



# Building Satellite Derived Bathymetry Capabilities in the MACHC Region Through Collaborations and Partnerships

1 December 2022

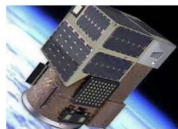
MESO AMERICAN - CARIBBEAN SEA HYDROGRAPHIC COMMISSION





Denver | Kingston | Ottawa | London

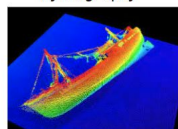
Remote Sensing



Physics



Hydrography



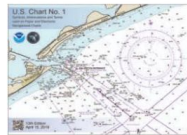
Geospatial Programing



Oceanography



Nautical Charting



Kyle Goodrich  
President & Founder



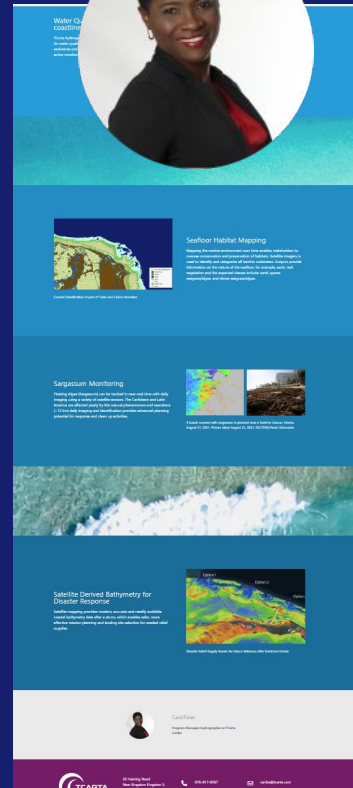
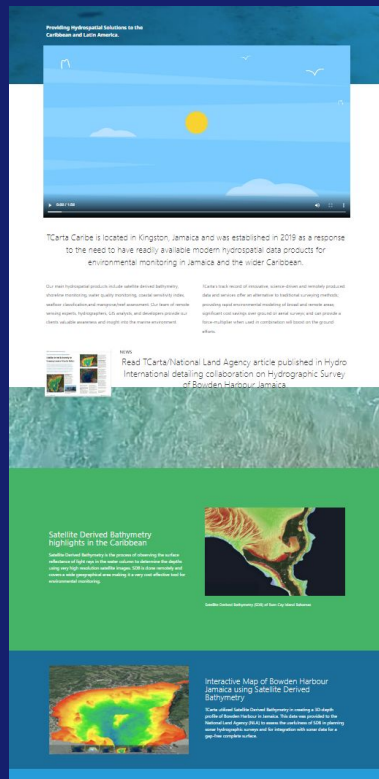
Corey Goodrich  
Managing Partner



