

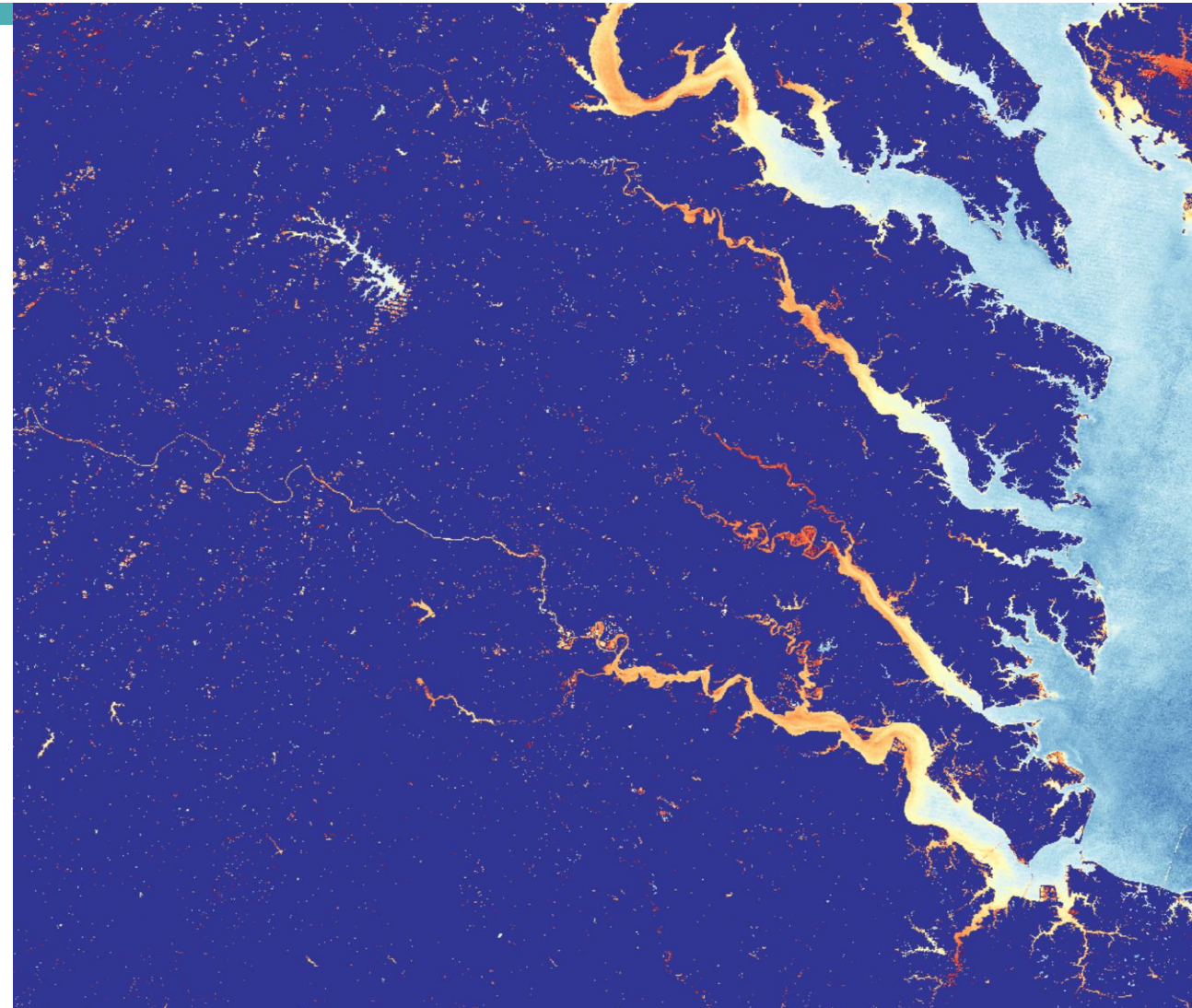


Chesapeake Bay

Water Resources

Characterization of Sediment Dynamics
for Enhanced Water Quality Monitoring in
the Chesapeake Bay

