NASA DEVELOP National Program
2024 Fall Project Proposal

Maryland – Goddard
Chesapeake Bay Water Resources
Using Earth Observations to Assess Spatial and Social Disparities in Water Quality Trends Shaping Swimming and Fishing Access in the Chesapeake Bay

Project Overview

Project Synopsis: This study will examine the spatial distribution of water quality parameters compared with sociodemographic characteristics of communities living nearby to shed light on public swimming and fishing access for communities living near the Chesapeake Bay. In partnership with the Ocean Conservancy and Blacks of the Chesapeake Foundation, one environmental and one Black, Indigenous, and other People of Color (BIPOC) community advocacy non-profit, the NASA DEVELOP team will evaluate water quality parameters, public swimming and fishing site data, sociodemographic vulnerability indicators, and the convergence of these variables in communities near the Chesapeake Bay. Harnessing the capabilities of PACE OCI, Terra and Aqua MODIS, Landsat 9 OLI-2, and Sentinel-3 OLCI, this project will examine patterns in water quality parameters such as Chlorophyll-a concentration and turbidity levels from 2020 to 2024. This project seeks to inform coastal cleanup and community outreach efforts for partners in the Chesapeake Bay region. .

Study Location: Chesapeake Bay, Anne Arundel County and Dorchester County (MD)
Study Period: 2020-2024 (May – October)

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Partner Overview

Partner Organizations:

Organization	Contact (Name, Position/Title)	Partner Type	Sector
Ocean Conservancy	Aspen Bataille, Science and Knowledge Fellow; Mikayla Spencer, Sr. Manager of Equitable Ocean Communities; Henry Huntington, Director of Arctic Science	End User	Non-profit
Blacks of the Chesapeake Foundation	Brynne Rardin, Filmmaker; Vince Legget, Founder & President; Deedee Strum, Chief Administrative Officer	End User	Non-profit

End User Overview

End User's Current Decision-Making Process & Capacity to Use Earth Observations: The Ocean Conservancy's Indigenous-led Conservation and Ocean Justice programs work closely with community partners to identify relevant issues and questions that need to be addressed through science and policy actions

at multiple scales. To increase equity in access to the outdoors and improve quality of life at a community level, Blacks of the Chesapeake Foundation decides where to prioritize limited monetary and time resources for outreach and community engagement by working with communities where present staff have pre-existing connections. Both partners do not currently use remote sensing for decision making around outreach, beach cleanup or water quality testing locations, but partners see remote sensing as an opportunity to equitably identify locations in need of resources and communities they have missed through geographic science.

Earth Observations Overview

Earth Observations:

Platform & Sensor	Parameter(s)	Use
Landsat 9 OLI	Turbidity	Landsat 9 OLI reflectance bands will derive turbidity at a 30 m resolution.
Terra MODIS	Chlorophyll-a	The standard Level -2 Chlorophyll-a product, with a spatial resolution of 1 km and daily temporal resolution, will derive near-surface concentration of Chlorophyll-a using three or more sensor bands spanning the 440 - 670 nm spectral range. Near-surface concentrations of Chlorophyll-a are using empirical relationships derived from in situ measurements of Chlorophyll-a and remote sensing reflectance values.
Aqua MODIS	Chlorophyll-a	The standard Level -2 Chlorophyll-a product, with a spatial resolution of 1 km and daily temporal resolution, will derive near-surface concentration of Chlorophyll-a using three or more sensor bands spanning the 440 - 670 nm spectral range. Near-surface concentrations of Chlorophyll-a are obtained using empirical relationships derived from in situ measurements of Chlorophyll-a and remote sensing reflectance values.
Sentinel-3 OLCI	Chlorophyll-a	Sentinel-3 reflectance at 300 m resolution will be used to retrieve Chlorophyll-a. Sentinel-3 will complement the MODIS sensors with finer spatial resolution, but a reduced temporal resolution of 27 days.
PACE OCI	Turbidity, Chlorophyll-a	Pending data availability, PACE will be used to investigate meaningful parameters and assess the spatial distribution of impaired waters, primarily those with high concentrations of Chlorophyll-a and turbidity, in the Chesapeake Bay. PACE data will be used to retrieve turbidity and Chlorophyll-a to derive water quality metrics and compared to other data sources at 1 km.