www.tcartacaribe.com



Carol Fisher

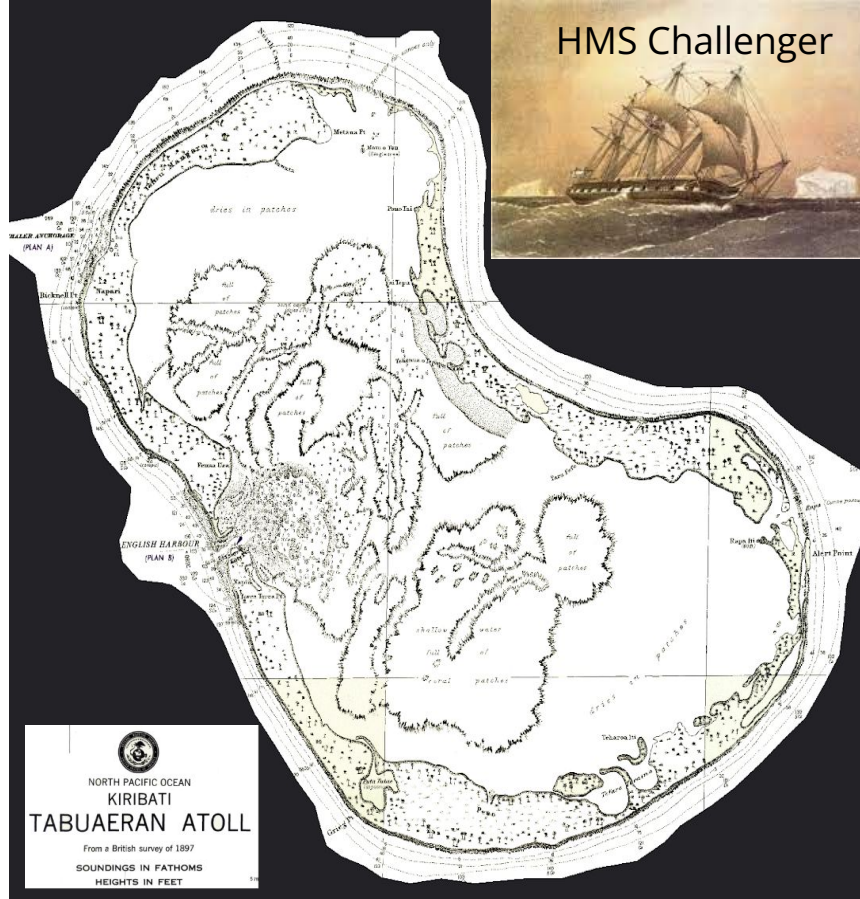


# Government Contracted Services 2018/19 - Kiribati

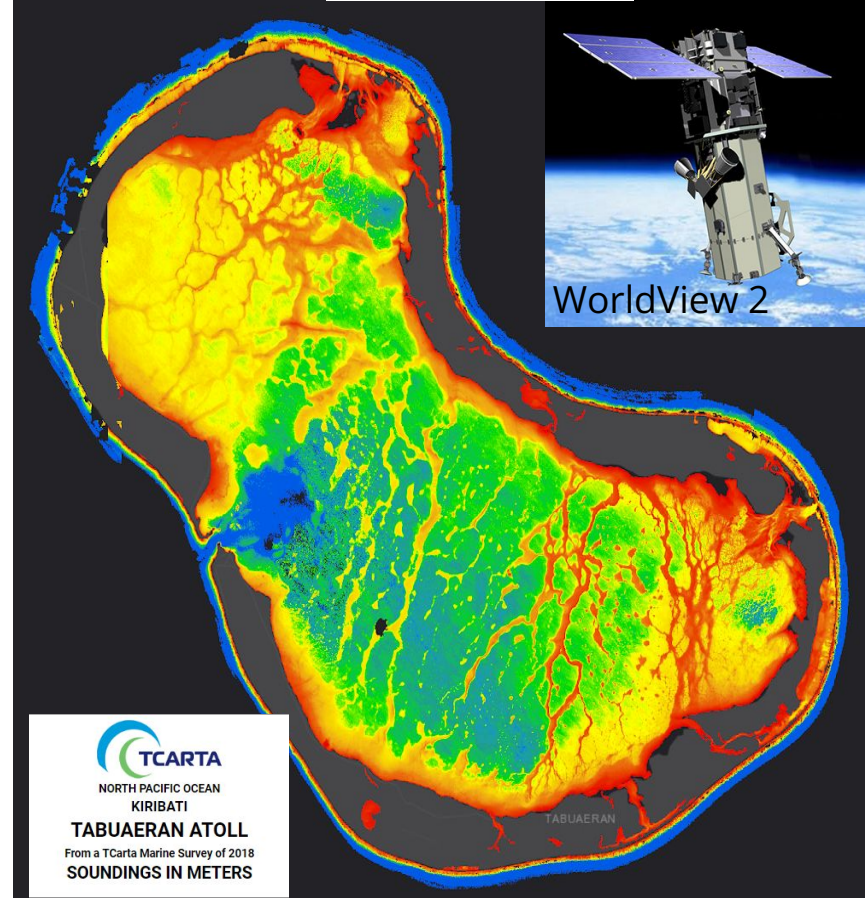


UK Hydrographic  
Office

HMS Challenger



WorldView 2

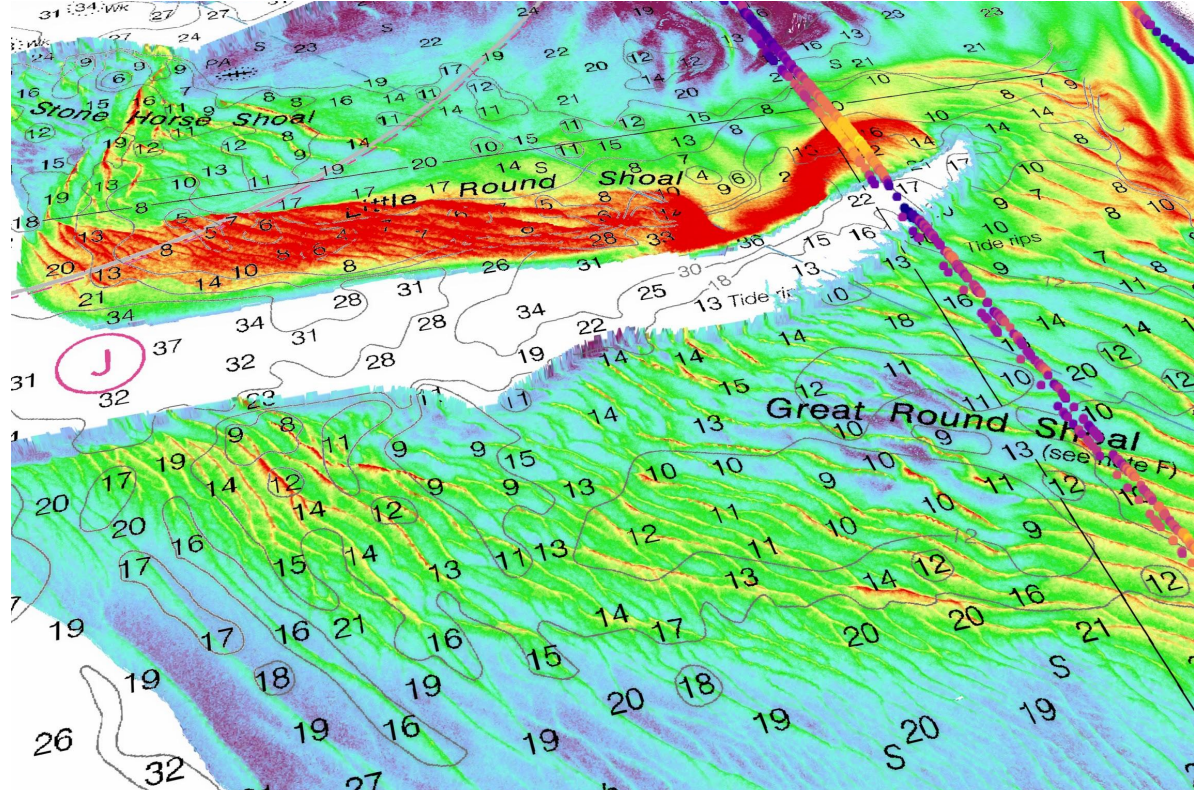
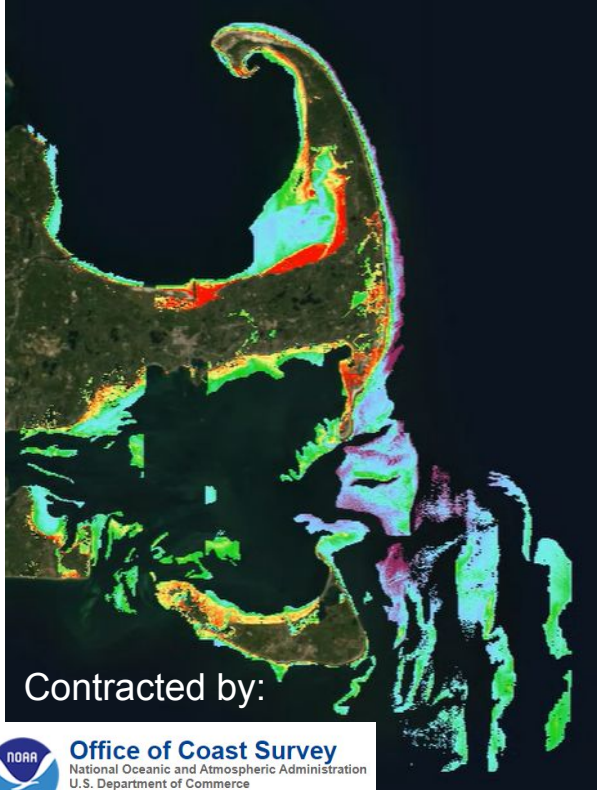




# Government Contracted Services

## 2020 - Cape Cod

High Resolution SDB 2020 Cape Cod – *Shifting Sands*





# Seabed 2030 Participation



## Seabed 2030 Partners



## Atlantic and Indian Oceans Regional Center

### Center Head



Vicki Ferrini



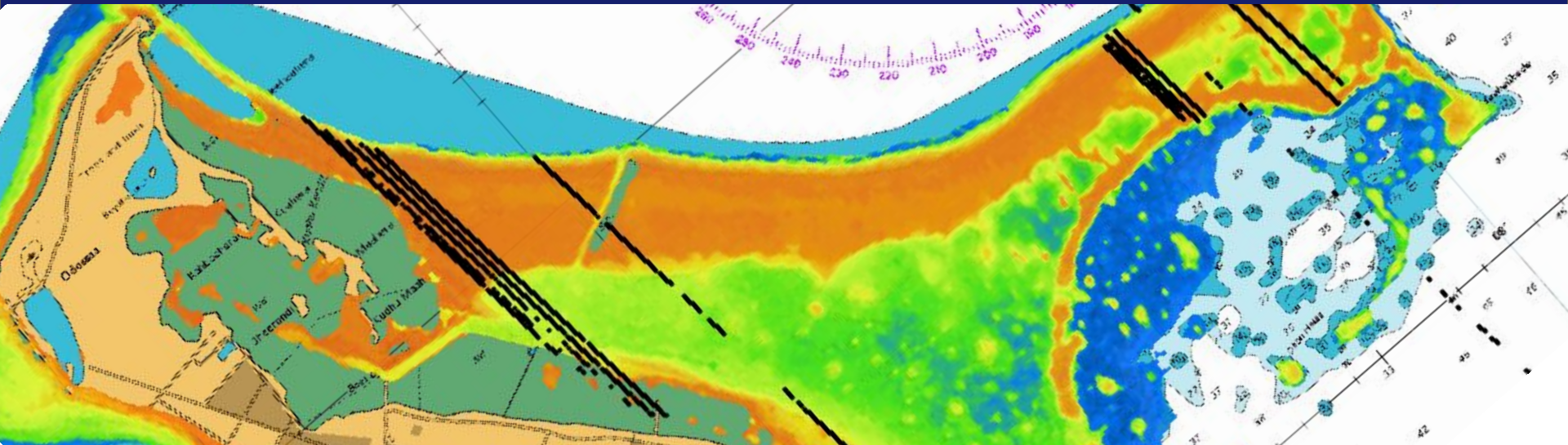
Contact:  
[atlantic-indian@seabed2030.org](mailto:atlantic-indian@seabed2030.org)

