

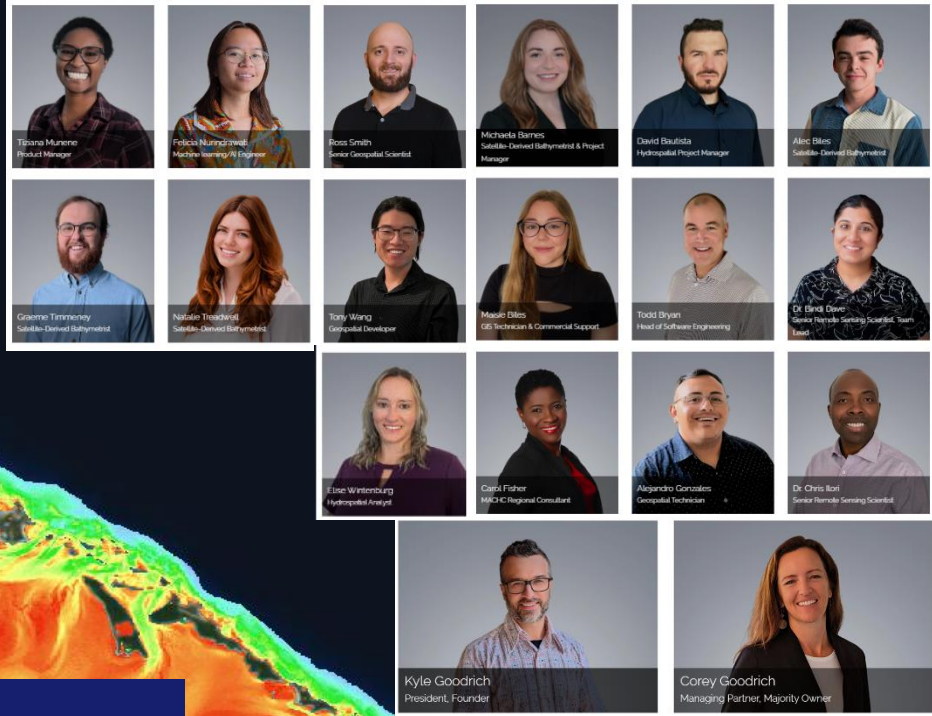
Integration of Satellite and Marine Based Hydrographic Survey Methods in the MACHC Region



Kyle Goodrich
President & Founder
kyle@tcarta.com
www.tcarta.com



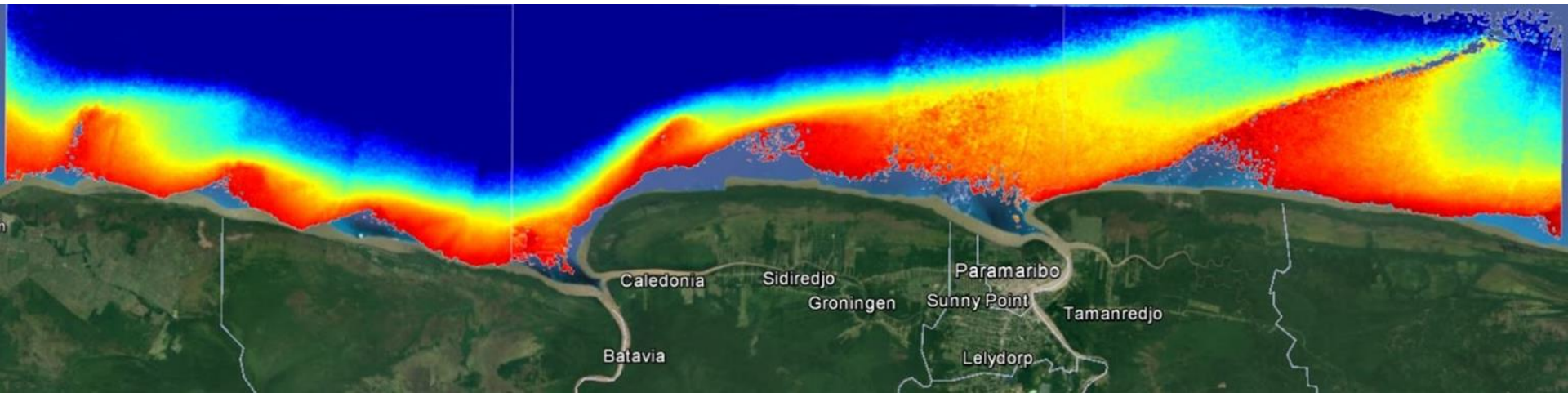
Meso-American and Caribbean Sea Hydrographic Commission
14 December 2023
Paramaribo, Suriname



TCarta uses machine learning and satellite imagery to accurately survey coastal water depths for industries and governments, enabling cost effective and remote site surveys, reconnaissance and navigational safety.

