

Project update-USGS Integrated Water Science in the Illinois River Basin

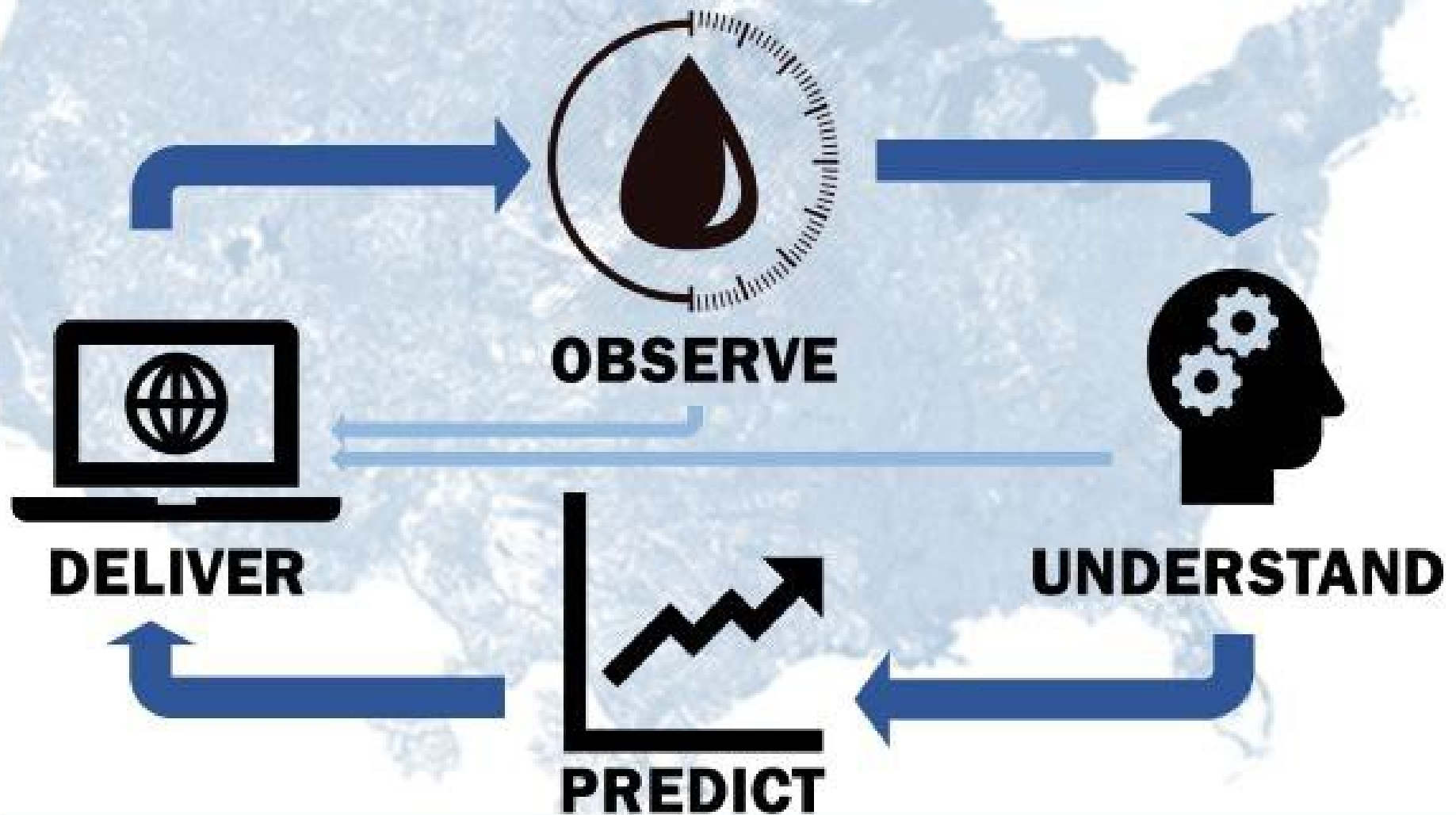
Jim Duncker

November 1, 2022

USGS Integrated Water Science Basin Activities in the Illinois River Basin



Integrated Water Science Process

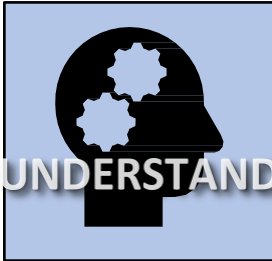


Integrated Water Science Initiative



Next Generation Water Observing System (NGWOS)

NGWOS collects real-time data on water quantity and quality in more affordable, rapid, and intensive ways than has previously been possible. The flexible monitoring approach enables USGS networks to evolve with new technology and emerging threats.



Integrated Water Availability Assessments (IWAA)

IWAAs examine the supply, use, and availability of the nation's water. These regional and national assessments evaluate water quantity and quality in both surface and groundwater, as related to human and ecosystem needs and as affected by human and natural influences.



Integrated Water Prediction (IWP)

IWP builds a powerful set of modeling tools to predict the amount and quality of surface and groundwater, now and into the future. These models use the best available science to provide information for more rivers and aquifers than can be directly monitored.



National Water Information System (NWIS) Modernization; National Water Dashboard

NWIS data systems that house USGS water information are being modernized to maximize data integrity, simplify data delivery to the general public, automate early warning to enable faster response times during water emergencies, and support the new National Water Dashboard.