### Center Team

- Frank Nitsche, Project Scientist, Mapping/GIS Specialist
- Tinah Martin, Data Manager
- Hayley Drennon, Data Manager
- Sheila Cáceres, Data Manager
- John Morton, Applications Developer
- Angela Martin, Admin. Support

# Regional Demonstration Project

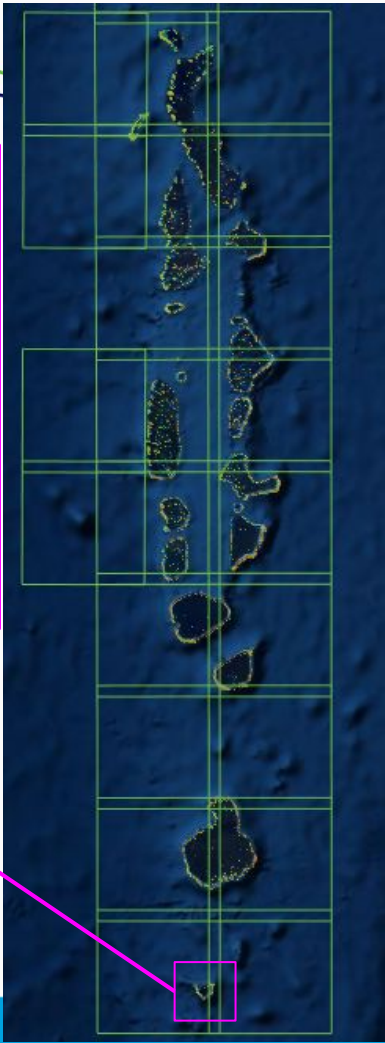
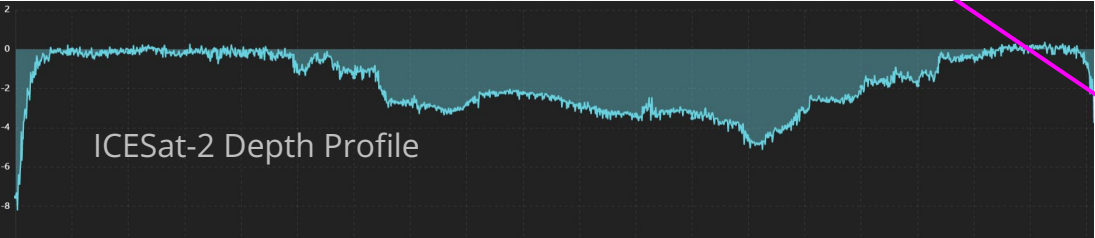
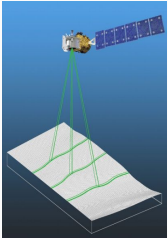
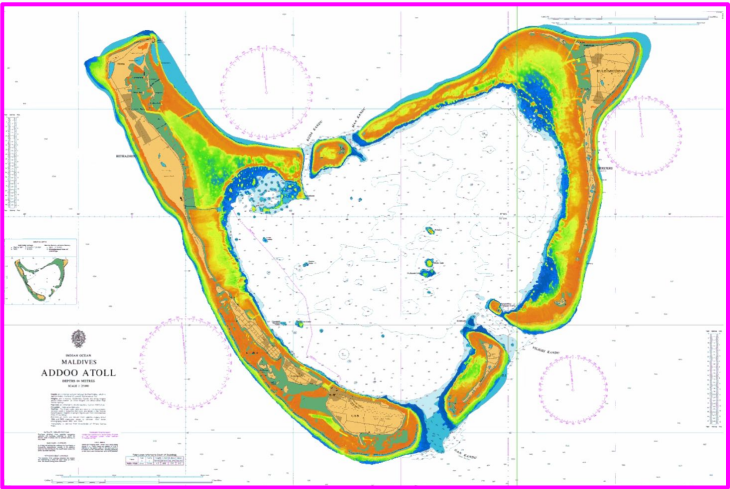
## Maldives - 2021





## Demonstration Tally

- 1,136,608 ICESat-2 points.
- ~4,200 sq km of 10m SDB produced
- 3200+ Sentinel Images Assessed
  - 509 Images Processes
- ~1 month production time



## Technology Integration:

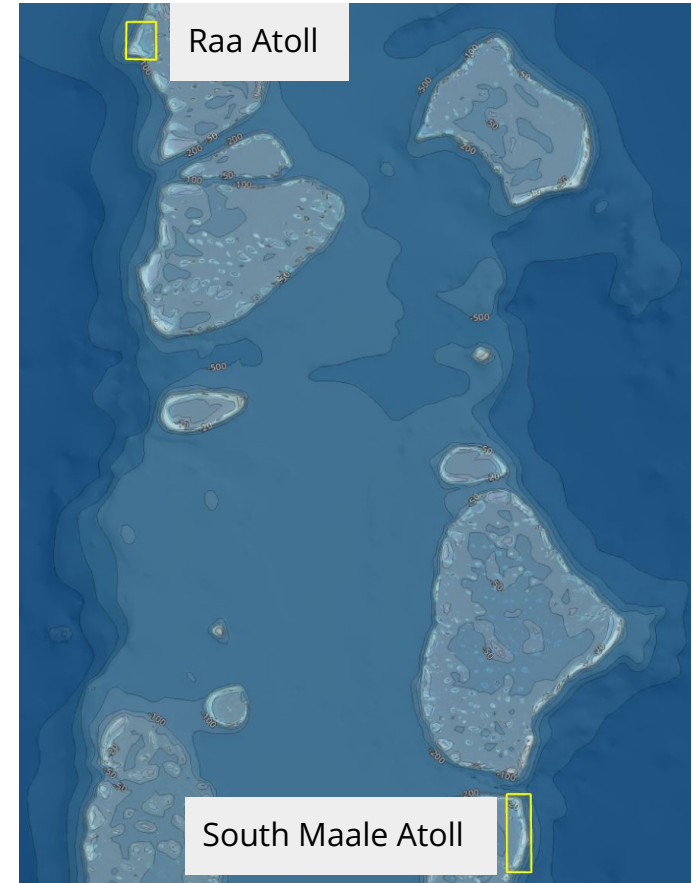
TCarta - Satellite Derived Bathymetry  
Maldives - Multibeam Echosounder



