Monitoring Harmful Algal Blooms (HABs) in inland water bodies

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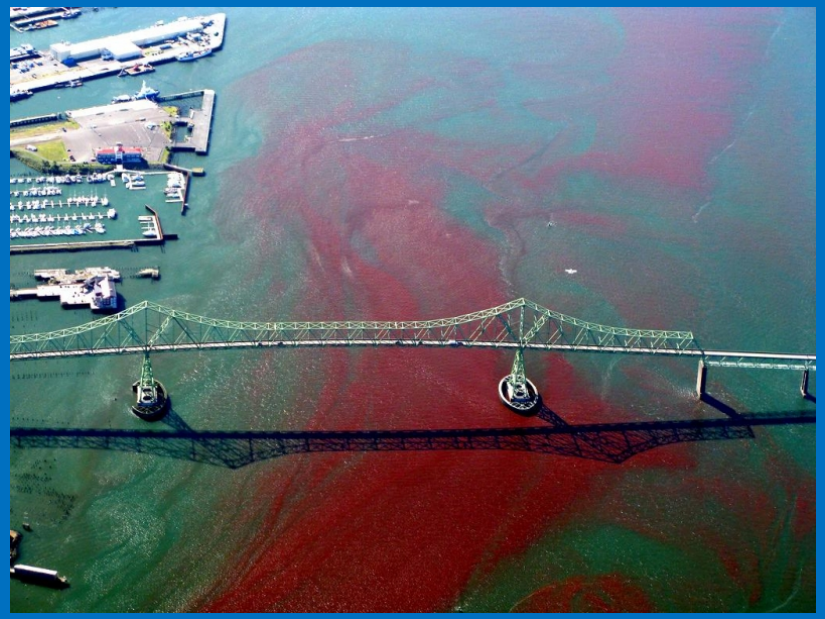
HABs in the southern great plains

Milford Lake, Kansas (2018)

Grand Lake O' the Cherokees, Oklahoma (2011)

Algal toxin concentrations several times higher than the WHO recommended threshold for adverse health effects (100,000 cells/mL)

HABs form Toxic surface scums



Examples: cyanobacteria (blue-green algae) and red tide

HABs monitoring issues

- Surface scums are very dynamic in nature (they can form in localized areas within hours due to wind patterns)
- May occur at times/locations outside the sampling frame
- Make it hard to control human/animal exposure
- Need real time monitoring

Efforts to overcome this monitoring challenge

- The Cyanobacteria Assessment Network (CyAN): 2015 –
  - USEPA, NASA, USGS, NOAA

- NASA Ocean Color tools:
  - GIOVANNI
  - SeaDAS

GIOVANNI The Bridge Between Data and Science v 4.29

Select Plot

Maps: Time Averaged Map | Comparisons: Select... | Vertical: Select... | Time Series: Select... | Miscellaneous: Select...

Select Date Range (UTC)

YYYY-MM-DD HH:mm

- - 00 : 00 to - - 23 : 59

Valid Range: 1948-01-01 to 2019-04-01

Please specify a start date.

Select Region (Bounding Box or Shape)

Format: West, South, East, North

Select Variables

▼ Disciplines

- Ocean Biology (16)
- Oceanography (13)

▼ Measurements

- Chlorophyll (15)
- Organic Carbon (4)
- Particulate Matter (2)
- Phytoplankton (8)

▶ Platform / Instrument

Number of matching Variables: 16 of 1987 **Total Variable(s) included in Plot: 0**

Please select at least 1 variable

Keyword : chlorophyll Search Clear

Variable	Units	Source	Temp.Res.	Spat.Res.	Begin Date
Total chlorophyll (NOBM_DAY vR2017)	mg m-3	NOBM Model	Daily	0.67 x 1.25 °	1998-01-01
Chlorophyll a Concentration (OCTS_L3m_CHL v2014)	mg m-3	OCTS	Monthly	9 km	1996-11-01
Total chlorophyll (NOBM_MON vR2017)	mg m-3	NOBM	Monthly	0.67 x	1998-01-01