Topics

1. Wave Kinematic Bathymetry in Suriname
2. Marine Institute & Seabed 2030 Collaboration
3. Port Antonio SDB & MBES Integration Project



Wave Kinematic Bathymetry (WKB)

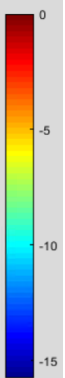
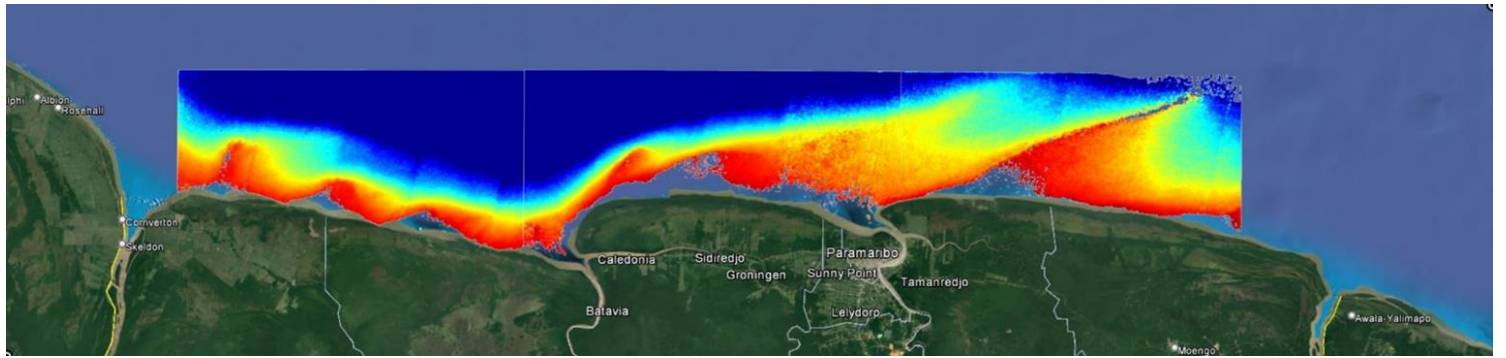
Suriname is a case study for highly dynamic and turbid environment.
This work was a collaboration with TCarta in the NSF funded Trident program
Single-beam transects provided by the Suriname hydrographic office (MAS)



Typical Sentinel 2 image



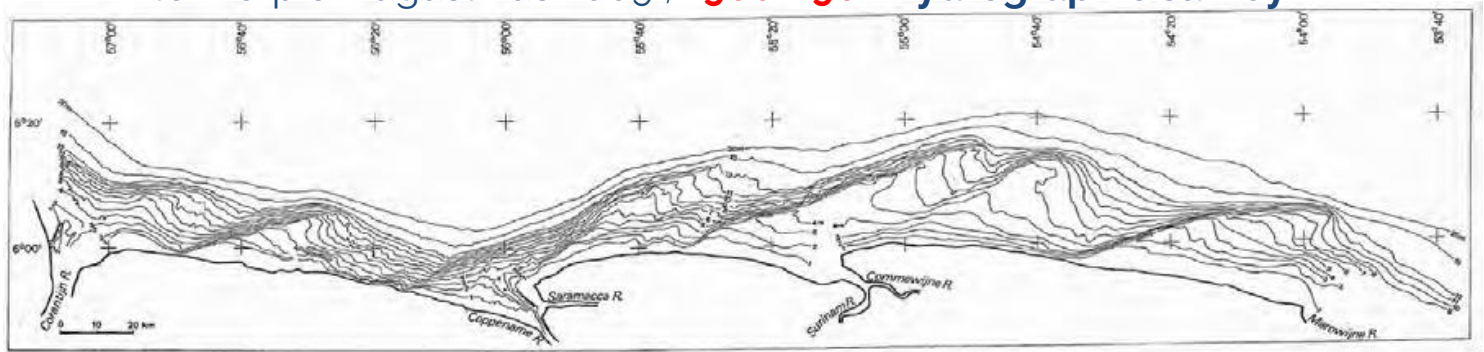
Sentinel 2 derived bathymetry (WKB method) 2017.7-2019.7



In partnership with



Winterwerp & Augustinus 2009, 1960-1962 hydrographic survey

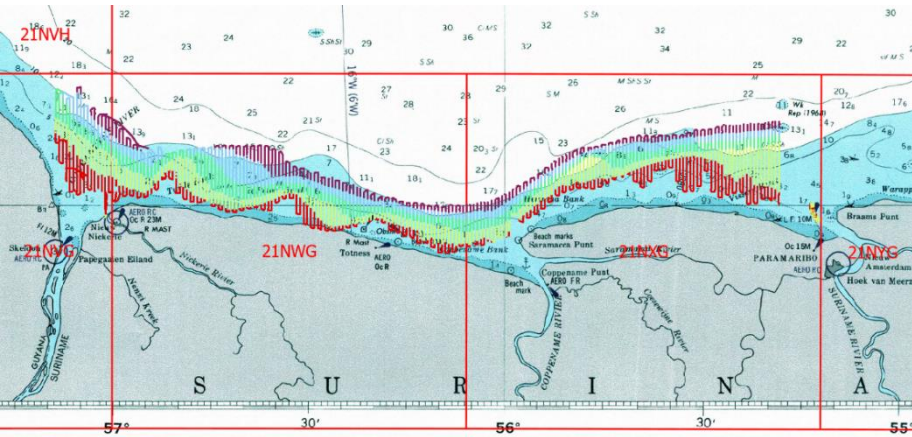


*Winterwerp H & Augustinus P. (2009) Coastal morphodynamics report. Physical description of the Suriname coastal system. ICZM Plan Suriname.