Katherine Hahn
Abigail Sgan
Julia Atayi
Julia Portmann



Study Area: Chesapeake Bay

- ▶ Largest estuary in the United States



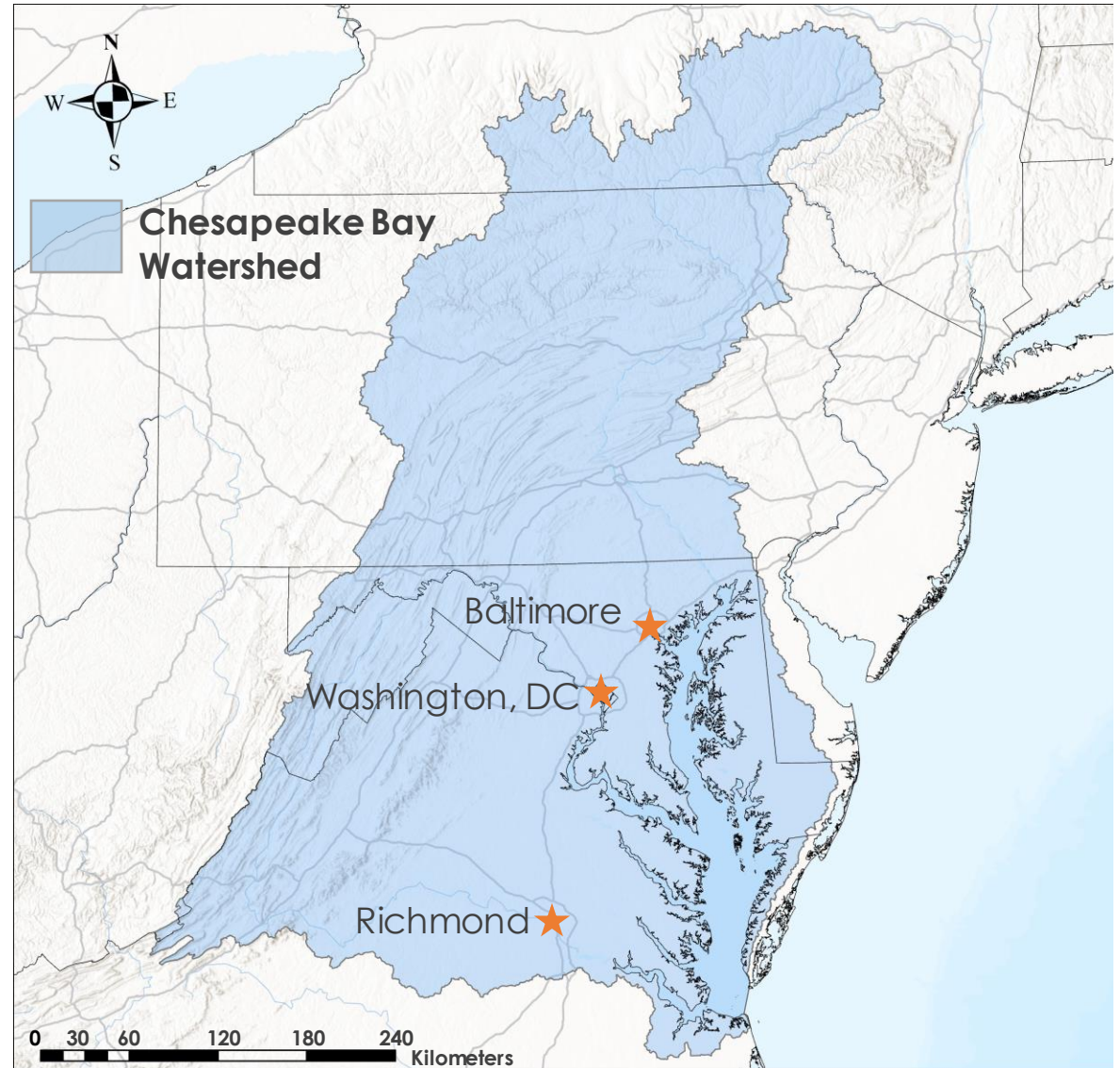
- ▶ High **biodiversity**



- ▶ Economically important

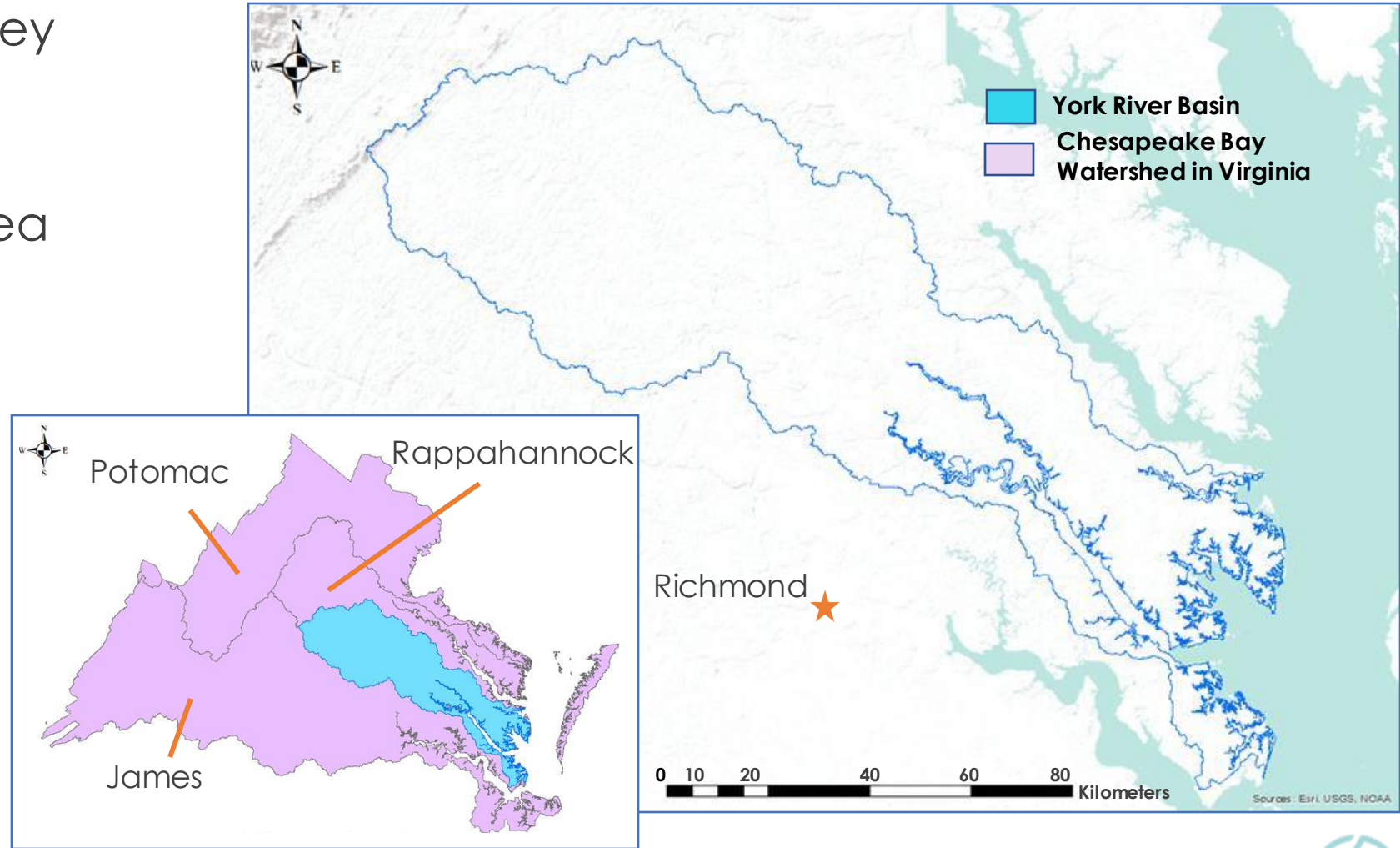


- ▶ History of **pollution**



Study Area: York River

- ▶ Mattaponi and Pamunkey Rivers
- ▶ NOAA Habitat Focus Area
- ▶ Chesapeake Bay National Estuarine Research Reserve (CBNERR)
- ▶ Long-term water quality dataset



Community Concerns

- ▶ Historic **decline** in water quality due to increased **turbidity** and **sedimentation**
 - ▶ Agriculture
 - ▶ Erosion
- ▶ Tourism industry
- ▶ Fishing and wildlife
 - ▶ Keystone species: oysters
 - ▶ Submerged Aquatic Vegetation (SAV)



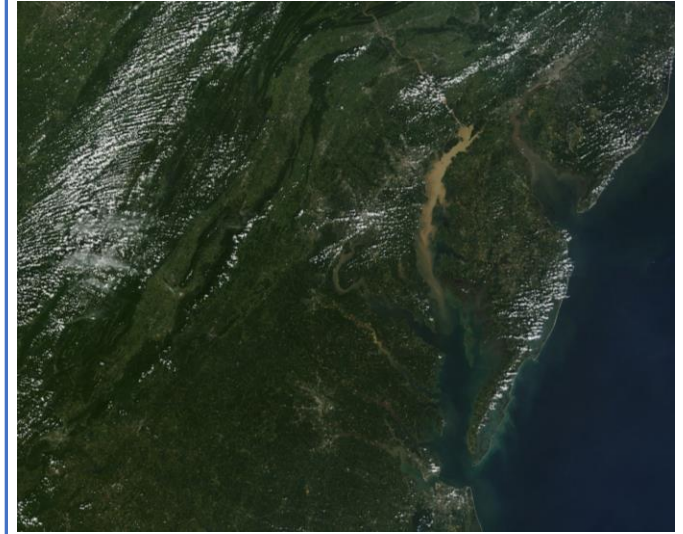
Project Objectives



**Identify changes in water quality
from 2009-2019**



**Use SWAT and ORCAA models
to assess sedimentation and
turbidity**



**Analyze suspended sediment
concentrations in the York
River**



Virginia Department of Environmental Quality (VADEQ)



Collaboration

Commitment



Closure

**Mission
Vision
Values**

Consistency



Communication

Certainty



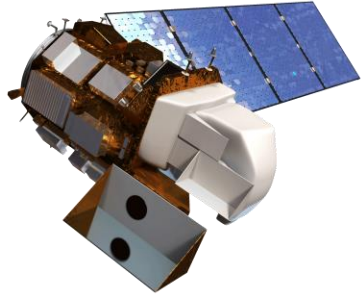
Collaborators

- ▶ Chesapeake Bay National Estuarine Research Reserve (CBNERR)
- ▶ Group on Earth Observations (GEO) AquaWatch
- ▶ Committee on Earth Observation Satellites Coastal Observations Applications Services and Tools (CEOS COAST)