Priority Basin Issues-

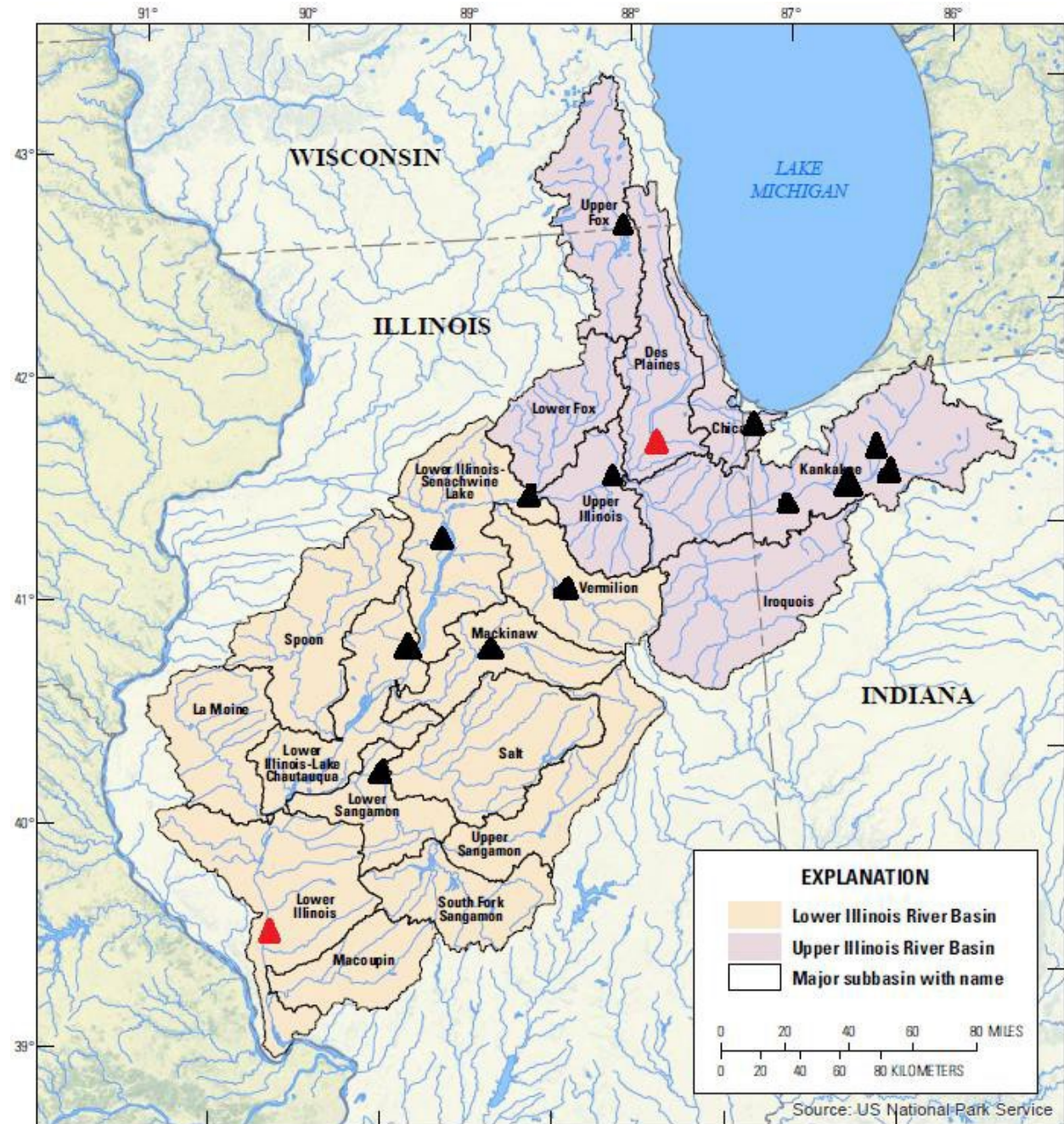
NUTRIENTS

- Build off existing science
- Better understanding of nutrient cycle processes
 - Urban
 - Agricultural
- Increase resolution of spatial distribution
- Understanding legacy nutrients



Map- supergages

Fifteen supergages-
either upgrades in
instrumentation or
complete new
gaging stations.

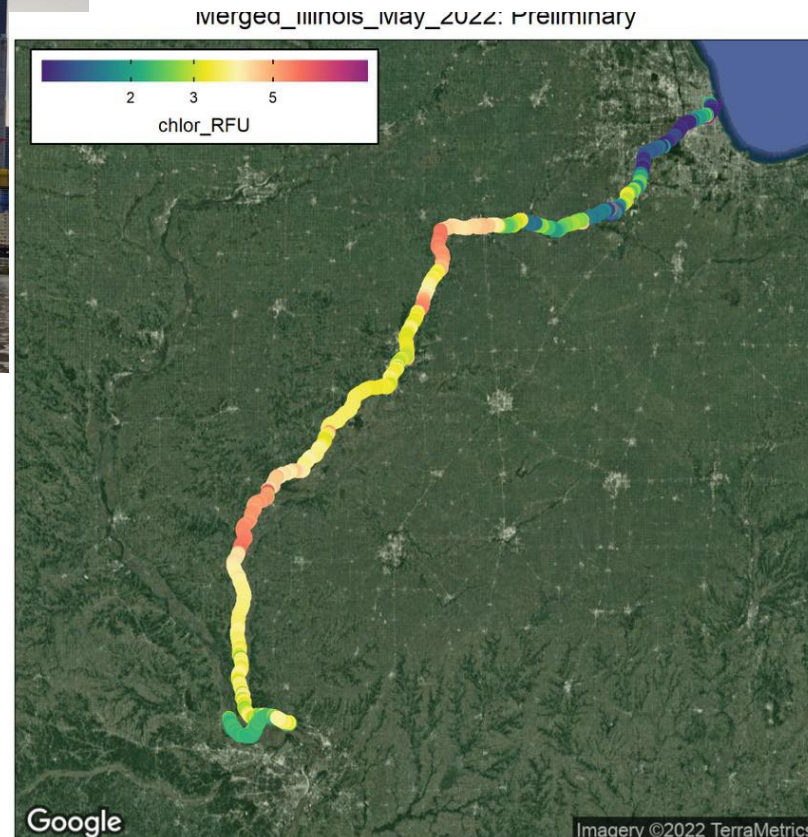


Supergages



- Continuous river stage and discharge
- Continuous water quality
 - Water temp
 - pH,
 - DO
 - Specific conductance
 - Chlorophyll-a
 - Phycocyanin
 - Turbidity
- HABs camera imagery
- LSPIV

FLAME Continuous QW survey



A few quick takeaways from May 2022 survey:

CO₂: The river is supersaturated everywhere (above ~400ppm). There is a large increase at the Chicago WWTP outfall, but the urban portion of the river was elevated compared to downstream.

CH₄: Methane is also elevated in the urban part of the river as I would expect.

O₂: Dissolved oxygen is pretty close to saturation throughout the river.

Nitrate: Pretty high values coming out of the Chicago WWTP and a few of the ag basins (Sangamon was the highest) and Hansen Backwater Lake.

Chlorophyll/Blue green algae (BGA): More phytoplankton in the ag portion of the river compared to the urban

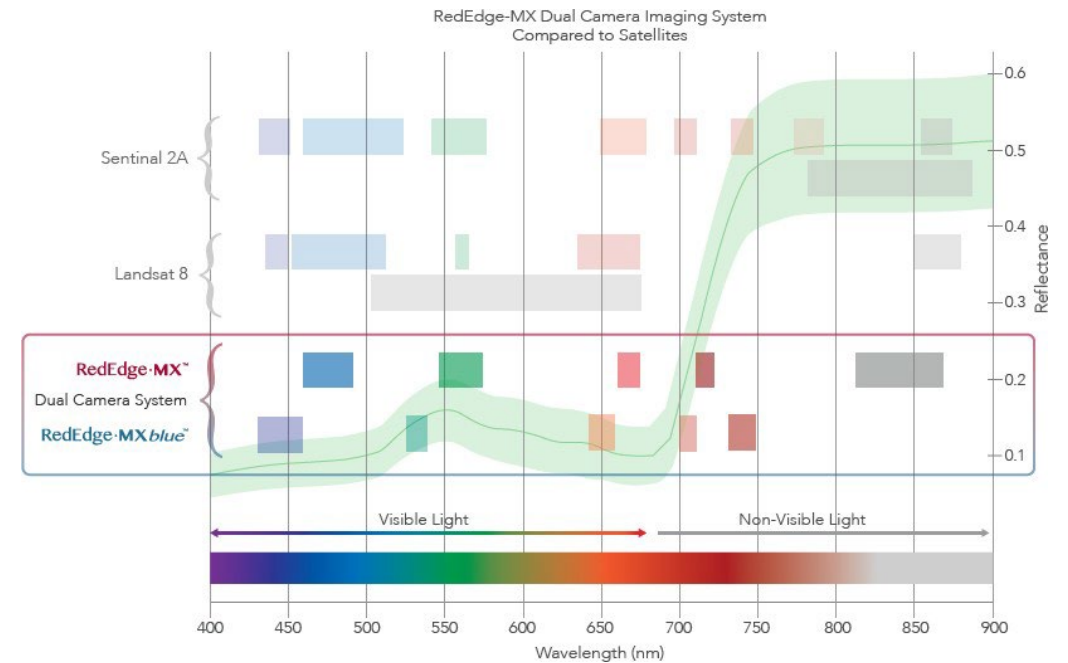
Basin Issues

HARMFUL ALGAL BLOOMS

- Better understanding of HABs.
- Identify the algal communities.
 - Baseline information
 - Compare to historical algal community assemblages (LTRM)
- Improve early detection.
 - Nuisance blooms and harmful algal blooms
- Deploy multi-spectral cameras.
- Link multi-spectral cameras to remote sensing data.



