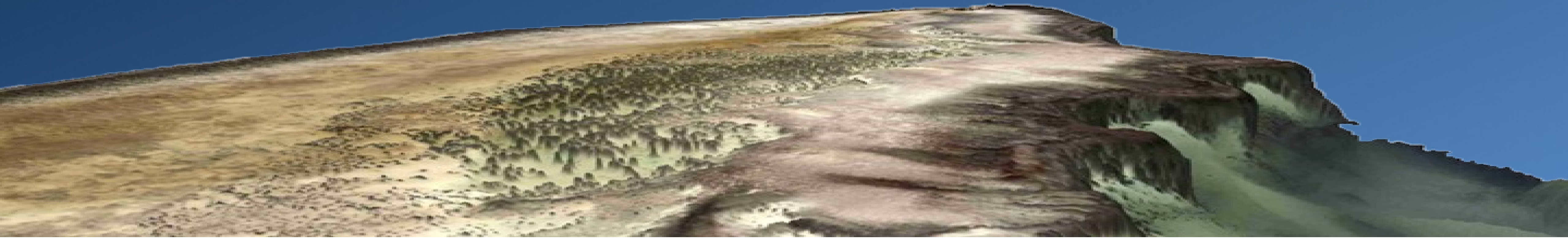
Satellite-Derived Bathymetry in Hydrographic Surveys

SWPHC16
February 13-15, 2019
Niue

EOMAP
Germany, Australia



SDB and EOMAP

Satellite-Derived Bathymetry: SDB

Passive system: earth-orbiting sensors + sunlight

Non-intrusive, rapid, low cost, shallow/remote/in-accessible locations

Empirical: easy to implement, requires in situ data

Physics-based: no in situ data, higher accuracy, uncertainty estimates

EOMAP

Mapping and monitoring aquatic environments worldwide

First and leading commercial SDB provider (13 years)

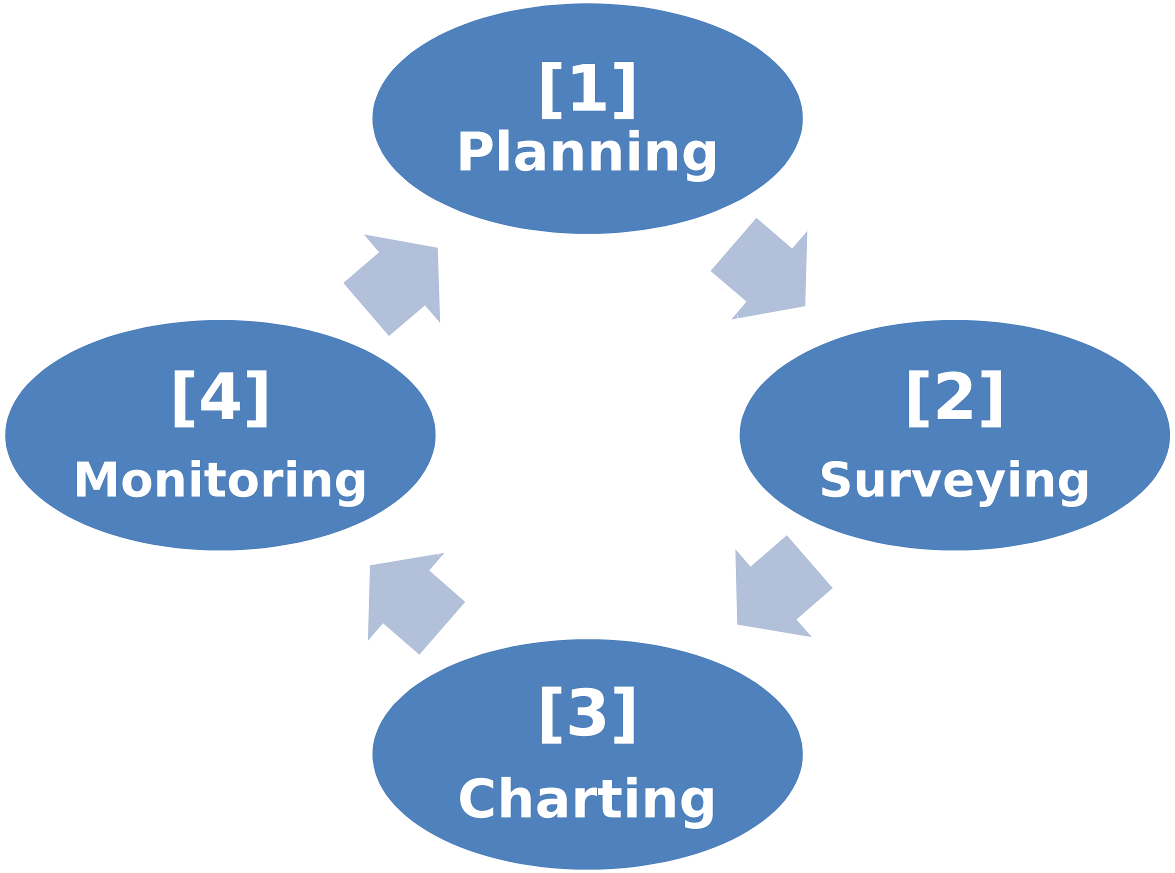
>75 projects in 25 locations in just the last 2 years

Offices in Germany and Australia

SDB in hydrographic surveys

Prioritise locations, optimise deployment, (inform safety of navigation)