Reset Plot Data

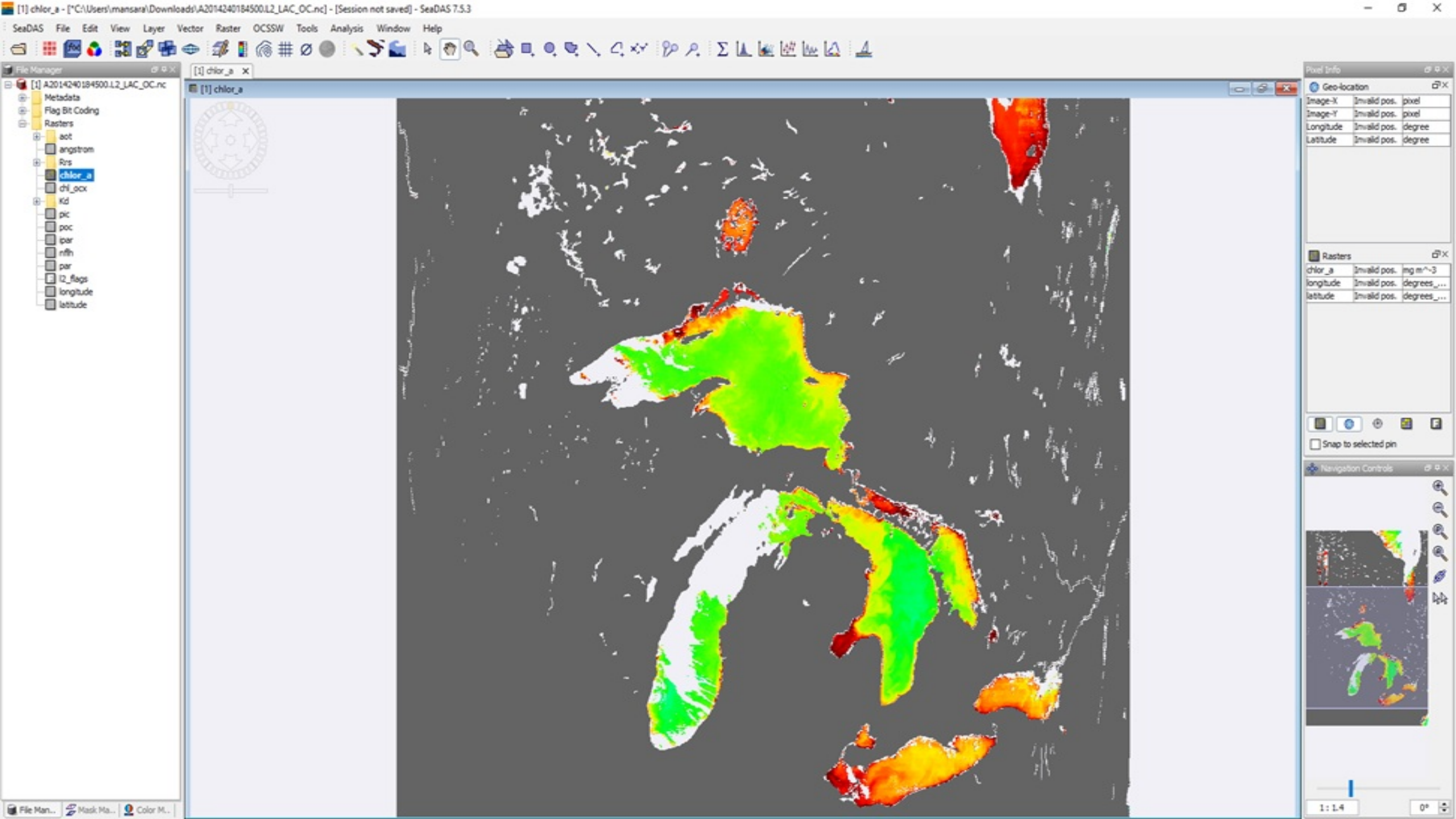
GIOVANNI

The NASA Goddard Earth Science Data and Information Services Center (GES DISC) Giovanni system

[GES DISC Interactive Online Visualization ANd aNalysis Infrastructure]

Website: https://giovanni.gsfc.nasa.gov/giovanni/

Problem: Low spatial resolution – Based on MODIS (4 km pixel size)


[1] chlor_a - [*C:\Users\mansara\Downloads\A2014240184500.L2_LAC_OC.nc] - [Session not saved] - SeaDAS 7.5.3
SeaDAS File Edit View Layer Vector Raster OCSSW Tools Analysis Window Help
File Manager
[1] A2014240184500.L2_LAC_OC.nc
Metadata
Flag Bit Coding
Rasters
aot
angstrom
Rrs
chlor_a
chl_ocx
Kd
pic
poc
ipar
nflh
par
l2_flags
longitude
latitude
[1] chlor_a
[1] chlor_a
Pixel Info
Geo-location
Image-X Invalid pos. pixel
Image-Y Invalid pos. pixel
Longitude Invalid pos. degree
Latitude Invalid pos. degree
Rasters
chlor_a Invalid pos. mg m^-3
longitude Invalid pos. degrees_...
latitude Invalid pos. degrees_...
Snap to selected pin
Navigation Controls
1 : 1.4
0°
File Man...
Mask Ma...
Color M...

SeaDAS

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The SeaWiFS Data Analysis System (SeaDAS) is a comprehensive software package for the processing, display, analysis, and quality control of ocean color data: https://seadas.gsfc.nasa.gov/

Problem: Low spatial resolution - effective for very large lakes or the oceans

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Since 2015, OSU, GRDA, & Applied GeoSolutions have been working to develop a HABs advisory software tool

Grand Lake Water Quality Issues

- Harmful algal blooms (HABs)
  - Public health concern in 2011
  - Elevated Microcystin: 18x > WHO Adverse Health Effects threshold
  - Advisory for non-body contact (July 4th)

