

# CORPS SHOALING ANALYSIS TOOL (CSAT)

## FY24 DEVELOPMENT AND APPLICATIONS

*FY24 CSAT Team:*

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**October 1, 2024**

**COASTAL INLETS RESEARCH PROGRAM**  
*FY24 IN PROGRESS REVIEW*



U.S. ARMY



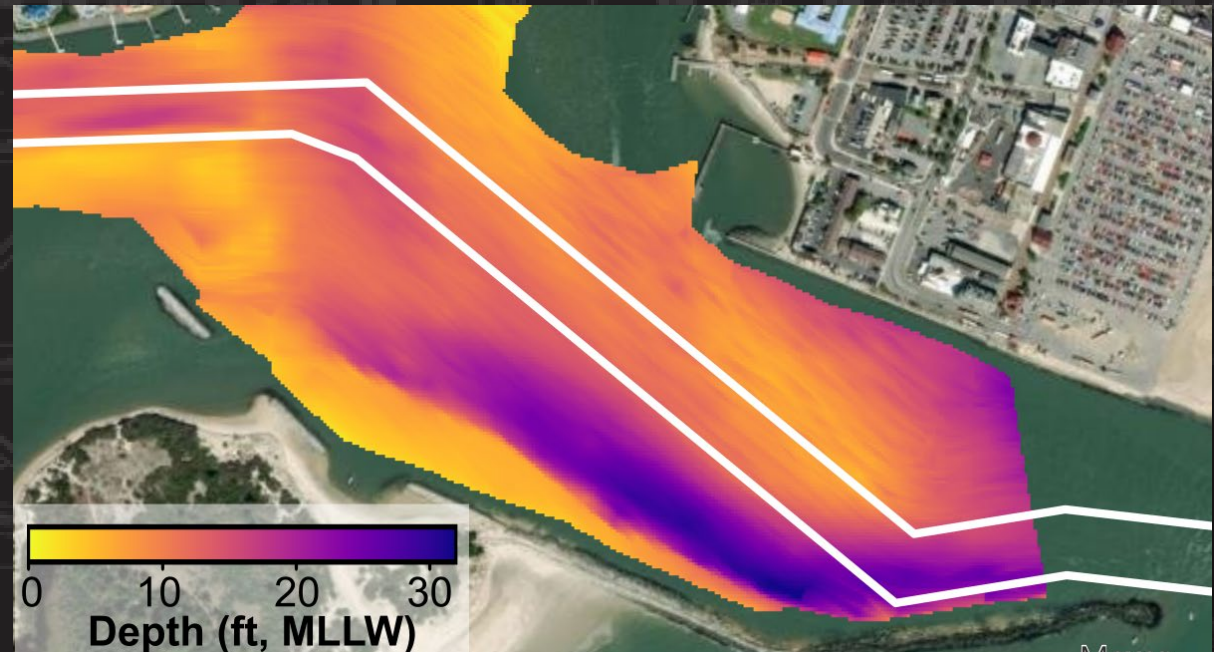
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# PROBLEM STATEMENT



U.S. maritime infrastructure is vital to the nation's economy, facilitating the movement of approximately 2.5 billion tons of cargo annually. This extensive network, consisting of over 300 commercial ports and 25,000 miles of inland and coastal waterways, is essential for industries like manufacturing, agriculture, and energy.

However, the costs associated with maintaining the overall waterborne commerce system have been increasing, exacerbated by issues such as changing climate conditions, aging infrastructure, and availability of resources. These challenges underscore the need for innovative solutions to optimize maintenance and operational strategies.

The Corps Shoaling Analysis Tool (CSAT) is an analytical tool that leverages more than 100,000 hydrographic surveys collected across the USACE portfolio to quantify the rate of navigation channel filling and estimate future channel dredging volumes. CSAT can be used to help predict shoaling issues more accurately, allocate resources better, and minimize navigation system disruptions.

CSAT is an ongoing project in the Coastal Navigation Portfolio Management Work Unit.