Satellites and Sensors

Landsat 8 OLI



Sentinel-2 MSI



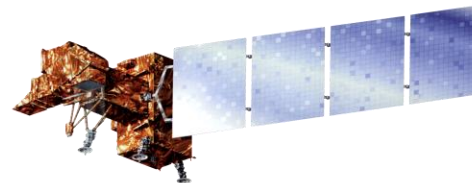
GPM IMERG



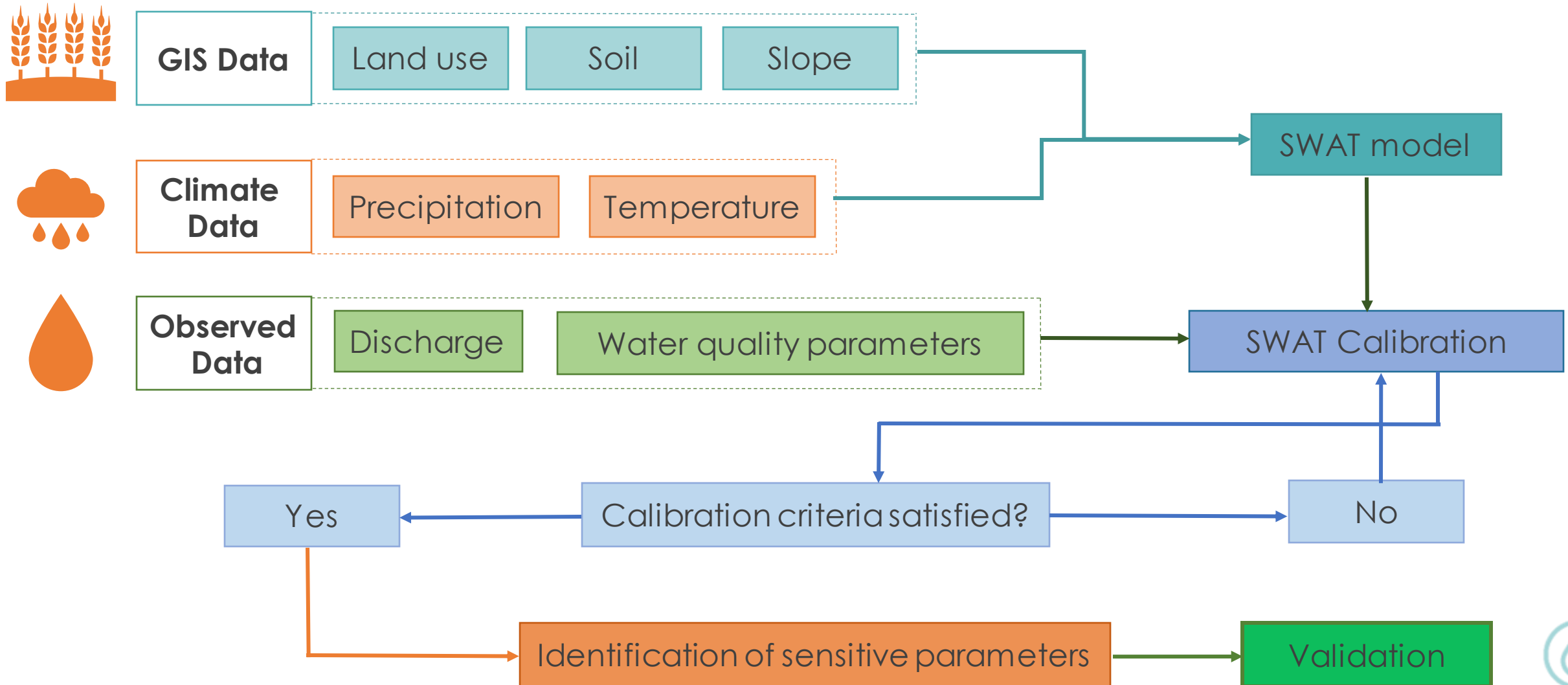
Landsat 5 TM



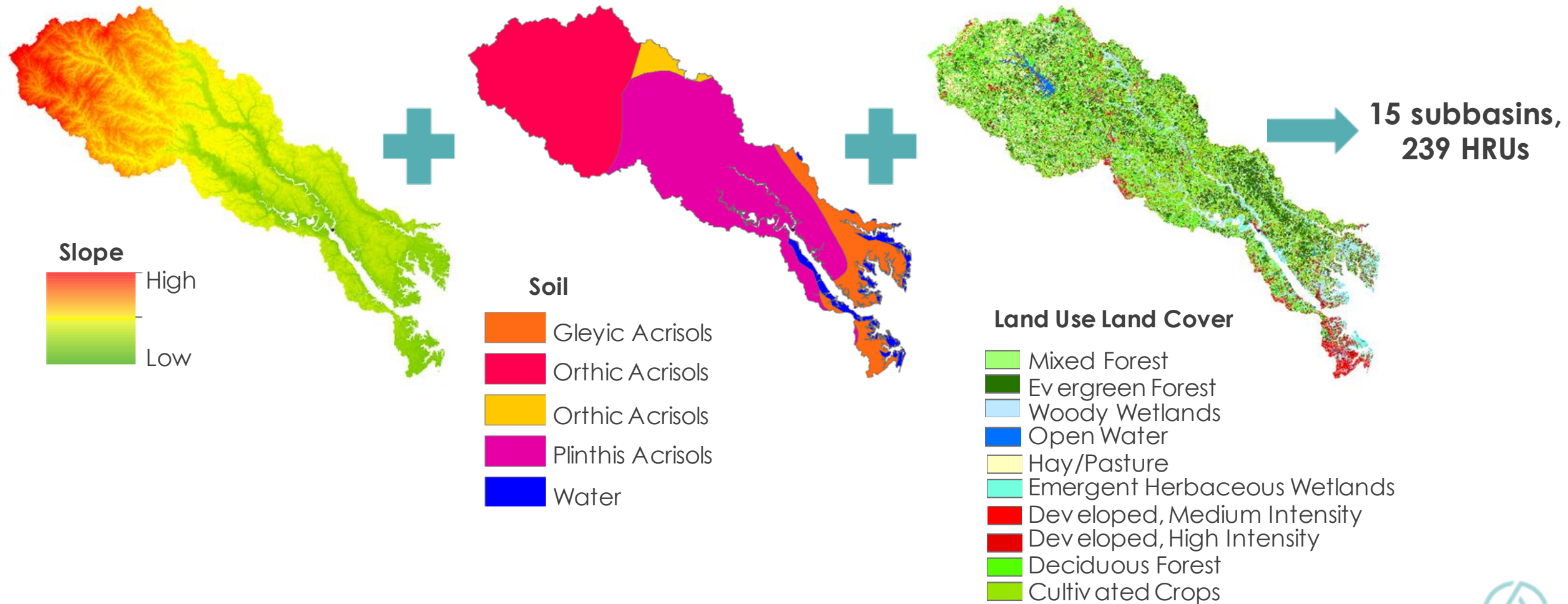
Landsat 7 ETM+



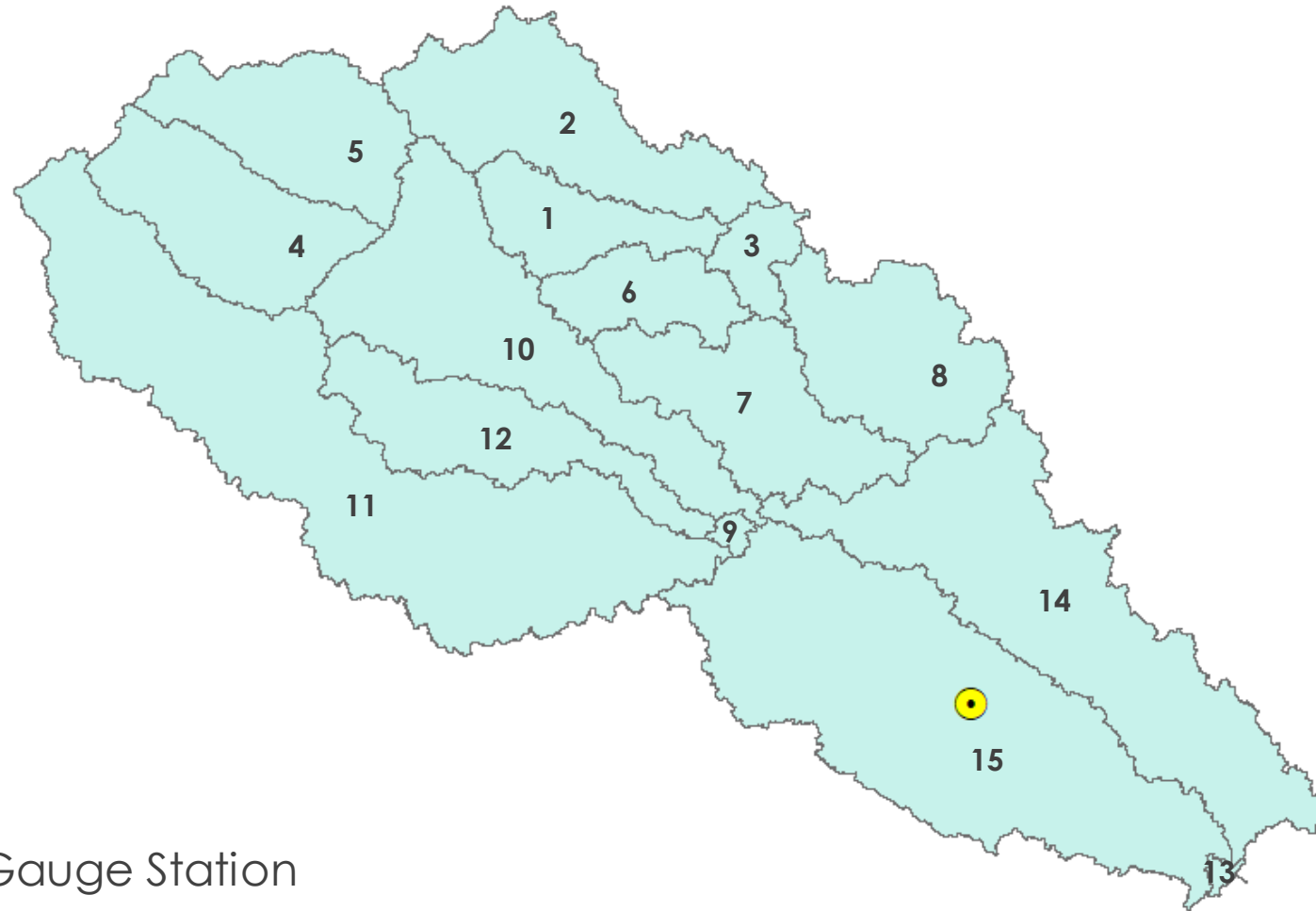
Methodology: SWAT



Methodology: SWAT



