

Frequent Synoptic Monitoring of Cyanobacterial Harmful Algal Blooms for Potential Prevention of Disease Outbreak

Chintan B. Maniyar^{1*}, Abhishek Kumar², Deepak R. Mishra¹

¹Department of Geography, University of Georgia, GA, USA

²Department of Environmental Conservation, University of Massachusetts, MA, USA





About Cyanobacterial Harmful Algal Blooms (CyanoHABs)

- A distinct group of phytoplankton
- Adaptable to a *variety* of aquatic environments
- Need nutrient rich waters and warm temperature to bloom
- Multiply quickly to form colonies or blooms
- Can be potentially linked to global climate change



CyanoHABs: Toxicity, Health Hazards and Economic Impacts

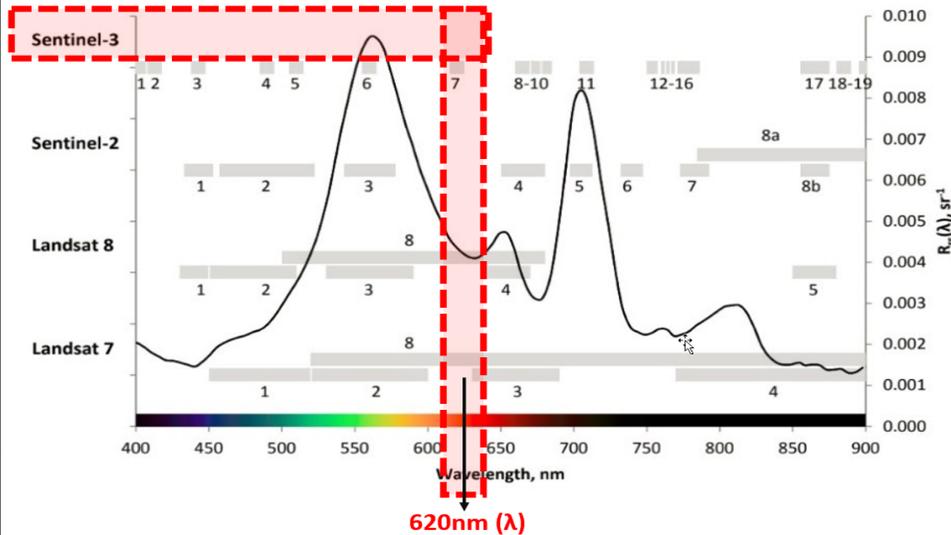
- CyanoHABs can be toxic – affect the entire waterbody
- Fishes, corals and aquaculture, cattle can die
- Hepatotoxins and Neurotoxins – hazardous to humans too
- Degrade water quality and hamper recreational activity
- Adversely effect a nation's economy



Source: Dr. Hans Paerl

Remote Sensing of CyanoHABs

- Visual detection very difficult – highly synonymous with green algae



Unique absorption Property of the Phycocyanin pigment

- Visual detection very difficult – highly synonymous with green algae
- Phycocyanin pigment absorbs light strongly at 620nm
- This absorption feature used to detect CyanoHABs
- Sentinel-3 – only opensource satellite sensor to have a dedicated 620 nm band