MicaSense Multi-Spectral Cameras



Photographs and Slide provided by Jessie Garrett, U.S. Geological Survey

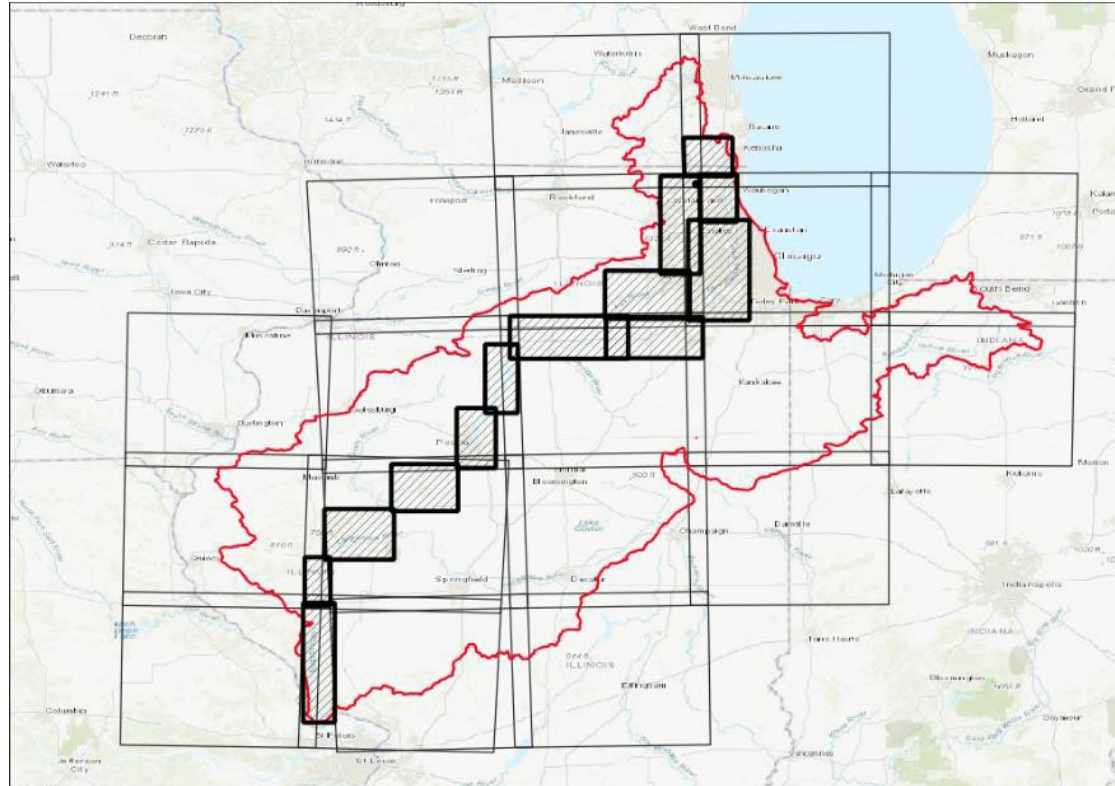
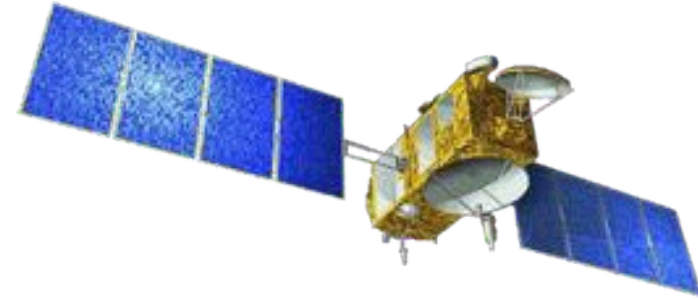


Nutrient Diffusing Substrates

- Determine which nutrient(s) are limiting algal growth, toxin production, and species composition
- Respiration measurements using PreSens sensor (closed chamber technique).
- oxygen measurements can tell us about **stream metabolism** (the balance between respiration and photosynthesis).
- light chambers are used for net primary productivity (autotrophs) and the dark are used for community respiration (heterotrophs).
- **gross primary productivity /stream metabolism.**
- When a HAB occurs the communities shift thus altering these rates.

Sentinel 2

Satellite imagery



Satellite Remote Sensing of Water Quality



Example Workflow

- Ingest satellite imagery
- Atmospherically correct
- Calculate spectral indices
- Link spectral index to water quality constituent
- Compute ensemble statistics
- Deliver content

Satellite Imagery



Collected: ~11:30
Available: < 23:30

Spectral Index



23:35

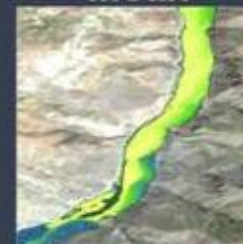
Link Function



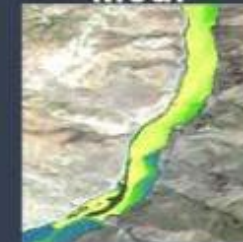
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Ensemble Stats

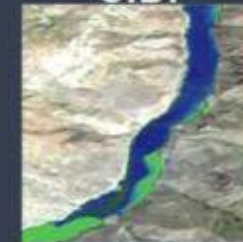
Mean



Med.

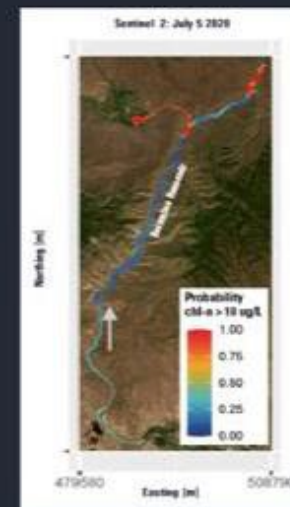


S.D.