Subbasins & USGS Gauge Station



Pamunkey River Gauge Station

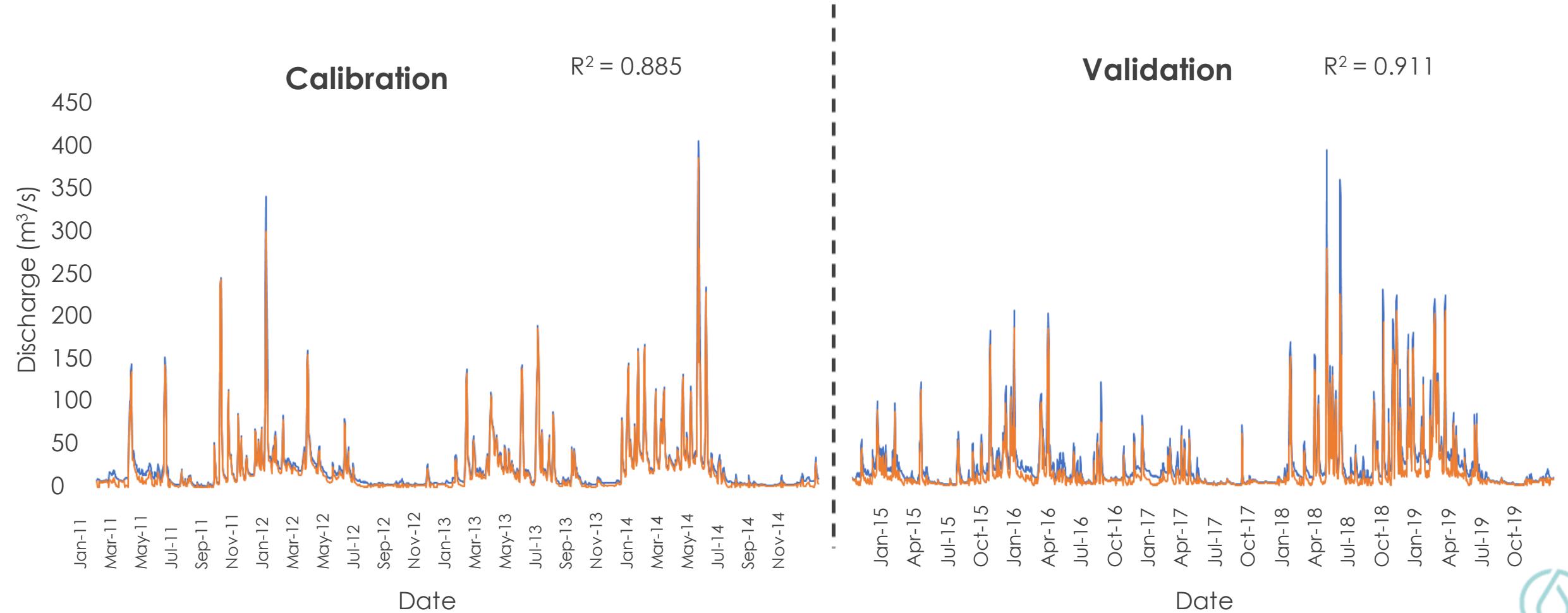


Subbasins



Results: Calibration & Validation, Discharge

— Observed
— Simulated

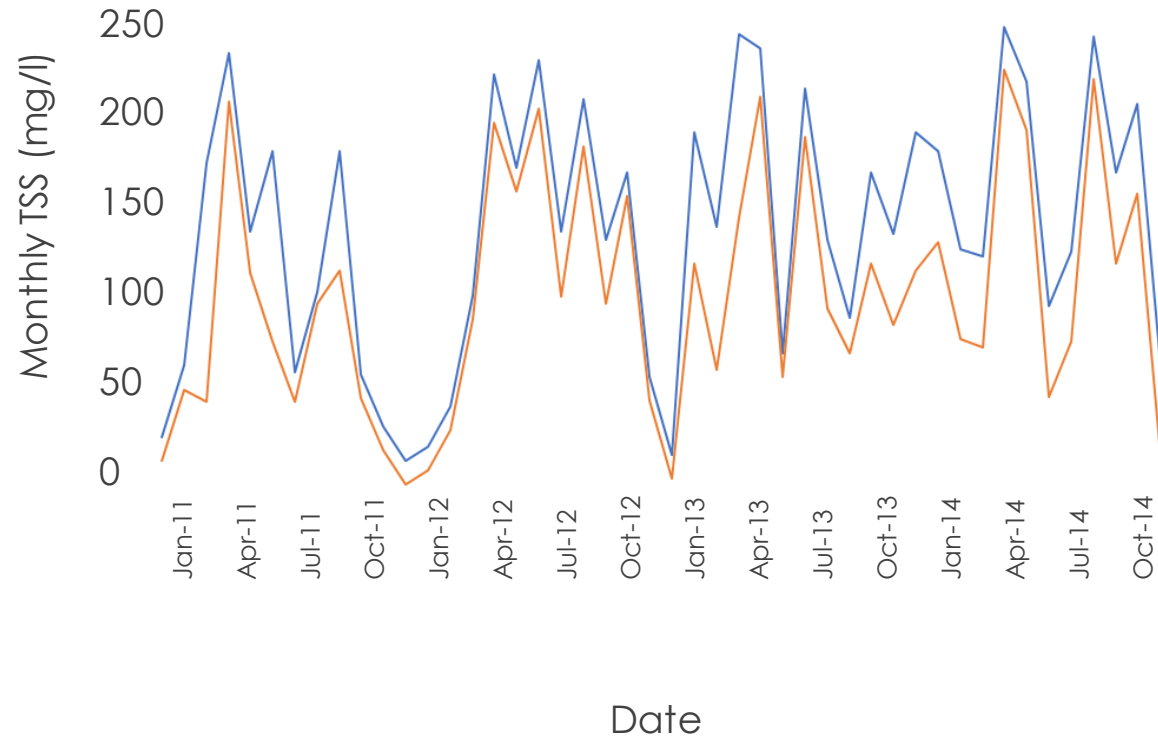


Results: Calibration & Validation, Total Suspended Sediments

