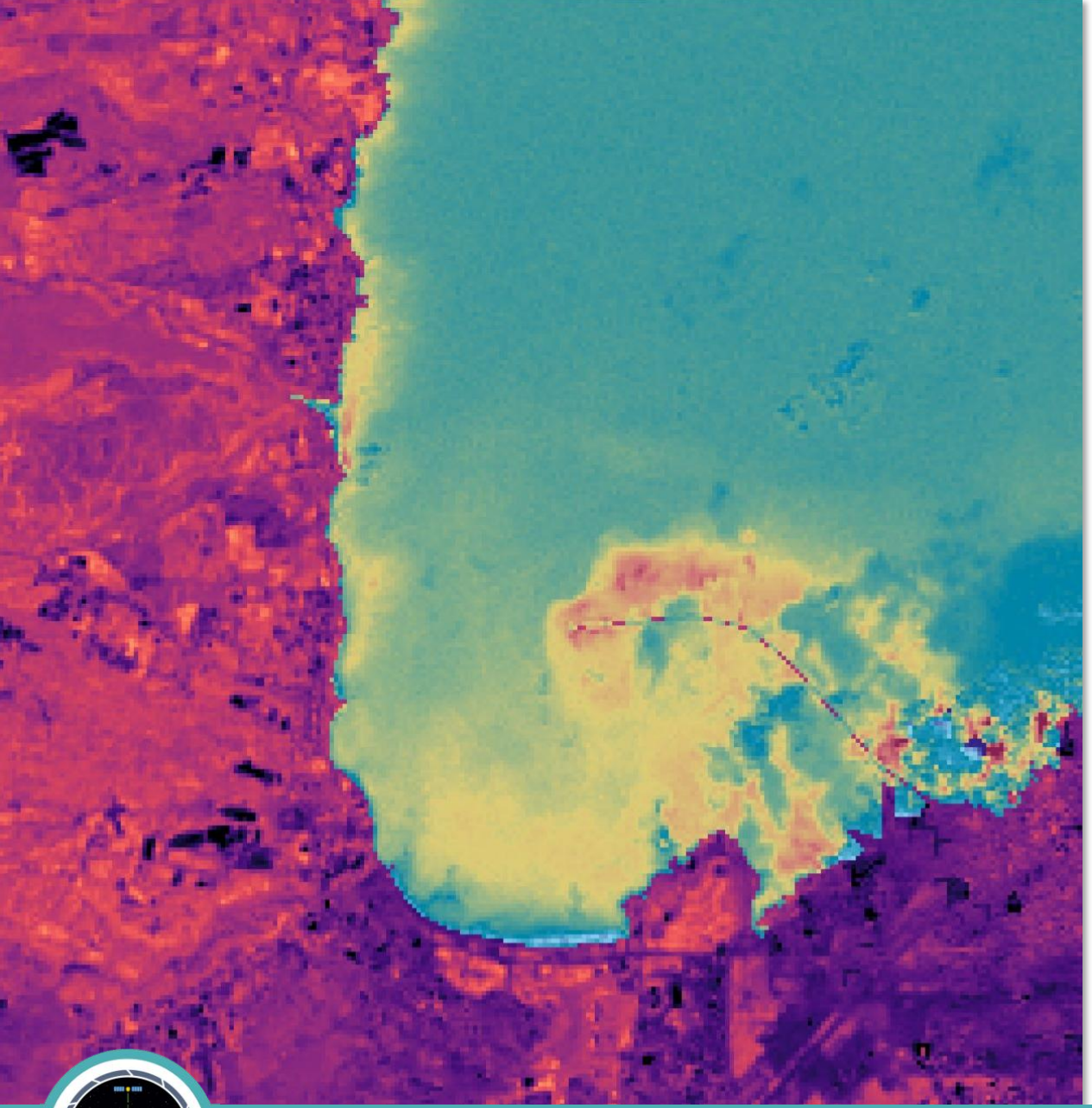


National Aeronautics and Space Administration

HILO BAY WATER RESOURCES

Monitoring Water Quality in Hilo Bay, Hawai'i to Support Future Community Planning

Dani Sonobe

Kandi Shimabukuro

Ashley N. Clark

Samantha White-Murillo

Pop-Up Project – ASU Center for Global Discovery and Conservation Science | Summer 2024

Land Acknowledgement

Our team acknowledges that the ‘āina (land) which this project has grown out of is the ancestral homeland of Kanaka Maoli (Native Hawaiians). It is because of them, that we can be here today. As visitors and settlers, aloha ‘āina in the moku of Hilo on Hawai‘i Island, we are deeply grateful for the generations of Native Hawaiians who have stewarded, cared for, and honored this ‘āina over the past 1,600 years.

Ola i ka wai... Water is life!

Image Credit: Wasif Malik

Meet the Team

Dani Sonobe

Samantha White-Murillo

Kandi Shimabukuro

Ashley N. Clark

Study Area & Period

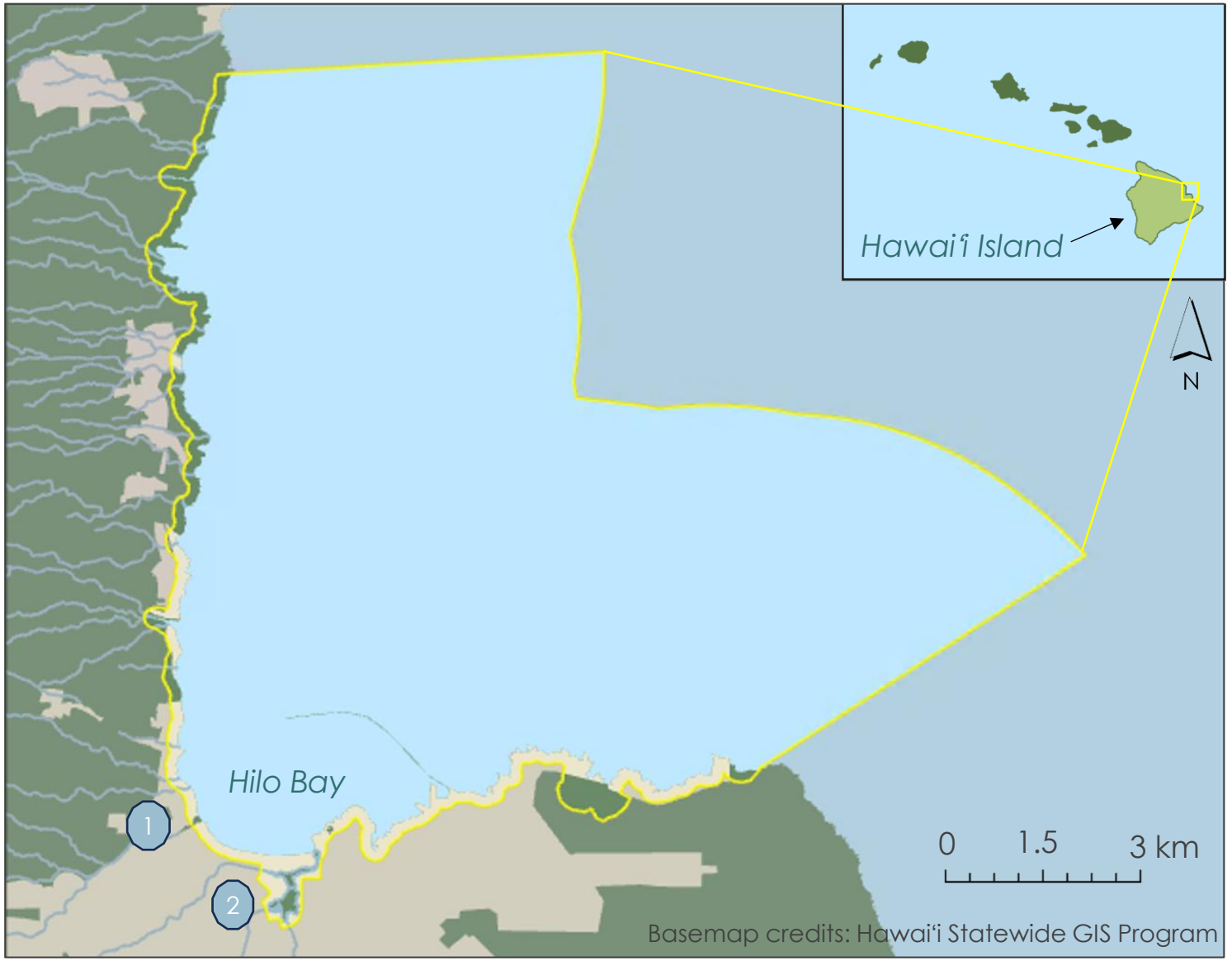
Study Area:

Hilo Bay Region, Hawai‘i

Study Period:

February 2013 to June 2024

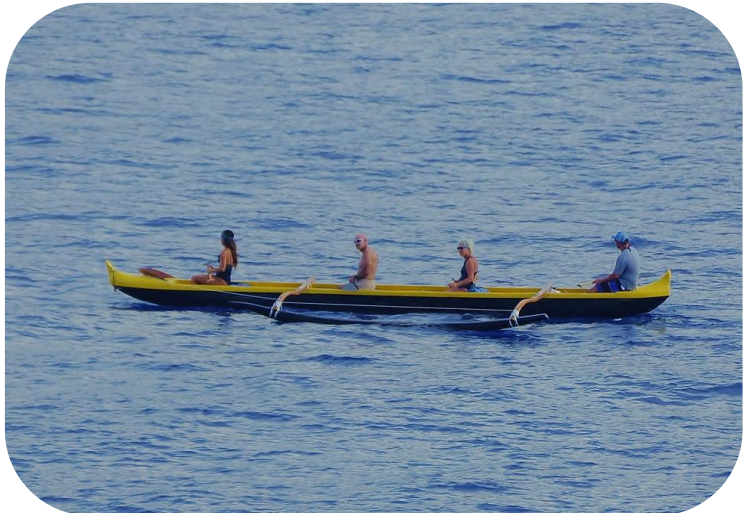
- Study Area
- Urban Land Use District
- Streams
  - 1 Wailuku River
  - 2 Wailoa River



Community Concerns

The Hilo Bay Region places in the 89th percentile in the USA for **risk from wastewater discharge**

Silt and contaminants present in brown water **threaten native and endangered wildlife**



Hazardous water quality **inhibits cultural and recreational use**

Image Credits: (left) U.S. Department of Agriculture, (middle) Steve Jervetson, (right) user @chumlee10

Objectives

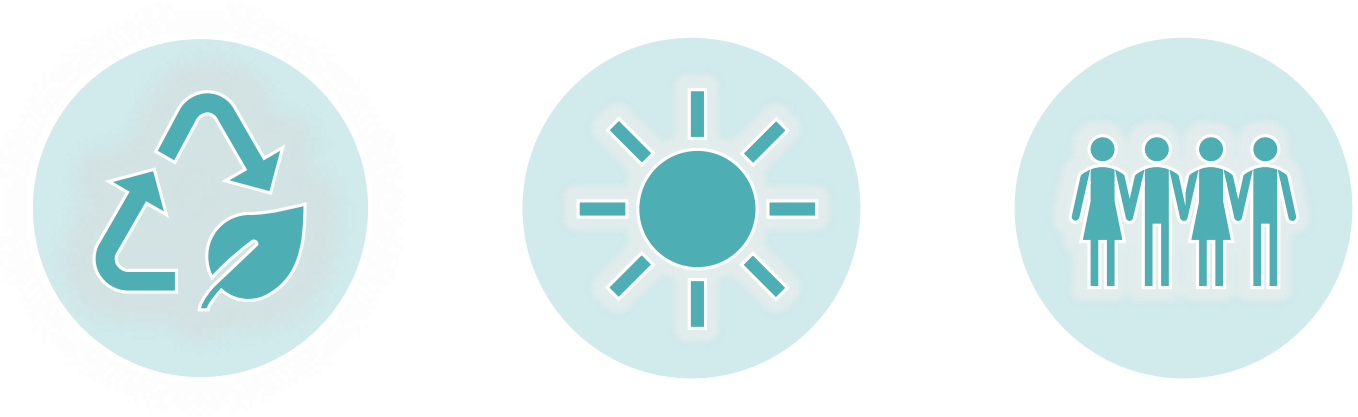
Analyze water quality parameters (turbidity & chlorophyll-a) in the Hilo Bay Region

Generate a set of water quality time-series that showcase periods of Brown Water Advisories (BWA) and non-Brown Water Advisories

Produce useful water quality maps for end-user decision making and an educational brochure for community engagement

Partners

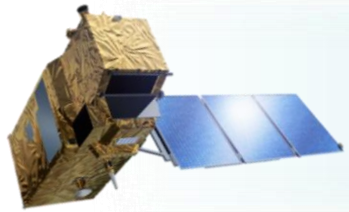
The County of Hawai‘i
Office of Sustainability, Climate, Equity and Resilience (OSCER)



Mission: Create lasting, sustainable and immediate change to achieve sustainability, climate, equity and resilience goals within the local community

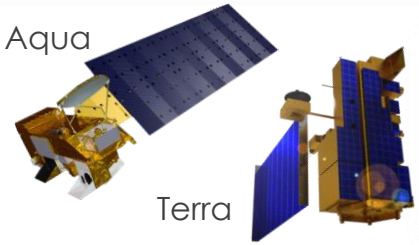
Earth Observations

Data Acquisition Periods



Sentinel-2 Multispectral Instrument (MSI)
(10 m, 5-day revisit time)

2015–2024



Aqua/Terra Moderate Resolution Imaging Spectroradiometer (MODIS)
(1 km, 1 to 2-day revisit time)

2018

Landsat 8 Operational Land Imager (OLI)
(30 m, 16-day revisit time)

2013–2024

Landsat 9 OLI-2
(30 m, 16-day revisit time)

2021–2024

Image Credits: NASA & ESA

Methodology: ORCAA

Earth Observations

Sentinel-2 MSI
Landsat 8 OLI
Landsat 9 OLI-2

2013-2024

Optical Reef and Coastal Area Assessment (ORCAA) Tool

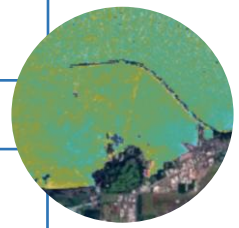
Brown Water Advisory Dates (Dept. of Health)

ArcGIS Pro

Python

Classification
BWA and non-BWA images

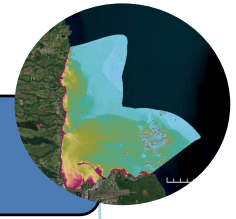
Qualitative Selection
Poor, Good, Perfect images