23:45

Content Delivery



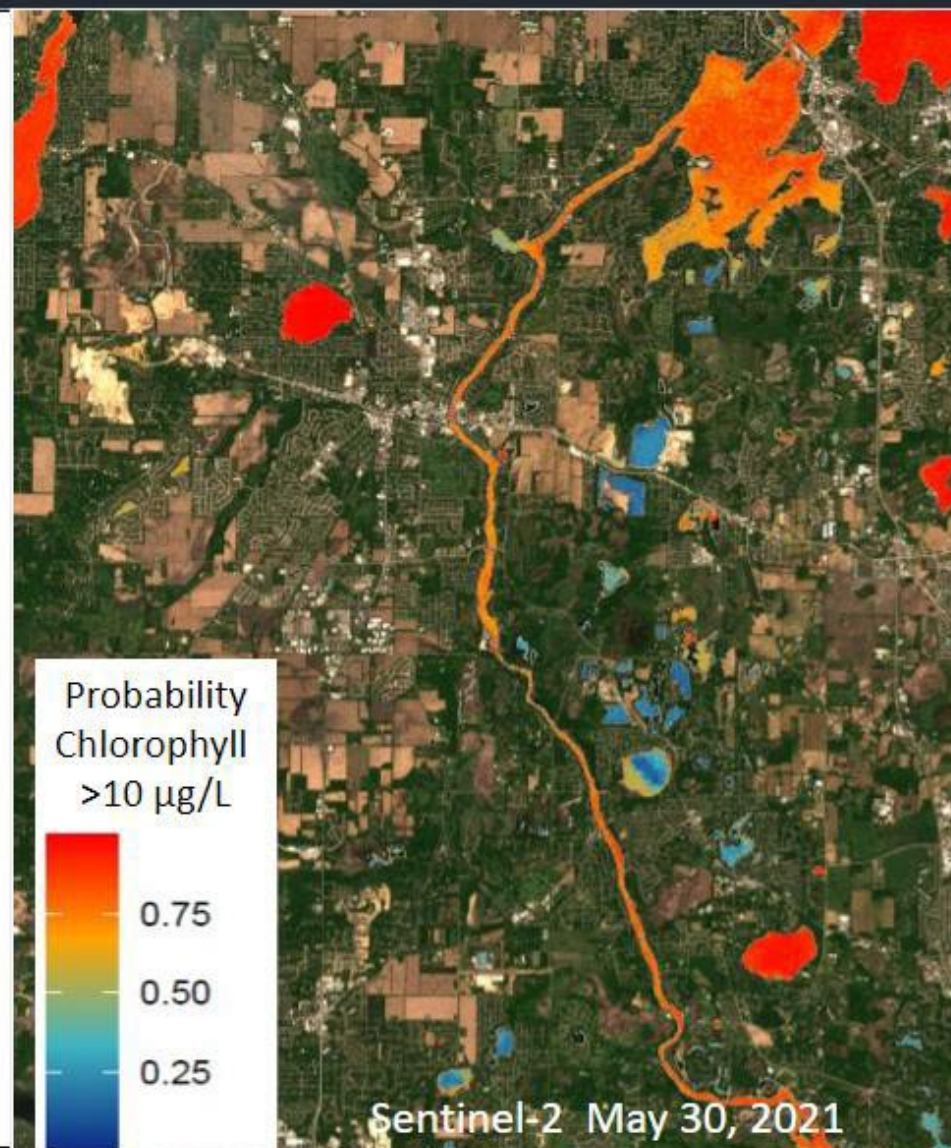
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Remote Sensing of Water Quality

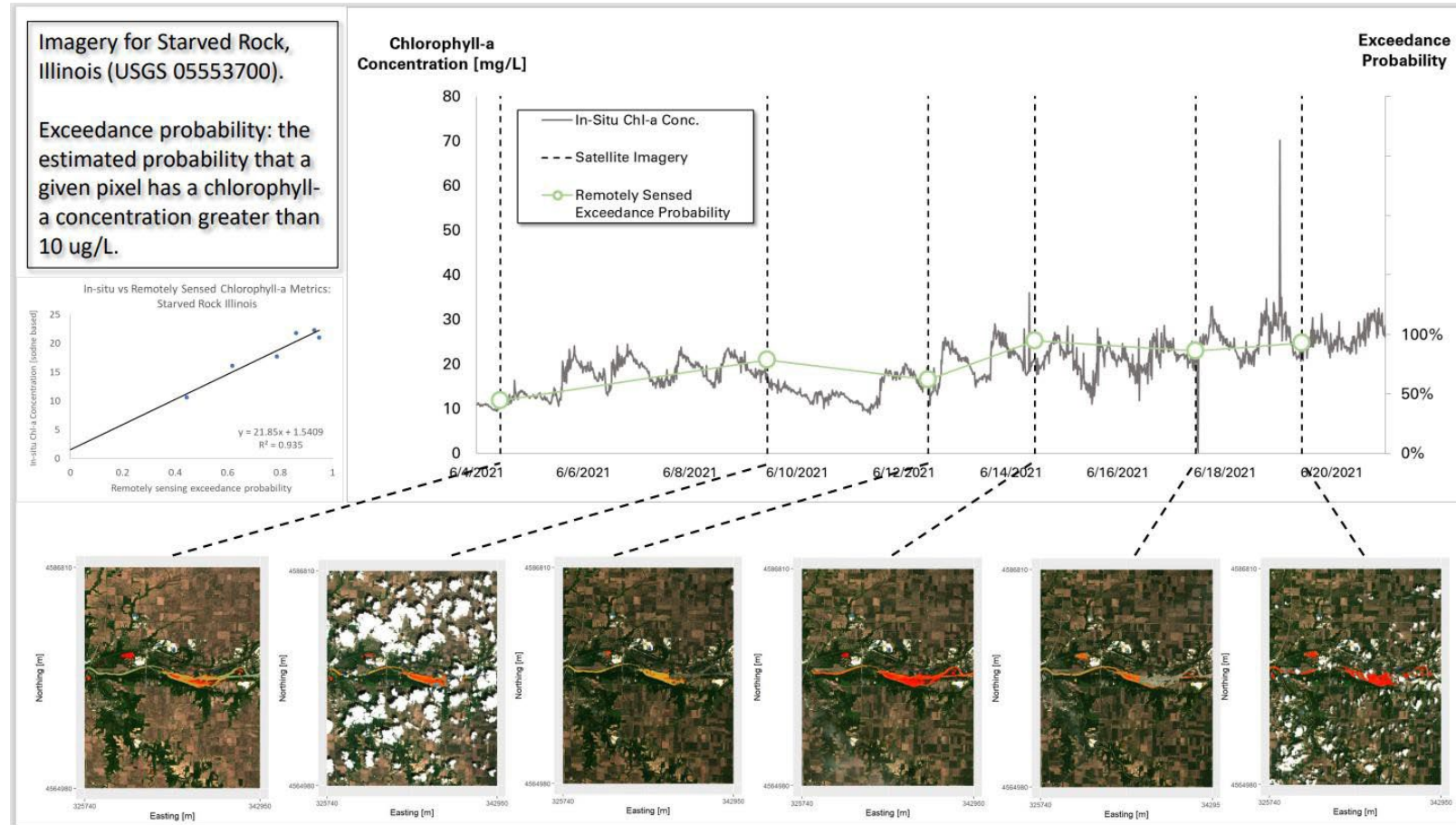
Goals:

1. Retrieve WQ from historic and current satellite imagery
2. Operational application
3. Start with NGWOS pilot basins, extend to entire US
4. Focus on accuracy and quantifying uncertainty