Regular monitoring of seabed change



Optimise survey efficiency; reducing costs, time and risk

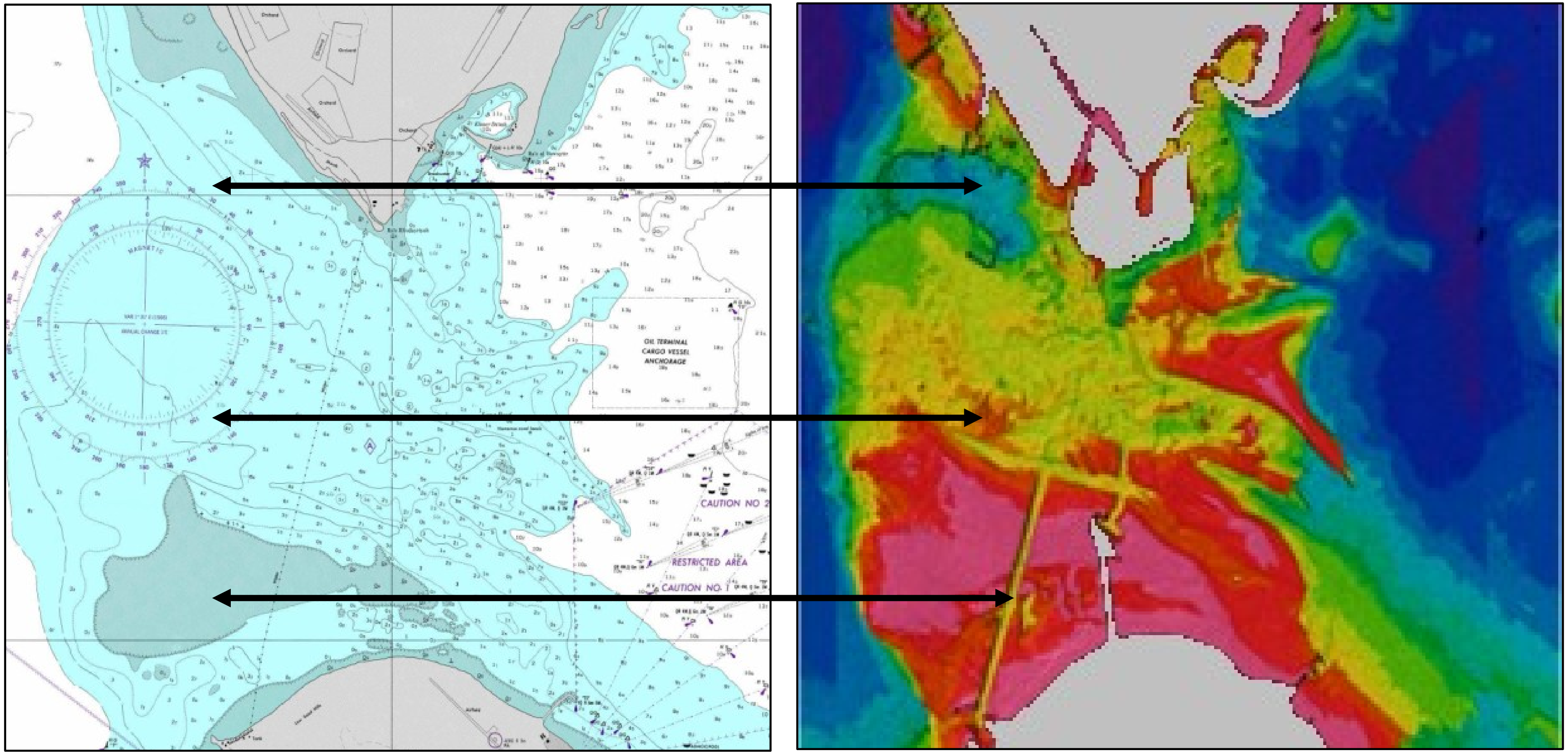
Access shallow, remote or otherwise in-accessible areas

Integrated survey approach: complementary technologies.

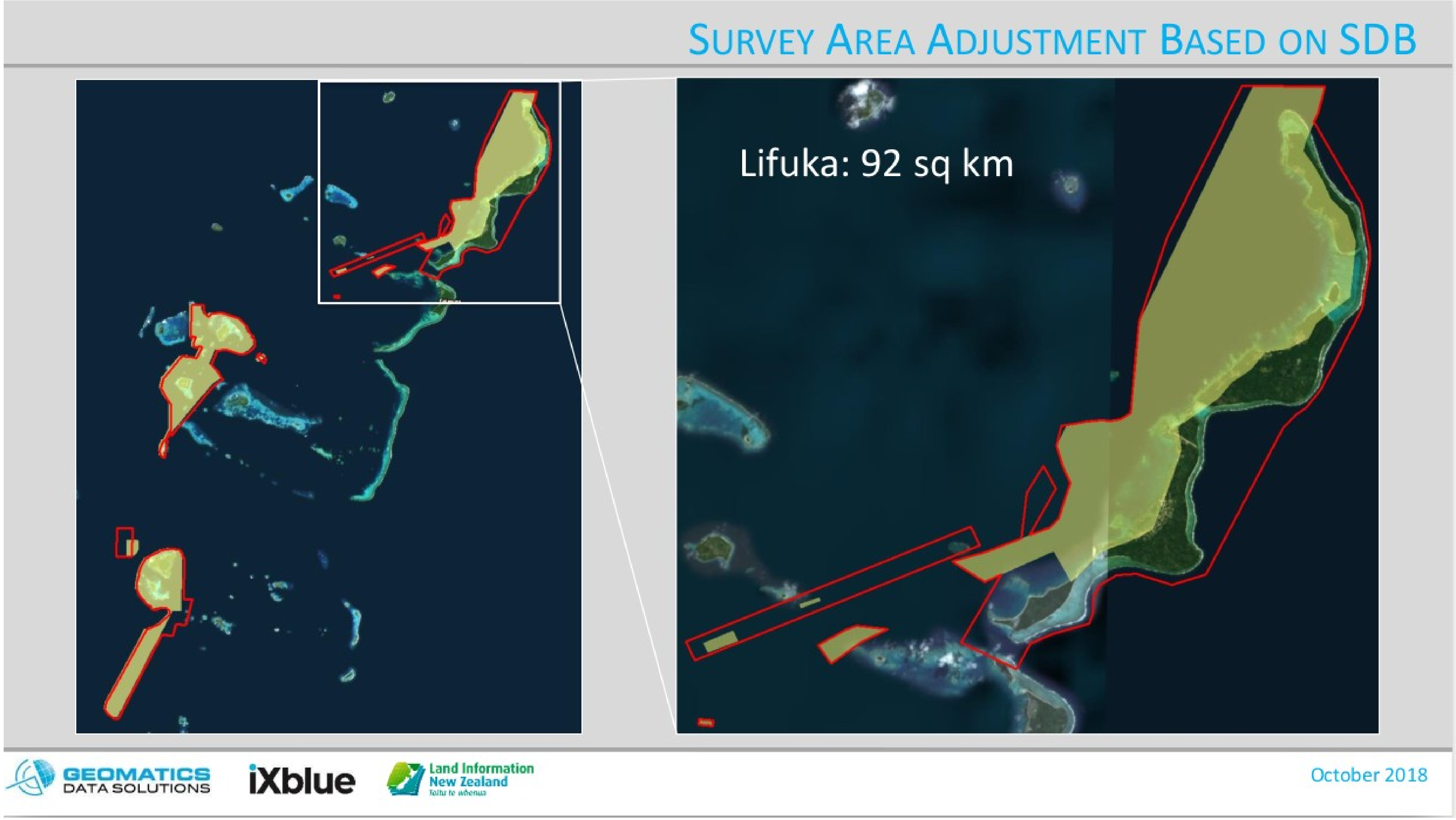
Integration of SDB in charts

Planning

Initial planning



Optimising resource deployment



Land Information New Zealand Toitū te whenua iXblue EOMAP

Contribute to safety of navigation

- Identify potential hazards for on-site ship-based surveys
- Identify 5m/10m contour to plan ship survey routes more efficiently and with reduced risks
- Increase understanding of local seabed and morphology

