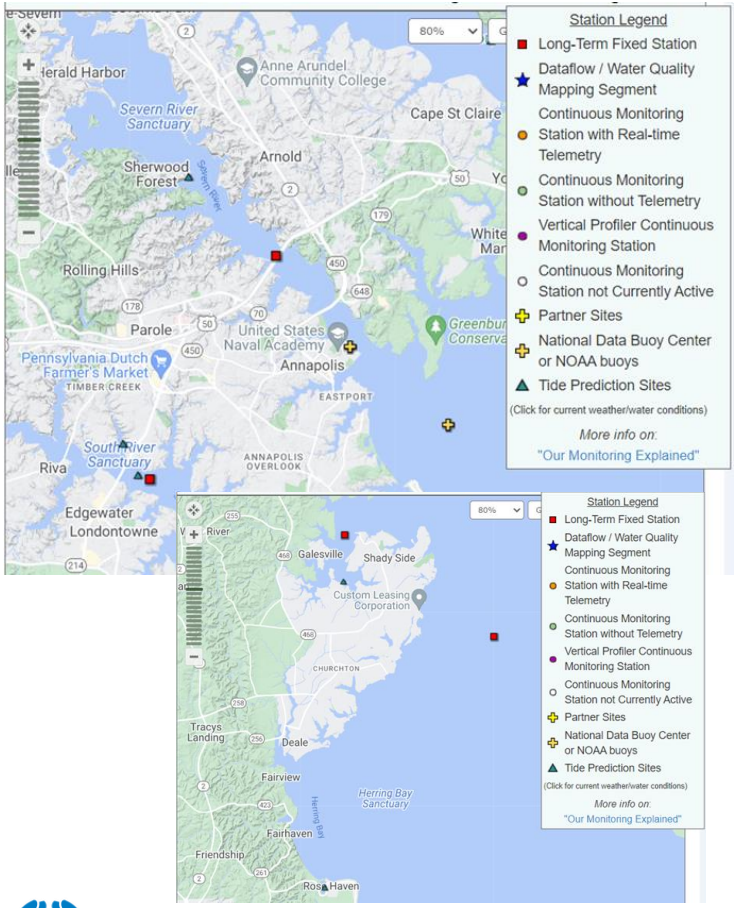
- Lack sufficient monitoring of frequency and severity of nuisance, blue sky and storm-induced flooding around coastal and at-risk communities

Action:

- Work with stakeholders and community groups to Identify high risk areas and underserved communities that lack monitoring

- Deploy a high-density network of low-cost water height monitors; provide real time data access to data via user dashboard (or app)

- Invite marinas, private citizens and businesses to join water level and weather monitoring networks



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Pilot Project :

- City Dock area in Annapolis
- Charles County Cobb Island
- Southern Anne Arundel County (Deale)

Site Selection:

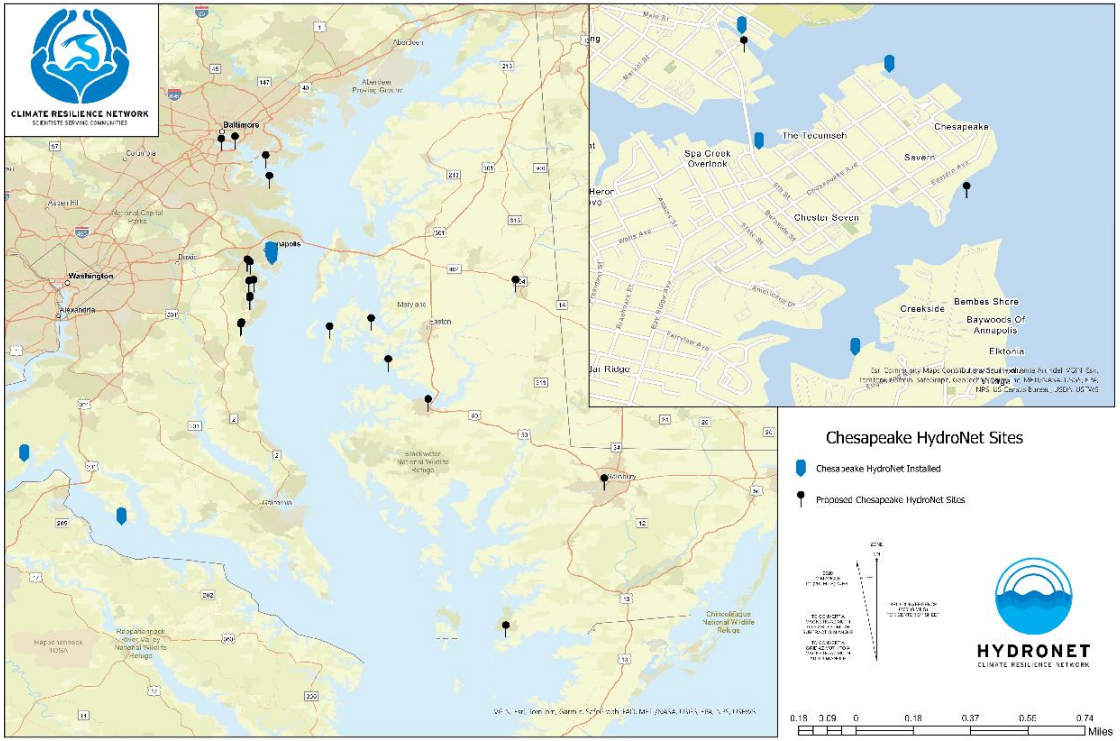
- Frequent Nuisance Flooding
- Little or No Monitoring
- Communities that Lack Resources