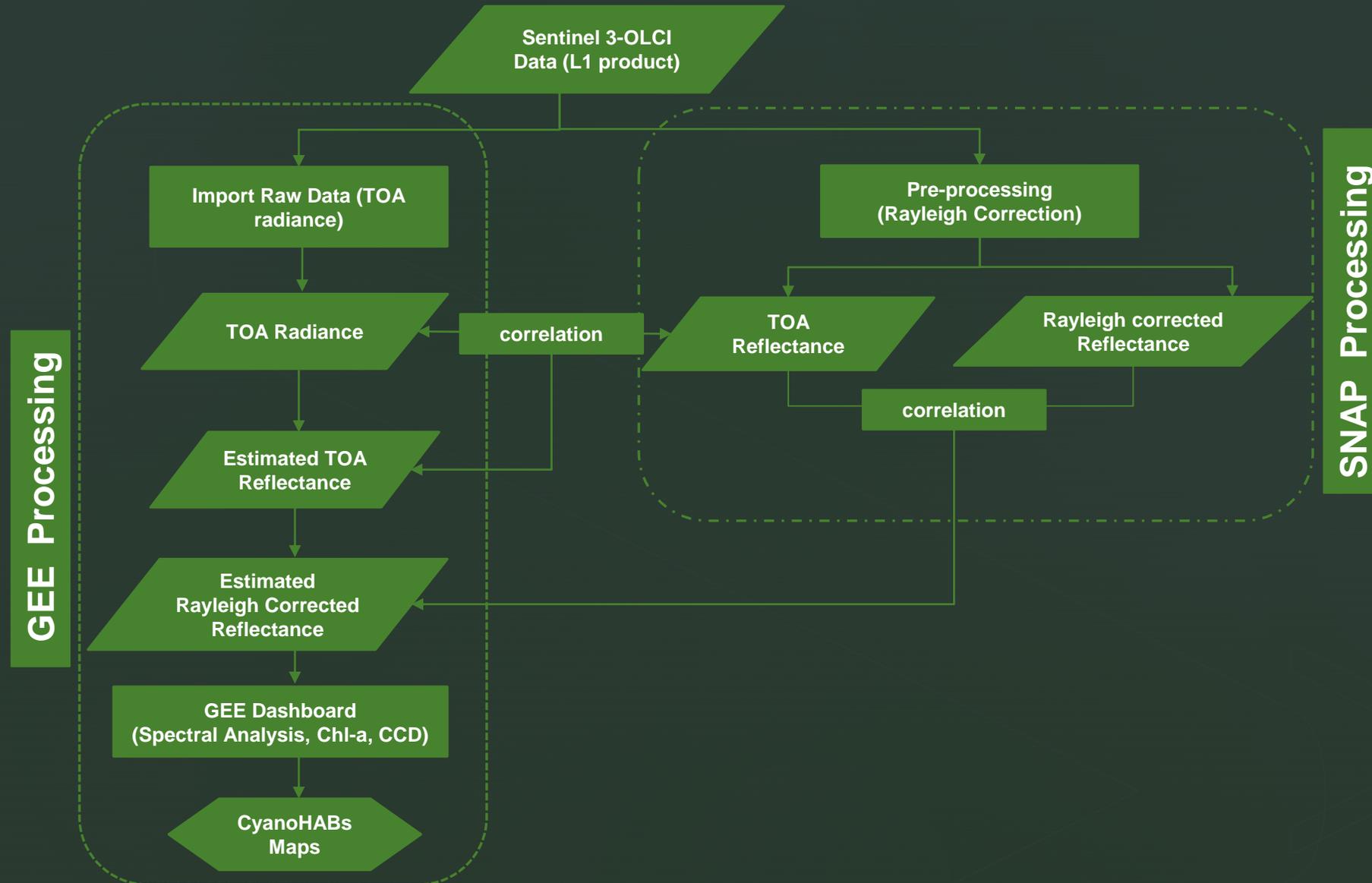


Overall Objective

- Monitor global inland and coastal water bodies for CyanoHABs using remote sensing (Sentinel-3)
- Develop an accessible, web-based dashboard for quick analysis and visualization of remotely sensed CyanoHABs
- Ultimately aid in better decision making of water quality and serve as early warning system to take timely action



Methodology



Google Earth Engine Dashboard Interface

Google Earth Engine Search places and datasets...

CyanoHABs Dashboard

This dashboard is designed for quick analysis of CyanoHABs and Water Quality Assessment using Sentinel-3 imagery

1) Select Waterbody
Chilika_Lake_India (a)

2) Select Cloud Mask And Non-Water Area Flag
 Mask Cloud Cover and Non-Water Area (b)

2018-06-01
2018-06-30 (c)

Filter Map to center
Apply Filter

3) Select an image (dated)
S3A_20180615T042249_20180615T042549 (d)

4) Select Visualisation
Natural color
False color
NDCI
NDVI
PC
PC-3
Chlorophyll-a
SSC
Cyanobacteria_Cell_Density (e)