## Statements of Need:

- NAV-21-1671 "Corps Shoaling Analysis Tool (CSAT) Enhancement"
- 2015-N-15 "Integration of national and local monitoring datasets to support navigation and operations projects"
- 2015-N-40 "Reducing the need for dredging"

FY24 – New CSAT user guide, improved dredge activity detection, handle custom AOIs, new user interface prototype

FY23 – eHydro & JALBTCX data integration, improved CSAT setup experience,

FY22 – New shoaling rate methods



# CAPABILITY AND STRATEGIC IMPACT

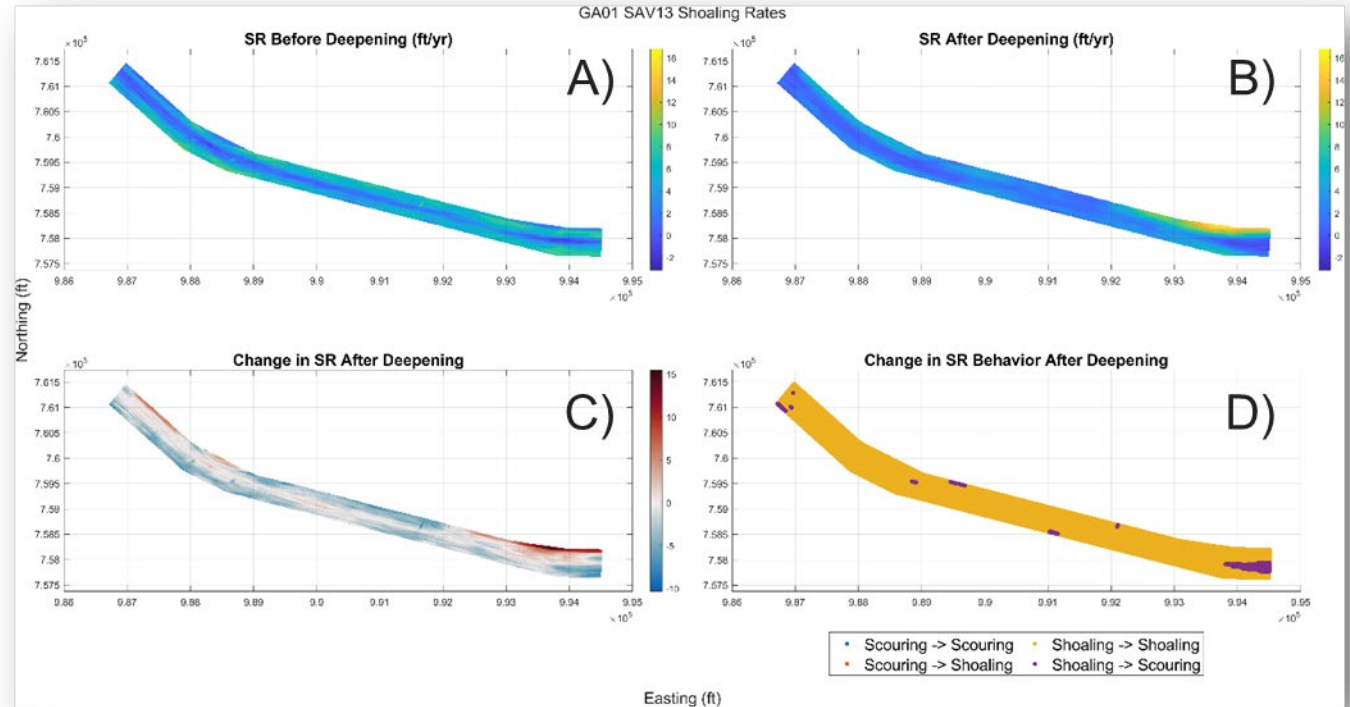


## Capability

- ❑ Suite of computational routines for calculating historical shoaling rates from eHydro survey data and forecasting future dredging needs based on observed trends.
- ❑ Shoaling is calculated on a 10 ft-by-10 ft grid, with results available for all surveyed reaches in the National Channel Framework.
- ❑ Efficient calculations permit enterprise-level rollup using local computing resources.

## Strategic Impact

- ❑ Districts use CSAT to quantify project-level shoaling rates, identify shoaling hotspots, and plan for future maintenance requirements.
  - Recent projects include Matagorda (SWG), Houston-Galveston (SWG), Calcasieu (MVN), Southwest Pass (MVN), Gulfport (SAM), King's Bay (SAJ), and **Savannah (SAS; figure at right)**.
  - Our team answered questions for 24 USACE customers across 11 districts during FY24!
- ❑ Enterprise-level shoaling summaries support planning by USACE Headquarters.
- ❑ We were also contacted by 3 industry consultants from 2 private engineering firms in FY24.
  - Not our target customers, but this illustrates growing credibility among the broader engineering community!