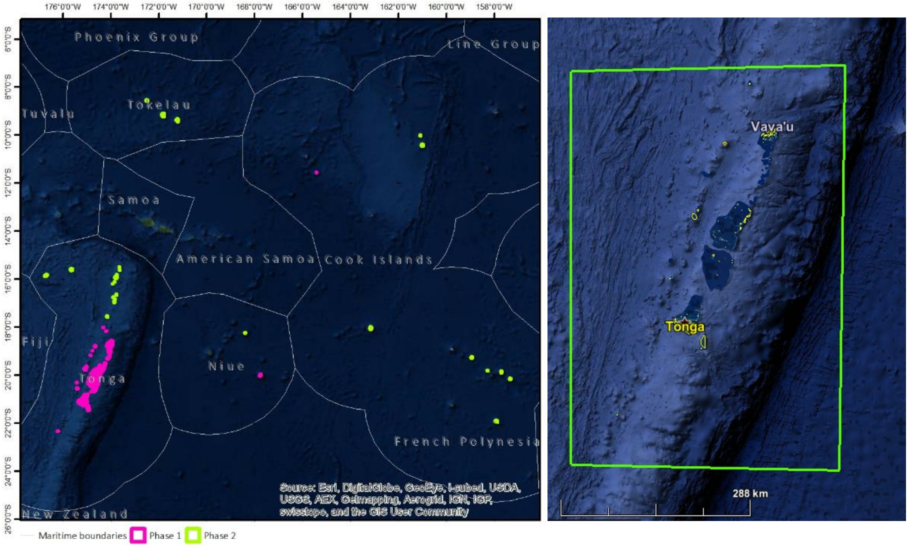
Tonga project example:

SDB used to aid in navigation for positioning tide gauges

Surveying

Surveying, data collection and processing

- Effectively fill data gaps in the challenging shallow water zone
- Access remote, large or otherwise in-accessible locations
- Reduce risk, time and/or cost
- Not as accurate (vertical) as ALB or MBES
- Uncertainty measure (per pixel)
- Can be refined with further calibration / validation procedures



SDB for entire study area

1. broad scale imagery (15m grid) for rapid identification of **all** shallow areas – *un-charted features?*

2. high resolution (2m grid) imagery acquistion and SDB mapping (includes tasking)

SDB for Tongan archipelago and surrounding (remote) locations

SDB as end product (where no ALB or MBES)

Navigation and positioning for tide gauge deployment

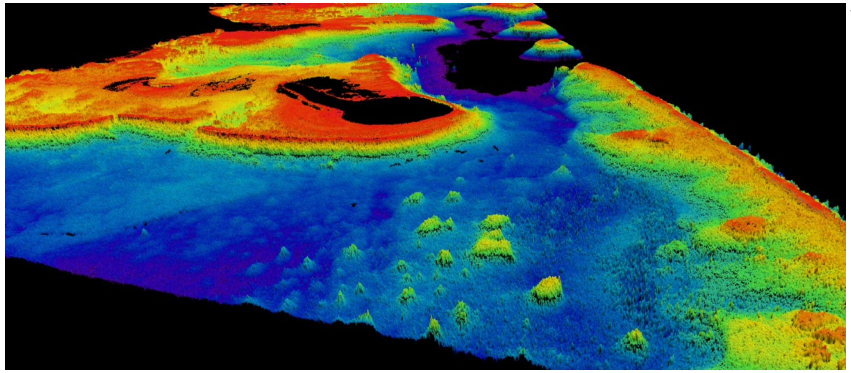
Flight planning for ALB

Navigation and planning for MBES

Further validation of SDB

Calibration of optical models for potential re-processing of SDB

Fine-tuned SDB (overlaping regions)