Images within10-day timeframe

Turbidity Data

End Products



Turbidity Maps

Precipitation and Turbidity Time-series

Precipitation Data

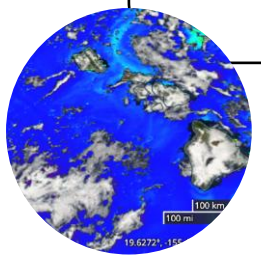
Image Credits: DEVELOP Hilo Team

Methodology: MODIS

Data Source

Aqua & Terra MODIDS

2018



Tools and Processing

ArcGIS Pro

Defined area for data extraction

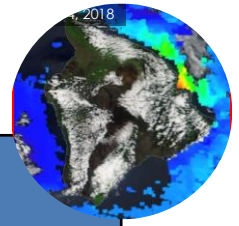
Python

Processed the data to find zonal average chlorophyll-a values on acquired days

Excel

Plot the points over the duration of 2018

End Products

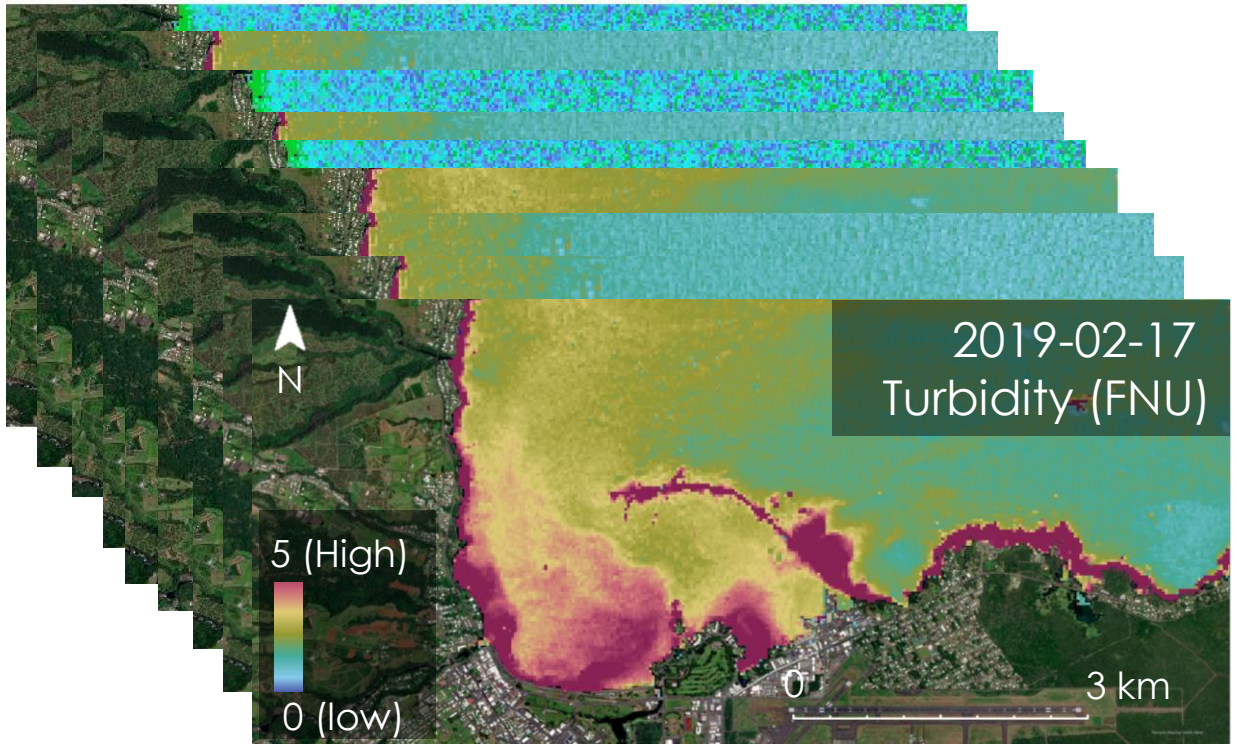


Chlorophyll-a Time-series