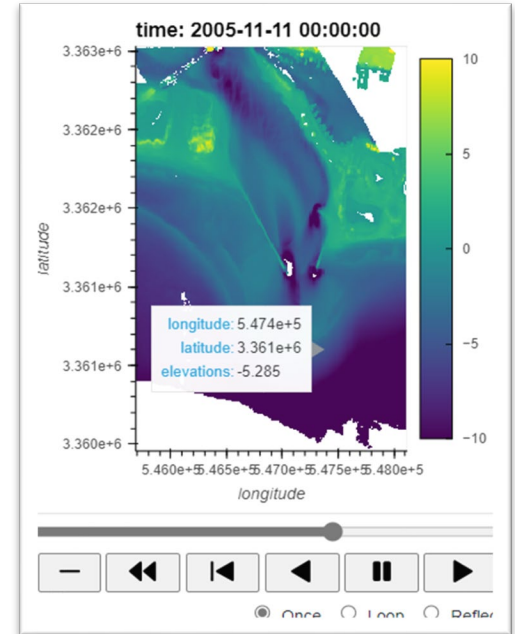
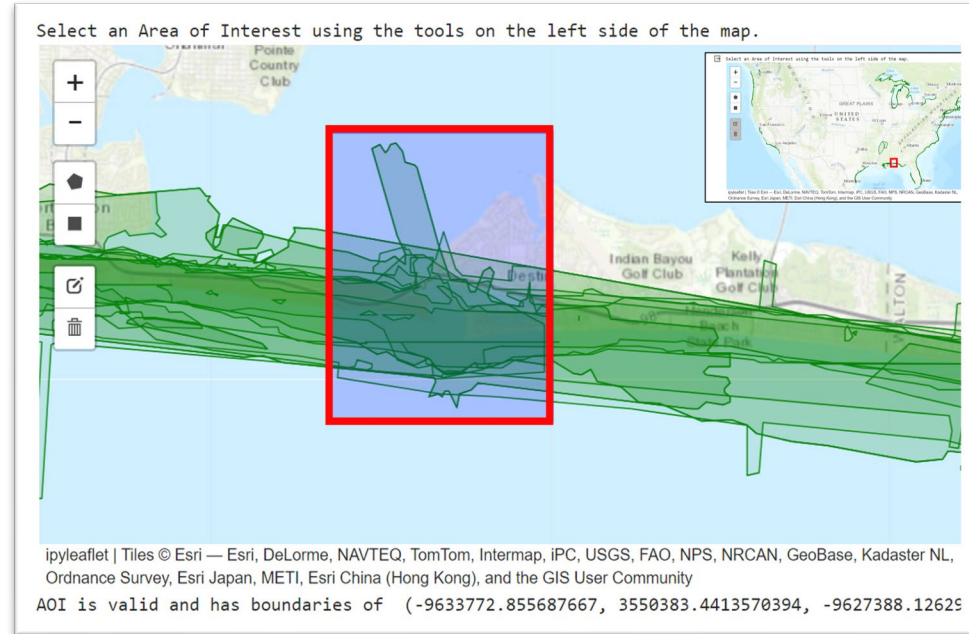
Maps of Reach 13 in the Savannah Harbor showing the pre-deepening shoaling rates (A), post-deepening shoaling rates (B), change in shoaling rates (C), and change in shoaling rate behavior post-deepening (D)




# MAKING CSAT BIGGER...



- ❑ Districts have requested the capability to perform CSAT-style shoaling rate calculations in regions outside the boundaries of the National Channel Framework.
- ❑ In FY23, CSAT and JALBTCX collaboratively produced an automated workflow which quantifies shoaling inside a user-defined polygon using all available lidar and eHydro surveys.
  - *JALBTCX datasets hosted in AWS by NOAA Digital Coast.*
  - *AOI-based search and discovery.*
  - *On-the-fly DEM generation.*
- ❑ **Workflow released as a Jupyter Notebook in the ERDC public Gitlab during FY24, with corresponding documentation published.**





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ERDC/CHL CHETN-??-??  
Month 2024