— Observed
— Simulated

Calibration

$R^2 = 0.928$



Validation

$R^2 = 0.856$



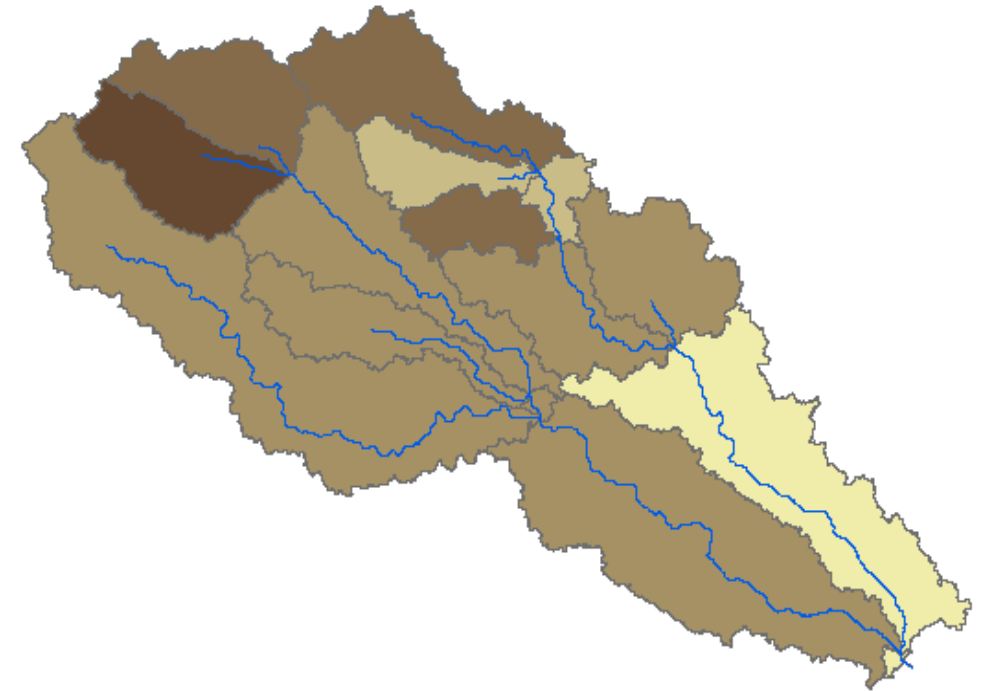
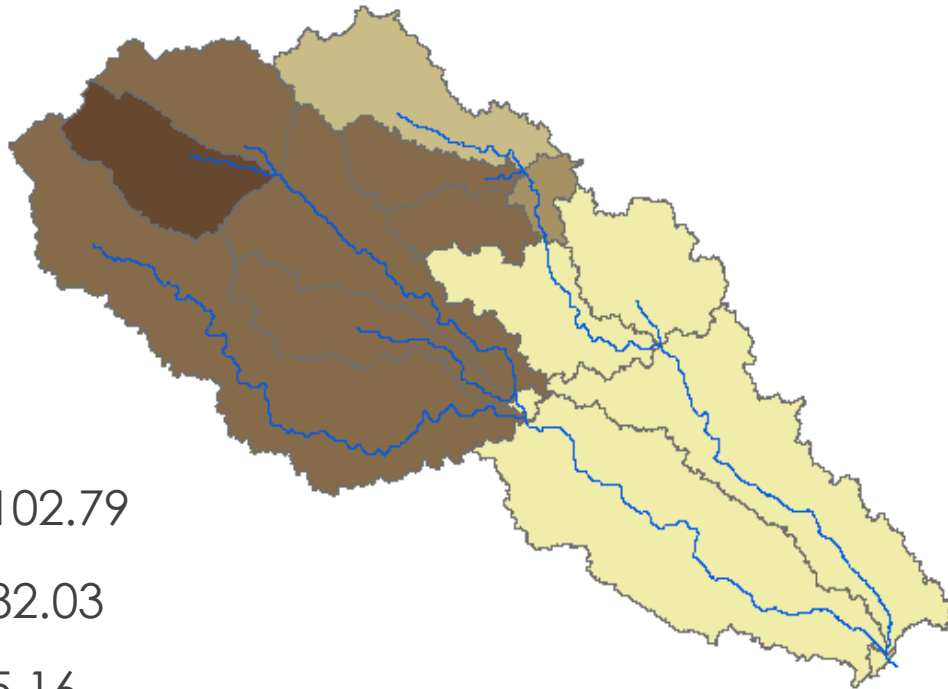
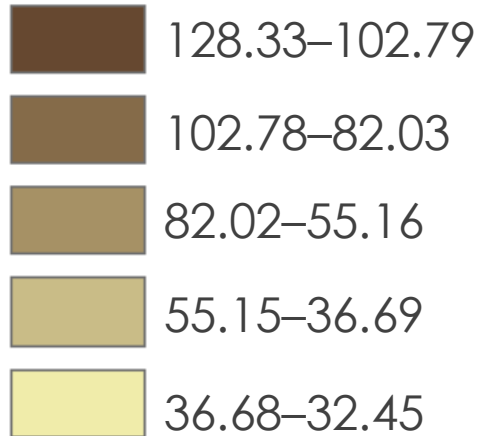
Characterizing TSS 2009–2019



2009

2019

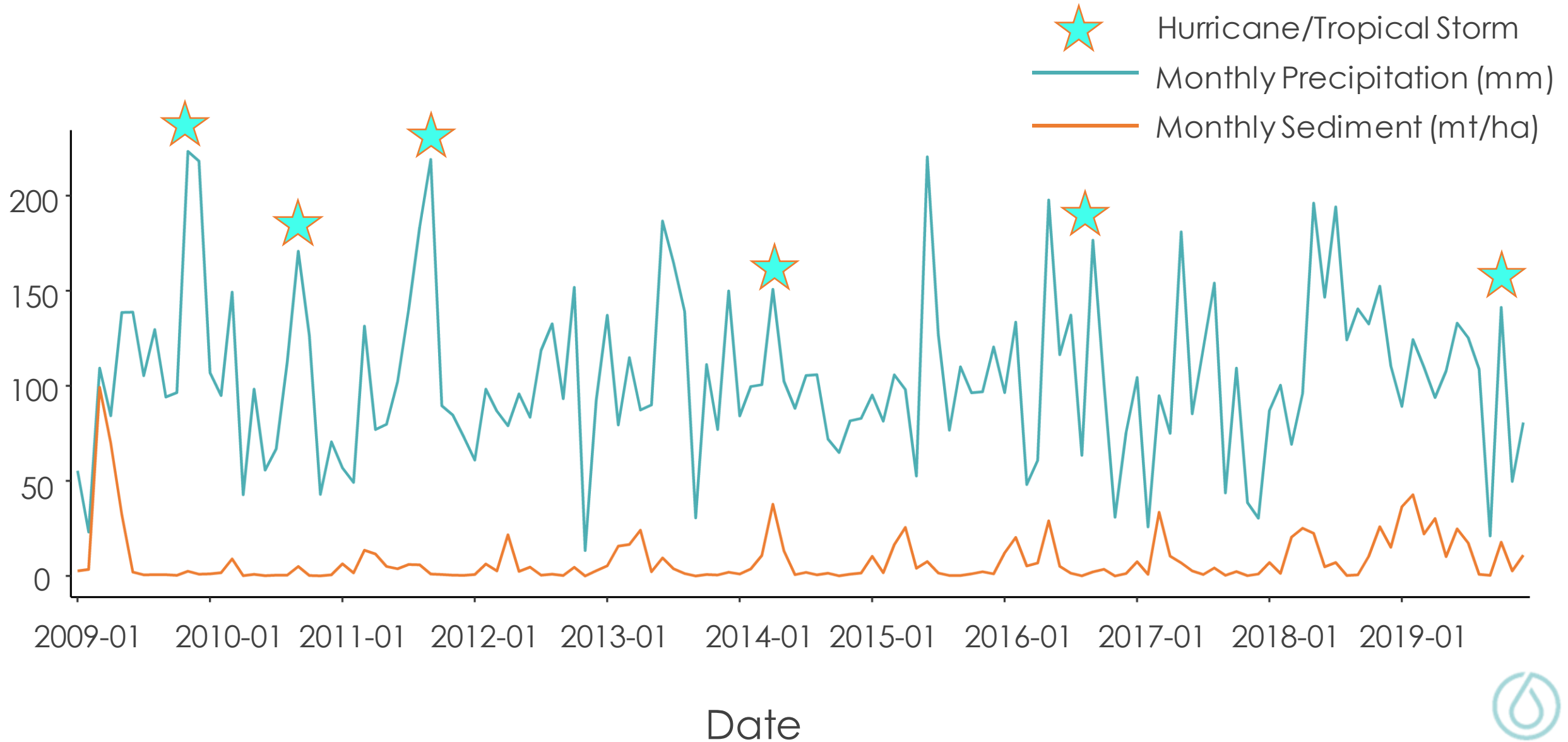
TSS (mt/ha)