Maldives Land and Survey Authority  
Republic of Maldives

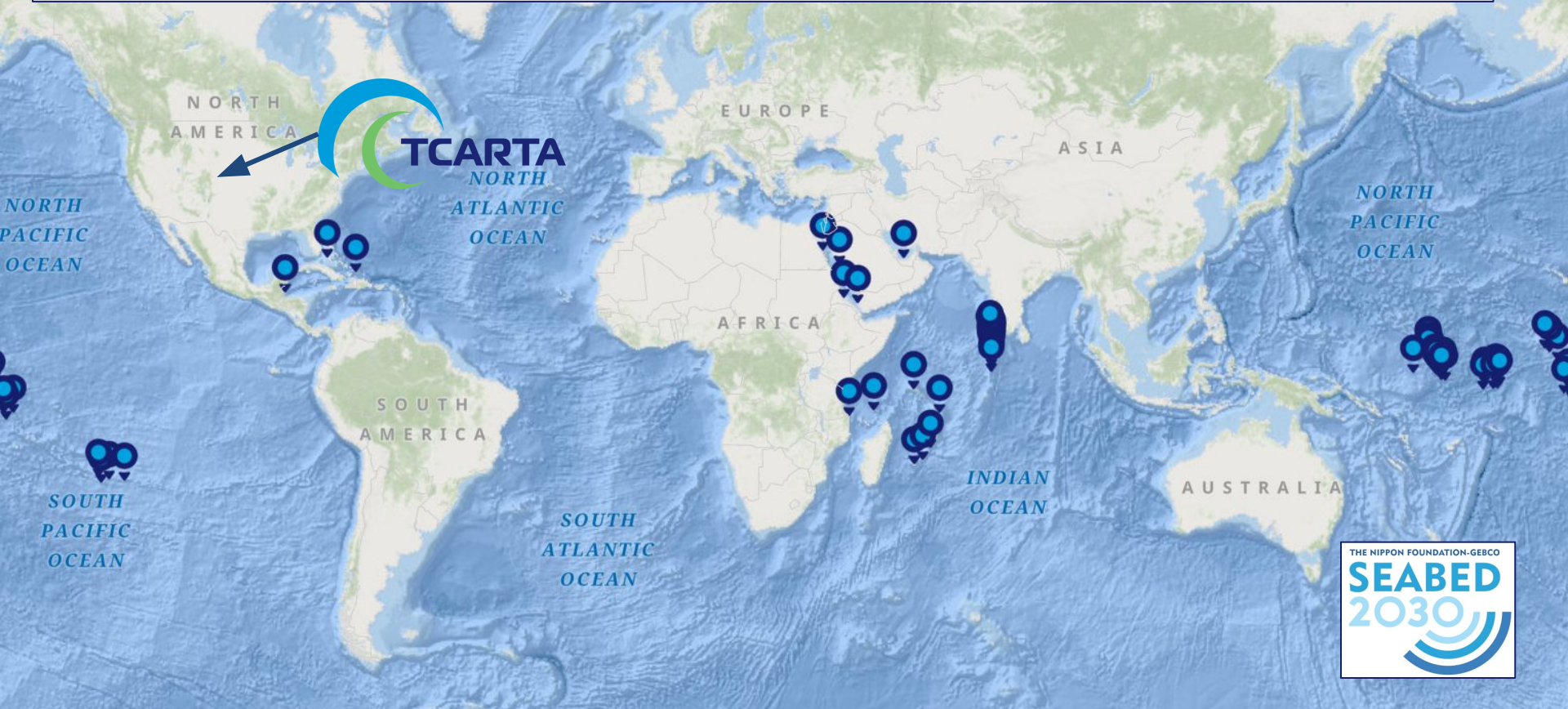
2021/09/21

2022/03/12





Through partnerships, TCarta has provided, directly or indirectly, over 175,000 sq km of SDB to the Seabed 2030 project spread across the globe.



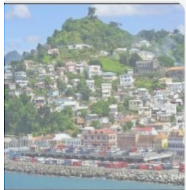


Data made available on Caribbean GeoPortal

[www.caribbeangeoportal.com](http://www.caribbeangeoportal.com)



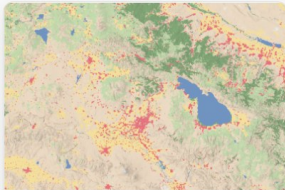
## Trending Items



An Island

than 7000 islands, the  
is a magical place!  
to encourage geo-...

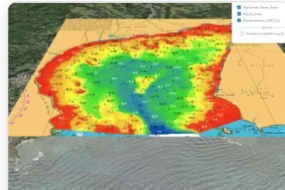
Explore



Esri 2020 Land Cover

A ten-class global land use/land  
cover (LULC) map for the year  
2020 at 10-meter resolution.

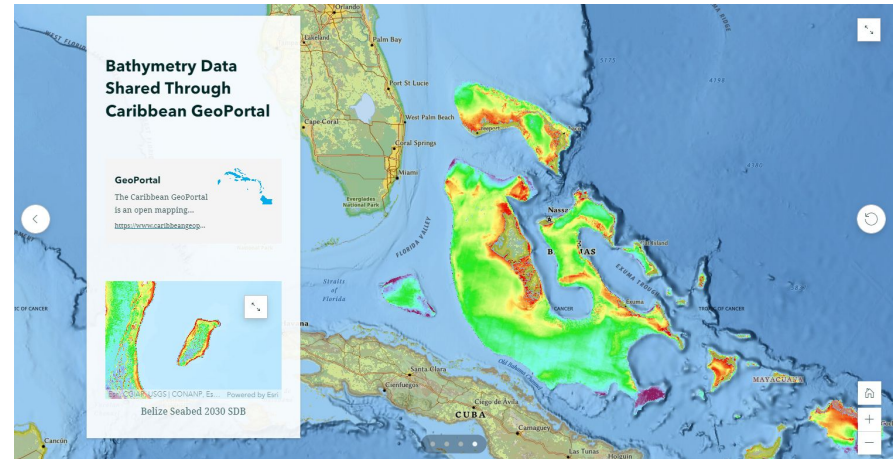
Explore



Webscene of Bathymetry  
of Bowden Harbor...

Survey planning SDB calibrated  
and validated with entirely  
remote ground-truth data.