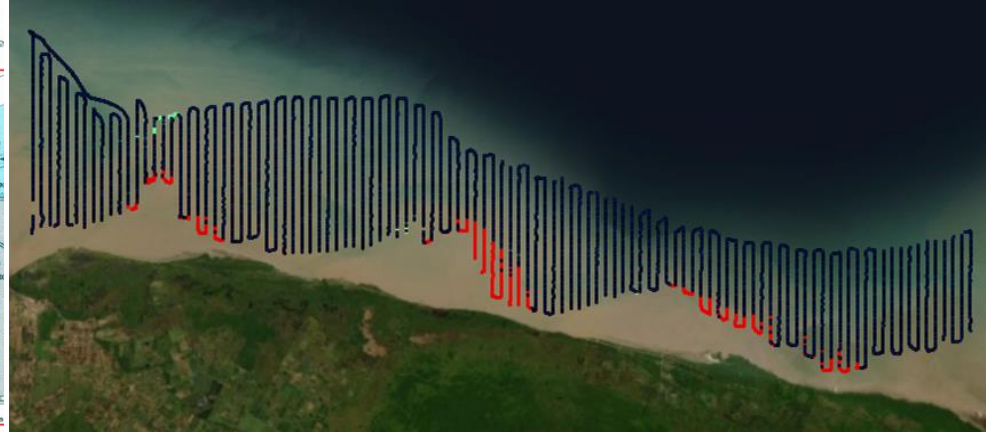
- Over 300 Sentinel 2 images were downloaded spanning five years
- Sentinel-2 images are continuous push-broom scans of the Earth's surface.
- Time delay built into the band collection that allows for stop-motion movement detection.

- WKB produced 5552 sq.km of bathymetry
- Min. depth 0.02m and max. Depth 42.03m
- Mean depth of 13.56m

MAS 2016 single beam survey



Largest difference between WKB and SBES on Eastern side of mudbanks indicating an eastward migration of shoals



Marine Institute Summer Work Term Program



Co-funded by:

THE NIPPON FOUNDATION-GEBCO

SEABED
2030



2 graduate students - ongoing

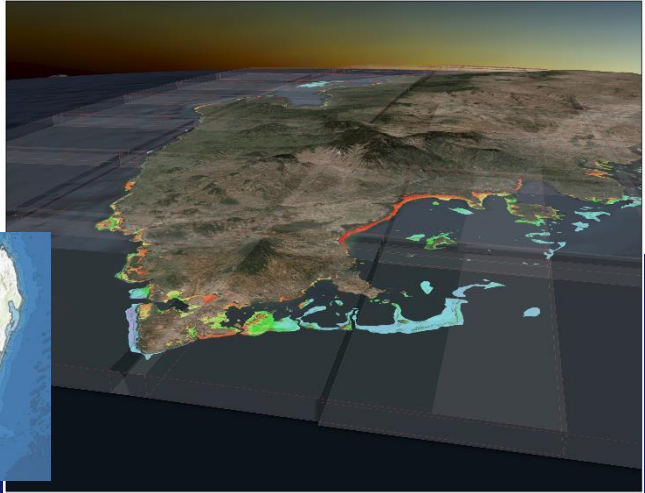
6 undergraduate - 12 week summer work term

Real World Satellite Derived Bathymetry Work

- In-person instruction and virtual workrooms
- Student-generated SDB
- Marine Institute Native Village Research Sites AOIs
- SDB produced contributed to Seabed 2030



Summer Staff Producing SDB for Seabed 2030 Project



Madagascar
Newfoundland
Kinngait, Nunavut
Sanikiluaq, Nunavut



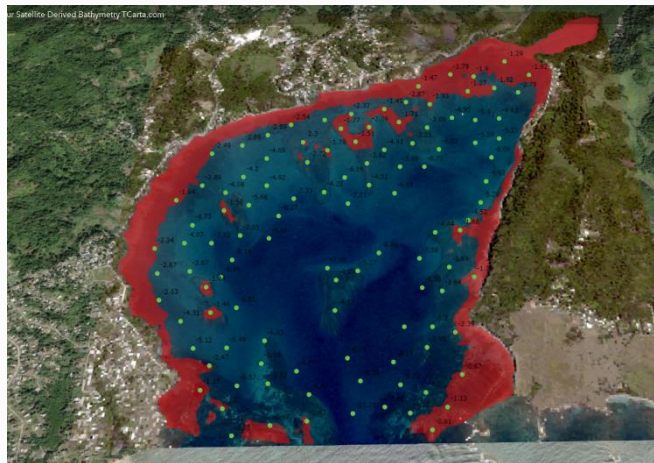


Collaboration with Hydrographic Office - Combined Benefits of SDB and SBES Survey