- Need to improve timeliness and spatial extent of HABs detection

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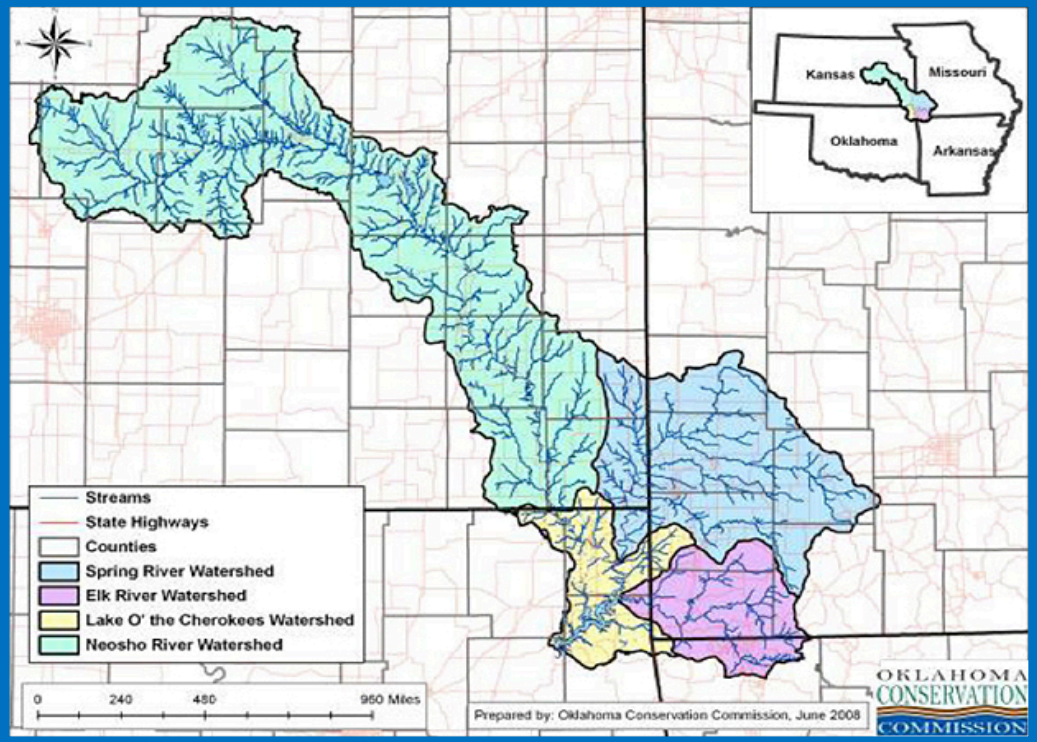
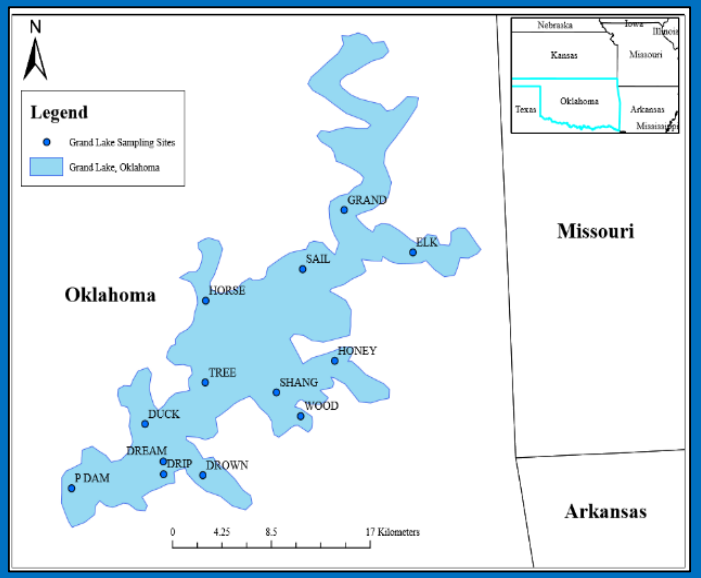
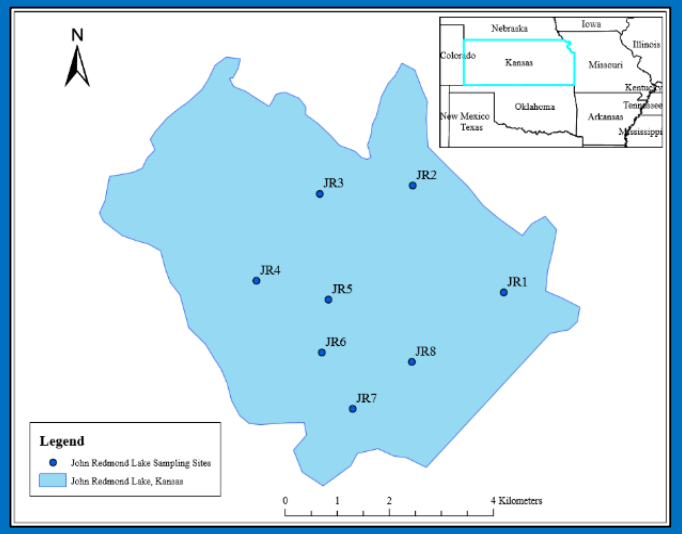
The Grand Lake Watershed