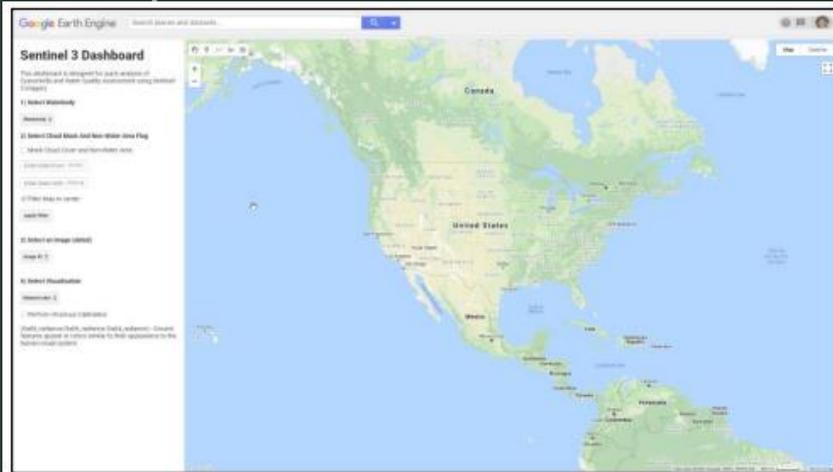
(f) Google

Layers Map Satellite

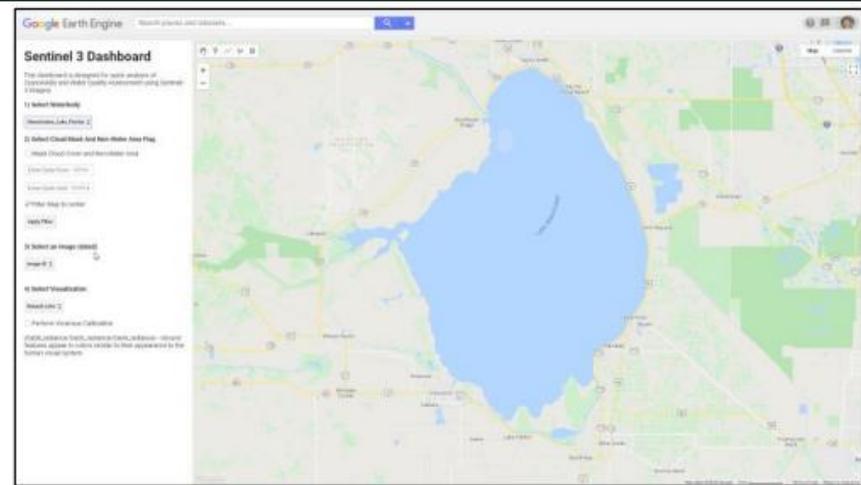


Map data ©2020 5 km Terms of Use Report a map error

Dashboard Interface – Loading Imagery



GEE Dashboard Interface



Provide Location and Date-Range



Cloudy pixels and Non-water Pixels masked

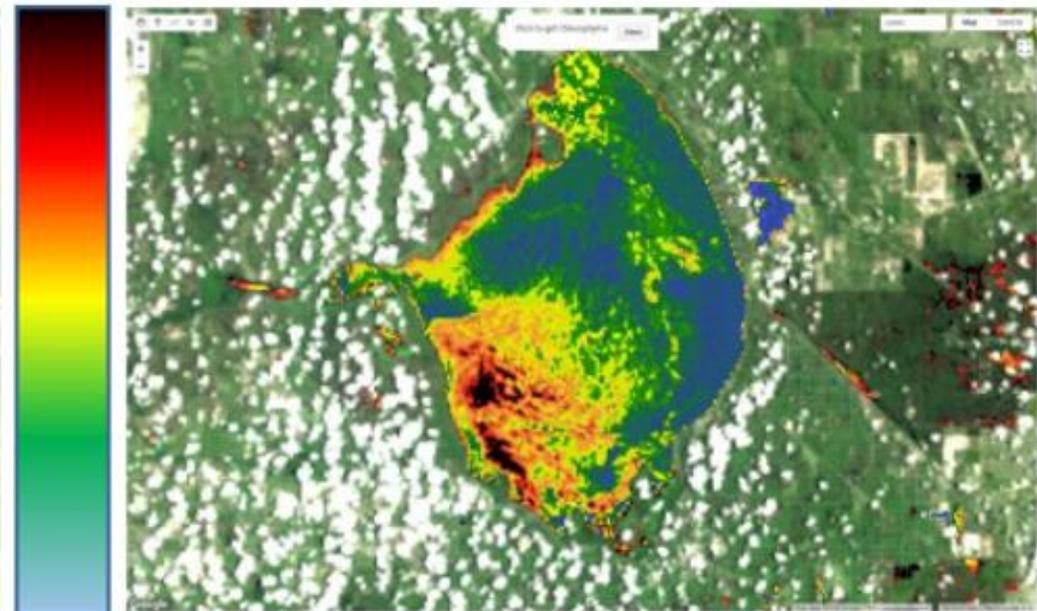


Natural Color Image

Dashboard Interface – Visualizations & Functionalities

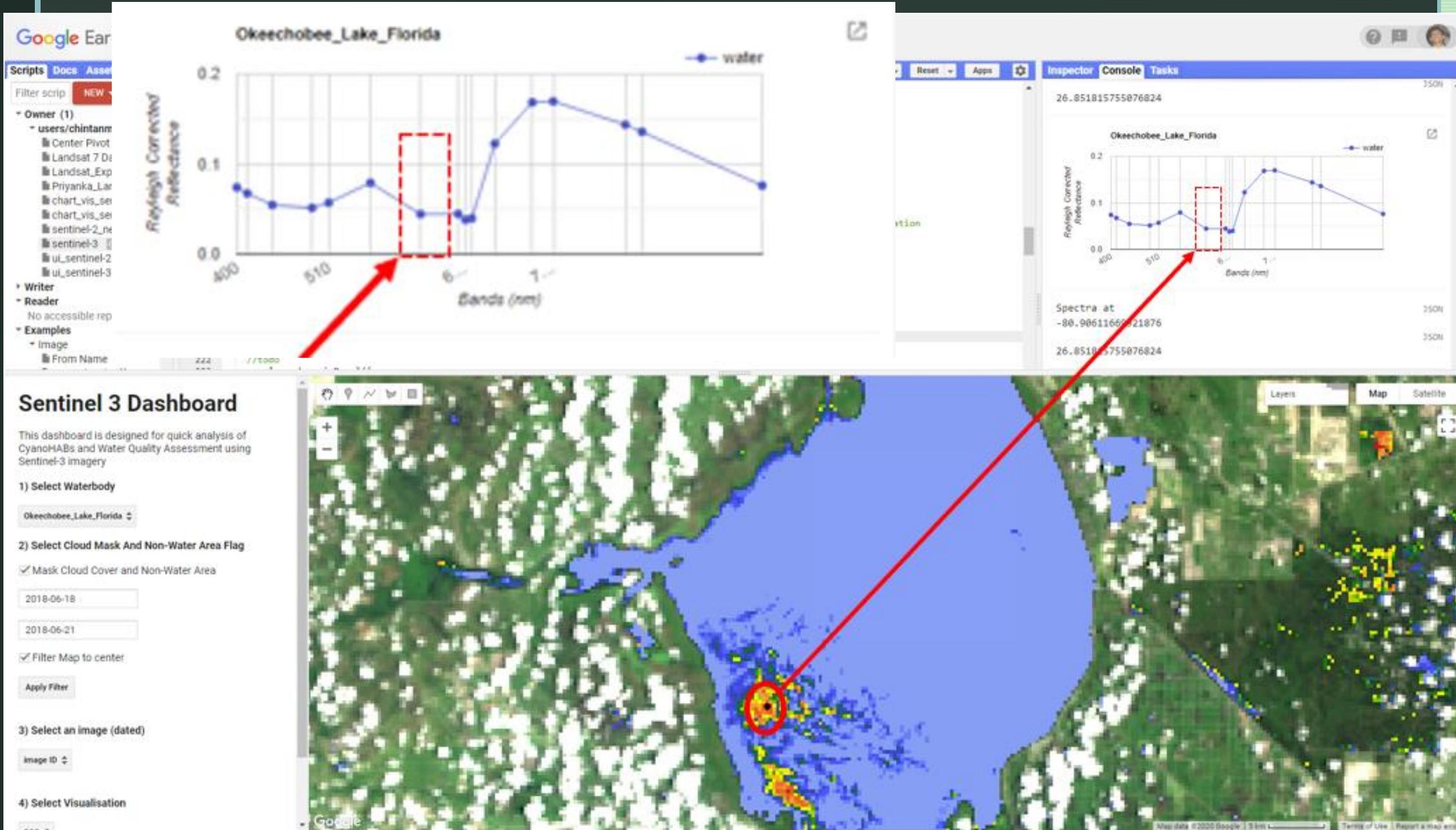


Cyanobacterial Cell Density
Map overlaid on Natural
Color



Chl-a Concentration Map
overlaid on Natural Color

Detecting a CyanoHAB – Bloom Location



Detecting a CyanoHAB – Non-bloom location

Google Earth

Scripts Docs Assets

Filter script NEW

Owner (1)

- users/chintann
- Center Pivot
- Landsat 7 Di
- Landsat_Exp
- Priyanka_La
- chart_vis_se
- chart_vis_se
- sentinel-2_n
- sentinel-3_
- u_sentinel-2
- u_sentinel-3

Writer

Reader

No accessible rep

Examples

- Image
- From Name

Okeechobee_Lake_Florida

Rayleigh Corrected Reflectance

Bands (nm)

water

Inspector Console Tasks

27.062356969639193

Okeechobee_Lake_Florida

Rayleigh Corrected Reflectance

Bands (nm)

water

Spectra at

-80.72964880371094

27.062356969639193

Sentinel 3 Dashboard

This dashboard is designed for quick analysis of CyanoHABs and Water Quality Assessment using Sentinel-3 imagery

1) Select Waterbody

Okeechobee_Lake_Florida

2) Select Cloud Mask And Non-Water Area Flag

Mask Cloud Cover and Non-Water Area

2018-06-18

2018-06-21

Filter Map to center

Apply Filter

3) Select an image (dated)