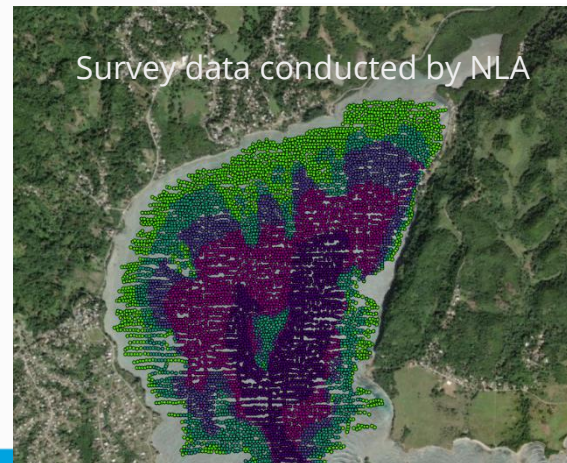
Bowden Harbour, Jamaica



SDB for No-Go Areas & Shoalest Points for Caution



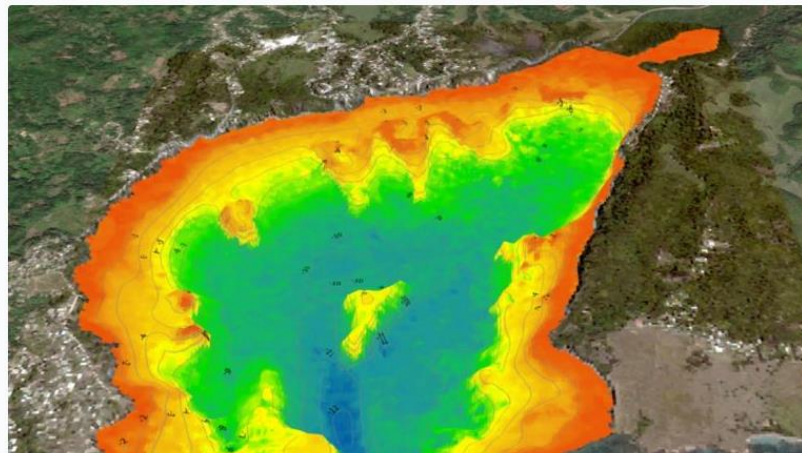
NLA Survey Team at Bowden Harbour



First SDB Demonstration Project with Jamaica - 2021

Bowden Harbour SBES & 10m SDB Integration

- Fully remote engagement due to Covid
- Didn't go quite as planned
- Healthy debate on SDB's potential to be used to fill in gaps from a hydrographic standpoint
- Results not perfect -both sides, still found success, next steps



ARTICLE

Satellite-derived bathymetry for surveying Jamaica's coastal waters

Towards time efficiencies, cost savings and improved safety

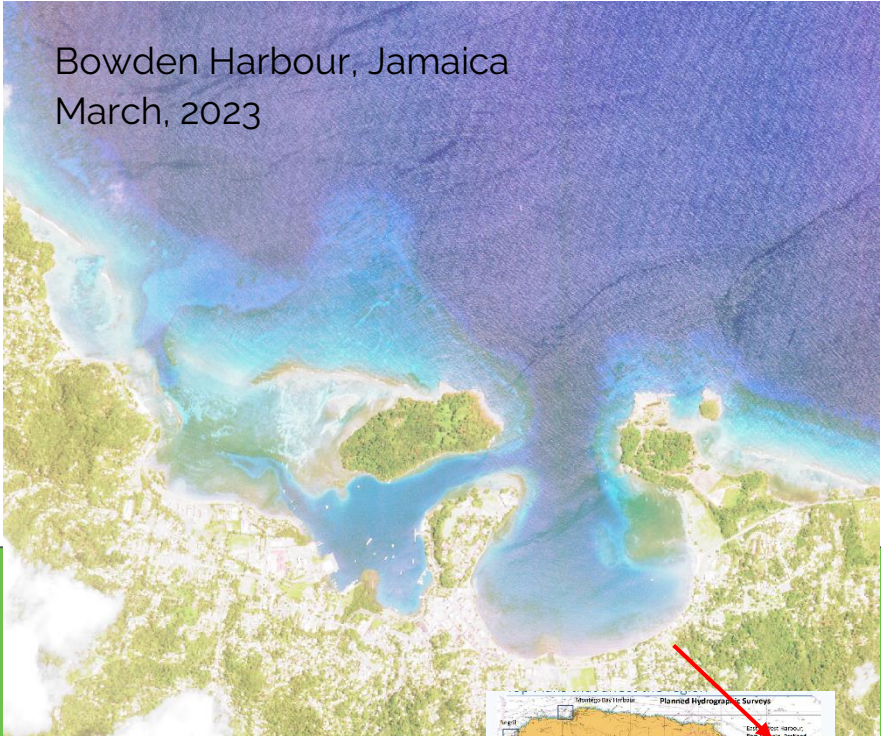
By Carol Fisher, Antonio Williams • March 29, 2022

The national land agency in Jamaica has integrated satellite-based hydrography to benefit from time efficiencies, cost savings and improved safety as part of its hydrographic programme in support of the nation's further economic development.