Fox River Near McHenry, IL

June 2021 HABs event-Illinois River at Starved Rock



Provisional data-
Subject to revision

Tyler King, USGS

Basin Issues

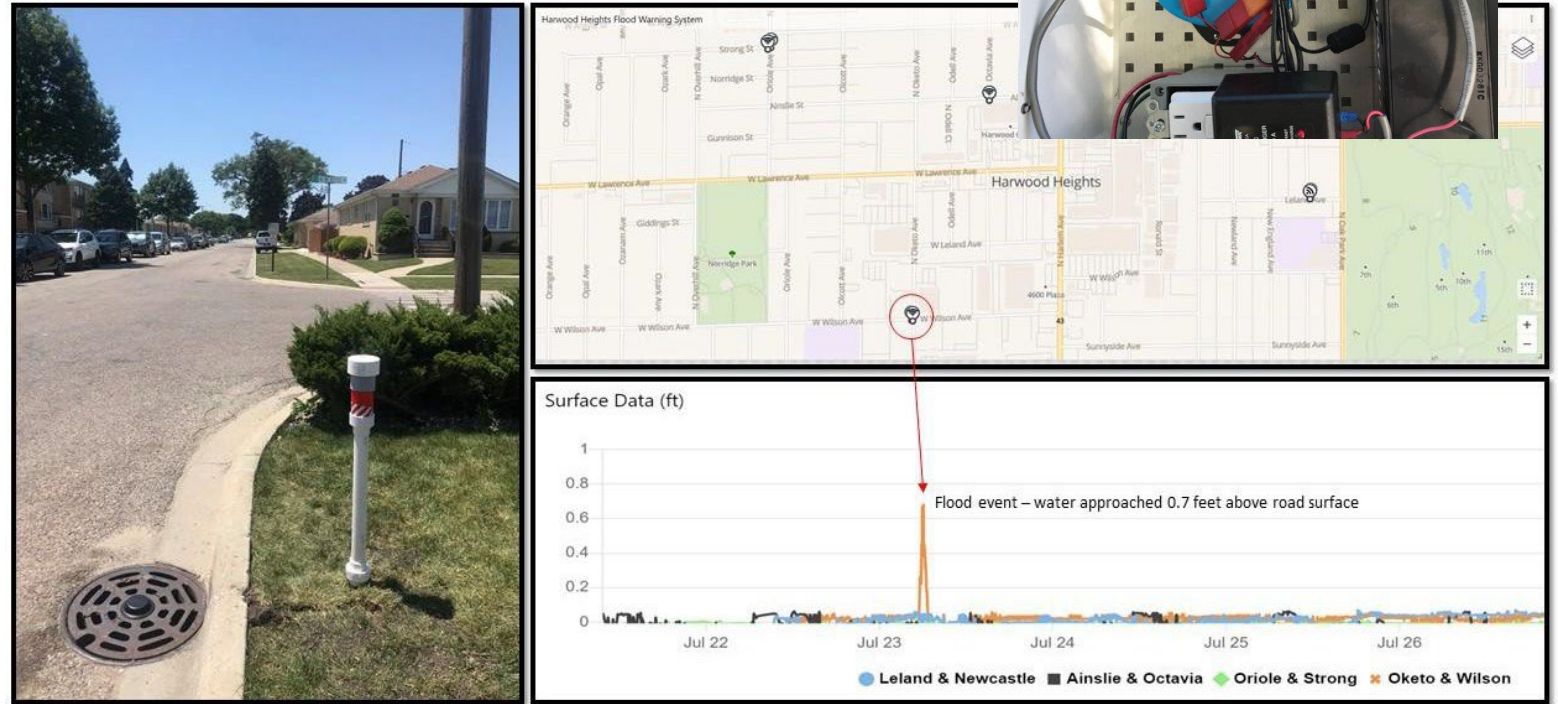
NON-RIVERINE URBAN FLOODING

- The Illinois Dept. of Natural Resources' urban flooding report identifies that between 2007 and 2014, there has been more than **\$2.3 billion** in documented flooding damages, most of which was a result of basement flooding and sewer back-ups on private property..

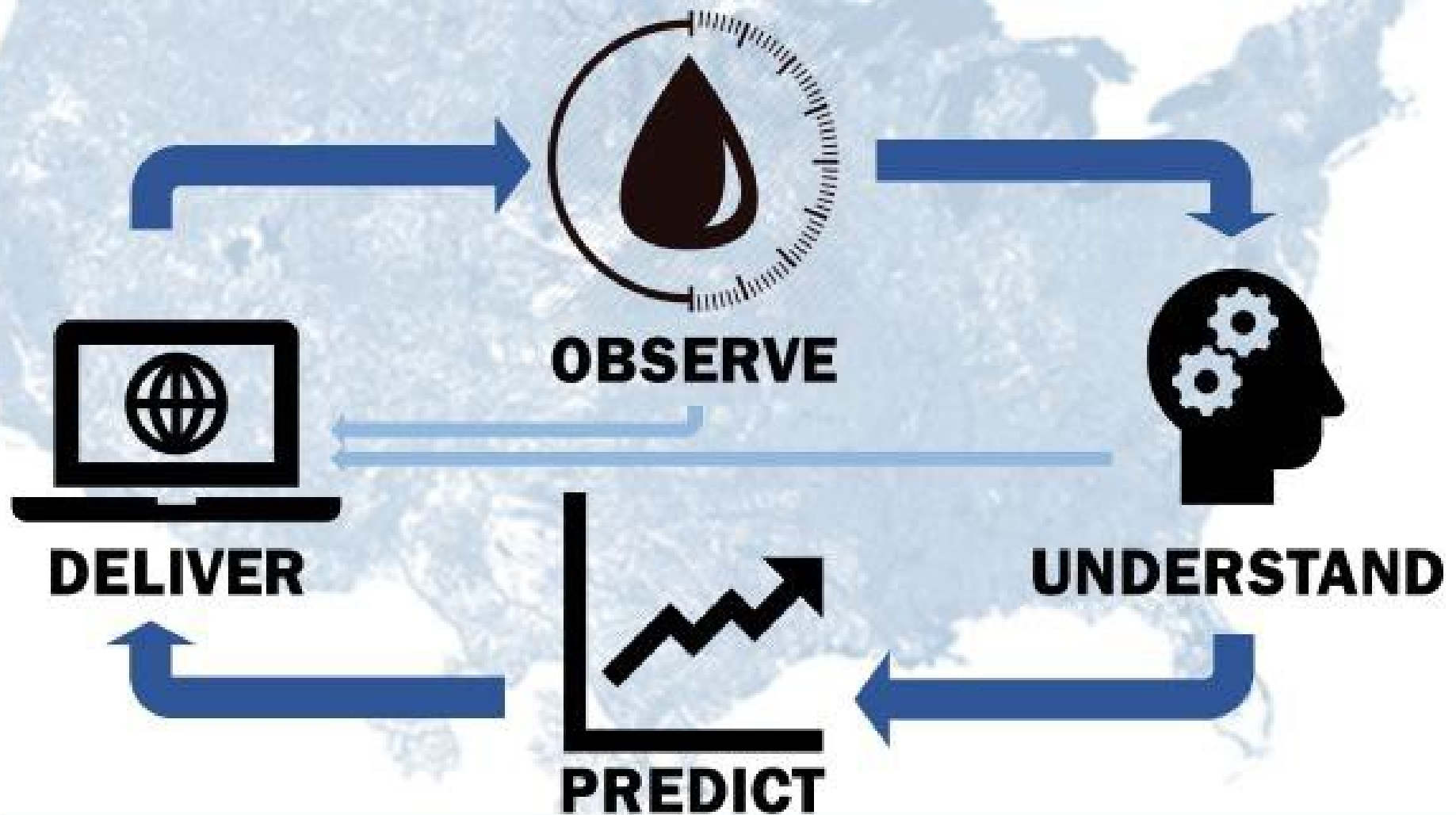


Non-riverine urban flooding testbed

- pilot monitoring and alert program with a community that experiences frequent urban flooding.
- Leverage existing local sewer mapping and expertise to establish a notification system and develop a toolbox with actions homeowners can do to protect their homes.
- Low-cost sensors
- LoRa WAN telemetry
- Data dashboard