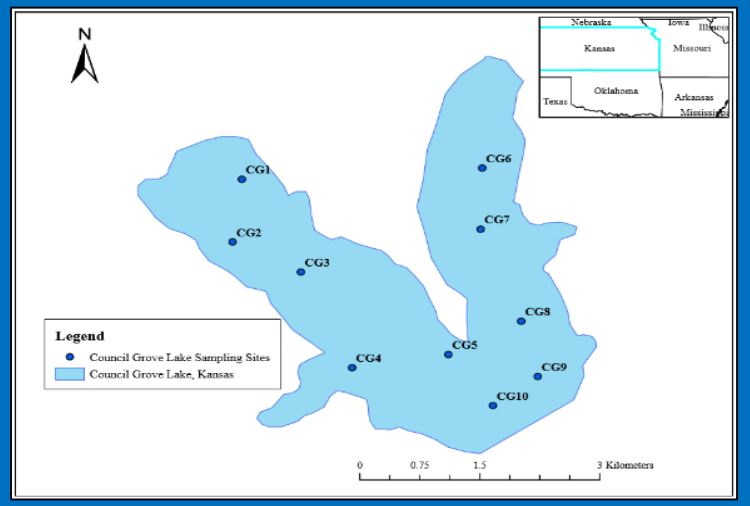




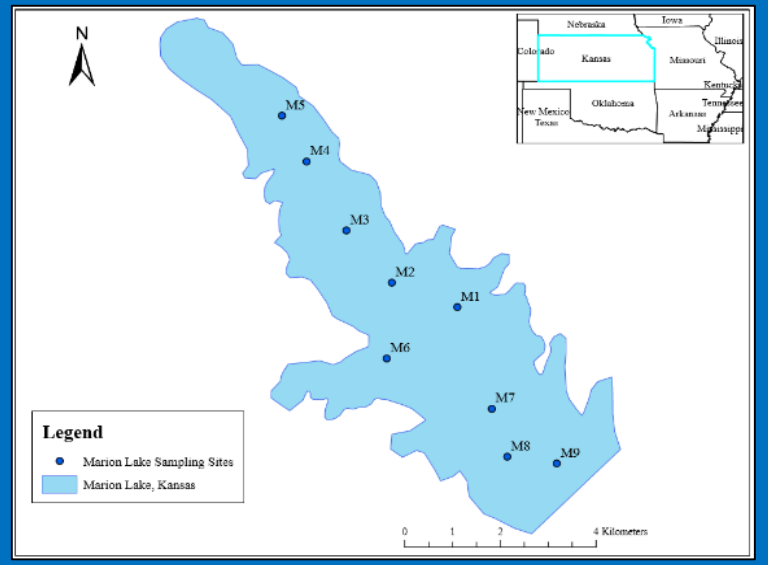
Grand Lake O' The Cherokees



John Redmond Lake



Council Grove Lake



Marion Lake

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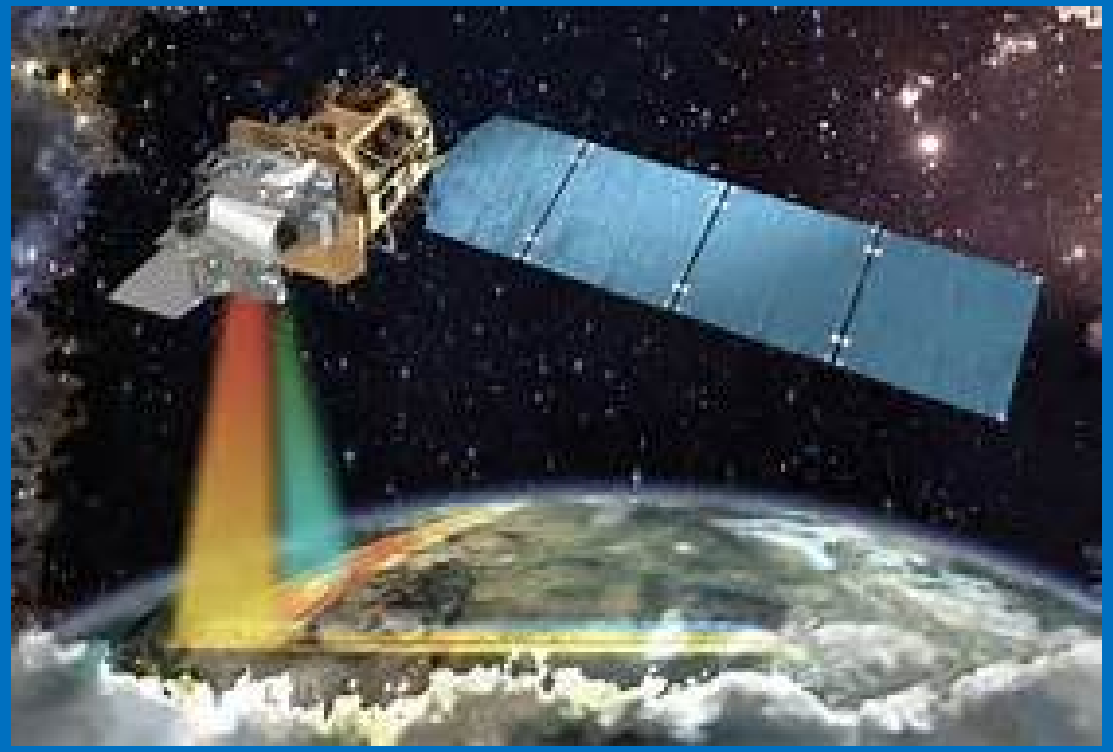
Grand Lake Landsat Project