Co-Authored Hydro International Article - Mar 2

Satellite Derived Bathymetry & MBES Integration Project

Bowden Harbour, Jamaica
March, 2023



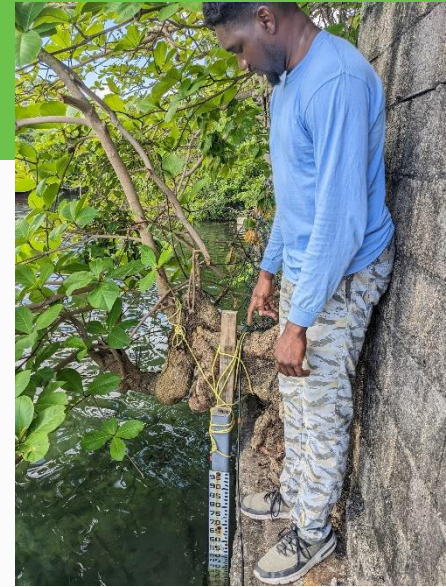
Leads to Port Antonio MBES & SDB Integration Project

Port expansion project

2-way training

1.5 - 100+m depths

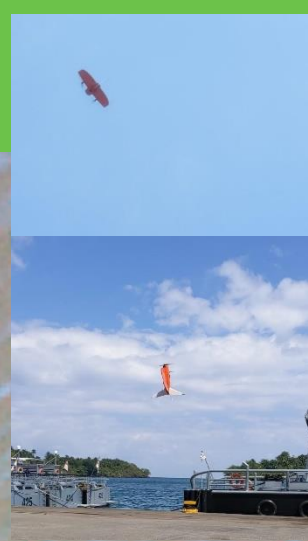
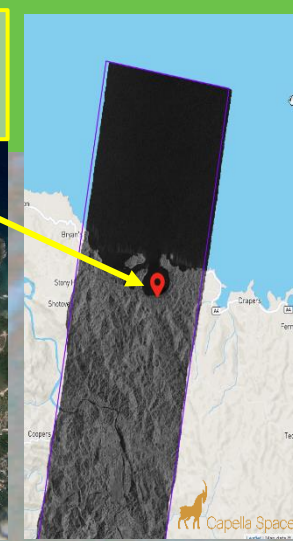
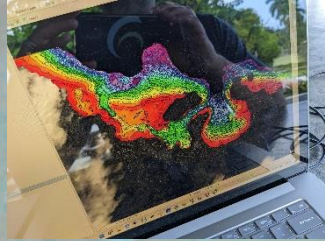
Shallow water obstacles and challenges



'All-Source' Integration

MBES | SDB | SAR | UAV

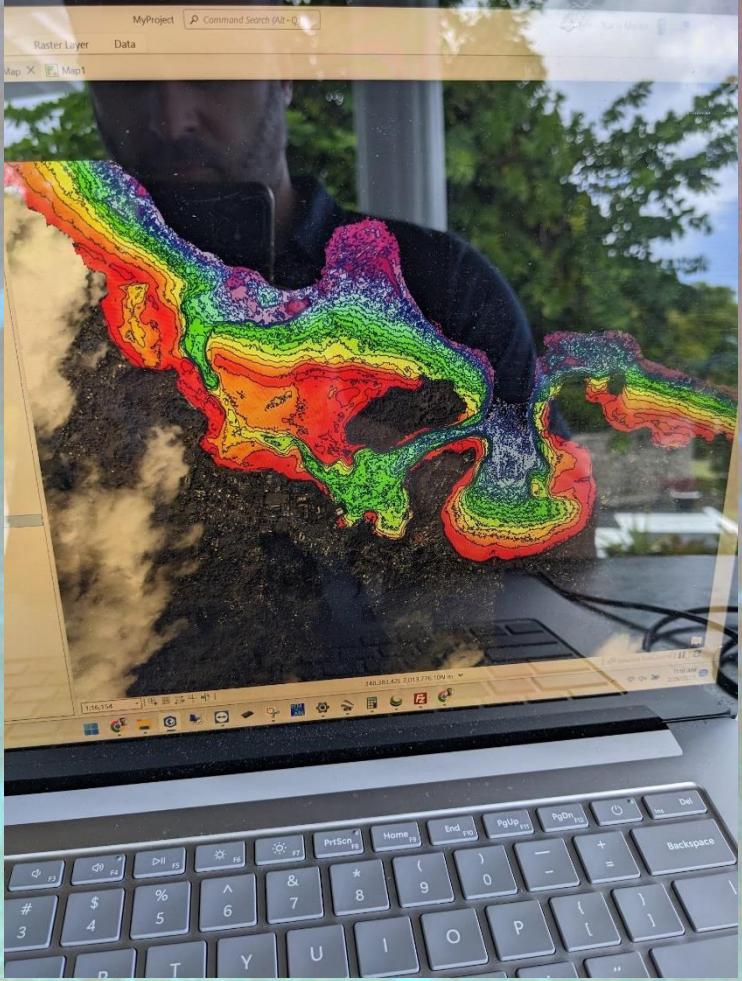
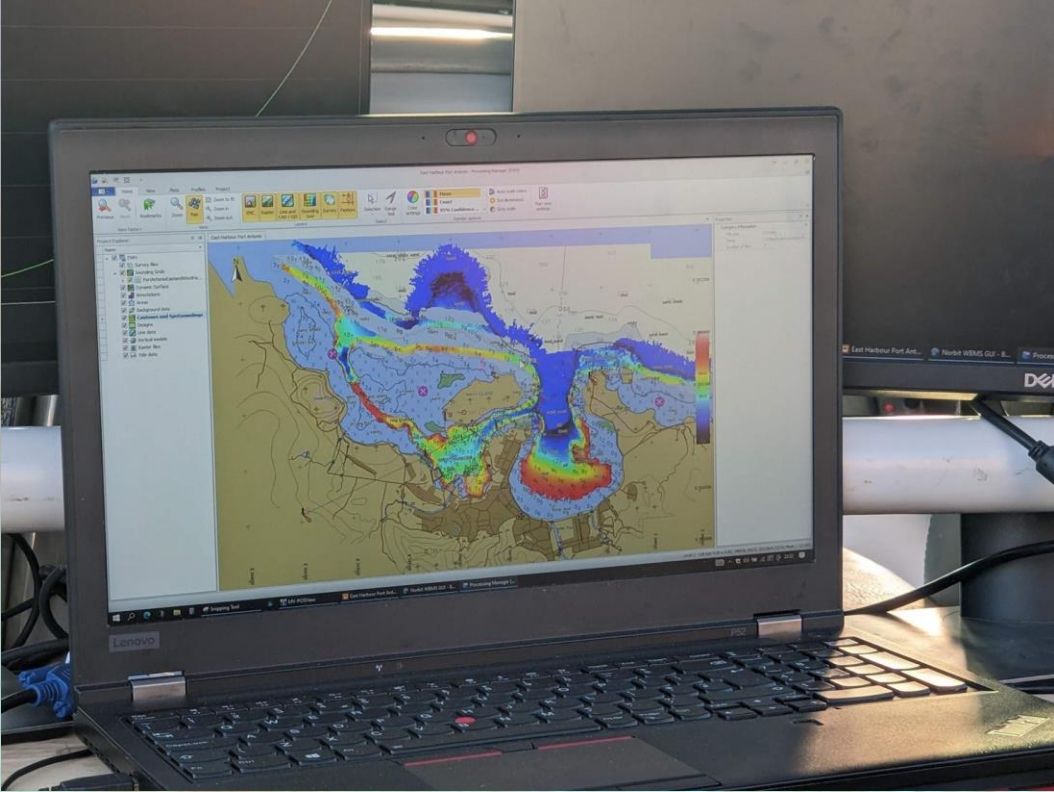
Imagery Tasked During Survey