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Toitū te whenua

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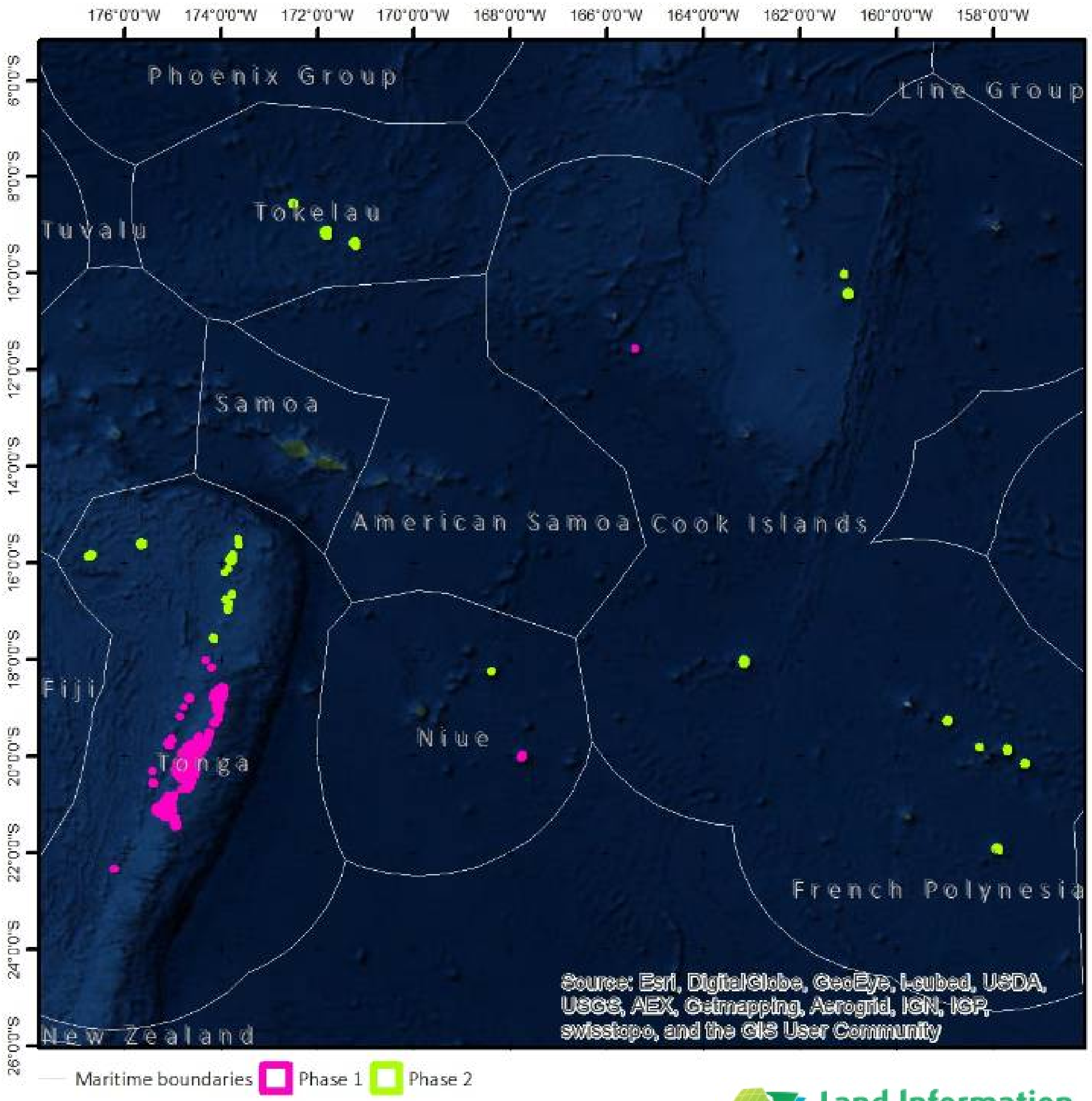
EOMAP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20°0'0"S
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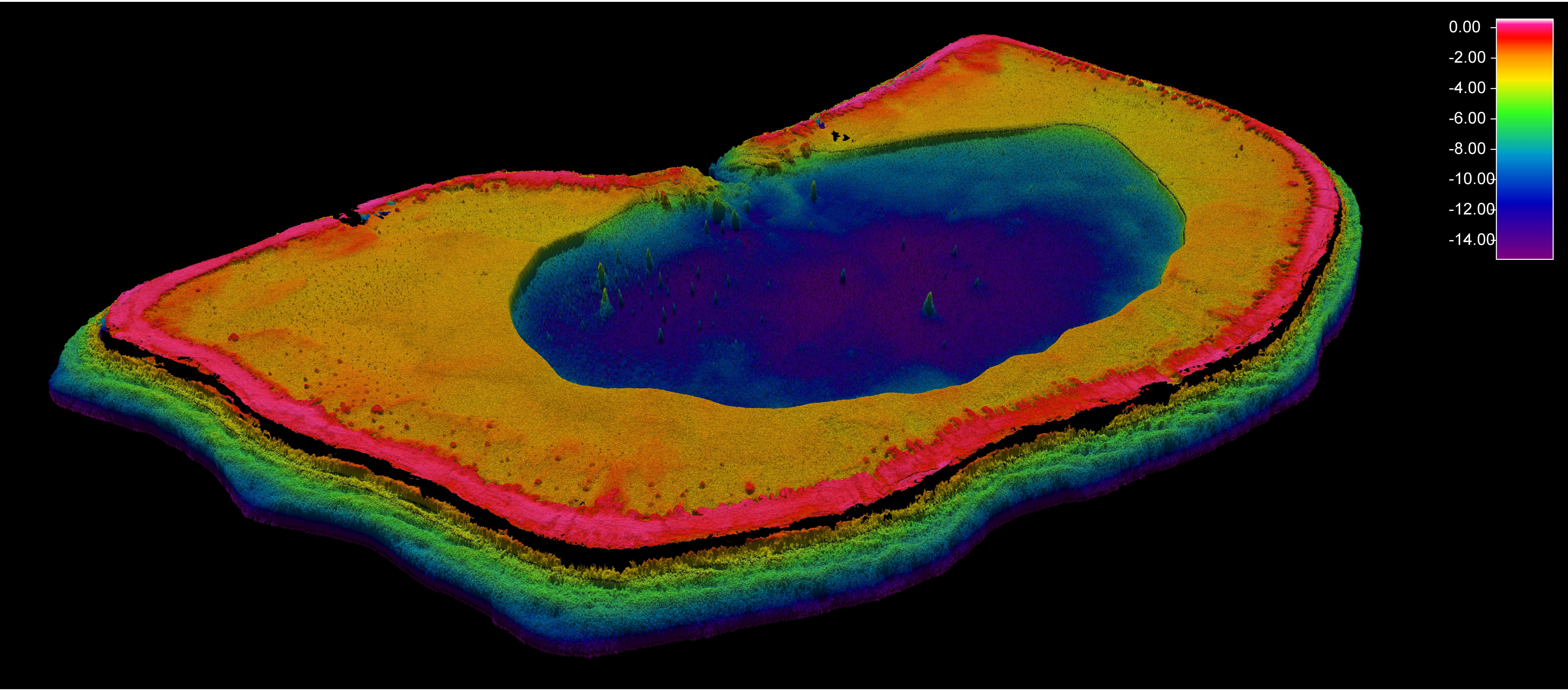
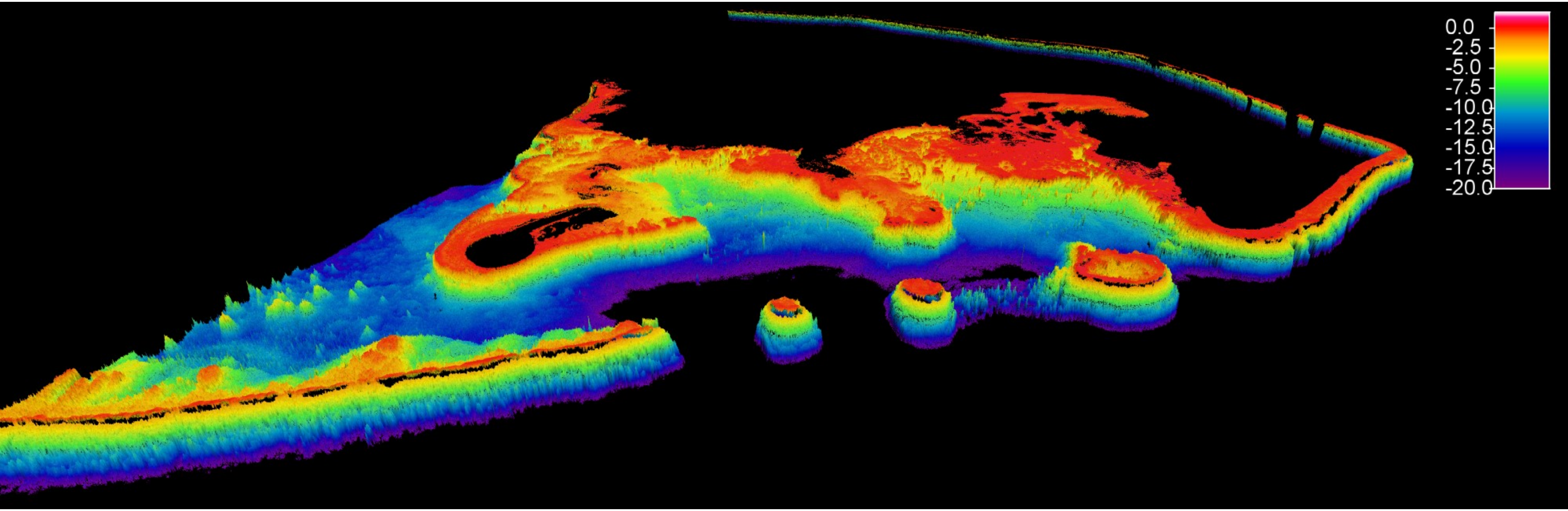
24°0'0"S
26°0'0"S
Phoenix Group
Line Group
Tokelau
Tuvalu
Samoa
American Samoa
Cook Islands
Fiji
Niue
Tonga
French Polynesia
New Zealand
Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community
Maritime boundaries
Phase 1
Phase 2