***Cloud-Based Workflow to Process  
Regional Topobathymetric Lidar Datasets  
for Integrated USACE Shoaling Analyses***

*by Charlene S. Sylvester and Michael A. Hartman*

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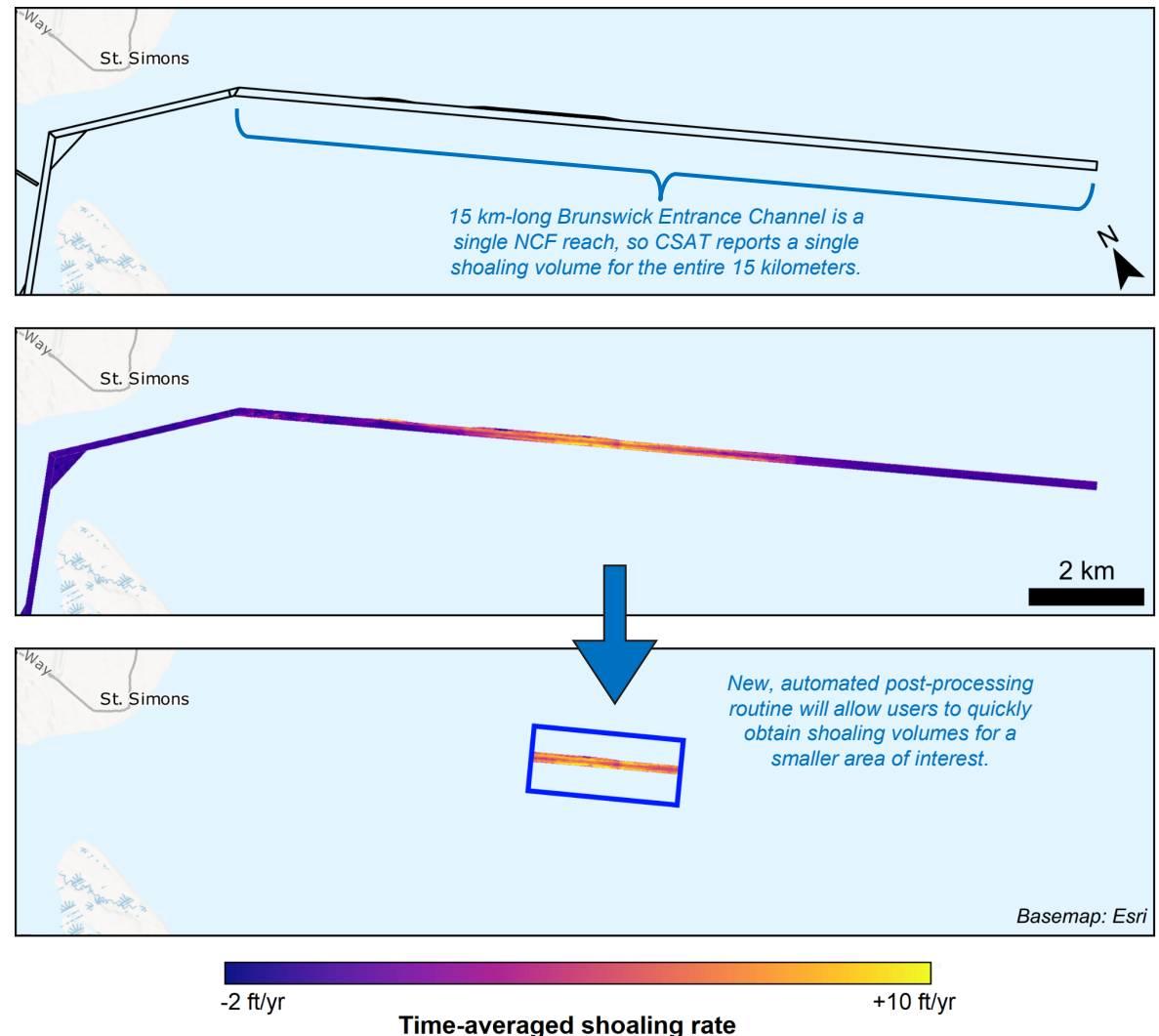
**PURPOSE:** This Coastal and Hydraulics Engineering Technical Note (CHETN) details a methodology to process and format regional topobathymetric datasets for use in the US Army Corps of Engineers (USACE) Corps Shoaling Analysis Tool (CSAT).