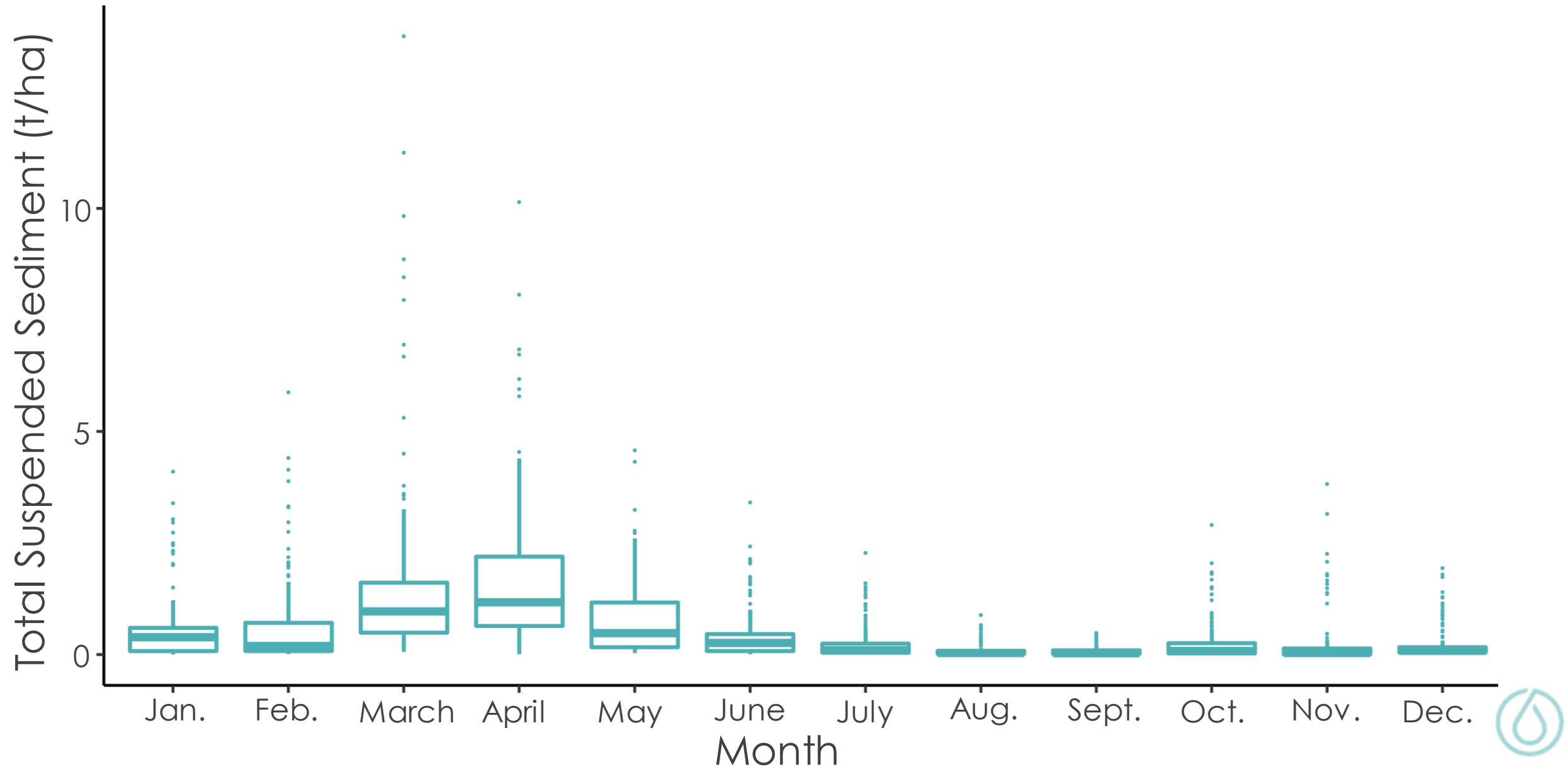
0 10 20 40 60 80 km



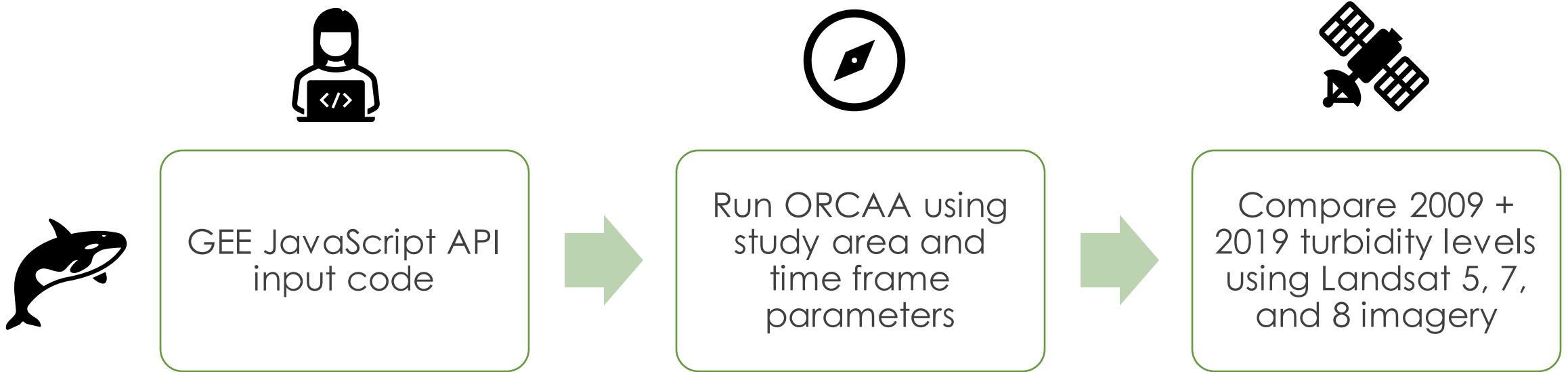
Sediment & Precipitation



Total Suspended Sediment (mt/ha) 2009–2019




Methodology: ORCAA



yellow = higher turbidity

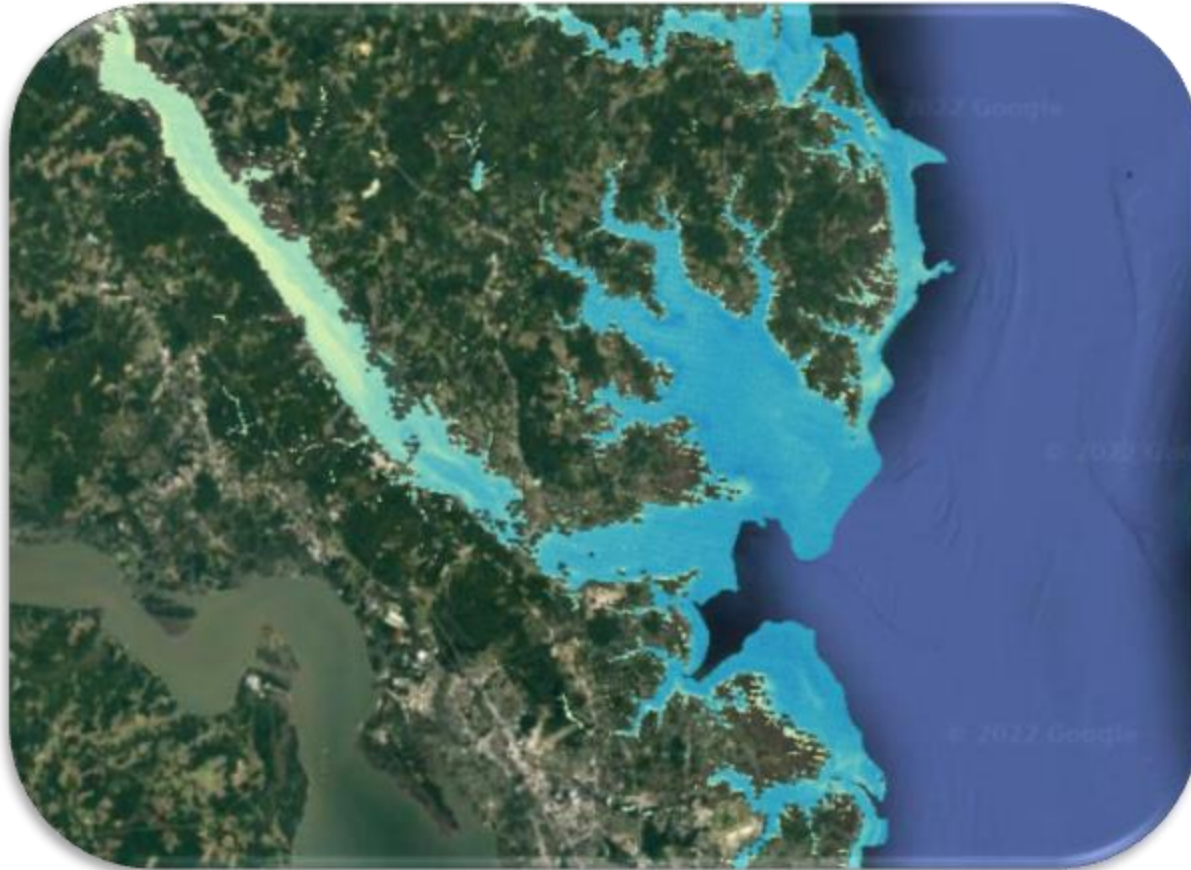
Results: ORCAA

Normalized Difference Turbidity Index



-0.5 0

January 2009



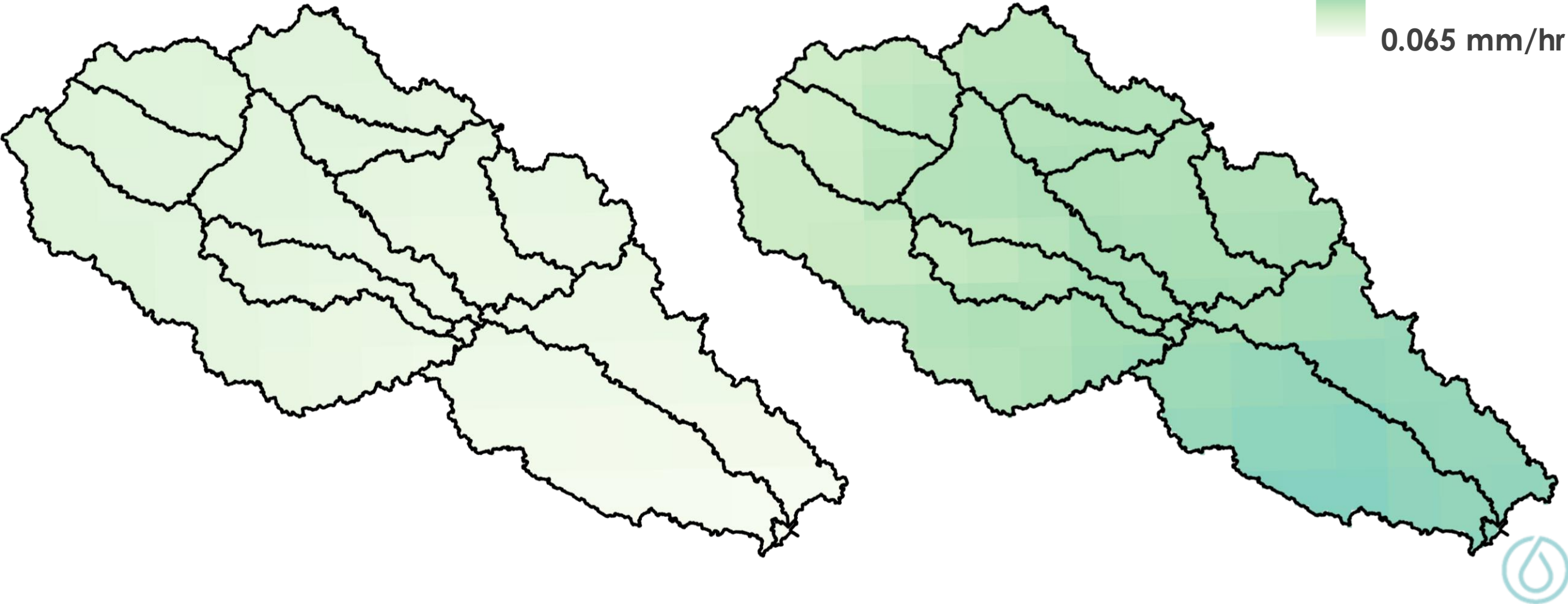
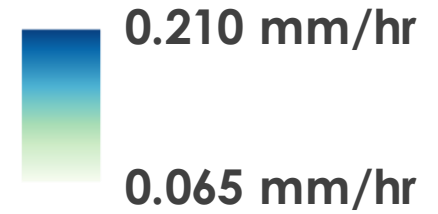