Beveridge Reef SDB (2m grid resolution)





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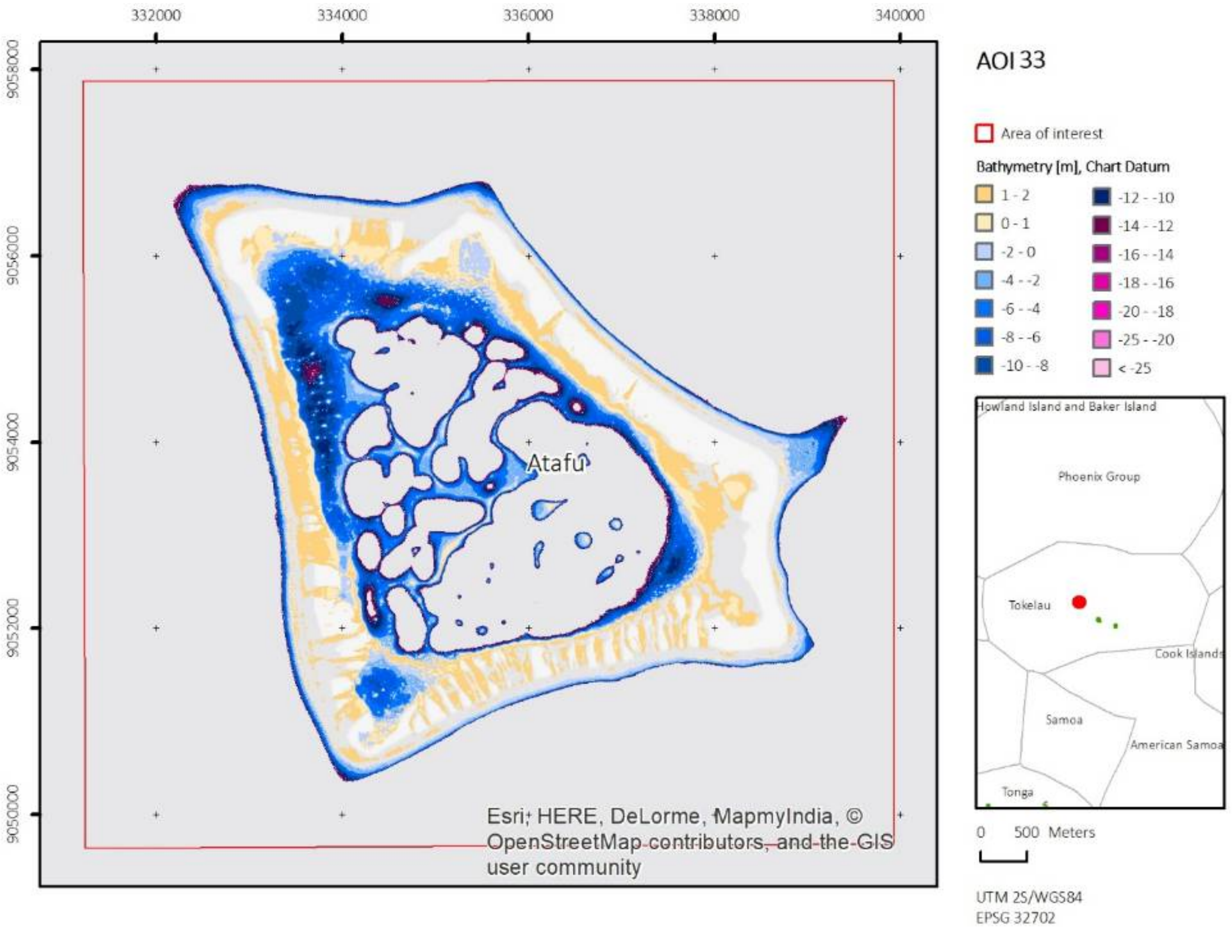