# ... AND MAKING CSAT SMALLER!

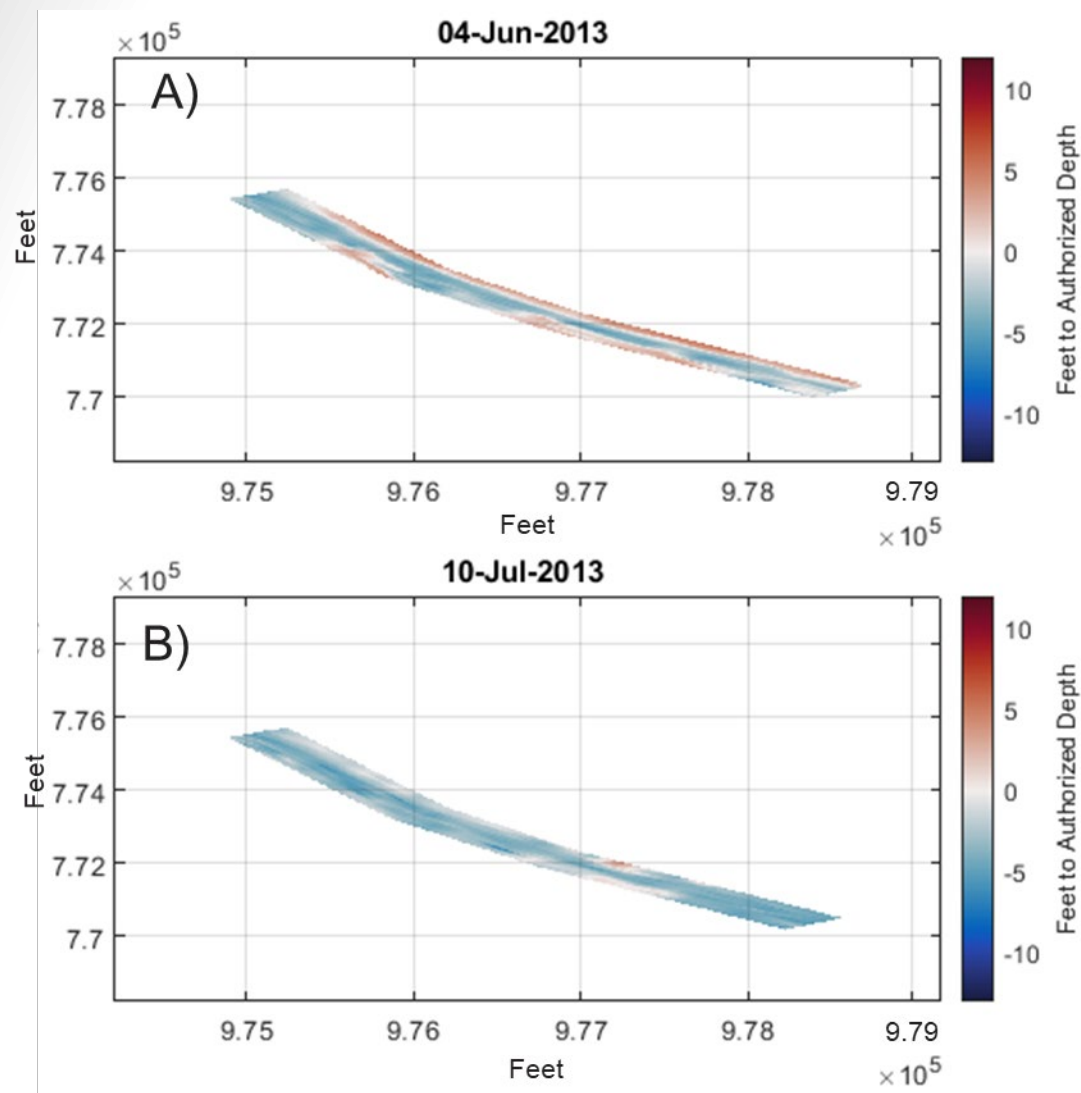


- ❑ In previous versions of CSAT, results were reported as an aggregated shoaling volume for each reach in the National Channel Framework.
- ❑ Within the past year, Chicago District and Galveston District both requested the capability to produce CSAT output with greater geographic specificity (e.g., sub-reach results for a smaller area of interest).
- ❑ **A post-processing routine was developed in Summer 2024 which automatically converts reach-level CSAT output into sub-reach shoaling volumes inside a polygon drawn by the user.**
- ❑ Will be integrated into public-facing CSAT routine in FY25!