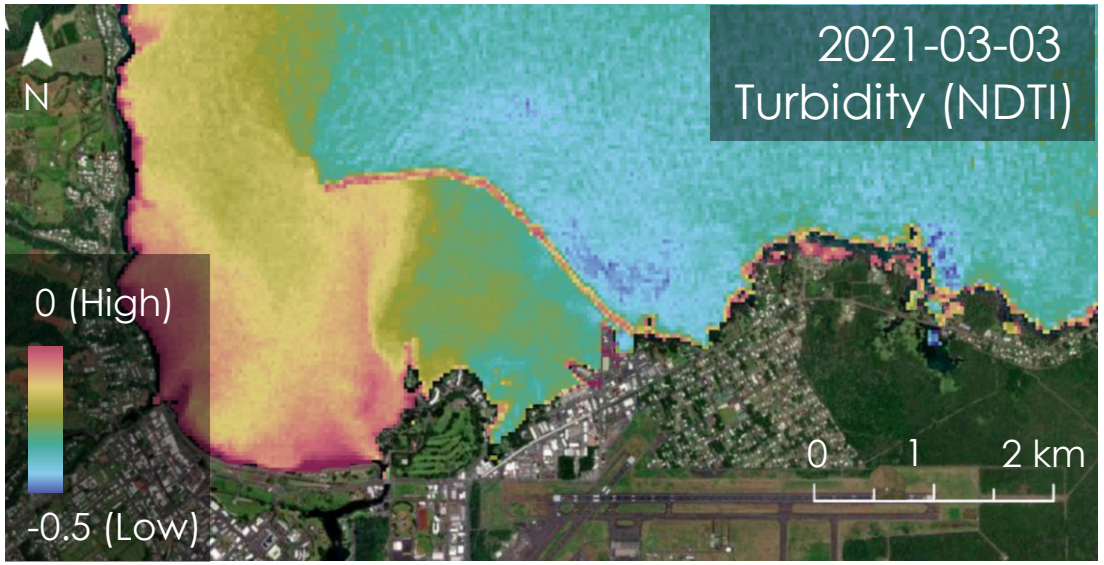
Image Credits: DEVELOP Hilo Team

Results: Image Availability During BWA

Sentinel-2 MSI (10 m)
22 viable images captured during BWA



Landsat 8 OLI (30m)
1 viable image captured during BWA

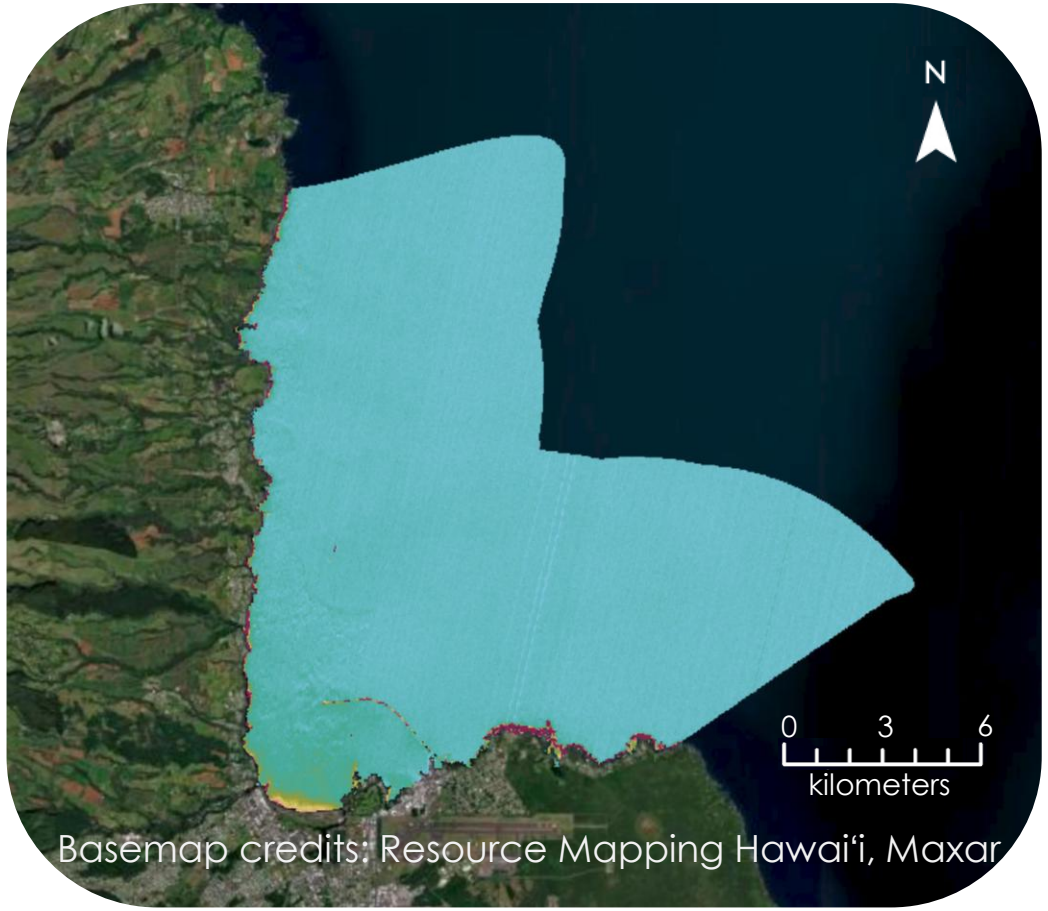


Basemap credits: Resource Mapping Hawai'i, Maxar

Image credits: DEVELOP Hilo team

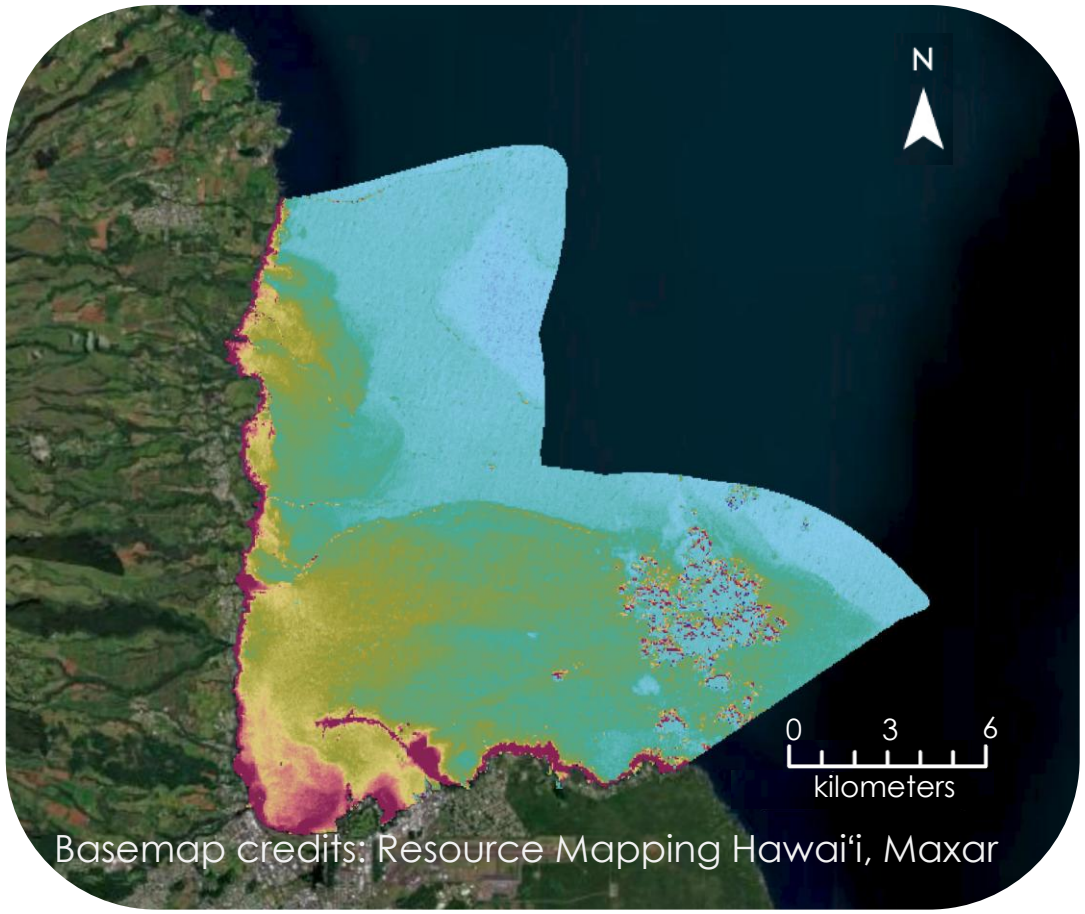
Results: Non-BWA vs BWA

Non-Brown Water Advisory



Satellite Date: 02/16/2022
Last BWA date: 1/28/2022 – 1/31/2022

Brown Water Advisory



Satellite Date: 2/17/2019
BWA Date: 1/28/2019 – 3/6/2019

Turbidity (FNU)