Image ID

4) Select Visualisation

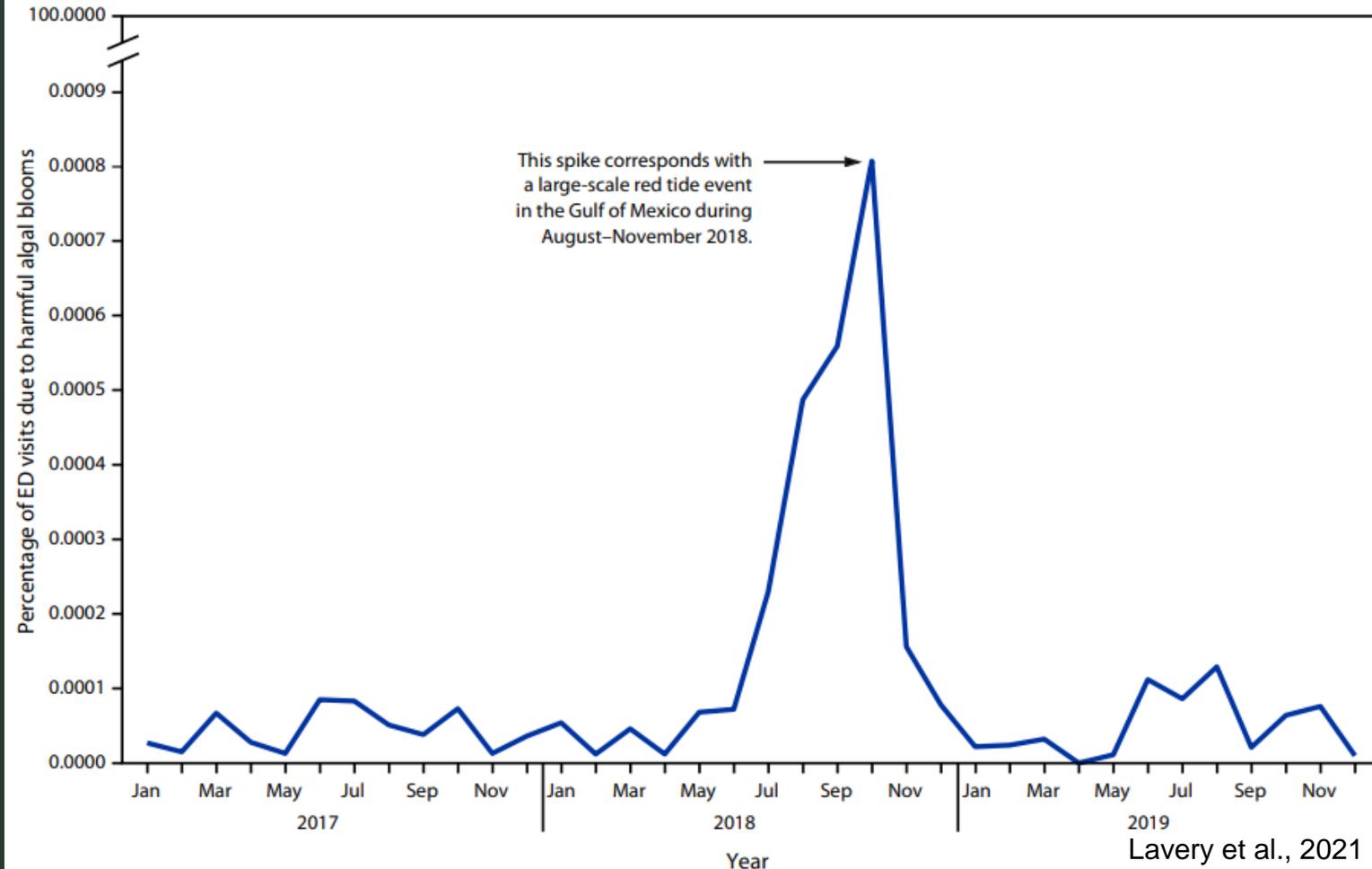
Google

Map Satellite

Map data ©2020 Google | 3 km | Terms of Use | Report a map error

Using this tool to prevent potential Disease Outbreak due to CyanoHABs

FIGURE. Harmful algal bloom exposure–associated emergency department visits among all emergency department visits, by month — National Syndromic Surveillance Program, United States, 2017–2019*