Explore

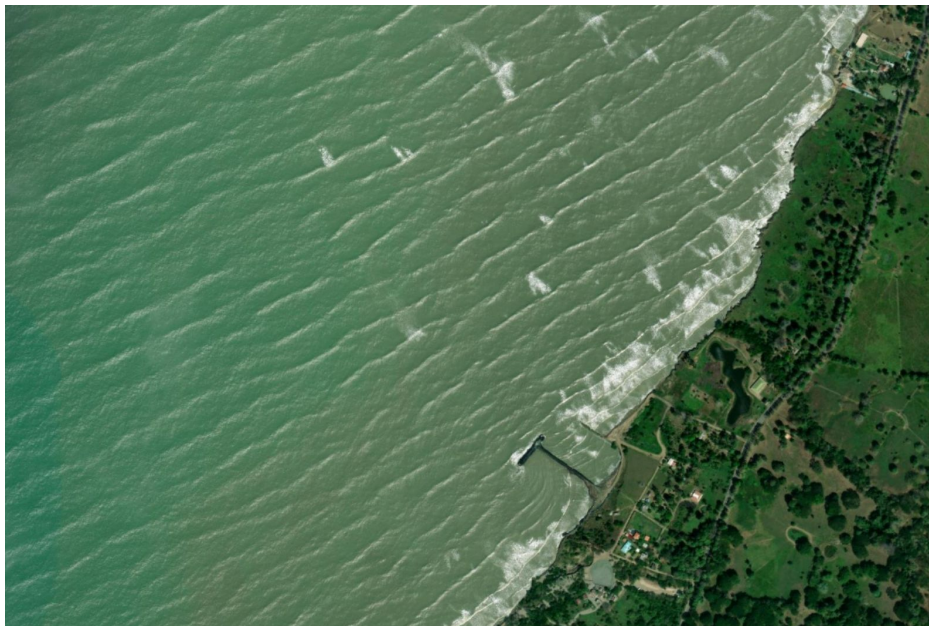




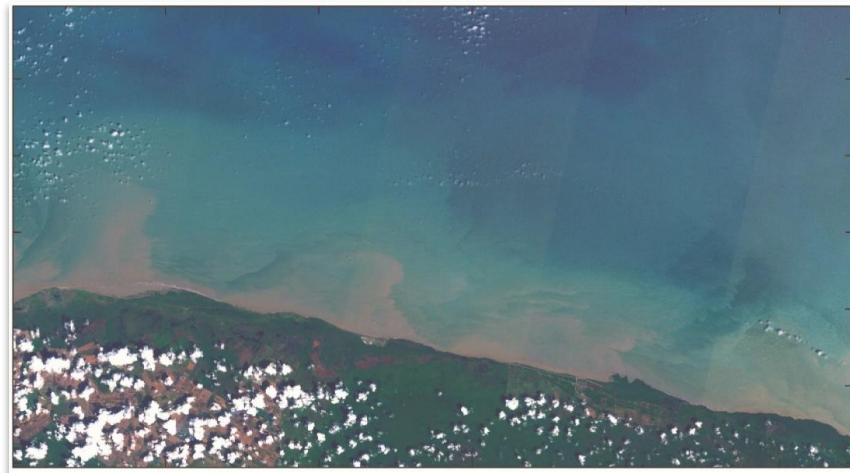


# Wave Kinematic Bathymetry (WKB)

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)

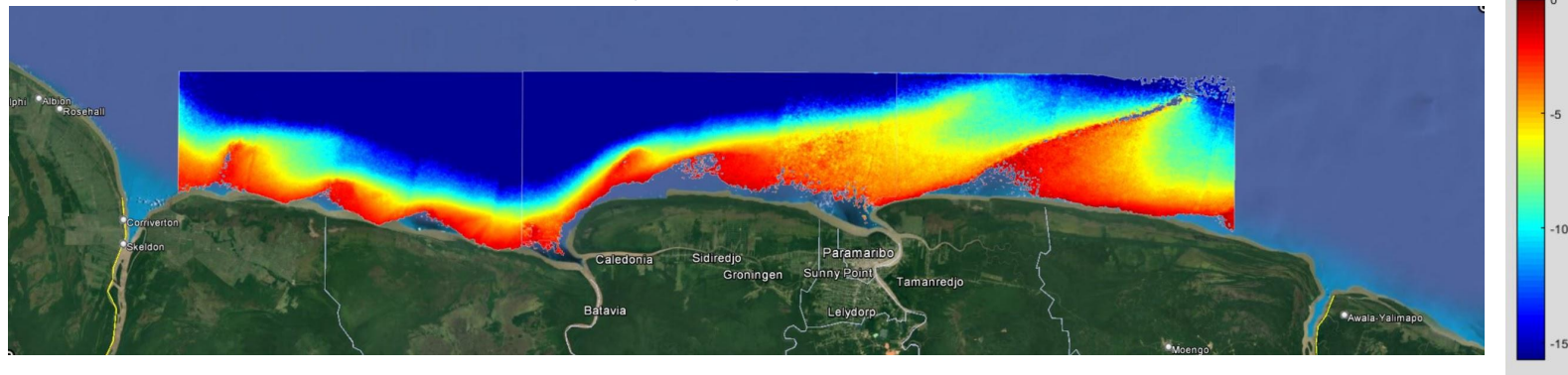


Typical Sentinel 2 image





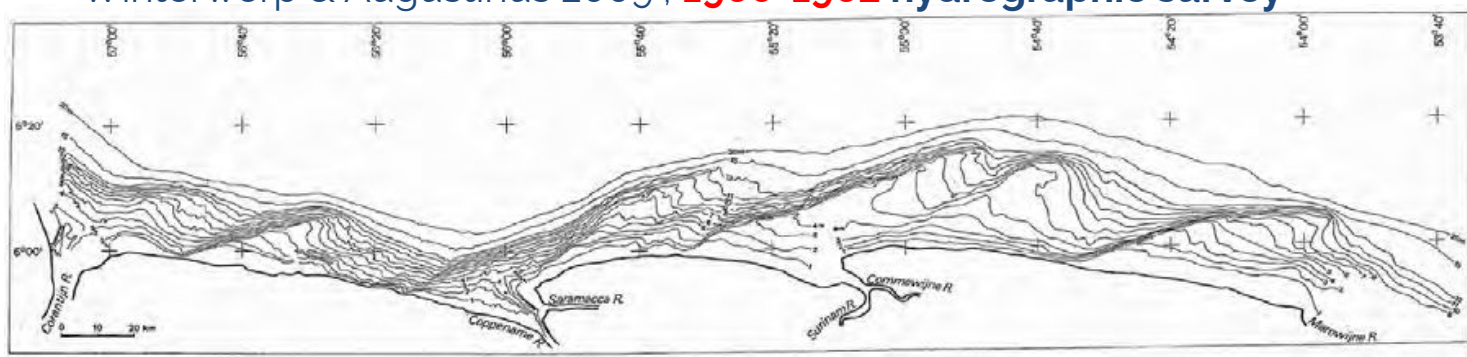
## Sentinel 2 derived bathymetry (WKB method) 2017.7-2019.7



In partnership with



## Winterwerp & Augustinus 2009\*, 1960-1962 hydrographic survey

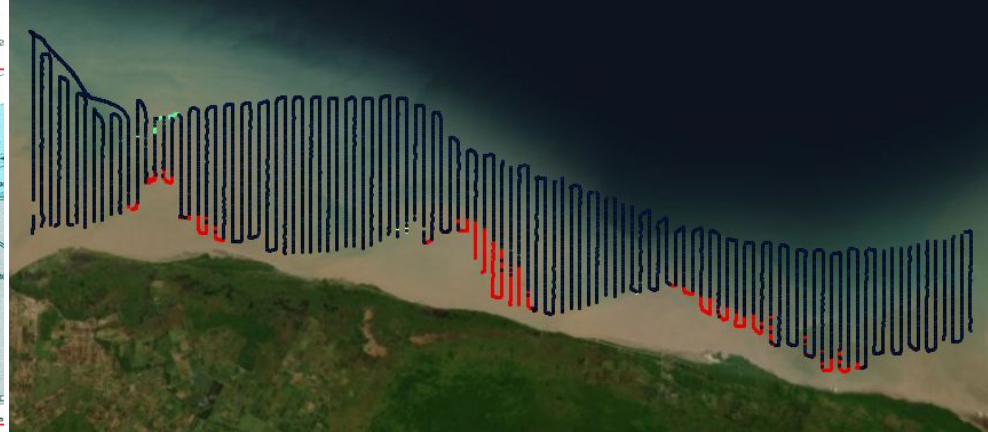


\*Winterwerp H & Augustinus P. (2009) Coastal morphodynamics report. Physical description of the Suriname coastal system. ICZM Plan Suriname.