low high

0 5

Image Credits: DEVELOP Hilo Team

Results: Non-BWA vs BWA

Before BWA
February 1-28, 2021

Beginning of BWA
March 1-14, 2021

Middle of BWA
March 15-31, 2021

End of BWA
April 1-19, 2021

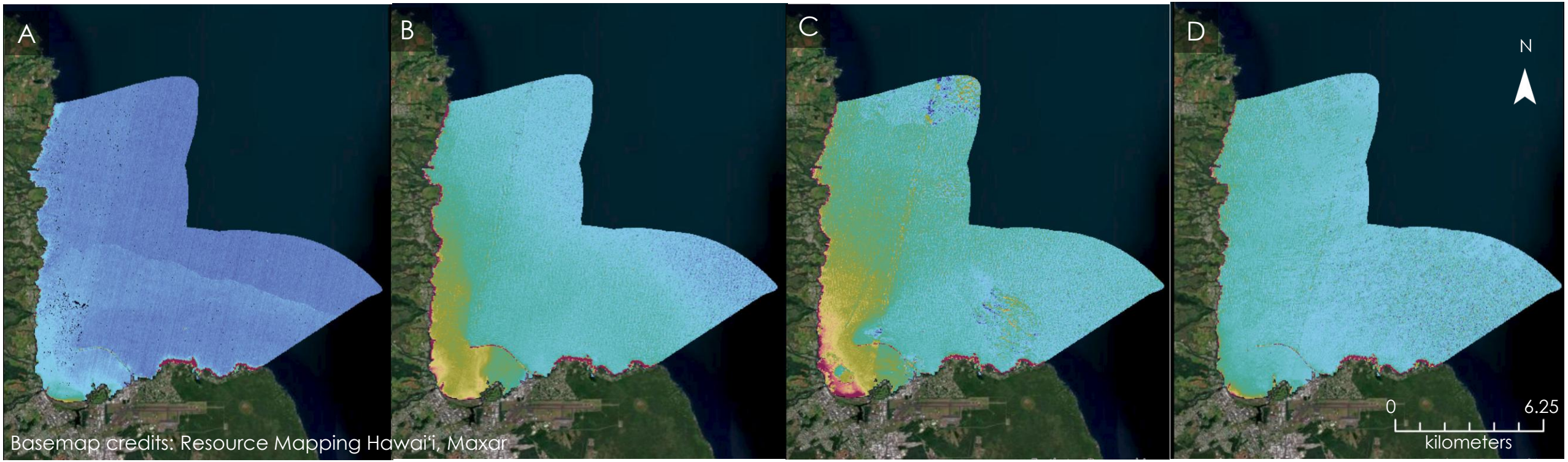


Image Date: 2/6/2021

Image Date: 3/3/2021

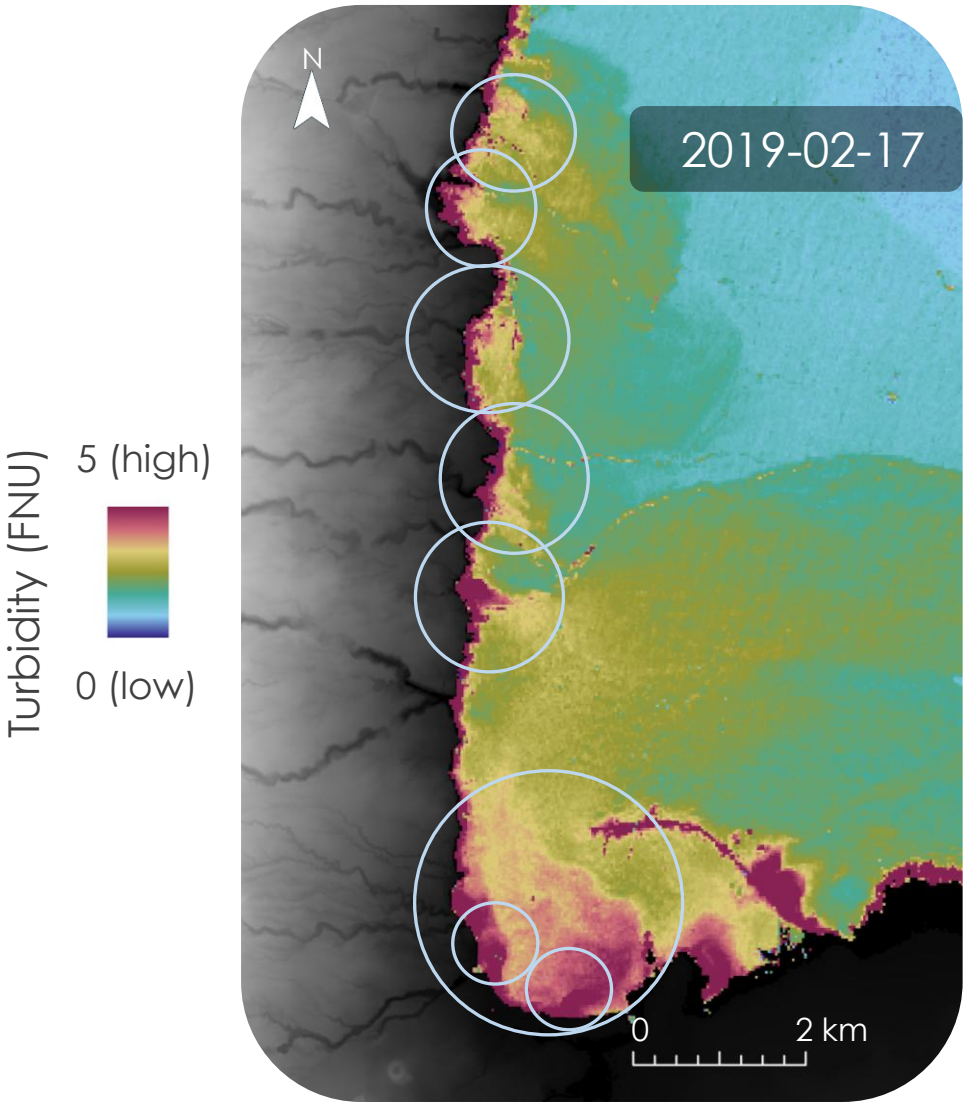
Image Date: 3/23/2021

Image Date: 4/17/2021

Turbidity (FNU)

Image Credits: DEVELOP Hilo Team

Results: Turbidity Plumes



Turbidity plumes: areas of higher turbidity on and extending offshore

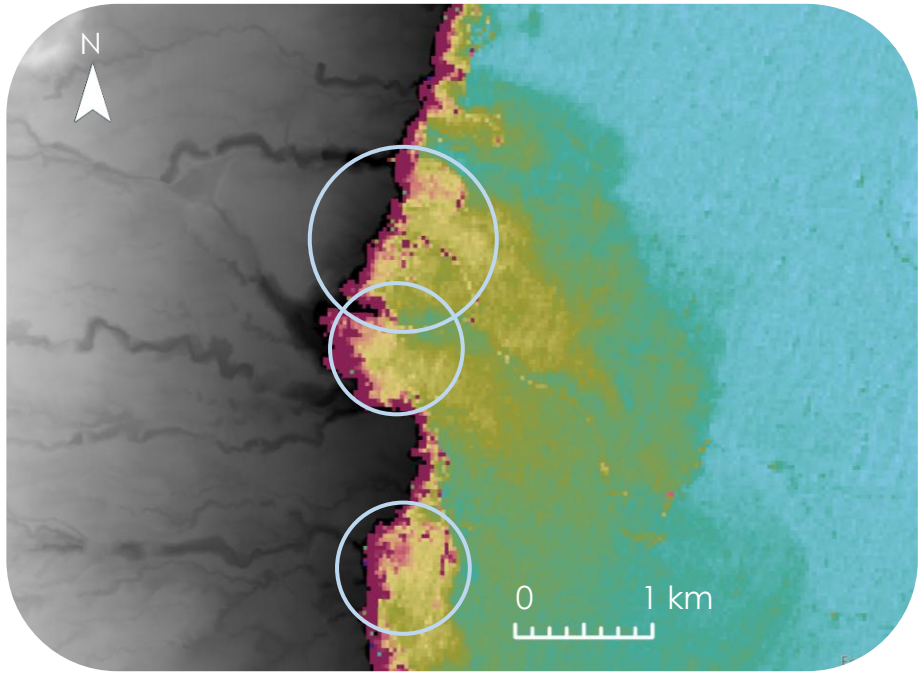
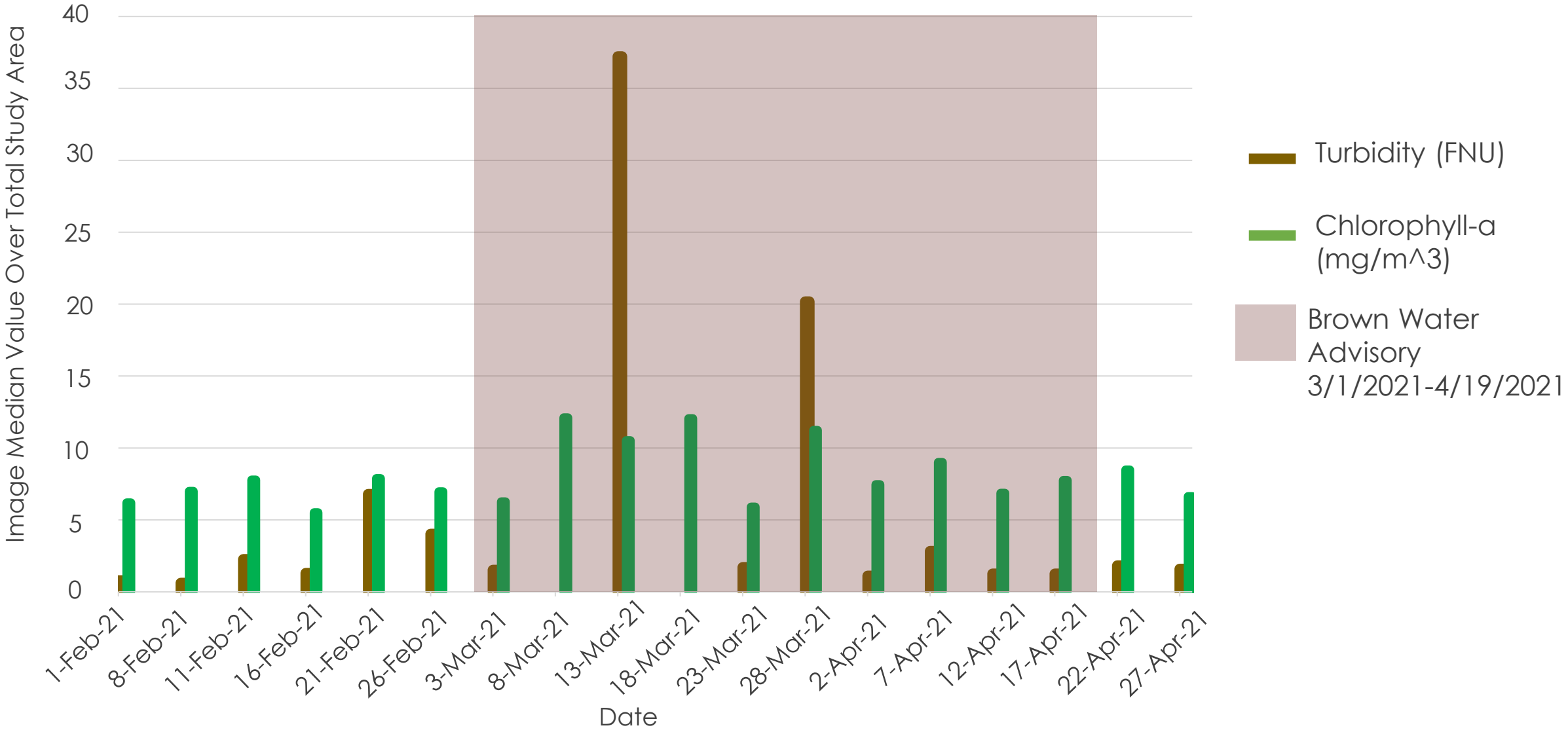