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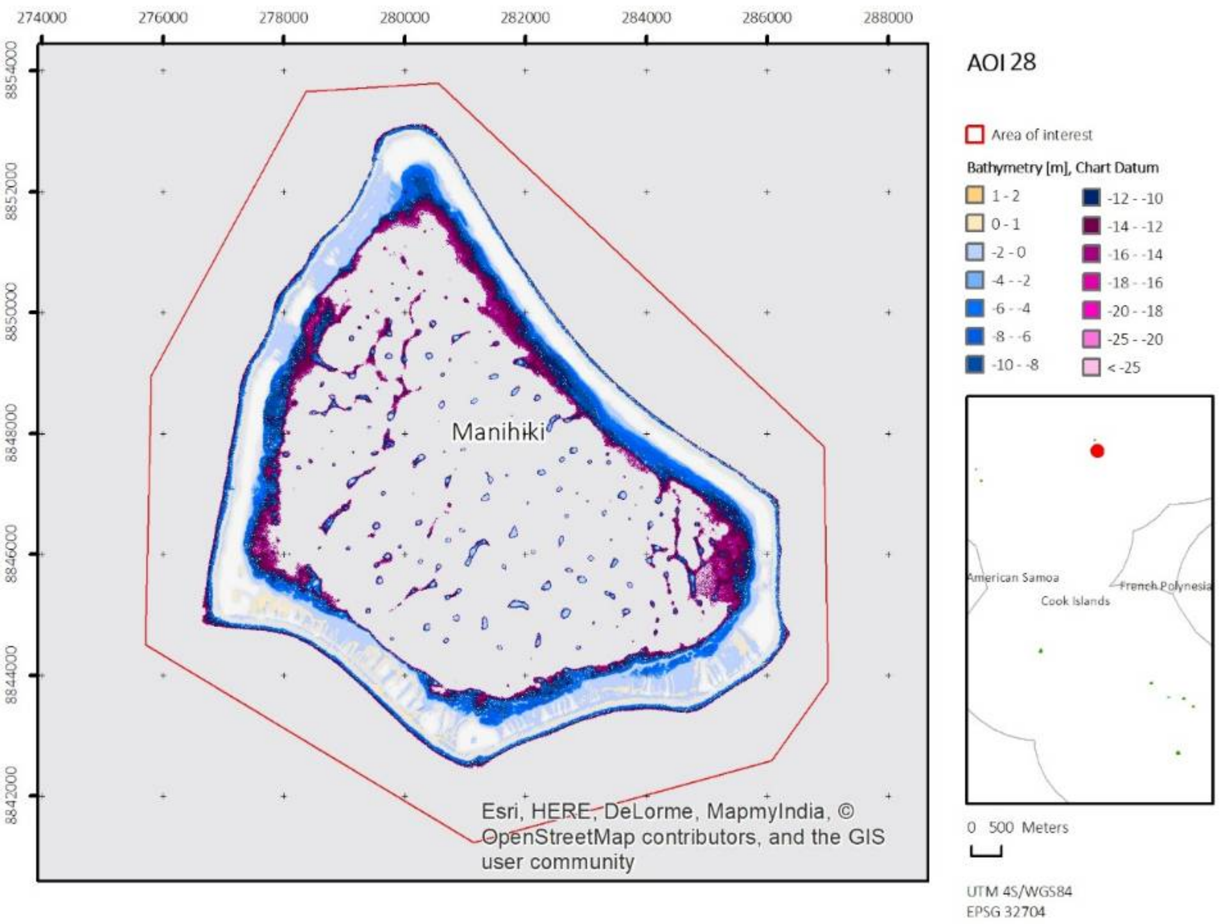
AOI 33
Area of interest
Bathymetry [m], Chart Datum
1 - 2
0 - 1
-2 - 0
-4 - -2
-6 - -4
-8 - -6
-10 - -8
-12 - -10
-14 - -12
-16 - -14
-18 - -16
-20 - -18
-25 - -20
< -25
Howland Island and Baker Island
Phoenix Group
Tokelau
Cook Islands
Samoa
American Samoa
Tonga
0 500 Meters
UTM 2S/WGS84
EPSG 32702