Related in-situ water quality and Landsat data



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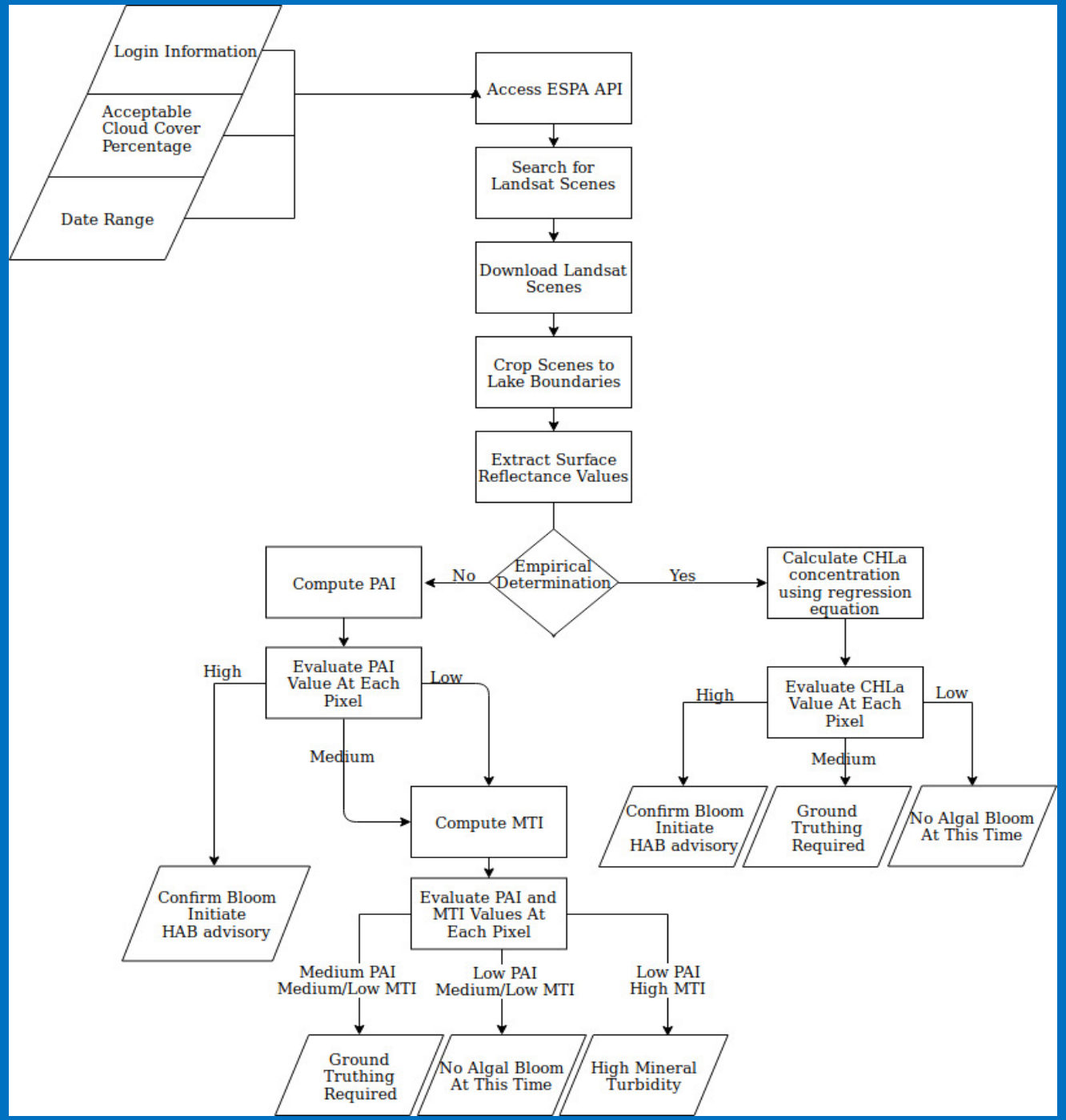
- Landsat based software tool for HABs advisory

- Three main scenarios:
  - There is a bloom!
  - There is no bloom
  - Ground truth required (emerging, diminishing, non algal, etc.)

- Based on a photosynthetic algal index (PAI) and mineral turbidity index (MTI)

- Goal: integrate with mapping software platforms for real time monitoring of relatively smaller inland water bodies – example, Grand Lake