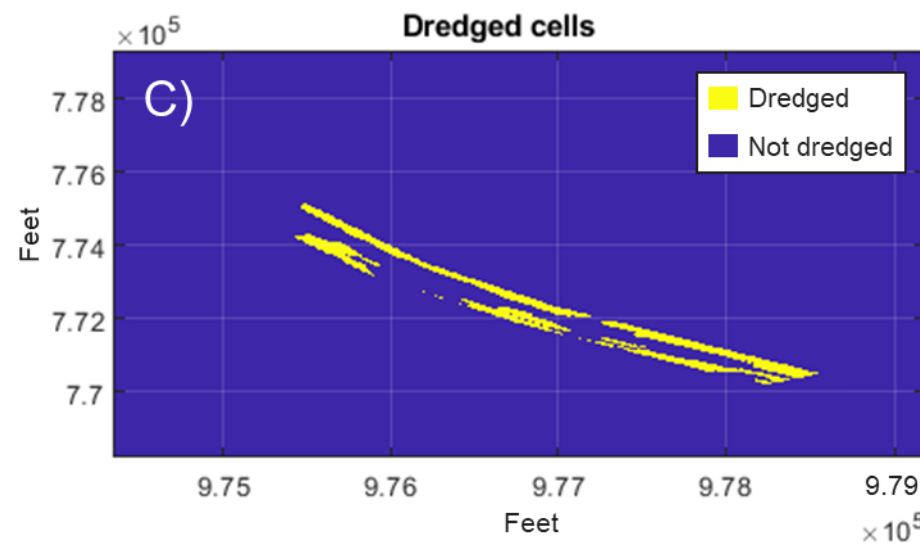




# IMPROVED IDENTIFICATION OF DREDGING EVENTS



- Dredge events currently identified from reach-level volume change.
  - *Problematic because typically only part of the reach is dredged, so the volume change threshold needs to vary by reach.*
- **During FY24, new pixel-level thresholding methods were developed to improve identification of dredge events.**
  - *Example: if >10% of the reach's grid cells experienced >15% elevation decrease between two consecutive surveys, the second survey is flagged as an "after dredge" survey.*



*Bathymetry (feet to authorized depth) for Savannah Harbor Reach 15 before (A) and after (B) a dredge event. C) Grid cells that were dredged are marked in yellow.*



# ENHANCING THE CSAT USER EXPERIENCE



## A brand-new user interface!

- GUI runs in local web browser
- Offers same control as batch script
- Choose a reach study area, select surveys which survey data to use, and set runtime options all in one place!

## Key Improvements

- Dropdown menus for options
- Interactive tables for reach/survey selection
- Map-based reach selection
- Survey data visualization
- Save/Load configuration for reuse

**Corps Shoaling Analysis Tool**

Welcome to CSAT!  
This app allows you to compute historic shoaling rates for reaches in the National Channel Framework using surveys available in eHydro.

1. Select a USACE District the dropdown.
2. Choose the desired time range of surveys used to compute the shoaling rate.
3. Select which reaches you want to compute shoaling rates for; by default, all reaches in the selected district will be run.
4. Edit the Survey Update Table if necessary to accurately represent the dredging activity. Individual surveys can be viewed by clicking the map icon in the survey's respective row.
5. Once all additional settings have been set, click the Run button.
6. TODO: Run configurations can be saved to quickly revisit past inquiries.

Select District: Buffalo

Start Date: 2010-01-01

End Date: 2024-09-27

Load Config

Made entirely with OSS packages: Panel, Holoviews, GeoViews, Bokeh, Pandas, Numpy. Bathymetry data sourced from eHydro.