Ancillary Datasets:

- NOAA National Centers for Coastal Ocean Science (NCCOS); Level 3 Mapped Ocean Data Near-Real Time – Algal Bloom Beta Products – mapped reflectance products for visualizing impaired water quality, including algal blooms
- Maryland Department of Natural Resources (DNR) Public Angler Access Map – coordinate point locations of public access fishing sites in the Chesapeake Bay to assess variations in community access
- EPA Beach Advisory and Closing Online Notification database – data on public swimming access sites and beach closures in Maryland to be aggregated by Census tract and compared across Census tracts
- EPA EJScreen: Environmental Justice Screening and Mapping Tool – CSV text file providing total population, poverty population, minority status, percent low income, unemployment rates, less than high school education, age less than 5 years, age greater 65 years, and life expectancy data used for the Social Vulnerability Index
- Chesapeake Bay Program (CBP) Water Quality Database (1984-Present) – water quality measurements, including Chlorophyll-a and turbidity, to provide historical context to spatial variation of water quality in the study area and to compare against remotely sensed observations
- Council on Environmental Quality Climate and Economic Justice Screening Tool – demographic data related to income, linguistic isolation, educational attainment, and poverty level for inclusion in the Social Vulnerability Index
- CleanSwell Coastal Cleanup Data from the Ocean Conservancy – debris data will not be used as any inputs for analysis, but could provide helpful context to participants about the study area and the Ocean Conservancy's work

Decision Support Tool & End Product Overview

End Products:

End Product	Partner Use	Datasets & Analyses
Water Quality Time Series	These maps will display a time series of key water quality parameters that shape fishing and swimming safety and access in the Chesapeake. The mapped parameters will include Chlorophyll-a, turbidity, and potentially Net Primary Production. These time series maps will be used by the partners for community outreach and education. Partners will also be able to use the time series to identify spatial trends or anomalies in water quality and identify nearby coastal communities impacted.	Landsat 9 OLI, Sentinel-3 OLCI, PACE OCI, NOAA Algal Bloom Beta Products, and Terra/Aqua MODIS will be used to derive maps of Chlorophyll-a concentrations and turbidity levels for the study area at varying spatial and temporal resolutions. CBP Water Quality Database in situ samples will be used to validate these maps.
Community Demographic and Recreation Access Maps	These maps of sociodemographic data by Census tract will be combined with water quality maps, and public access fishing and swimming site point data to provide partners with a stronger understanding of the spatial distributions and disparities at play within the Chesapeake Bay. Partners will use these maps to identify and	American Community Survey data and EPA EJ Screen Tool will be used to calculate Social Vulnerability Index values for each Census tract in the study area. EPA Beach Advisory and Online Closure Database and Maryland DNR Public Angler Access Map will be used to estimate total public access sites available by tract.

	communicate converging vulnerabilities to community stakeholders in the Chesapeake Bay region.	
Video or Social Media Series	This creative communication deliverable will document the project and showcase the partnership between all organizations involved to engage and inspire the BIPOC communities that Blacks of the Chesapeake Foundation works with.	NA

Project Timeline & Previous Related Work

Project Timeline: 1 Term: 2024 Fall

Similar Past DEVELOP Projects:

- 2024 Summer (PUP-FGCU) – Big Cypress Water Resources: Using Earth observations to assess Water Quality characteristics to Determine Operational Best Practices in Big Cypress Preserve, Florida

- 2023 Summer (VEJ) – San Joaquin Valley Health & Air Quality: Evaluating the Overlap of Social Vulnerabilities and Air Quality in the San Joaquin Valley Air Pollution Control District: https://www.devpedia.developexchange.com/dp/index.php?title=Portland_Urban_Development_VEJ_Summer_2023

Notes & References:

Notes:

- https://www.chesapeakeconservancy.org/images/Chesapeake_Public_Access_Plan.pdf
- https://www.epa.gov/chesapeake-bay-tmdl/wastewater-out-front-bay-restoration

References:

Browning, M. H., Rigolon, A., Ogletree, S., Wang, R., Klompmaker, J. O., Bailey, C., ... & James, P. (2022). The PAD-US-AR dataset: Measuring accessible and recreational parks in the contiguous United States. *Scientific Data*, *9*(1), 773.

Geary, R. S., Thompson, D. A., Garrett, J. K., Mizen, A., Rowney, F. M., Song, J., ... & Rodgers, S. E. (2023). Green-blue space exposure changes and impact on individual-level well-being and mental health: a population-wide dynamic longitudinal panel study with linked survey data. *Public Health Research*, *11*(10).

Harding Jr, L. W., Mallonee, M. E., Perry, E. S., Miller, W. D., Adolf, J. E., Gallegos, C. L., & Paerl, H. W. (2019). Long-term trends, current status, and transitions of water quality in Chesapeake Bay. *Scientific Reports*, *9*(1), 6709.

Wolny, J. L., Tomlinson, M. C., Schollaert Uz, S., Egerton, T. A., McKay, J. R., Meredith, A., ... & Stumpf, R. P. (2020). Current and future remote sensing of harmful algal blooms in the Chesapeake Bay to support the shellfish industry. *Frontiers in Marine Science*, *7*, 337.