Python programming workflow



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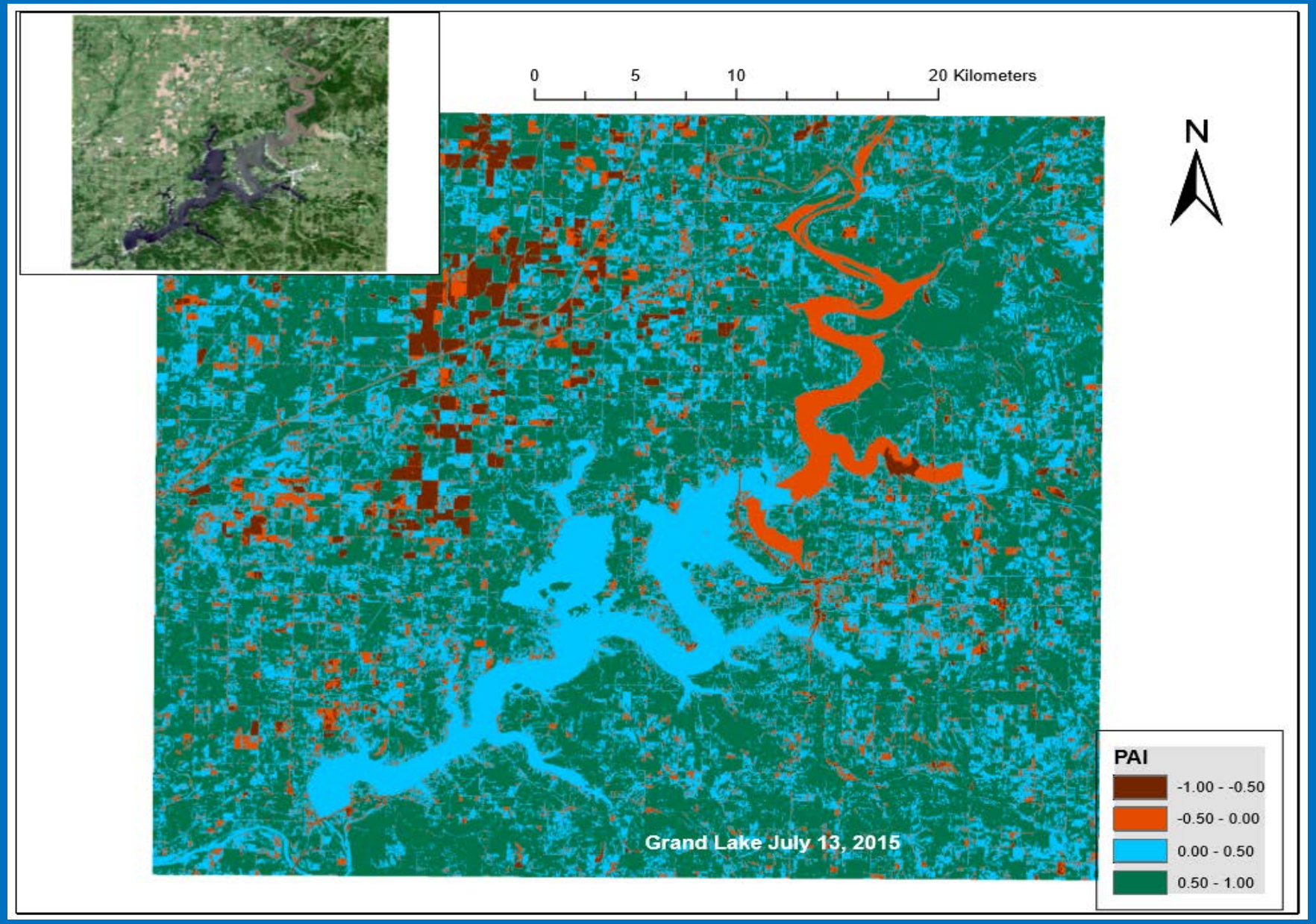
Landsat 8: PAI Compared to True Color 7/13/2015



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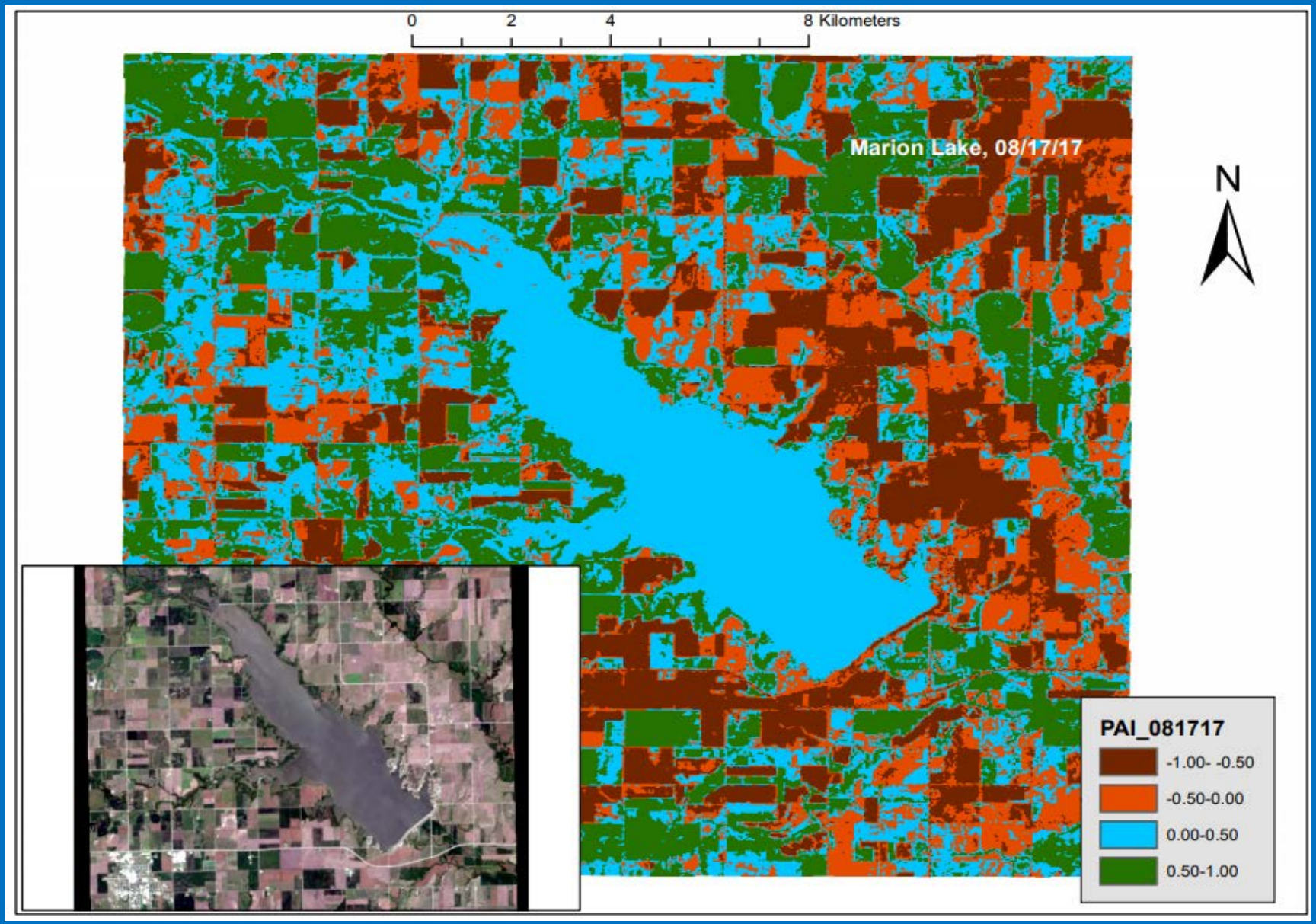
Landsat 8: PAI Compared to True Color 8/17/2017