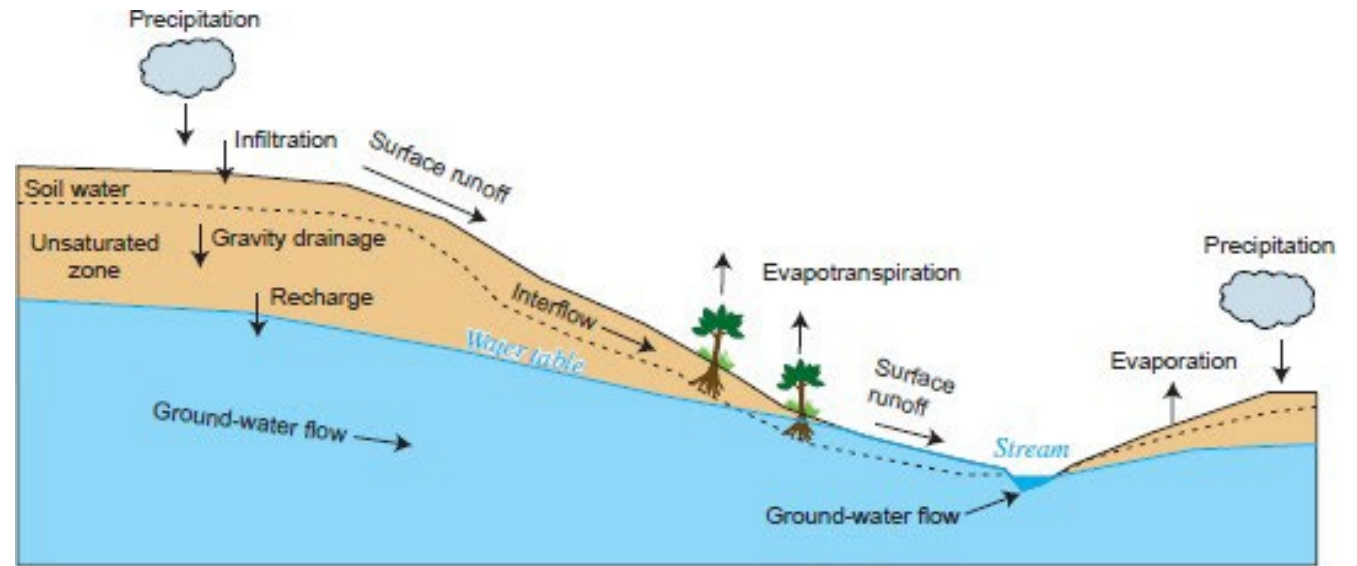


Integrated Water Science Process



IWAAs approach and implementation

- Goal-Regional and national water availability assessments
- Staggered time-frame (FY2022 start)
- “Fail fast” approach.
- Use modeling to ID data gaps
- Assembling basin models
 - MODFLOW
 - CE-Qual2E-W
 - SWAT
 - SPARROW
 - NOWCAST (HABs)