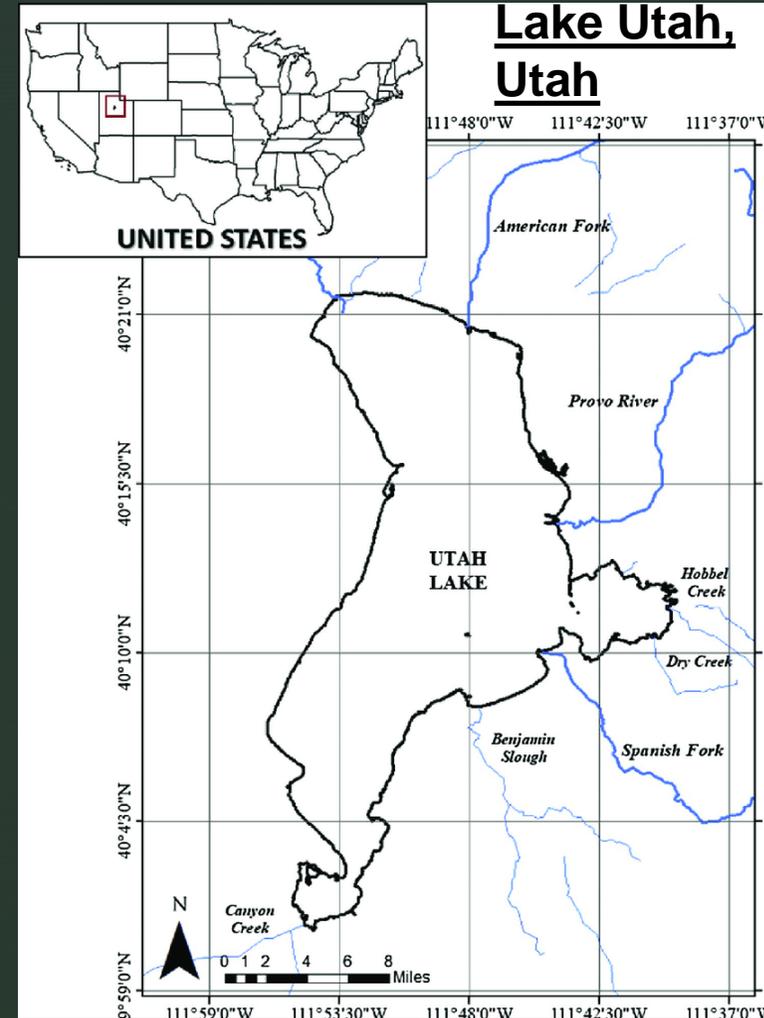
CDC Recently published a study correlating ER visits with the boom in harmful algal blooms in the GOM area