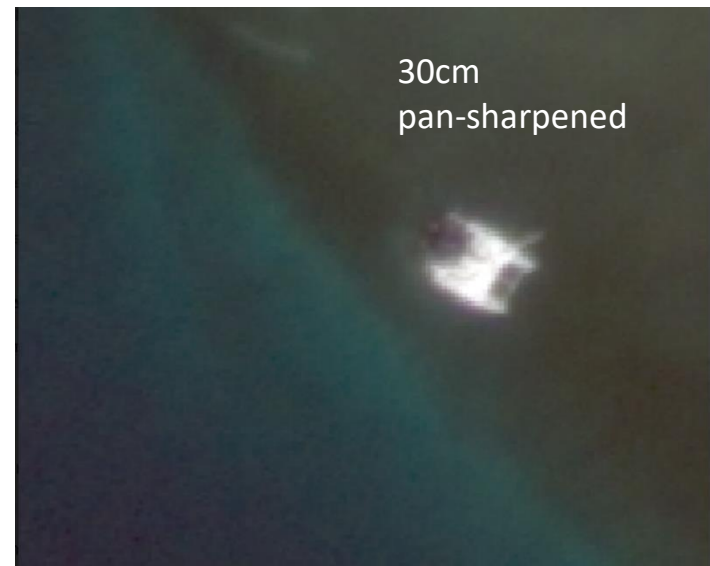
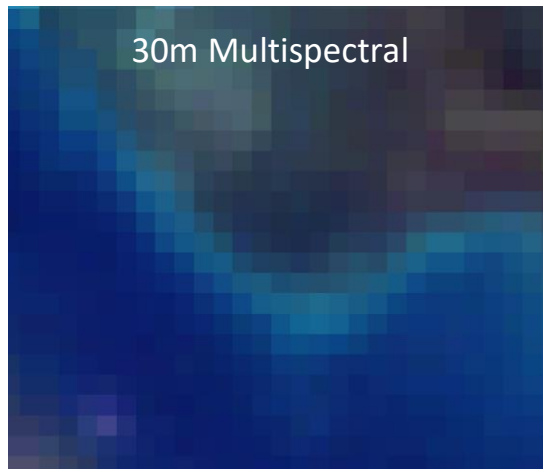
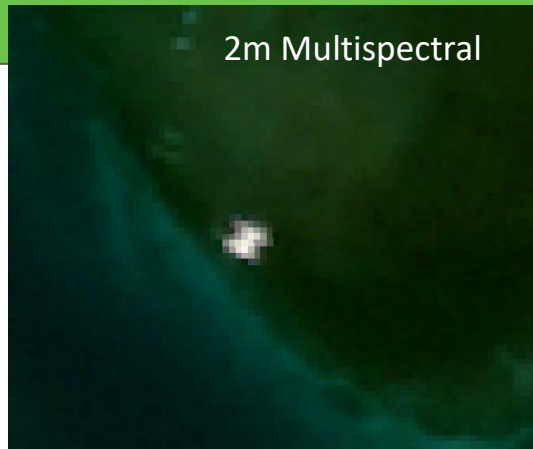
In the field