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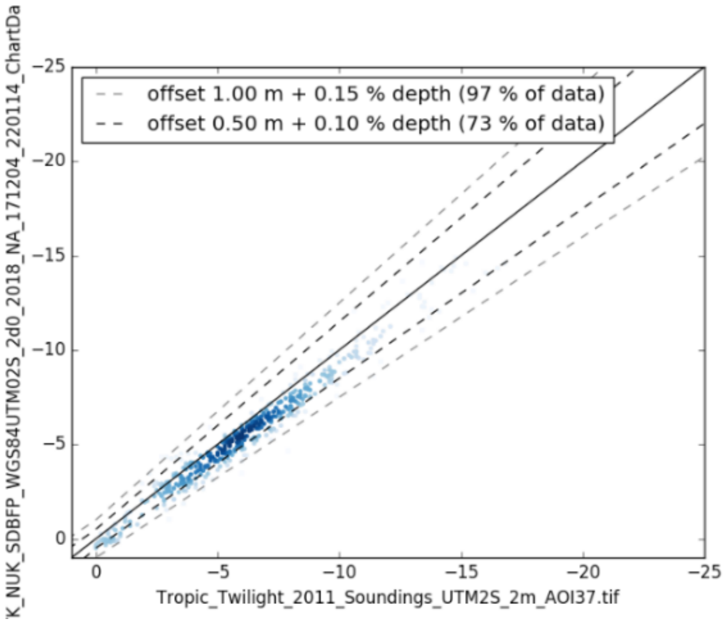
AOI 28
Area of interest
Bathymetry [m], Chart Datum
1 - 2
0 - 1
-2 - 0
-4 - -2
-6 - -4
-8 - -6
-10 - -8
-12 - -10
-14 - -12
-16 - -14
-18 - -16
-20 - -18
-25 - -20
< -25
American Samoa
Cook Islands
French Polynesia
0 500 Meters
UTM 4S/WGS84
EPSG 32704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offset 0.50 m + 0.10 % depth (73 % of data)
Tropic_Twilight_2011_Soundings_UTM2S_2m_AOI37.tif
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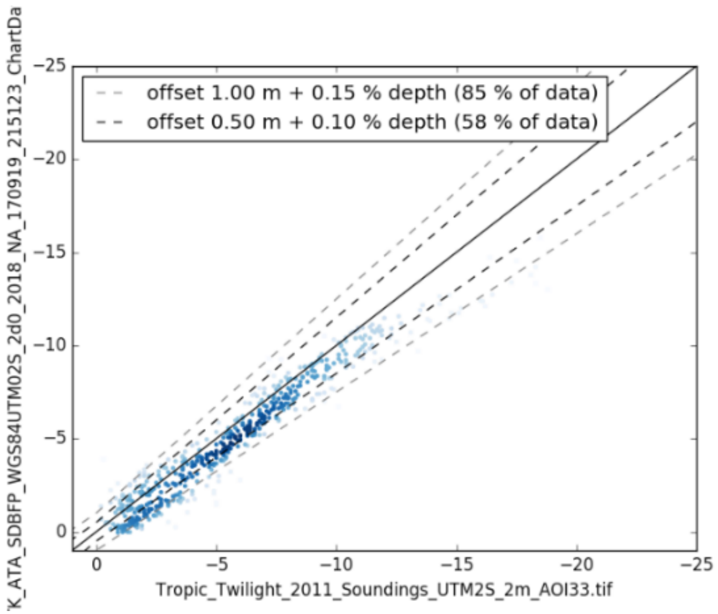
offset 1.00 m + 0.15 % depth (85 % of data)
offset 0.50 m + 0.10 % depth (58 % of data)