Spatio-Temporal Maps, Monitoring Waterbodies



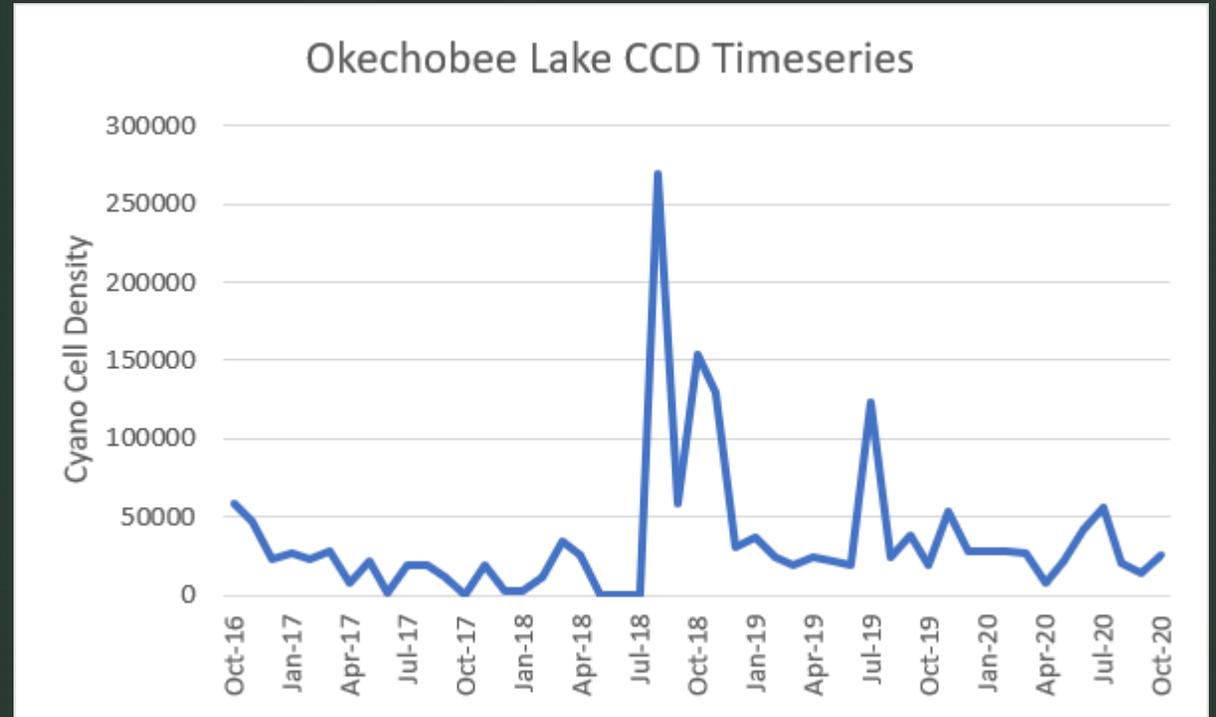
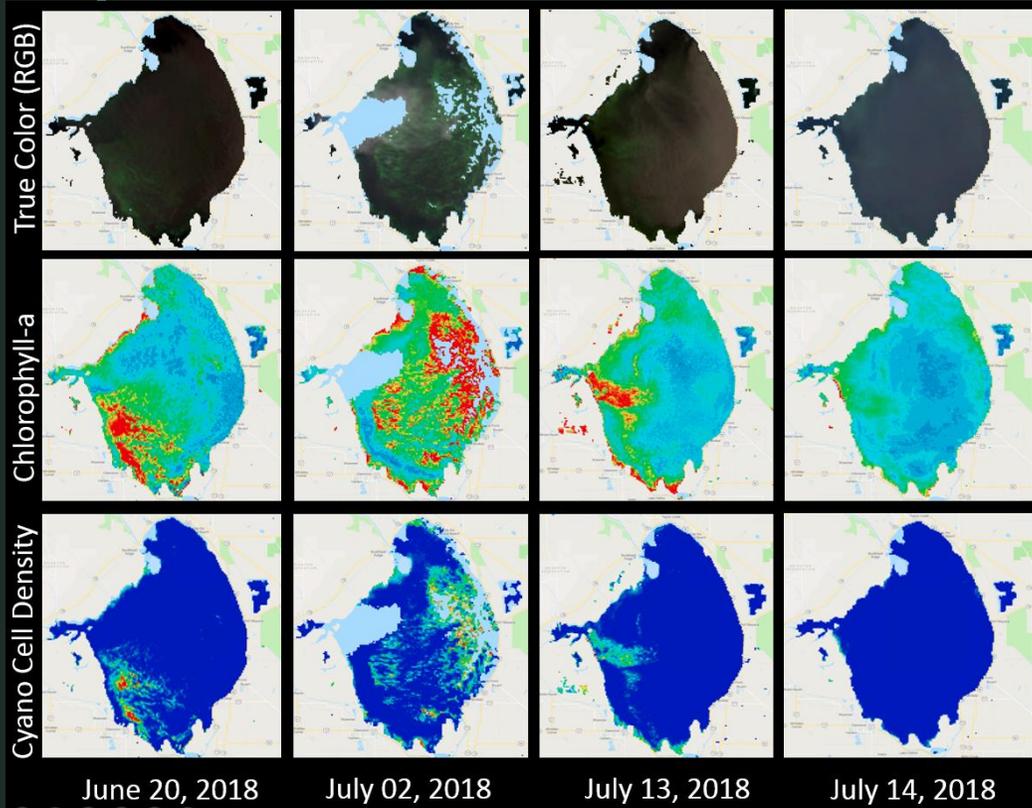
Lake Okeechobee, Florida, US