Primary Project:

- Chesapeake Bay in Maryland
- Tidal Rivers in Maryland
- Cities Centers and towns in Maryland

Extended Project:

- Delaware Bay and tidal tributaries
- Southern Chesapeake Bay
- Coastal Bays of Maryland



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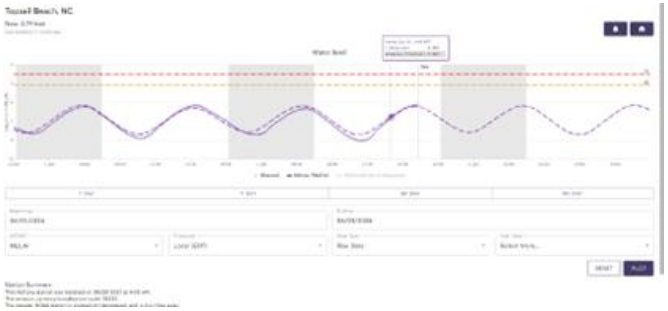
Information to Stakeholders:

- Near real-time maps of water level at sensor locations
- Send alerts to emergency managers when threshold water levels reached
- Provide projections of flooding based on real-time water level rise
- Integrate information from weather stations (MESONET)

New Sensor



Mature Sensor

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Experiential Experience and Education:

- Sumer Internship Program
- Curriculum development for Middle and High School
- Data Analytics Program Pilot: Nanjemoy Environmental Education Center
- Citizen Science

Regional Partnerships:

- MARACOOS committing support with focus on underserved coastal communities
- Resilience Authority of Annapolis and Anne Arundel County
- Resilience Authority of Charles County
- Chesapeake Bay Program

Global Partners:

- Hohonu, inc.
- Woods Hole Group
- University of Hawaii

HYDRONET
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Key Persons:

Principle Investigator: Tim Canty, tcanty@umd.edu

Project Manager and Stakeholder Engagement: Michael Maddox, mmaddox@umd.edu

Advisor: Louis Uccellini, luccelli@umd.edu

Communications: Chrysandra (Cazzy) Medley, cazzy@umd.edu

Education: Jennifer Collins, jcollin1@umd.edu

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Thank You

mmaddox@umd.edu

Davies, A. R., J. P. Smith, D. S. Mandell, G. Davis, and F. Y. Wan, 2022: Sustained Wind Forcing and Water Level Anomalies in Annapolis, Maryland. Earth Interact., 26, 52–65, https://doi.org/10.1175/EI-D-21-0013.1.

Meadow, A. M., D. B. Ferguson, Z. Guido, A. Horangic, G. Owen, and T. Wall, 2015: Moving toward the deliberate coproduction of climate science knowledge. *Weather , Climate, and Society*, **7**, 179-191, https://doi.org/10.1175/WCAS-D-14-00050.1.

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