January 2019



Mean Precipitation (GPM IMERG)

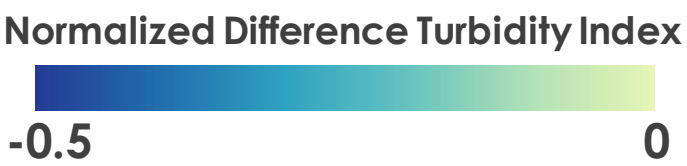
January 2009

January 2019



yellow = higher turbidity

Results: ORCAA



January 2009



April 2009



July 2009



October 2009



January 2019



April 2019



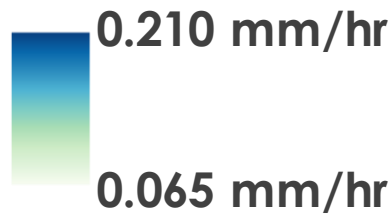
July 2019



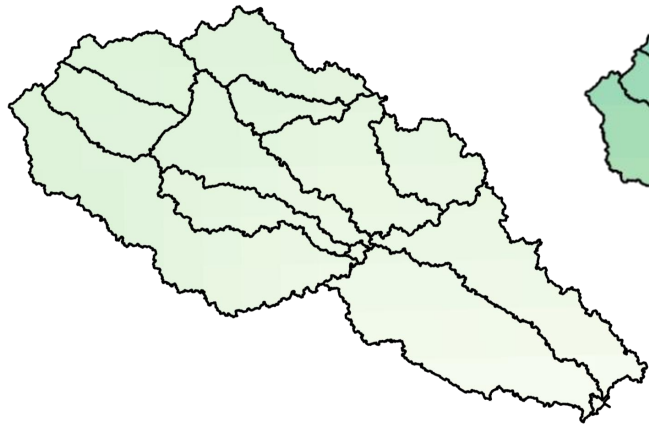
October 2019



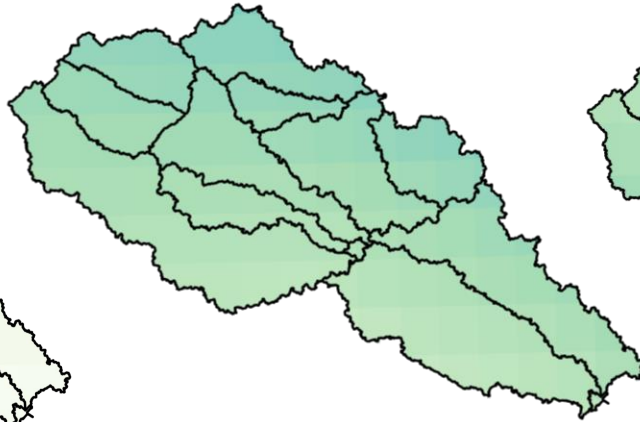
Mean Precipitation (GPM IMERG)