Suffered from heavy
Cyanoblooms in 2018

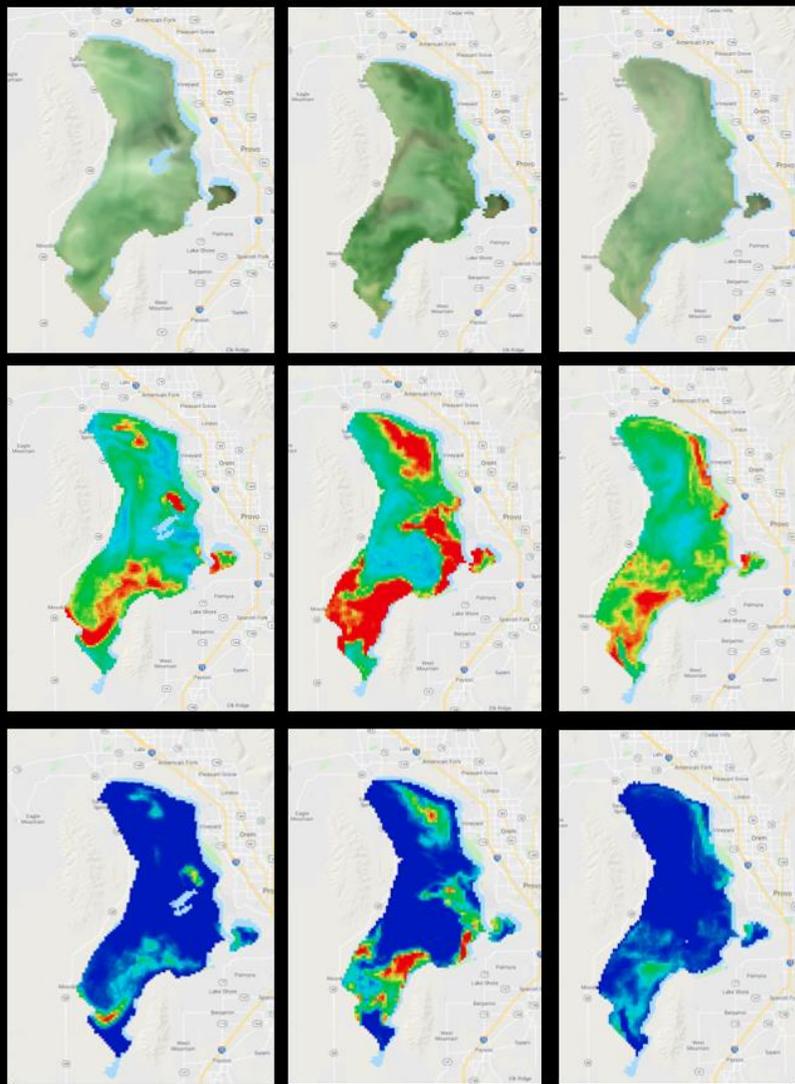


Map credits: B.Page et. al, 2017

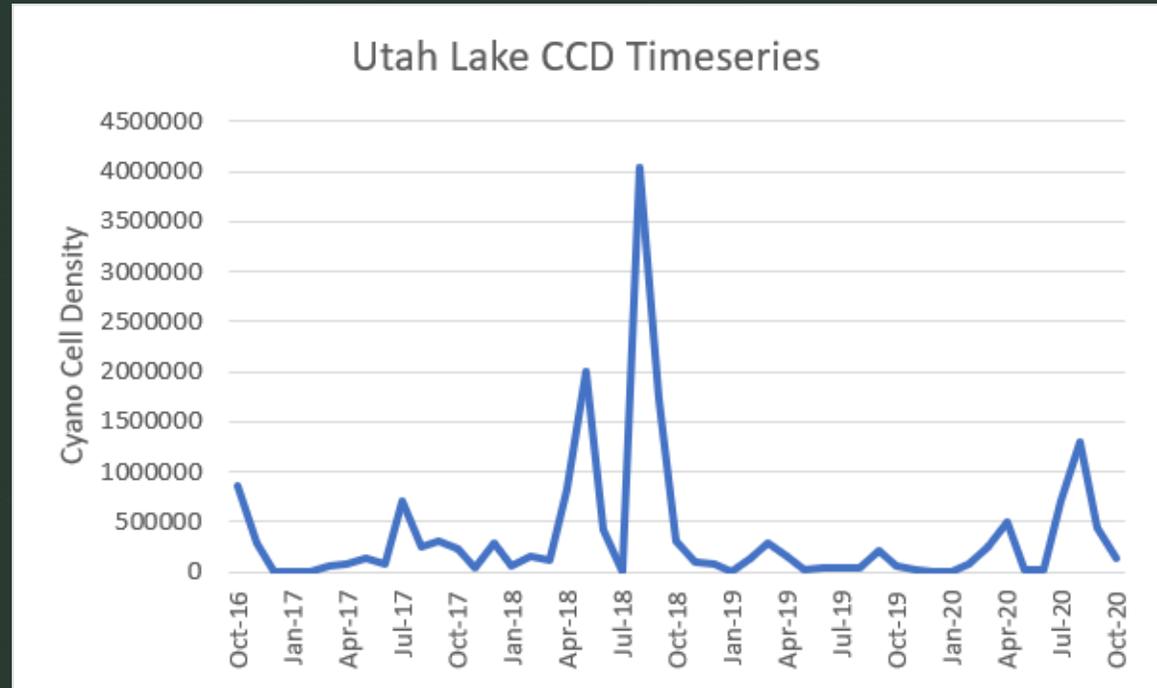
CyanoHAB Spatio-Temporal Maps: Lake Okeechobee



CyanoHAB Spatio-Temporal Maps: Lake Utah



Aug 04, 2018 Aug 08, 2018 Aug 12, 2018



Conclusion

- A GEE dashboard was developed for rapid detection and monitoring of CyanoHABs using Sentinel-3 data
- This dashboard can be easily shared with water resource managers who can follow simple steps to detect cyanobacteria and visualize the affected region within waterbodies
- This is very helpful and cost saving tool for lake managers in planning their field trip and forming management strategies timely
- Moreover, it can be used as an **early warning system** to prevent **potential disease outbreak in humans as well as other livestock** due to CyanoHABs
- Similar dashboard can be developed in future for other satellite sensors such as Landsat 8 and Sentinel 2 for monitoring other water quality parameters for smaller water bodies





THANK YOU

Questions?