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

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

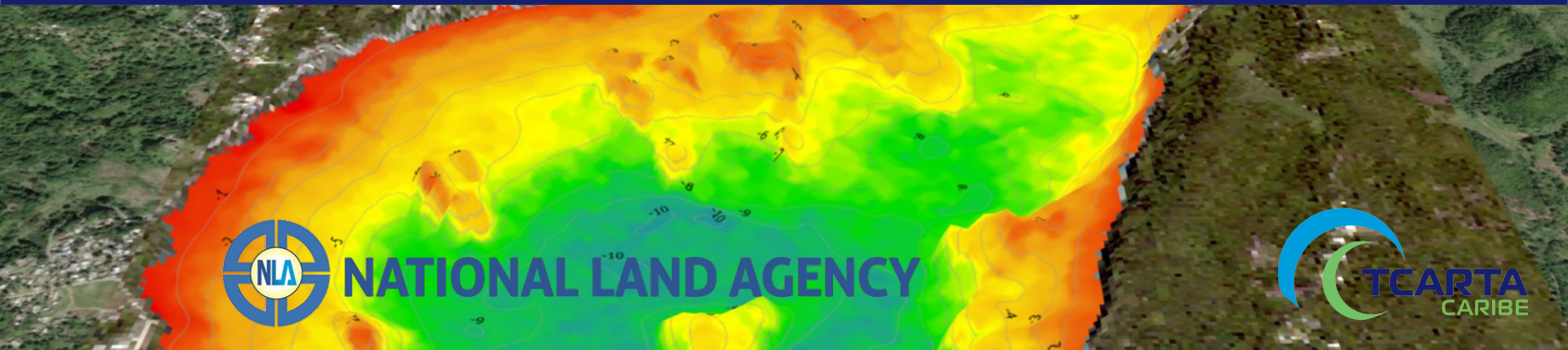


Hydrographic Office Technology Integration:



# Bowden Harbour Project - 2020

SDB & Singlebeam survey



**NATIONAL LAND AGENCY**



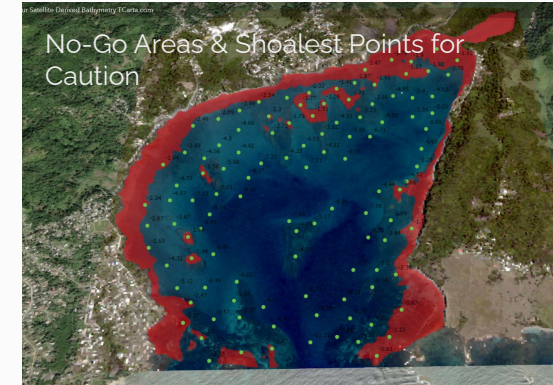
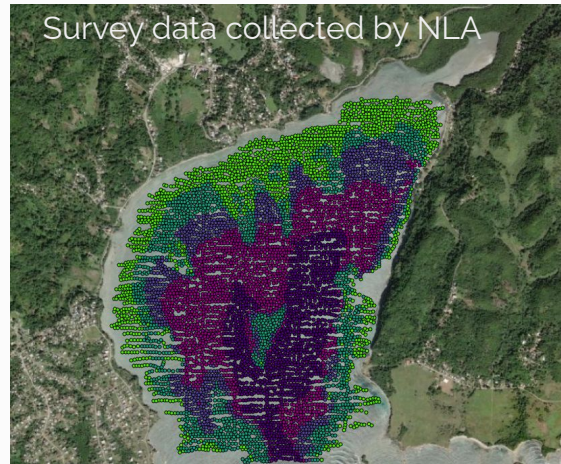




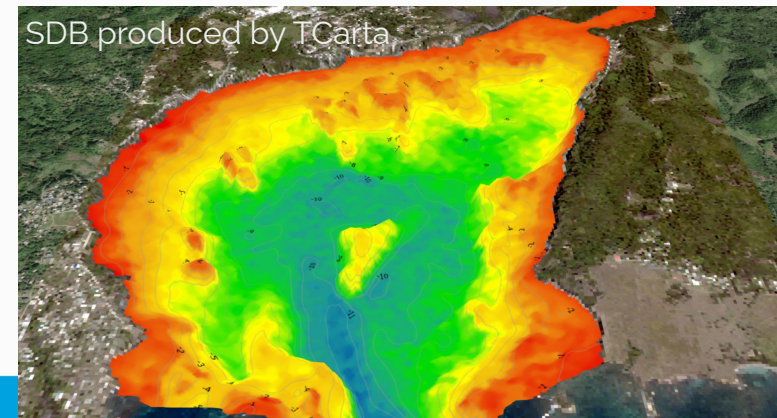
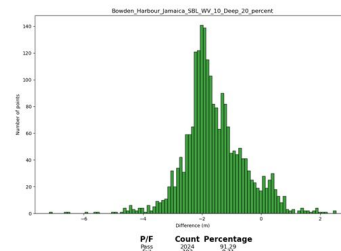
# Collaboration with National Land Agency - Combined Benefits of SDB and SBES Survey