Select Reaches to Process:

Select Surveys:

Survey Date	Survey Type	SurveyID	ReachID	Use	pctCoverage
2021-08-18	CS	LB_03_TOL_20210818_CS_1000TO1070	LB_03_TOL_1	true	34.11
2021-08-19	CS	LB_03_TOL_20210819_CS_1070TO1140	LB_03_TOL_1	true	34.3
2021-08-20	CS	LB_03_TOL_20210820_CS_1140TO1200	LB_03_TOL_1	true	29.09
2022-07-22	CS	LB_03_TOL_20220722_CS_1205TO1280	LB_03_TOL_1	true	3.44
2022-07-23	CS	LB_03_TOL_20220723_CS_1130TO1205	LB_03_TOL_1	true	36.36
2022-07-24	CS	LB_03_TOL_20220724_CS_1055TO1130	LB_03_TOL_1	true	36.2
2022-07-25	CS	LB_03_TOL_20220725_CS_980TO1055	LB_03_TOL_1	true	26.57
2023-07-24	CS	LB_03_TOL_20230724_CS_851TO1125	LB_03_TOL_1	true	59.25
2023-07-25	CS	LB_03_TOL_20230725_CS_1125TO1334	LB_03_TOL_1	true	41.2
2023-09-08	CS	LB_03_TOL_20230908_CS_FULLLSURVEY	LB_03_TOL_1	true	100.0

Additional Controls

Indicators

Save Config Start

LB\_03\_TOL\_20231214\_CS\_FULLLSURVEY

Latitude: 41.804, 41.803, 41.802, 41.801, 41.8, 41.799, 41.798, 41.797

Longitude: -83.25, -83.248, -83.246, -83.244, -83.242, -83.24, -83.238

For now, the GUI only handles getting CSAT configured and running. Additional features will be added in FY25 to help with exploring the CSAT results.

Please let us know if you are interested in testing out the new GUI. Send an email to CSAT Support - [dll-ceerd-csat@usace.army.mil](mailto:dll-ceerd-csat@usace.army.mil)



# SUMMARY



## FY24 Major Advancements in Capability

- Prototype CSAT GUI developed, including modularization of CSAT code for improved flexibility.
- Developed post-processing algorithm for quantifying shoaling volumes within a user-specified area of interest (e.g., sub-reach CSAT results).
- Developed pixel-level validation routine which uses a “leave-one-out” approach to quantify CSAT’s forecasting accuracy.
- Developed algorithm for identifying dredging events via pixel-level elevation thresholding (DIG-funded).

## FY25 Products & Advancements

### Planned CIRP-funded software / algorithm advancements

- Complete development of CSAT GUI and publicly release to district users.
- Integrate pixel-level dredge event identification into public CSAT version.
- Integrate sub-reach post-processing capabilities into public CSAT version.

### Planned CIRP-funded publications

- ERDC Technical Report detailing the CSAT validation results.

### Planned CIRP-funded customer support

- Multi-day series of CSAT training webinars open to all USACE personnel planned for Q1.
- In-person CSAT training with South Atlantic Division planned for Q2.

### Other planned CSAT advancements via non-CIRP funding

- Complete development of algorithm for quantifying inland channel availability using CSAT data products and produce written documentation.
- Develop methods for implementing nonlinear shoaling models within the CSAT algorithm.

## FY24 Major Products & Collaborations

### Software / data released

- Release of CSAT 2.6.4 for compatibility with updated dependencies (e.g., NumPy 2.0).
- Automatic daily updates to the CSAT input data.

### Customer support

- 2-day virtual CSAT training for Chicago District (March 2024).
- Set up designated “CSAT helpline” email address to improve customer support.
- Provided support to 24 USACE customers from 11 districts.
- Received CSAT questions from 3 industry consultants at 2 separate consulting firms who have started using CSAT.

### CIRP-funded publications

- 84-page CSAT user guide published as ERDC Special Report.
- CHETN describing the JALBTCX-CSAT integration.
- Conference paper on CSAT-DQM integration.
- CSAT storyboard completed and released.

### CIRP-funded presentations

- Poster presentation at the CWG meeting (November 2023).
- RD24 presentation on accelerated shoaling after channel deepening (April 2024).
- CIRP TD on accelerated shoaling after channel deepening (May 2024).
- Conference presentation at WEDA on CSAT-DQM integration (June 2024).
- Poster presentation for the National Dredging Meeting (June 2024, jointly funded by CIRP and DIG).
- CIRP TD on application of CSAT for Savannah District reimbursable (September 2024).

### Collaborations

- DIG-funded algorithm development for pixel-level thresholding to identify dredging events.
- Savannah District reimbursable project to quantify post-deepening changes in shoaling.
- Kansas City District reimbursable project to extend CSAT’s capabilities for quantifying inland channel availability.
- Jacksonville District reimbursable project to quantify shoal thickness in the King’s Bay navigation channel.