Image Credits: DEVELOP Hilo Team

Results: Turbidity Time Series

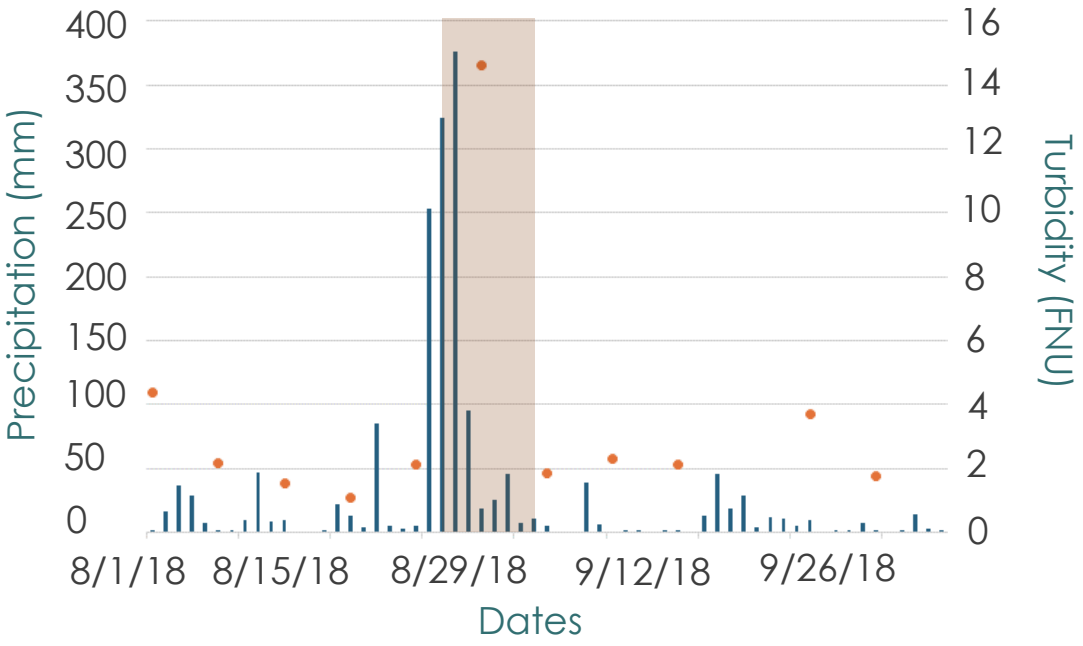


Case Studies: Turbidity and Precipitation during BWAs

Hurricane Lane

(8/15/18 – 8/29/18)

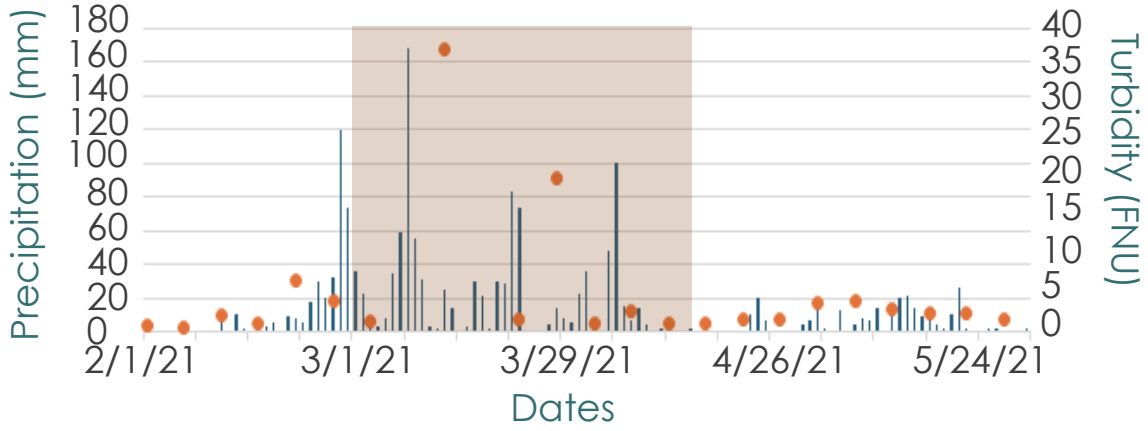
BWA: 8/24/18 - 8/31/2018



- Average Daily Precipitation (mm)
- Turbidity (FNU) Image Median Value over total study area