EXPLANATION

- Zone of aeration
- Zone of saturation
- Soil-zone base

Airborne electromagnetic survey-Fox River

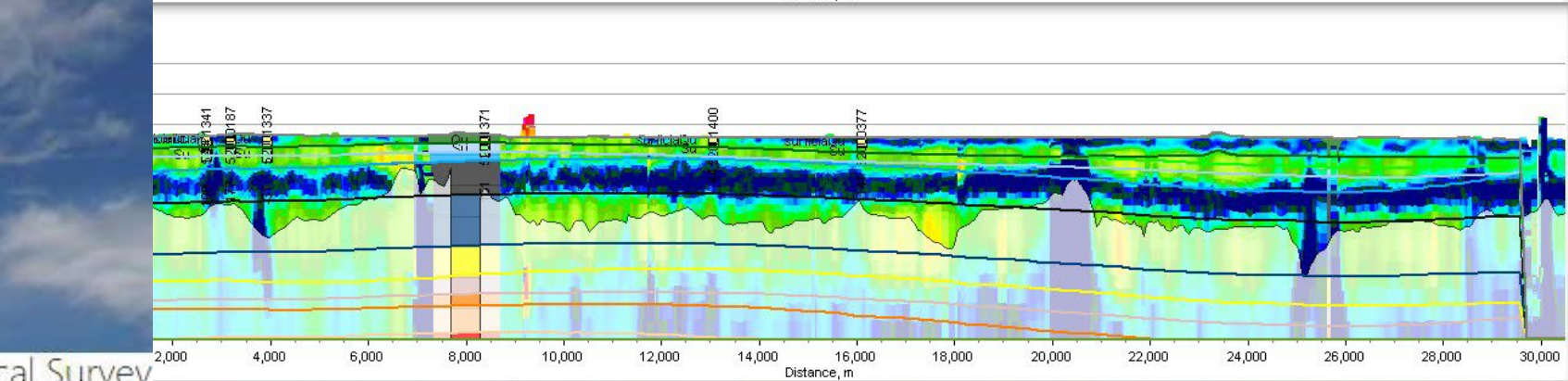
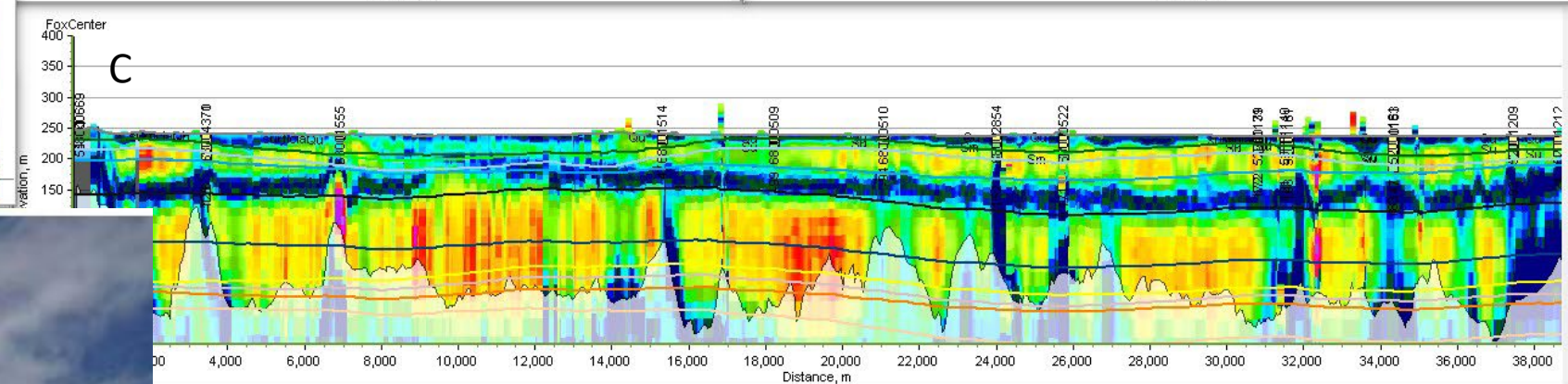
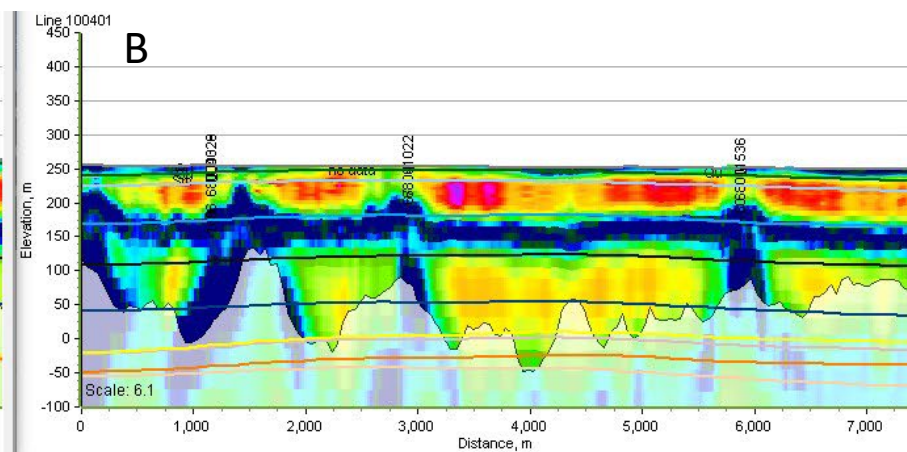
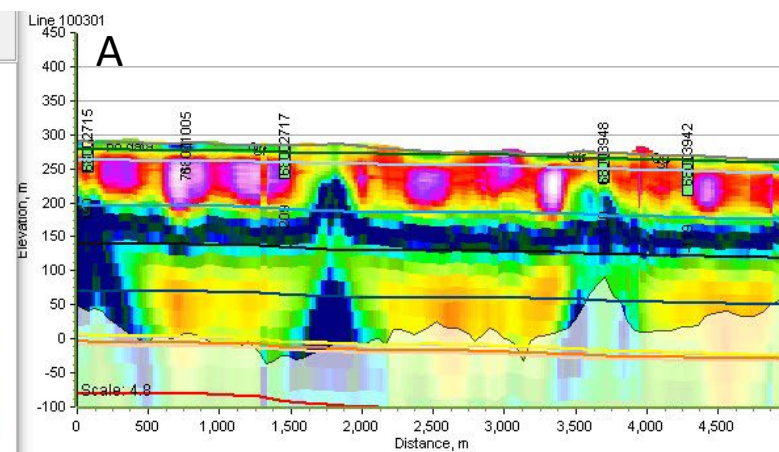
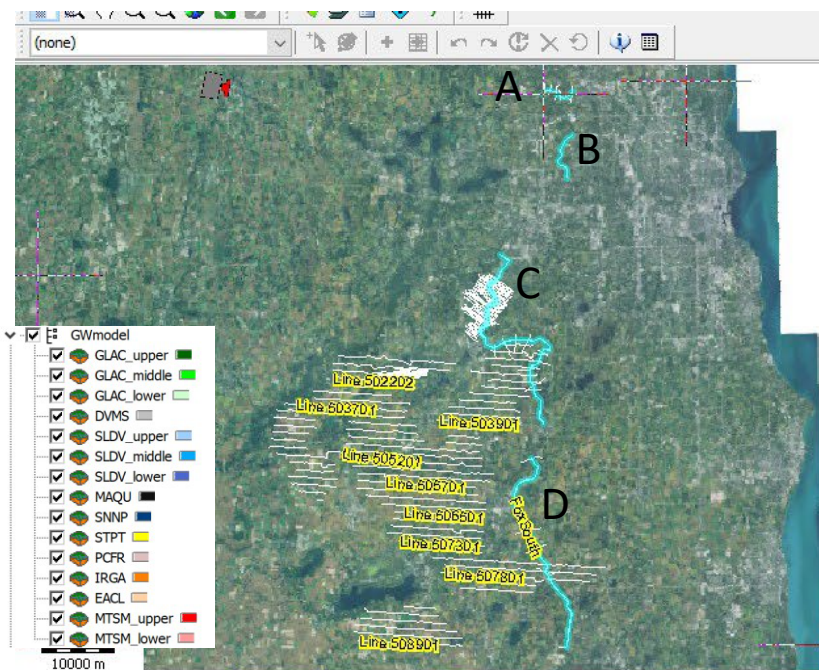
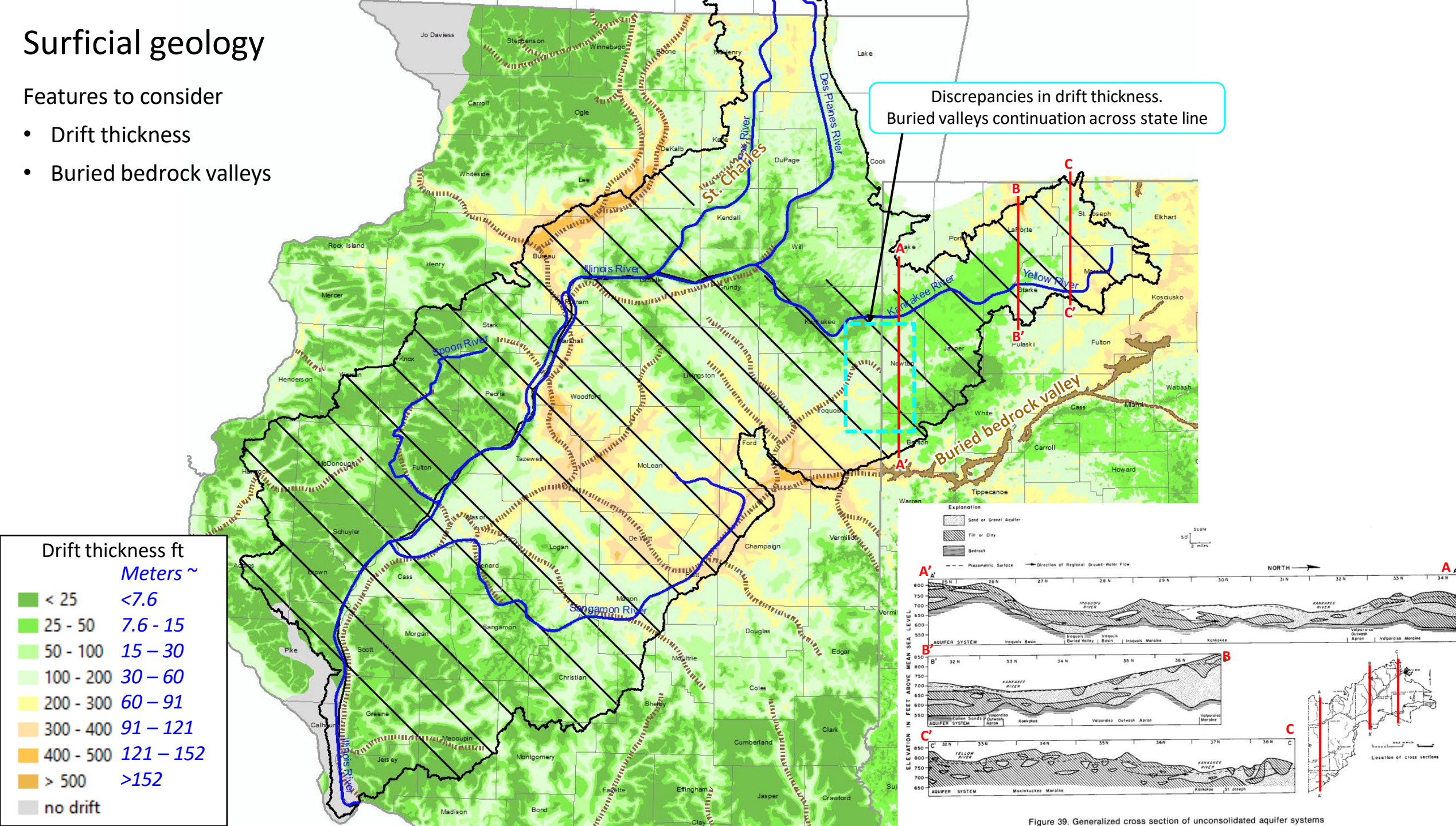