## Bowden Harbour, Jamaica

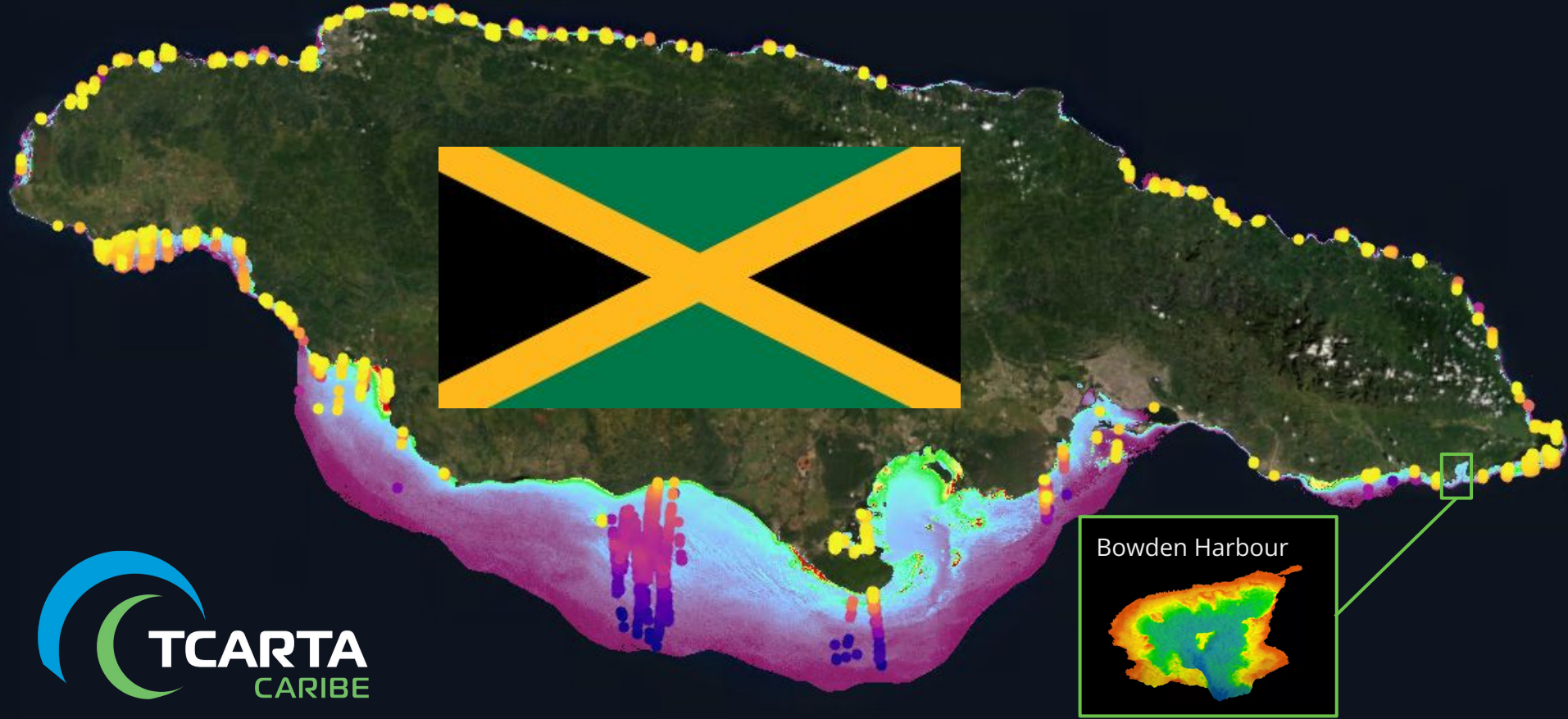
NLA Survey Team at Bowden Harbour



Data Collaboration and Capacity Building Workshop held in 2021



## Capacity Building Workshop - Planned for Q1 2022







# Satellite Derived Bathymetry Capacity Building Workshop

## Mexican Navy - August 2022

### Vera Cruz, Mexico



Esri training agenda for the Mexican Navy, developed in collaboration with Esri local reseller SIGSA. During this 4-day program, 5 navy participants will learn Esri ArcGIS Pro 3.0 and a list of GIS prerequisites for SDB software training.



## Curso: ArcGIS Pro Flujo de trabajo esenciales

### Objetivos del curso

Al concluir este curso, usted será capaz de ejecutar las siguientes tareas:

- Organizar, crear y editar información geográfica
- Gestionar, simbolizar y etiquetar capas de mapa
- Analizar y modelar información SIG para resolver problemas espaciales
- Compartir mapas y resultados de análisis

### Temario

#### ----- Día 1 -----

#### 1.- Iniciando con ArcGIS Pro

- Introducción
- Características de ArcGIS Pro
- Licencias de ArcGIS Pro
- Opciones de plantillas para iniciar ArcGIS Pro
- Estructura de un proyecto

Acceptance of invitation to participate in Capacity Building and Pilot Program.



SUBSECRETARÍA DE MARINA.  
DIRECTORATE OF GENERAL  
SERVICES AND HYDROGRAPHY  
JOINT GENERAL.  
DIRECTORATE OF OCEANOGRAPHY,  
HYDROGRAPHY AND  
METEOROLOGY.  
DIRECTORATE OF HYDROGRAPHY.  
OFICIO NUM. 339 / 22.

Subject: Pilot Program for the capacity building  
on Satellite Derived Bathymetry (SDB).

Mexico City, 7th April, 2022

Dear Kyle Goodrich  
President TCarta Marine  
TCarta Marine LLC  
1015 Federal Blvd  
Denver CO 80204  
USA

Ant's.- T-Carta Marine Letter of 3th March,  
2022.

It is my pleasure to greet you, in reference to your document aforementioned, regarding the T-Carta's free invitation to participate in the Pilot Program for the capacity building on Satellite Derived Bathymetry (SDB), in this sense I would like to inform you that DIGAOMH accept your kind invitation with the purpose of Hydrography Directorate staff located in the lighthouse building "Venustiano Carranza" in Veracruz, learn about the concepts and tools to carry out the technical processes to obtain Satellite Derived Bathymetry (BDS), in order to determine its possible usefulness in the nautical cartographic process of this institution.

Sincerely



Rear Admiral  
Deputy General Director for Oceanography,  
Hydrography and Meteorology  
José Chapo Téllez

C.C.P. SECRETARÍA DE MARINA

To: DIRECCIÓN GENERAL DE ASISTENCIA (Director of General and Hydrographic Services.- For your superior knowledge, Respectfully, Edifice)  
To the DIGAOMH, Director, For your knowledge. - Attentively - Veracruz, Ver.





## Mexican Navy Capacity Building Overview August 1-5, 2022 on-site Veracruz, MX


*This week:* 4-day Prerequisite Training in Esri ArcGIS Pro 3.0 provided by SIGSA

Day 1: **Satellite Derived Bathymetry 101** | Basics, benefits, and limitations of various methods of

Days 2- 4: **Cancun Case Study** | Produce SDB using TCarta's Trident Tools in Esri ArcGIS Pro 3.0

- Imagery
- ICESat-2
- Algorithms

Day 5: **SDB for Operational Use & Strategic Planning**



8


### Configuración del proyecto

Crear un proyecto nuevo en ArcGIS Pro cercano (NIR) de 10m Sentinel-2 rojo, predeterminada de 10m\_SentinelIm ubicado en el mismo archivo. Los pu puede servir como la aportación de la profundidades de la imagen multispectral.


### Para acceder Trident Tools e


La caja de herramientas de The Trident **Geoprocessing**: La herramienta de **Ratio, Multispectral Bathymetry Tool** utilizar la caja de herramientas de **Tr**

1. Navegar encima de la ventana pestaña **Geoprocessing**:



2. Dentro del panel **Geoproc** biquedre o desplácese abajo. Elija la flecha del izquierda de las herramientas disponibles:





21

### The Multispectral Bathym

TCarta's **Multispectral Bathym** data in-situ de batimetría produc banda algoritmo. Esta herramienta estadísticas de superficie en la fo table.

Para derivarse un superficie de b sigue estos pasos:


1. Haz clic en el **Multispectr Geoprocessing** y abre el p

Dentro de panel de **Multispectre**

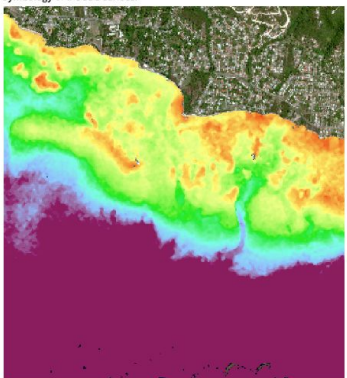
2. Asigne las bandas como desplegables o seleccione **Blue Band** será el **10m.B**

*Note:* Si necesita separar las band de **Extract Bands** ubicada en **Ra**

3. Opcional: Activa la casilla artefactos de la superficie **Automatic** o **Custom**. Si e



18. Para visualización óptima puede ajustar la superficie de SDB en la pestaña de **Symbology** of the SDB surface:



*Note:* Unos píxeles de la agua profunda podría ser quitado la **aportación** de SDB dado que la herramienta **MBT** elimina los píxeles más que 35m.