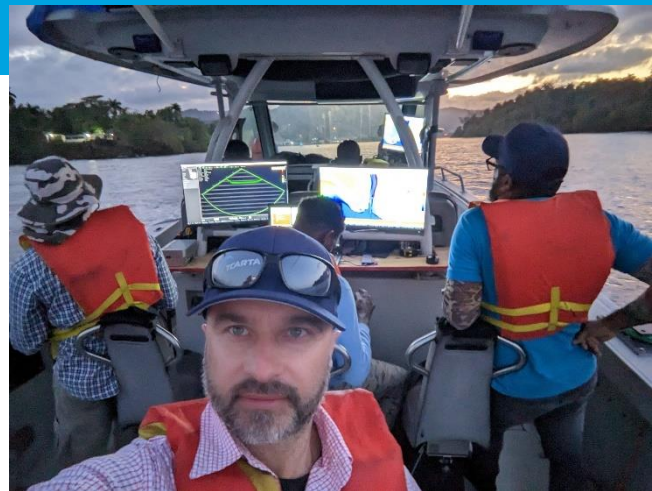
MBES & SDB



Pixels in Perspective



A Hydrographer's First survey!



SDB Training

- SDB 101 - Background & Basics
- Hands-on learning
- Production and Applications
- Customized training

In the office



Request for Collaboration: TCarta Marine LLC & NLA Jamaica

Date: 27 January, 2023
Reference: The Hydrographic Survey of Port Antonio Harbour

To: Ms Chenise Walcott (CEO of NLA)
cc: Mr Edward Chambers - Senior Director of Surveys and Mapping
Benjamin Bloomfield Acting Manager- Topographic and Hydrographic Surveys
Antonio Williams - Chief Hydrographer
Diego Billings - Senior Hydrographer

Let me take this opportunity to wish you and the team at the National Land Agency a successful and rewarding year.

Background: TCarta Marine, through its subsidiary in Jamaica, TCarta Caribe, has fostered a productive and game-changing relationship with NLA from 2020. This mutual partnership has resulted in a joint hydrographic survey of Bowden Harbor showcasing the merging of Satellite Derived Bathymetry with traditional Hydrographic survey. The success of this ground-breaking venture was published in a joint article in the Hydro International magazine. TCarta then facilitated a Capacity Building Workshop with the Hydro team in 2021 and are in the process of facilitating a second Capacity Building Workshop with NLA Hydro team proposed for Feb 27, 2023.

Purpose: This is a request for Kyle Goodrich, President of TCarta, to join NLA during the hydrographic survey of Port Antonio for the purpose of professional development and joint collaboration between TCarta and NLA on combined use of vessel-based hydrographic surveys and Satellite Derived Bathymetry.

TCarta will provide 3-5 days of Satellite Derived Bathymetry Capacity Building to NLA and any other Jamaican government agency in Kingston, Jamaica. TCarta and Kyle Goodrich will bear all the cost of and risk of participating in the Hydrographic survey and hereby absolves NLA and any other agency of responsibility.

Additional Requests:

- The Hydrographic Branch of NLA will provide TCarta with materials related to the data including but not limited to visuals, animations, results, assessments and analysis generated from the collaboration.
- Permission to post updates, images of the collaboration on TCarta's website and social media platforms, eg LinkedIn.
- Permission to present the collaboration results to the MACHC24

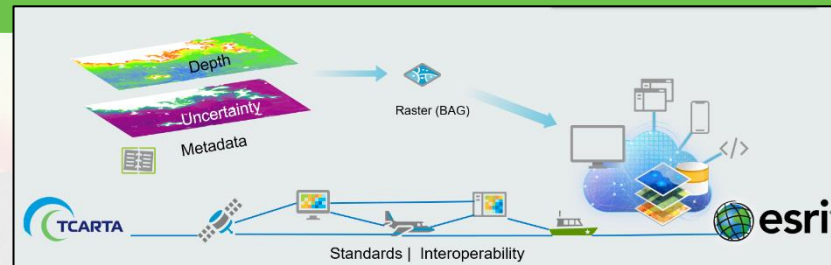
With Kind Regards,

Kyle Goodrich
President
TCarta



In-Person and Remote SDB Training

Partnering to develop the next generation of SDB-Ready Hydrosatial Professionals
It's about people too!