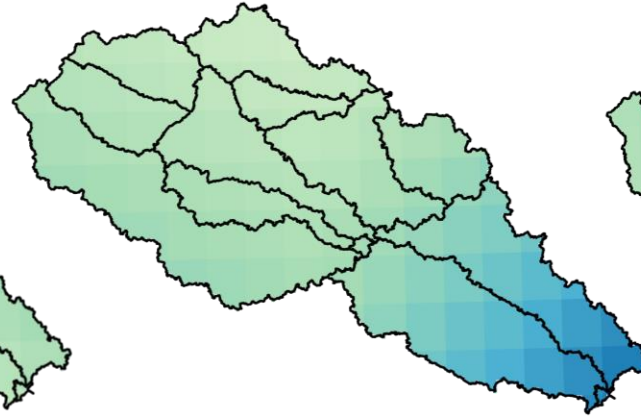
January 2009



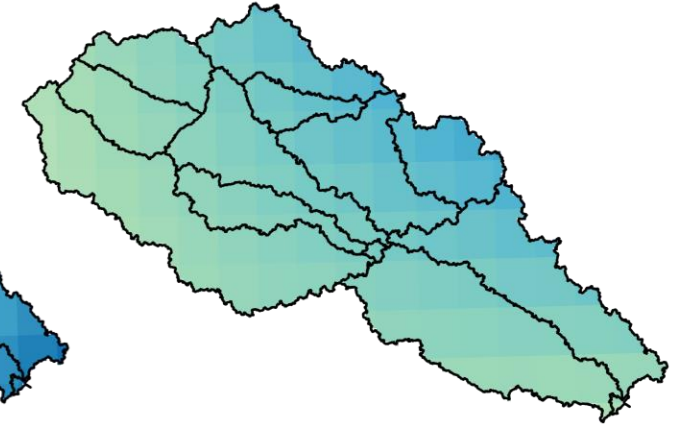
April 2009



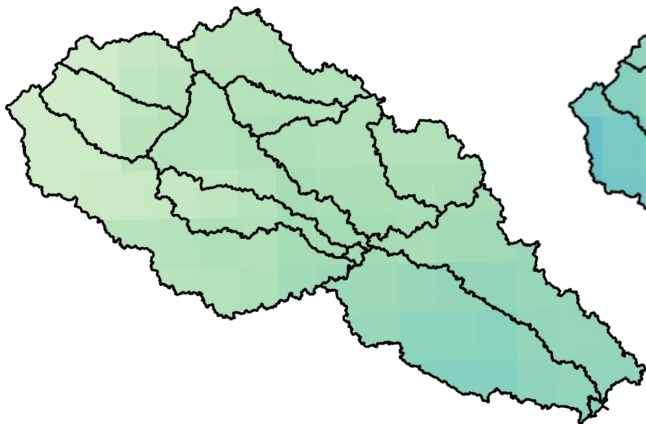
July 2009



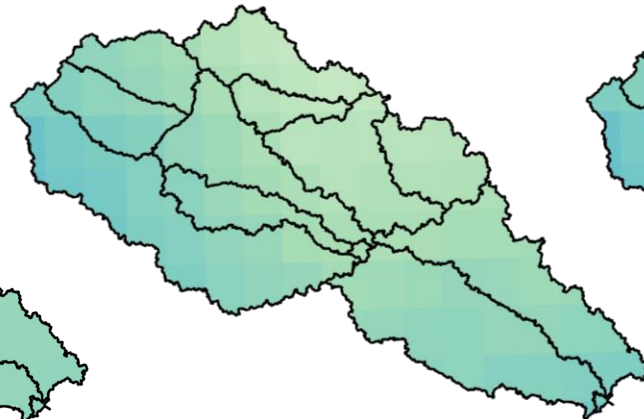
October 2009



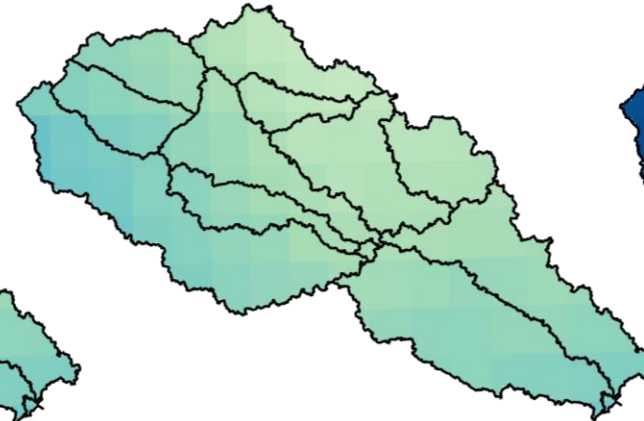
January 2019



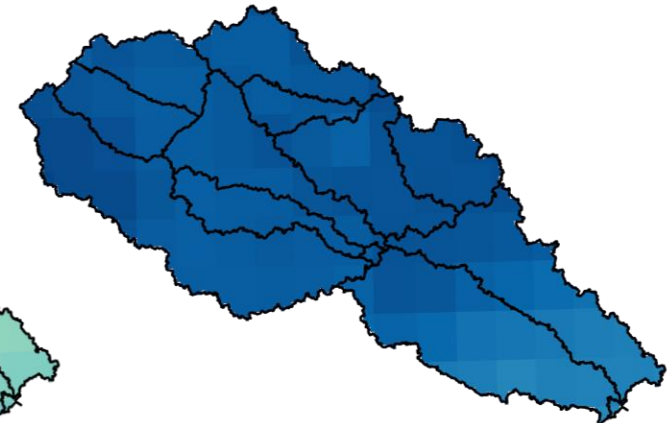
April 2019



July 2019



October 2019



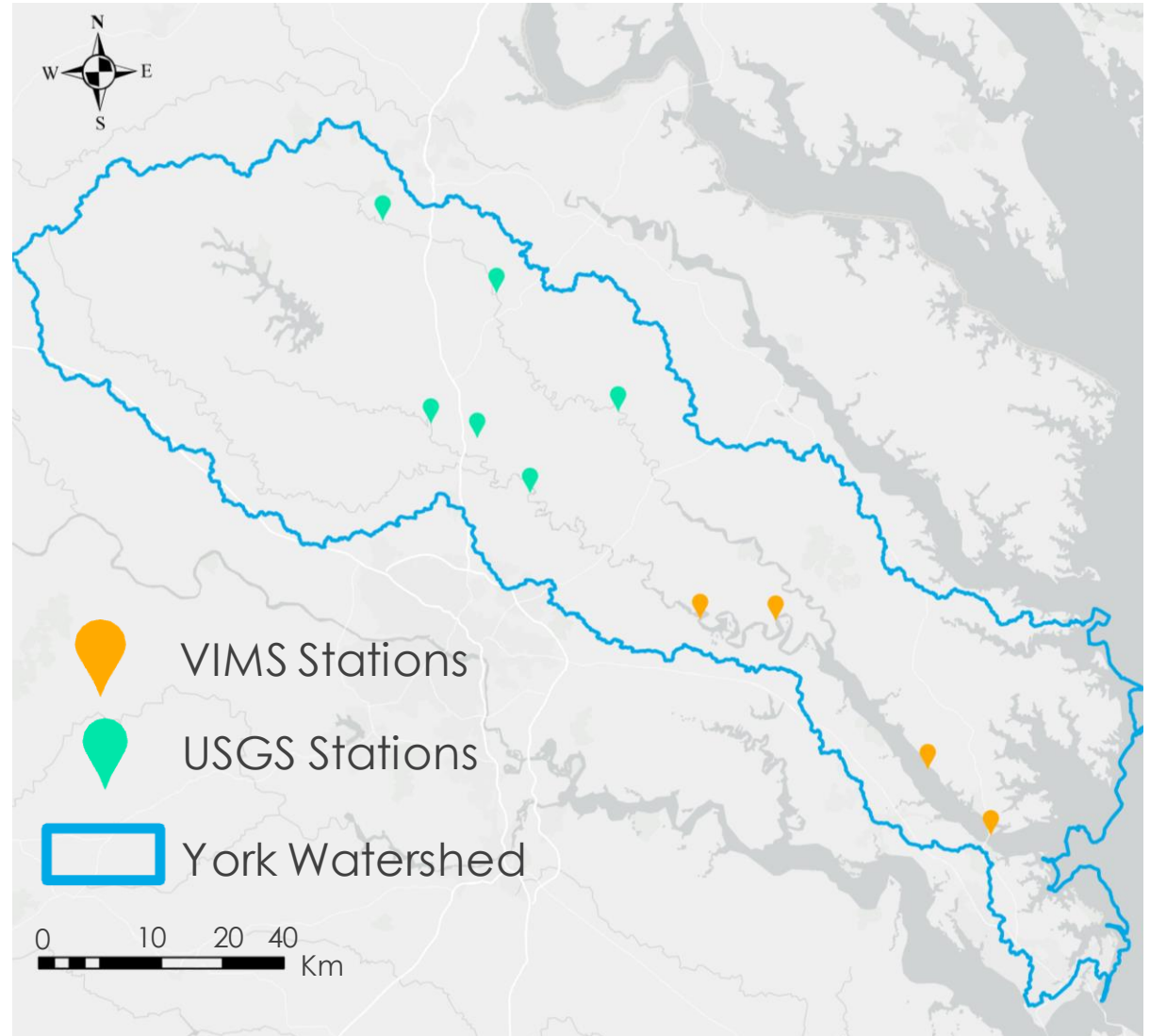
Conclusions

- ▶ Sediment yields from 2009–2019 **generally increased** and were highest in the **headwaters**
- ▶ Connection between precipitation and turbidity levels
- ▶ Other variables may affect turbidity
- ▶ Highlighted target areas for further improvement



Limitations & Uncertainties

- ▶ Reflectance
- ▶ Time
- ▶ Dataset availability throughout watershed
- ▶ What else is influencing turbidity?



Future Work

- Expand to other parameters (e.g., chl-a, CDOM, algae)
- Increase time span
- Identify major water quality events
- Implement riparian buffers in areas with high sediment yields



ACKNOWLEDGEMENTS

- **End User Partner**
 - **Amanda Shaver** (VA DEQ)
- **Science Advisors**
 - **Dr. Kenton Ross** (NASA Langley Research Center)
 - **Dr. Venkataraman Lakshmi** (University of Virginia)
- **Collaborators**
 - **Carl Friedrichs** (CBNERR)
 - **Steve Greb** (GEO AquaWatch)
 - **Merrie Beth Neely** (CEOS COAST)
- **Additional Thanks To:**
 - **Caroline Williams** (DEVELOP PUP Fellow)
 - **Duc Tran & Prakrut Kansara** (SWAT support)

This material contains modified Copernicus Sentinel data (2009 to 2019), processed by ESA.

Maps throughout this work were created using ArcGIS® software by Esri. ArcGIS® and ArcMap™ are the intellectual property of Esri and are used herein under license. All rights reserved.

This material is based upon work supported by NASA through contract NNL16AA05C. Any mention of a commercial product, service, or activity in this material does not constitute NASA endorsement. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Aeronautics and Space Administration and partner organizations.