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PAI of Landsat 5 - 7/2/2011

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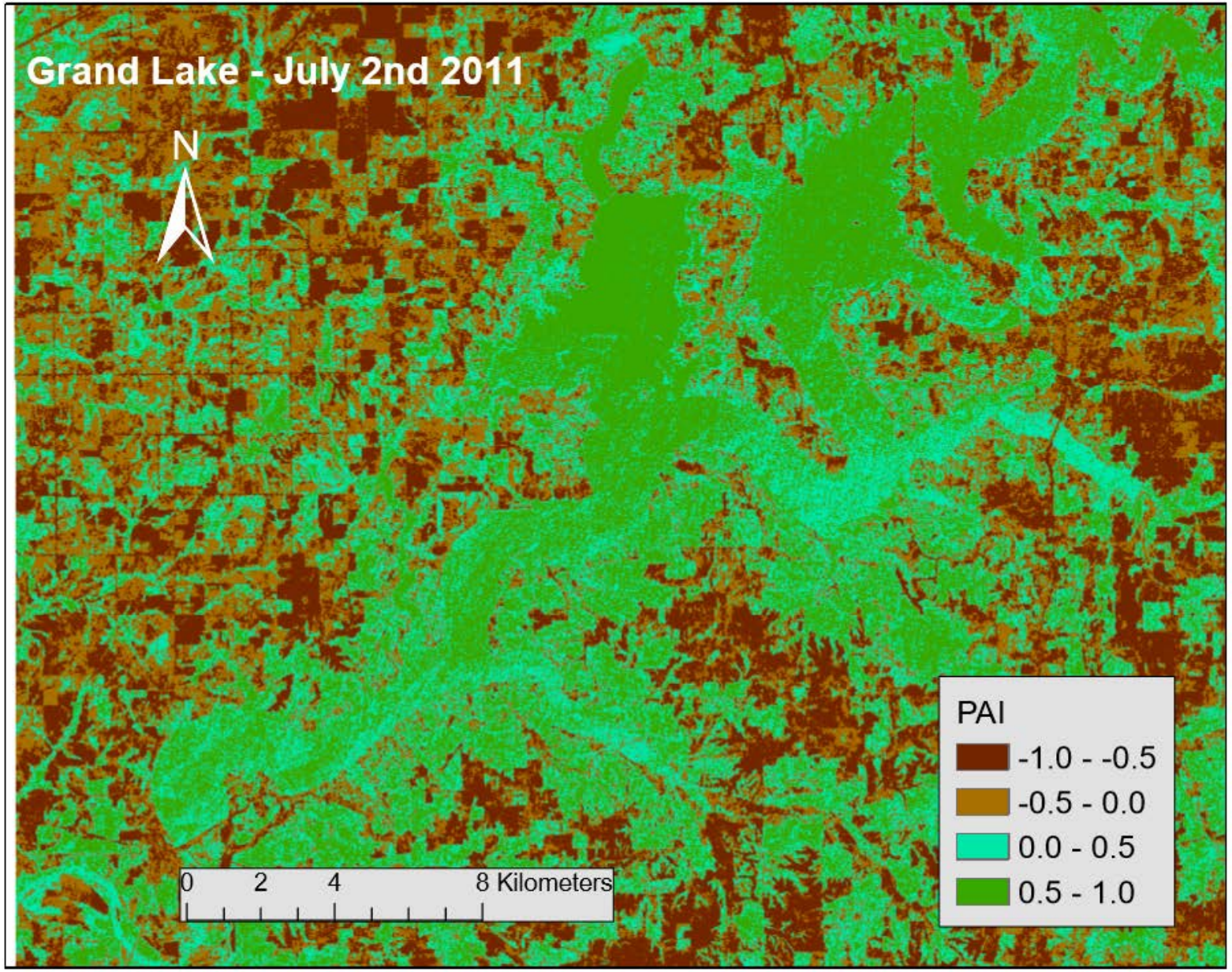