*Note:* Recomendamos cambiar la casilla situada junto a **Stretch Type** a **Minimum Maximum**, y activar el **Statistics** en **Custom**. En **Min** un valor de **15** dentro de la pestaña de **Symbology** luego elija **Statistics** va a mejorar la vista.



1

## Vera Cruz, Mexico

5 Day in-person Satellite Derived  
Bathymetry Capacity Building Workshop

01

/

08







3

## In Person Training

Lots of discussion, questions, over-the-shoulder screen pointing and, yes, some arm waving





4

## Mexico Naval Museum

Some cartographic fun, too!





## Pilot Project

## Virtual training & Support



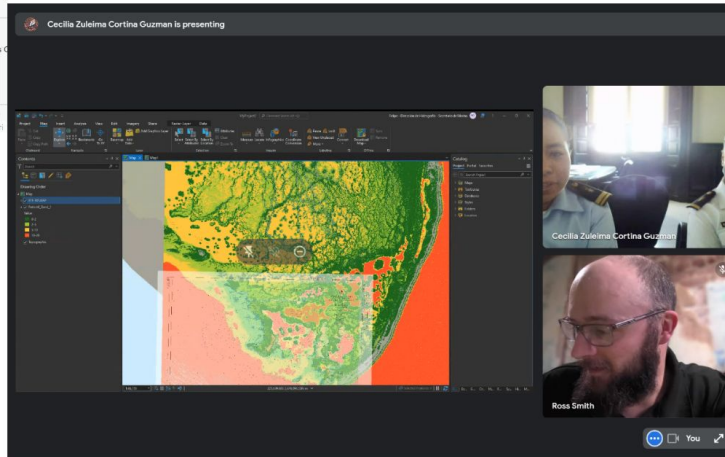
### 5 Pilot Project

Using Trident Tools in ArcGIS Pro



### 7 Virtual Workroom

Tips, Troubleshooting and Questions;  
Collaboration continues.



### Metodología para la generación de Batimetría Derivada por Satélite:

Los **insumos** necesarios para este proceso son los siguientes:

- Software Arcgis Pro Ver. 3.0.0 Extensiones: 3D Analyst y Spatial Analyst.
- Herramientas: Trident Tools.
- Imagen de satélite WorldView-2 con las bandas espectrales Roja, Azul, Verde e Infrarrojo Cercano (Bandas: 5,2,3 y NIR 7).
- Batimetría levantada con ecosonda multihaz o monohaz. Considerando que los datos sean actualizados o lo más cercano a la fecha de colecta de la imagen de satélite.

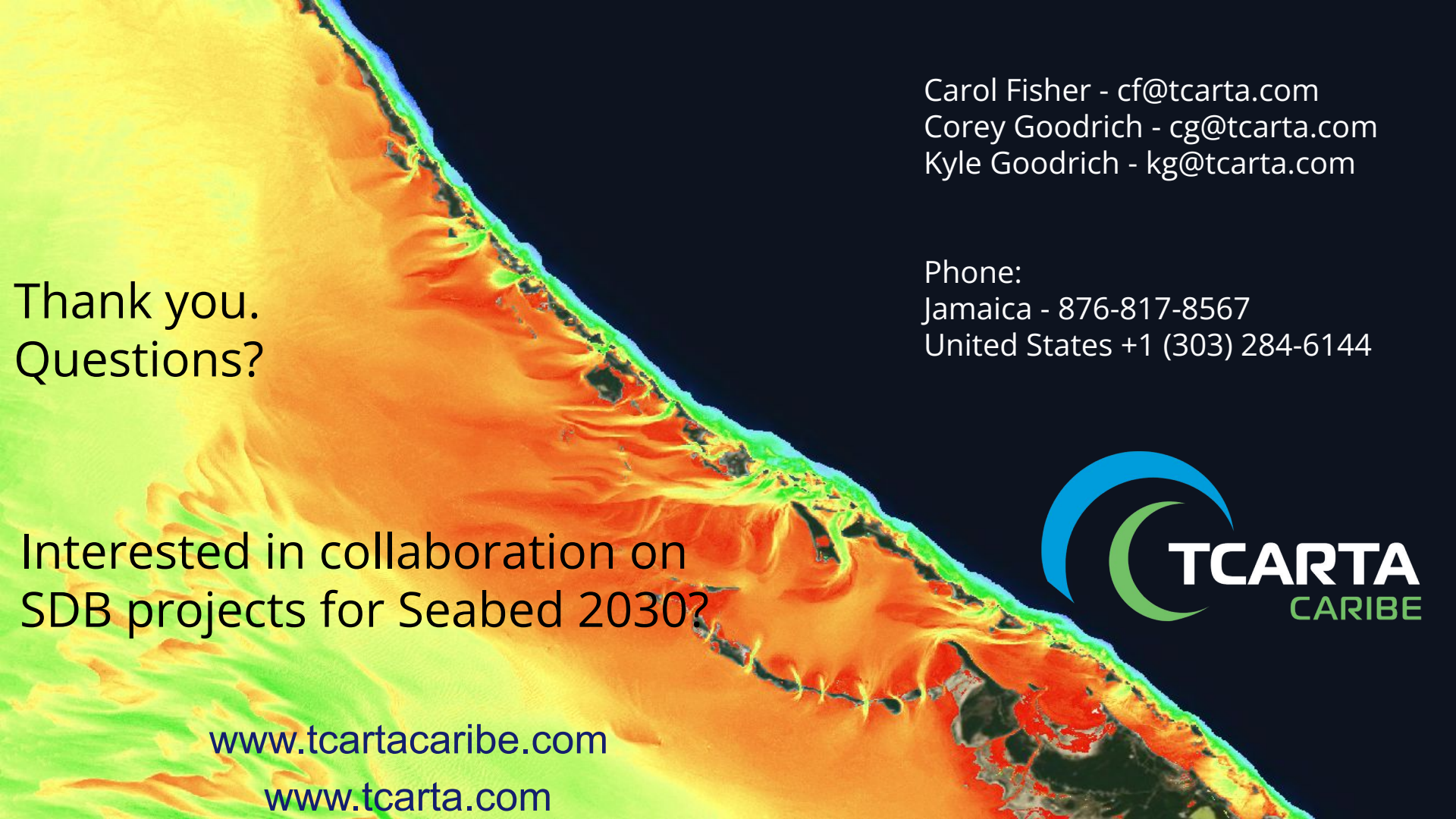


## Read More:

<https://storymaps.arcgis.com/stories/f9b70e50cc024197bb50f56ee83b98cd>

OR:  
[shorturl.at/yLW08](https://shorturl.at/yLW08)





Thank you.  
Questions?

Carol Fisher - cf@tcarta.com  
Corey Goodrich - cg@tcarta.com  
Kyle Goodrich - kg@tcarta.com

Phone:  
Jamaica - 876-817-8567  
United States +1 (303) 284-6144



Interested in collaboration on  
SDB projects for Seabed 2030?

[www.tcartacaribe.com](http://www.tcartacaribe.com)

[www.tcarta.com](http://www.tcarta.com)