Hydrographers

UAV Operator

GIS Specialists



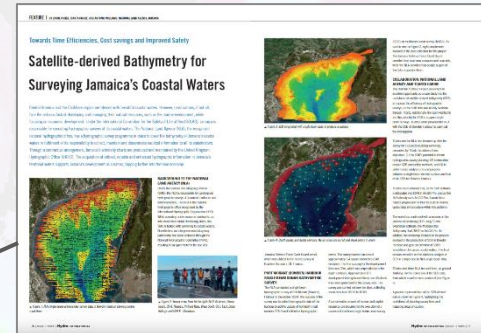
National Land Agency (NLA), Jamaica SDB Integration

from a healthy skepticism to strategic planning

2021

- April 2021 - TCarta provides a half-day virtual SDB intro, across NLA ranks, initiates proof of concept collaboration
- Integrated surveying of Bowden Harbour (TCarta SDB & NLA SBES)
- Co-authoring of Hydro International Article; debate over hydrographic applications of SDB
- Hydro International article receives a lot of positive attention; TCarta pursues further collaboration with NLA; Favorable leadership changes at NLA
- Technical Exchange: TCarta learns MBES on the water & Drone Collection; NLA learns SDB in the Computer Lab

2023



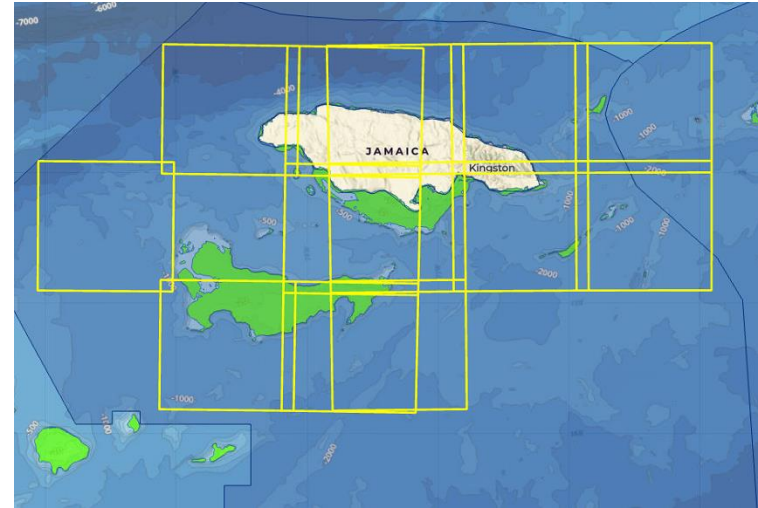
Onward Collaboration in 2024 - Contribution to Seabed 2030



Funded by:
THE NIPPON FOUNDATION-GEBCO

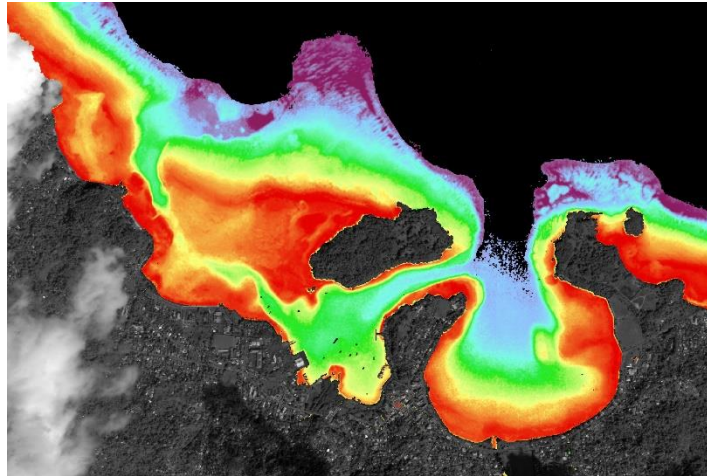
SEABED
2030

- Jamaican National Outcomes:
 - National Dataset for environmental modeling & conservation efforts
 - Jamaica's Seabed 2030 Contribution
- National Land Agency Outcomes:
 - SDB Technical Team of Experts
 - SDB as supplemental tool for national surveys
 - Example within MACHC for SDB
- **Outcome:** Empower and enable 2 hydrographic offices to produce national-scale Satellite Derived Bathymetry and contribute it to Seabed 2030
- **Scaled Potential through Expanded Partnership:** Other Caribbean Hydrographic Offices in collaboration with NLA and have previously expressed interest in participating in SDB training with NLA & TCarta



Benefits of Combining SDB and MBES

- Improve survey planning, efficiency and safety
- Avoidance of lower priority, shallow water areas during MBES survey
- Avoidance of hazards, reduction of time spent
- From ship-to-shore - complete data coverage
- MBES used to train SDB model improves accuracy



Integration Results

IN PROGRESS

Satellite Derived Bathymetry - Empowering Technology

- SDB is an equalizing technology within hydrography; Community based hydrography efforts
- Island nations as SDB producers; contribute SDB to Seabed 2030, license data to PCA for charting purposes
- Flip the narrative - use SDB capability to push data to update charts in your waters
- Build and diversify the technical skills of hydrographers in the Region
- Enable stakeholders to survey their own waters in combination with existing capabilities
- Utilize existing skills, talents and equipment in combination with SDB



Integration of Satellite and Marine Based Hydrographic Survey Methods in the MACHC Region

StoryMap with more examples:



Meso-American and Caribbean Sea Hydrographic Commission
14 December 2023
Paramaribo, Suriname



Kyle Goodrich, *President & Founder*
kyle@tcarta.com
www.tcarta.com