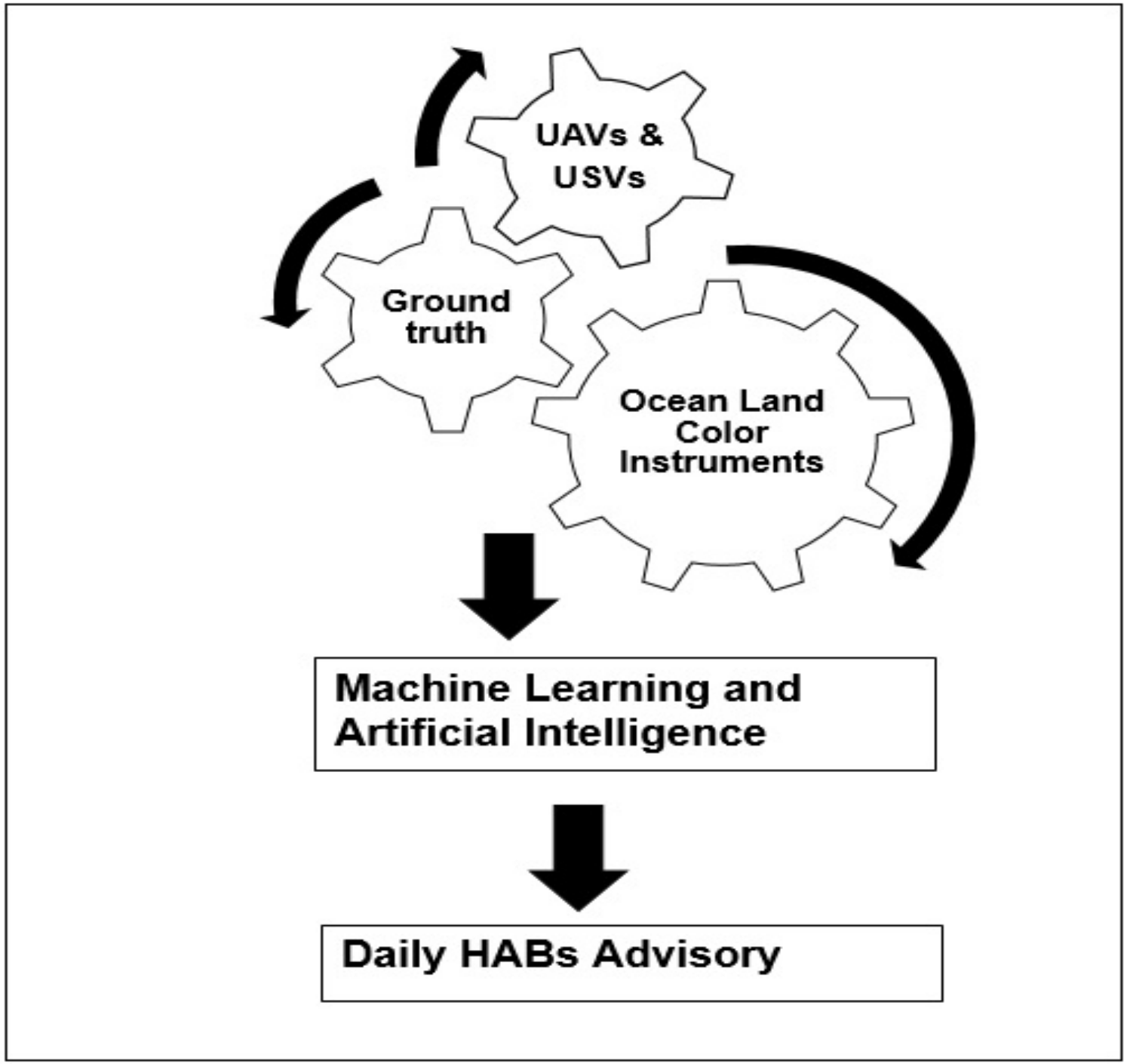
Empirical relationships (PAI & in situ CHLa)

Lake	Date	PAI vs. CHLa	
		p-value	R^2
Grand Lake	2015/07/13	0.004	0.579
Council Grove Lake	2017/08/01	0.001	0.738
Council Grove Lake	2017/08/17	0.003	0.679
Marion Lake	2017/08/17	0.005	0.707

Limitations

- Low spatial resolution (30 m); land-water mixed pixel issue
- Low temporal resolution (16 days) what if there’s bloom in-between?
- Images not available in real time

Our Goal: develop and algorithm that combines satellite, UAV, USV, and ground truth data



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- Satellites:
  - Ocean Land Color Instruments on MODIS, MERRIS, Landsat, Sentinel will give daily, weekly, and biweekly input data
- UAVs: (Unmanned Aerial Vehicles):
  - Validate satellite data
  - Delineate spectral signature of surface scums
  - Routine confirmatory checks
  - Pixel footprint of algal concentrations
- USVs (Unmanned Surface Vehicles):
  - High frequency algal data (example, every 1hr)
  - Algal cell determination at species level
  - Pixel footprint of algal concentrations
- Ground truth data: in situ & lab confirmatory tests

Acknowledgements

- GRDA, ESGP, OWRC, Applied GeoSolutions

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Thank you!