Photo courtesy of U.S. Geological Survey

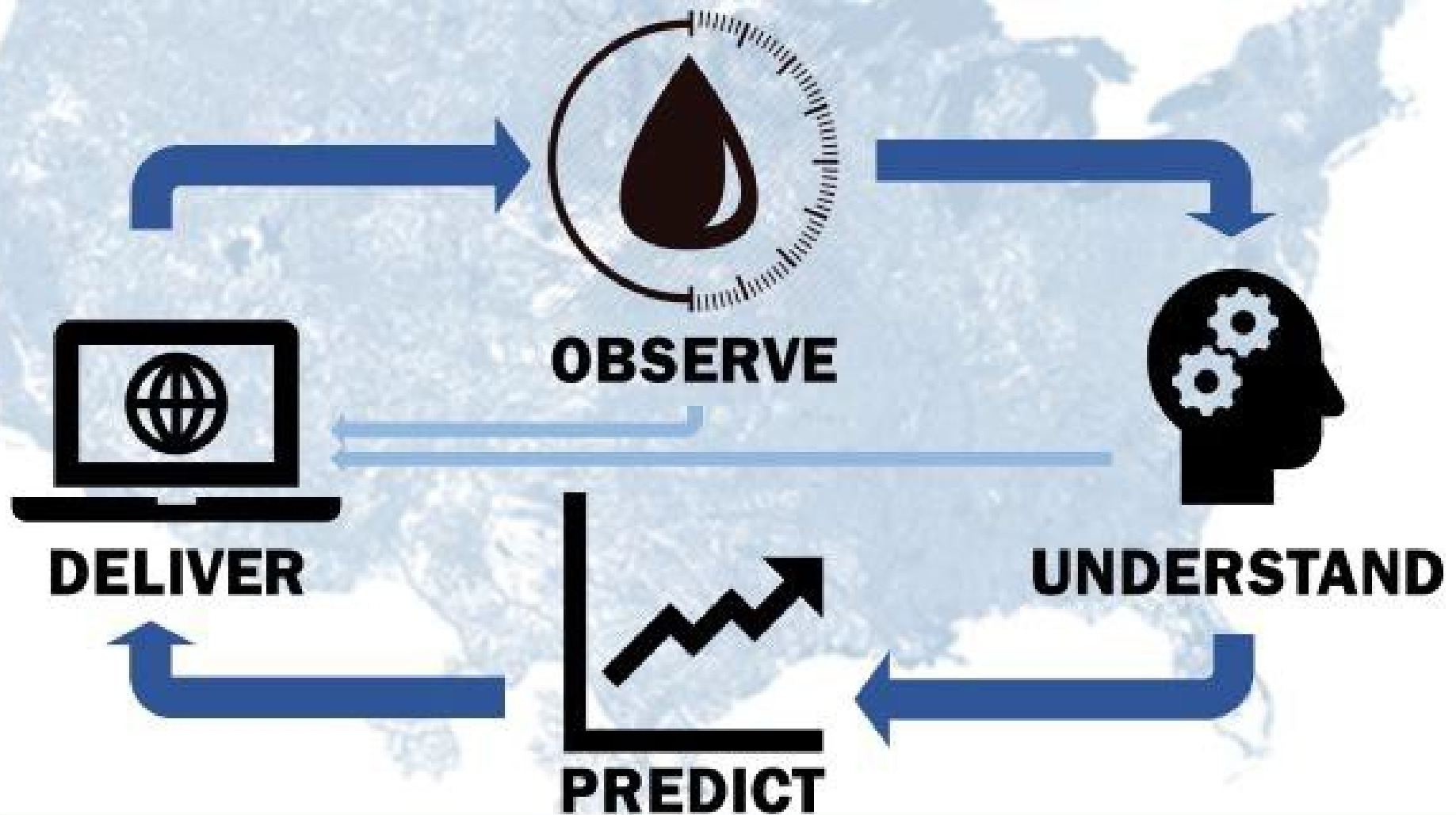
Surficial geology

Features to consider

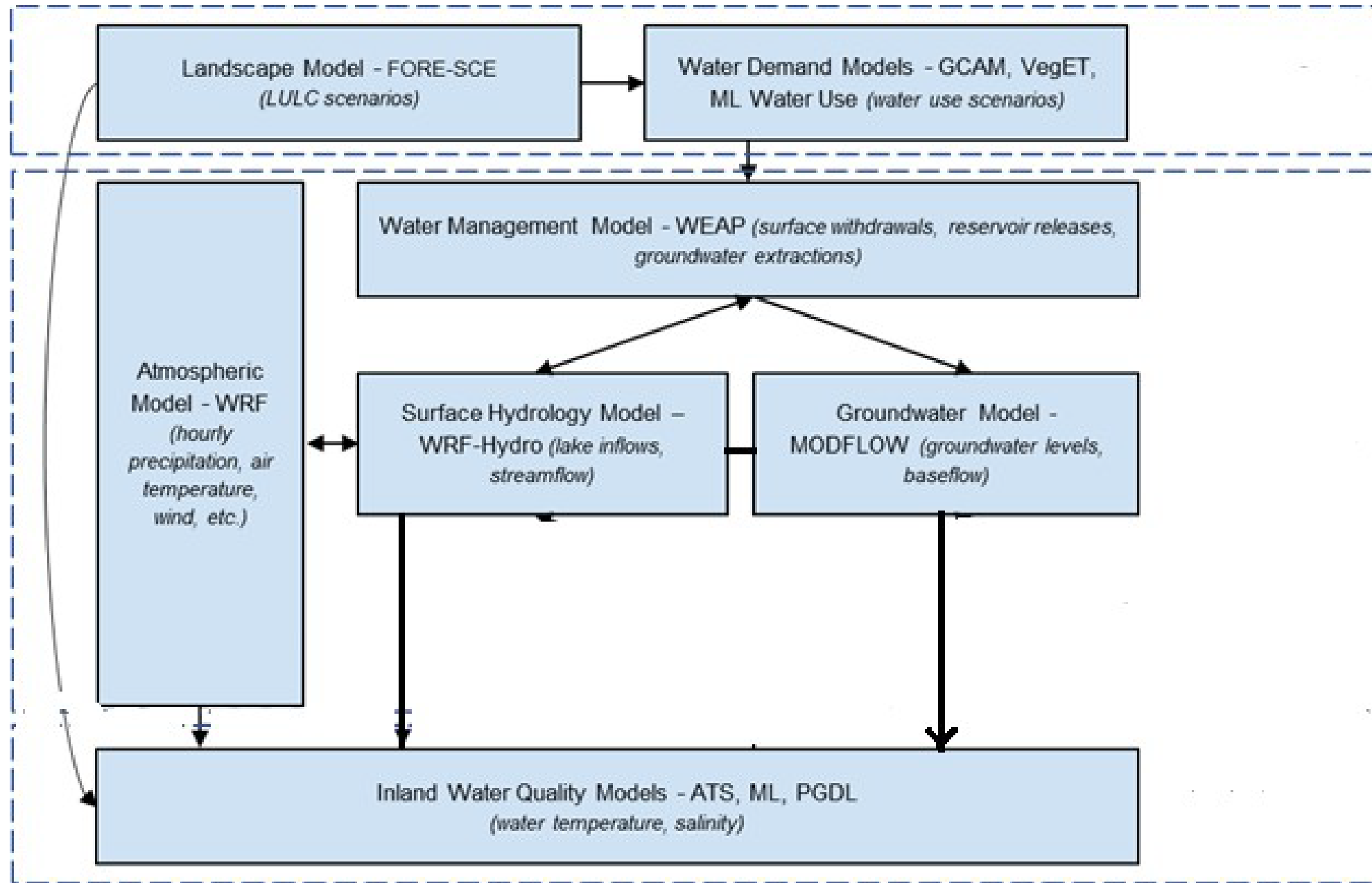
- Drift thickness
- Buried bedrock valleys



Integrated Water Science Process



IWP approach



Questions?

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