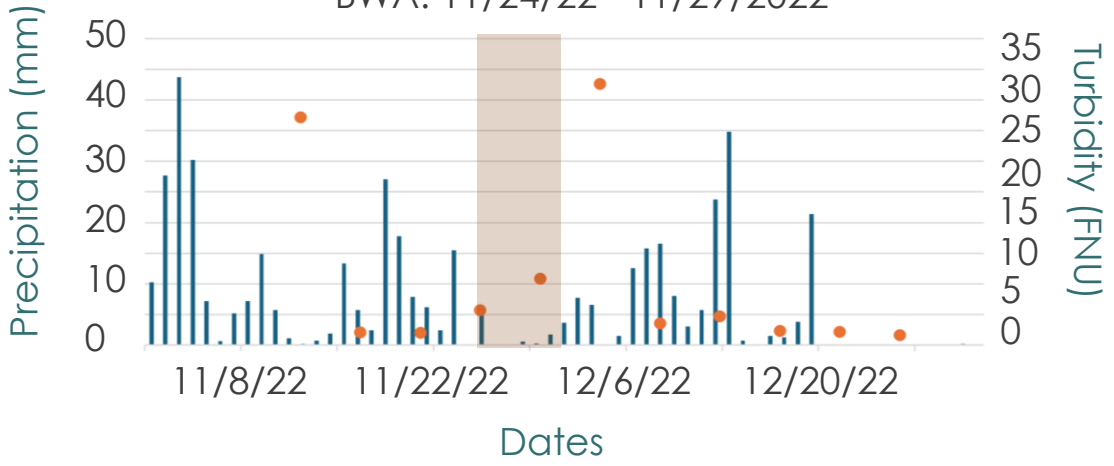
Heavy Rain

BWA: 3/1/2021 – 4/19/2021

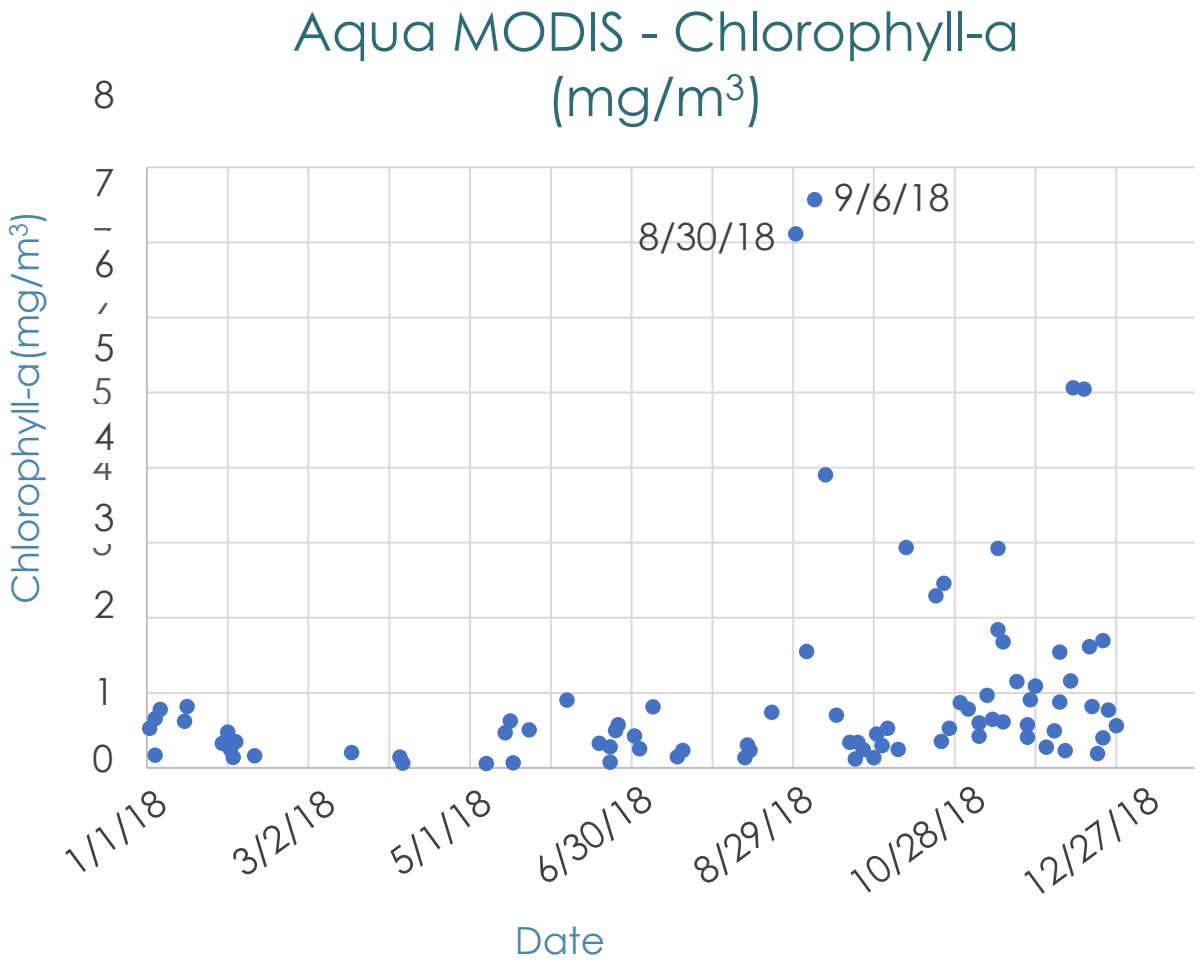


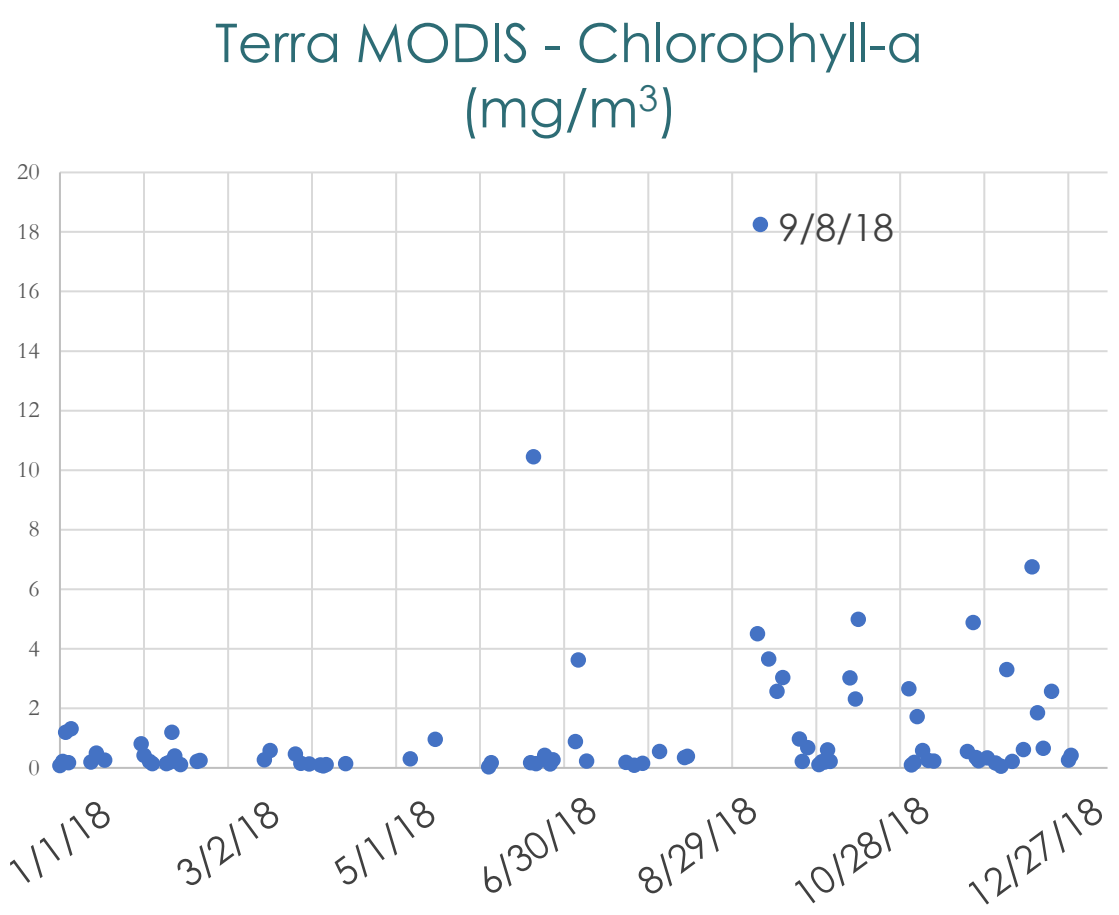
Sewage Spill

BWA: 11/24/22 - 11/29/2022

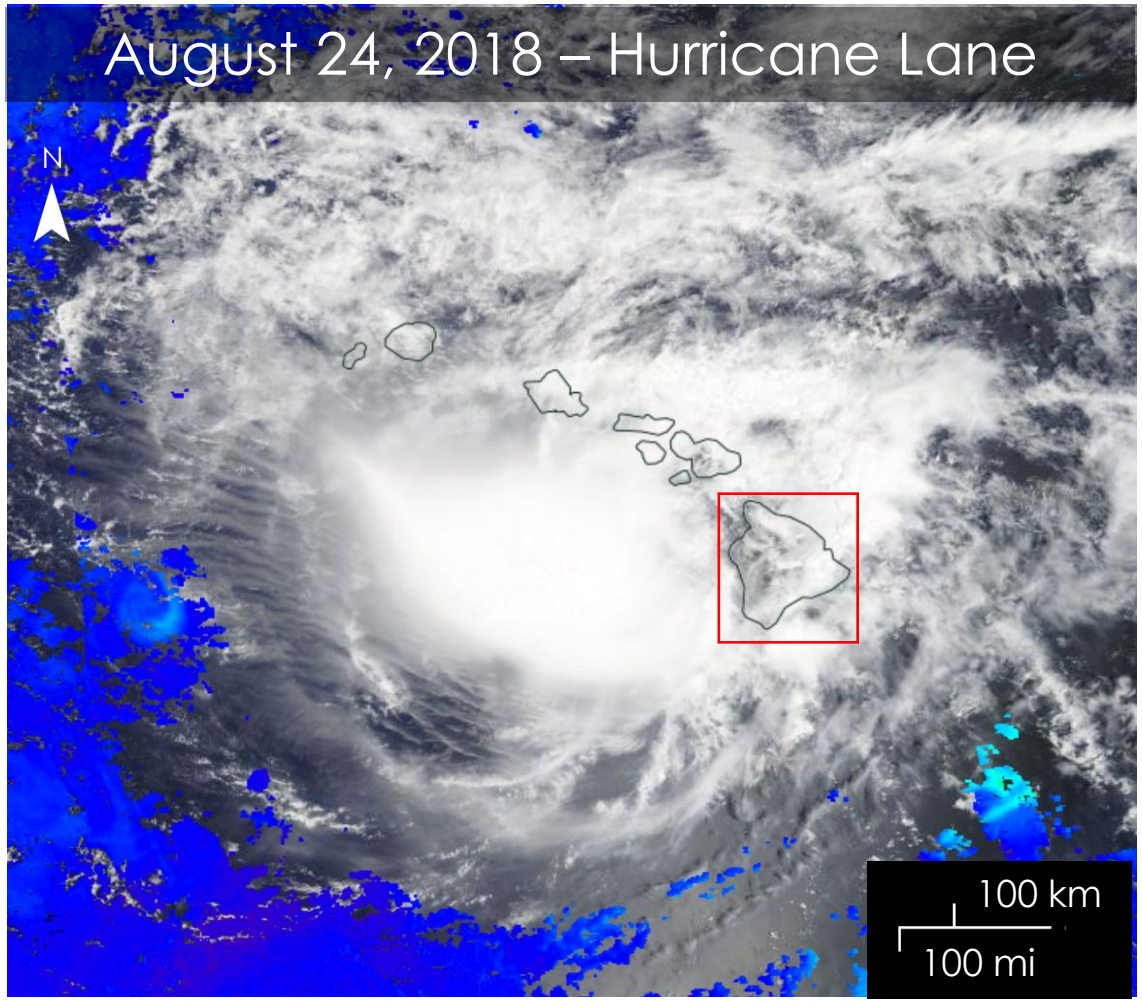


2018 MODIS (Aqua/Terra) Chl-a Values

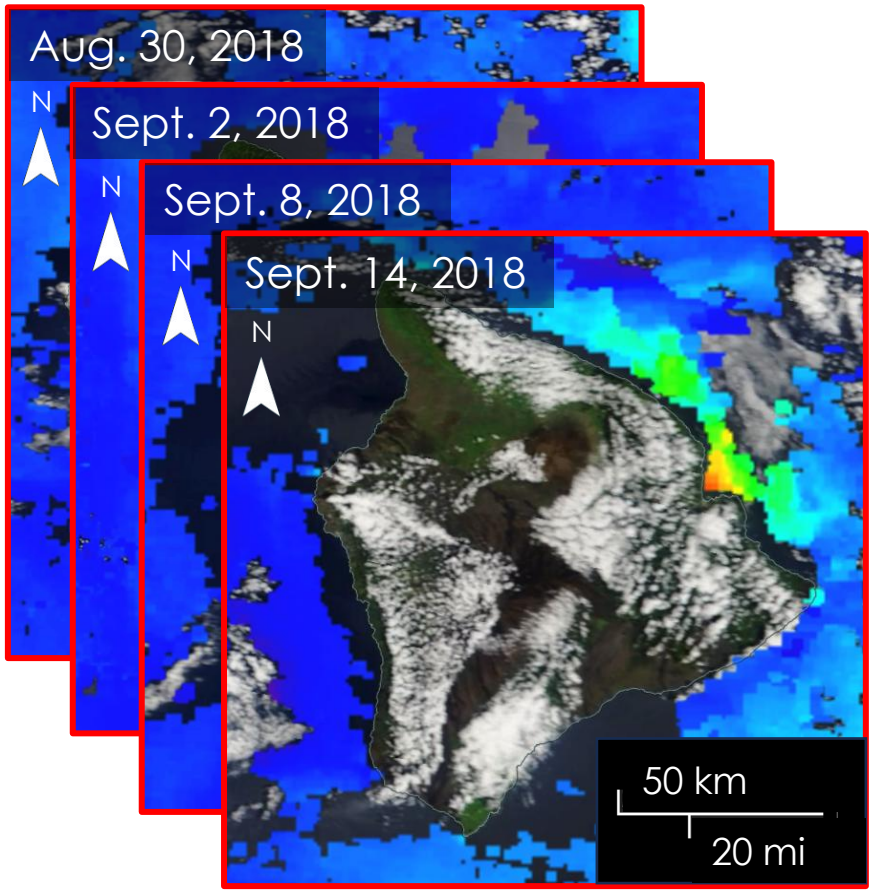




Example of Temporal Data: MODIS (Aqua/Terra)



Chlorophyll-a (L2)



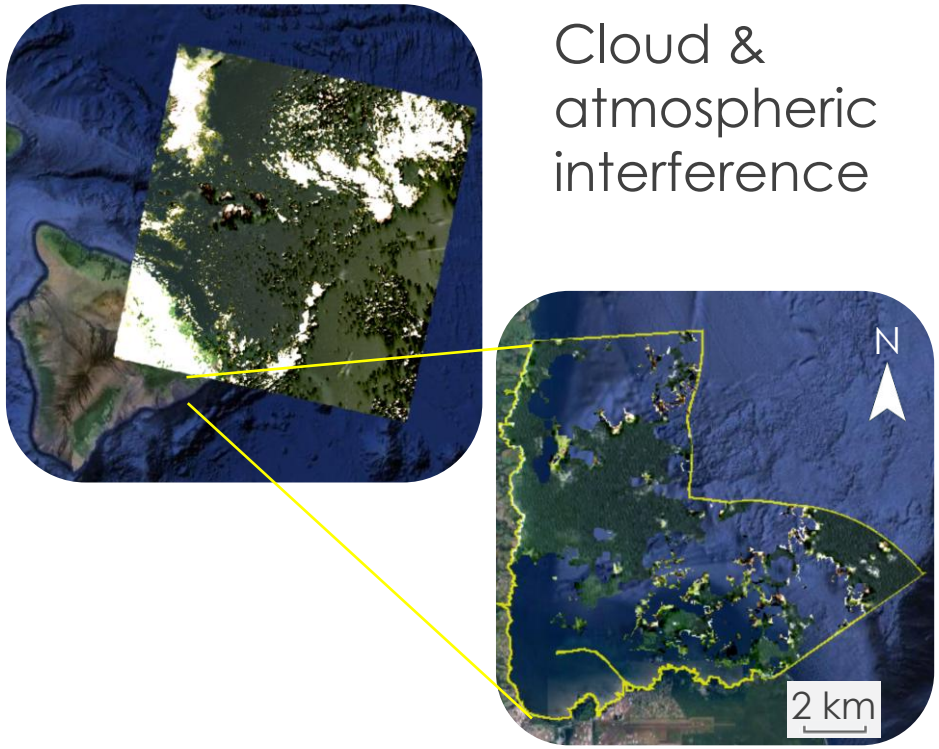
High
>=20 mg/m^3

<0.01 mg/m^3
Low

Image Credits: NASA Worldview

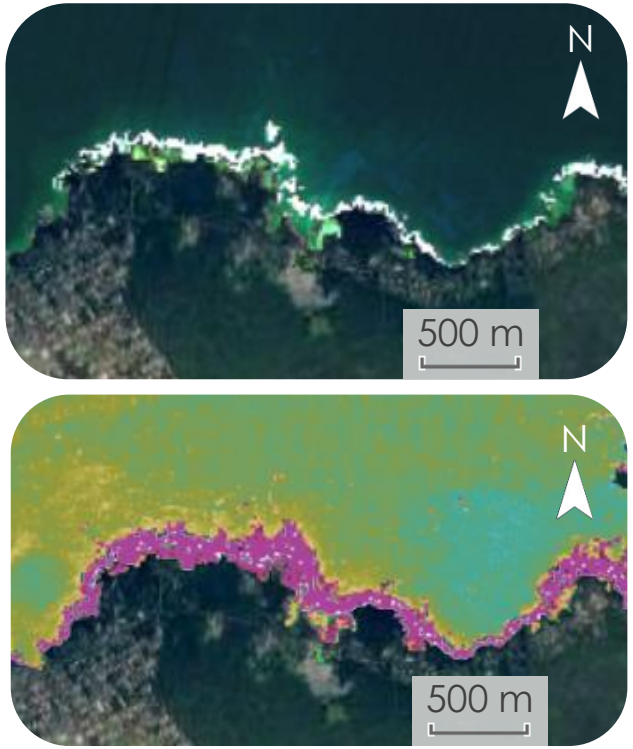
Errors & Uncertainties

Image Availability



Cloud & atmospheric interference

Study Area Conditions



Wave influence

Coastal Remote Sensing Algorithms

Data validation

Image Credits: DEVELOP Hilo Team

Feasibility & Partner Implementation

Earth observations are **feasible** for analyzing water quality parameters in the Hilo Bay region

Remote sensing methods provide turbidity and chlorophyll-a data at high temporal and spatial frequencies, which enable **effective long-term monitoring**

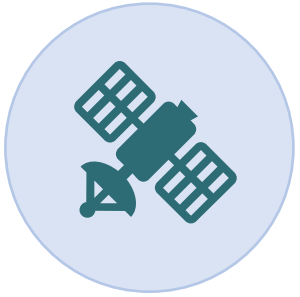
Identification of Brown Water Advisories and turbidity plumes through the ORCAA tool proves **promising** for future water quality management

Conclusions

Turbidity shows a **considerable increase** during most Brown Water Advisories

Turbidity plumes can be **visually identified** using satellite imagery

No association was observed between chlorophyll-a and turbidity in the Hilo Bay region



A multi-sensor approach can provide **valuable insights** to water quality conditions in Hilo Bay

Acknowledgments

Our team is deeply grateful for the support and guidance of the following people:

Science Advisors:

- Dr. Robin Martin (Arizona State University), Dr. Kelly Hondula (Arizona State University), Dr. Xia Cai (NASA LaRC), and Dr. Kenton Ross (NASA LaRC)

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Lead:

- Maya L. Hall (California – Ames)

Project Coordination Editor:

- Kaitlyn L. Lemon (Idaho – Pocatello)

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