Tropic_Twilight_2011_Soundings_UTM2S_2m_AOI33.tif
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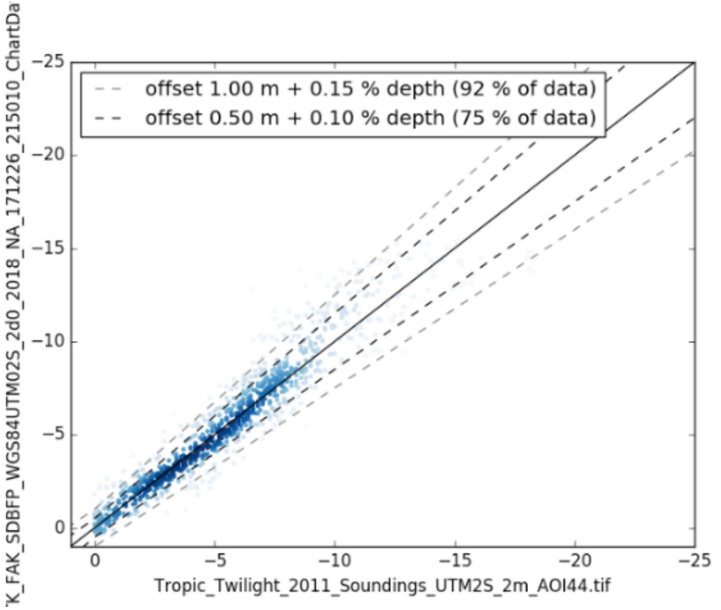
offset 1.00 m + 0.15 % depth (92 % of data)
offset 0.50 m + 0.10 % depth (75 % of data)
Tropic_Twilight_2011_Soundings_UTM2S_2m_AOI44.tif
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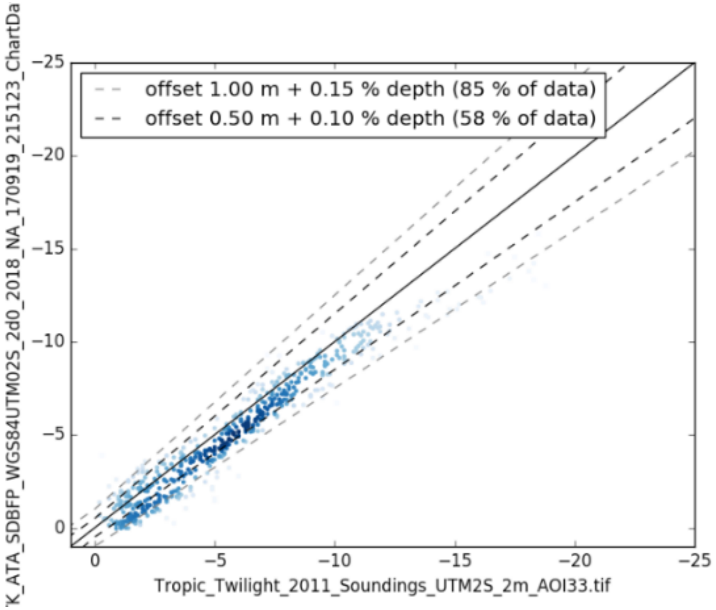
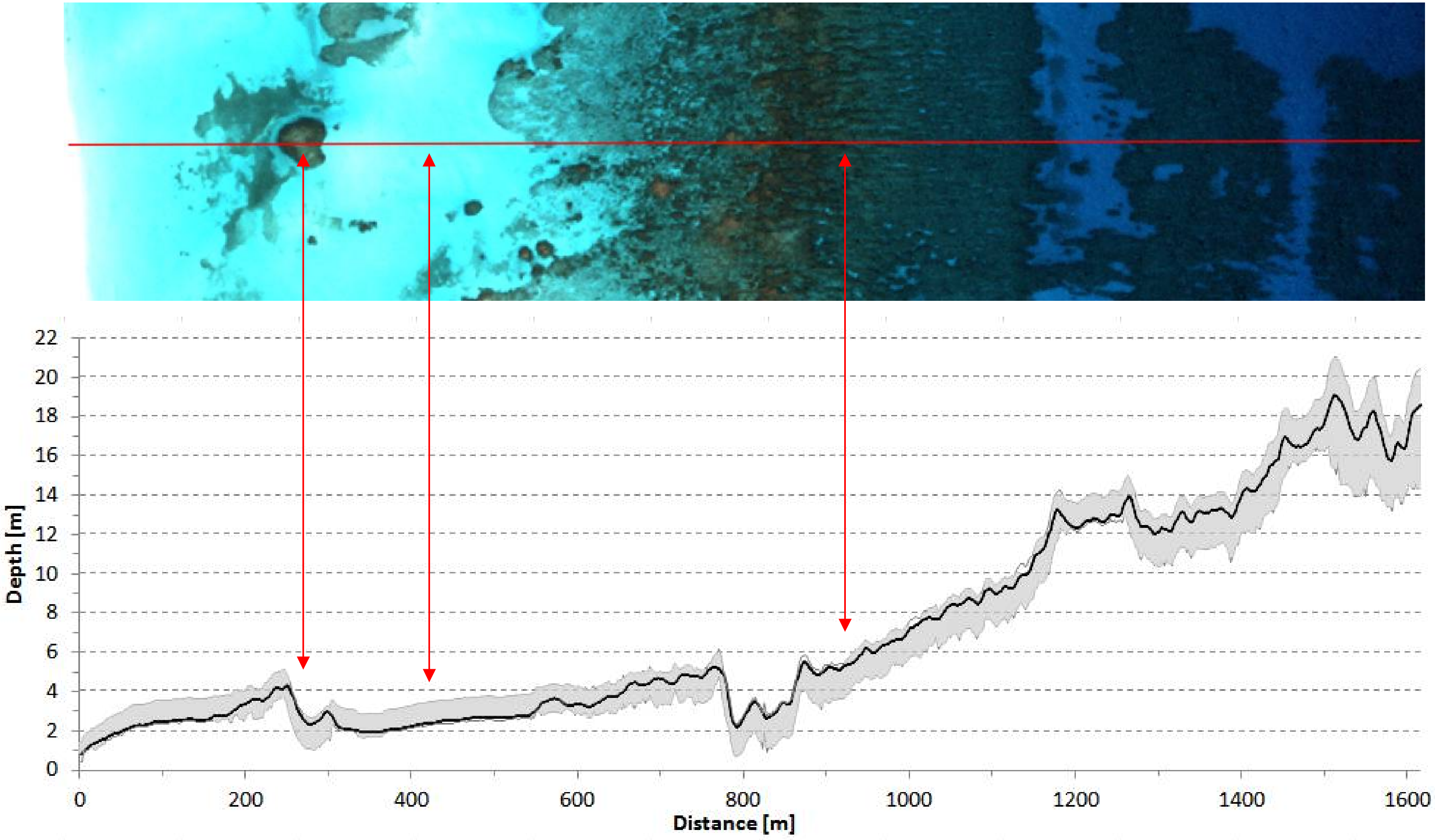
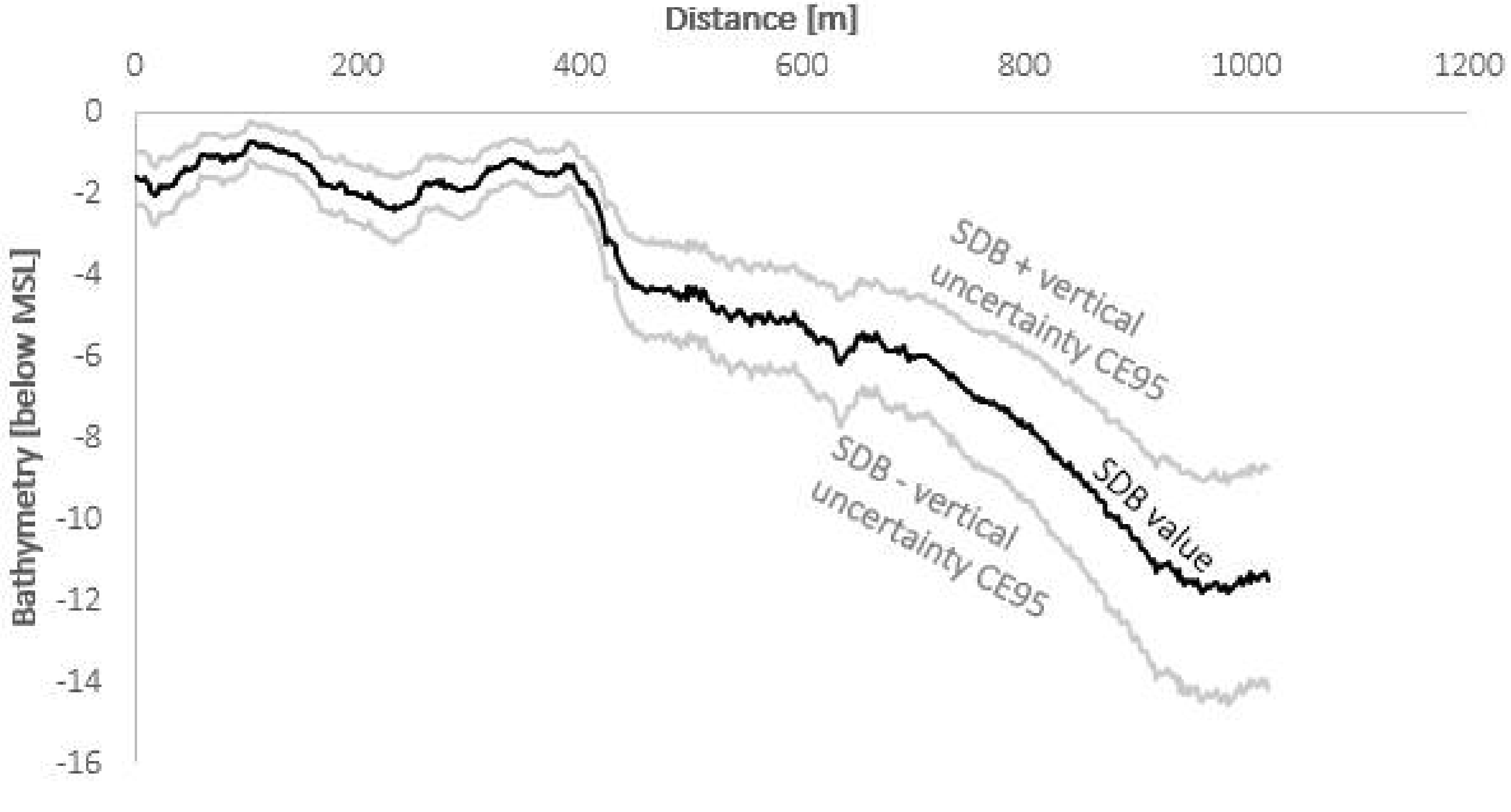
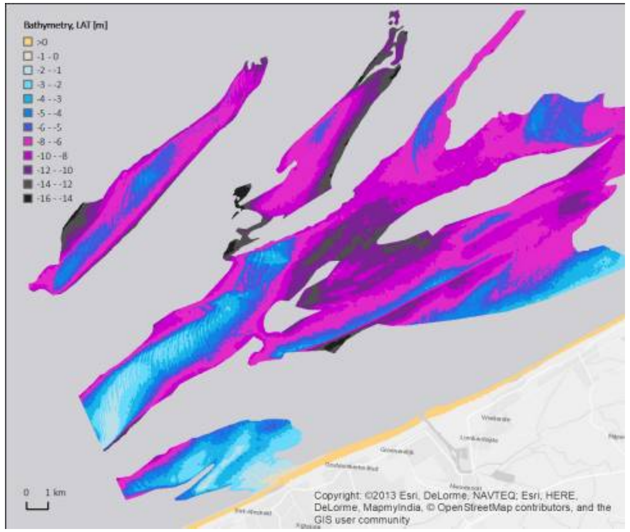

offset 1.00 m + 0.15 % depth (85 % of data)
offset 0.50 m + 0.10 % depth (58 % of data)
Tropic_Twilight_2011_Soundings_UTM2S_2m_AOI33.tif
K_ATA_SDBFP_WGS84UTM02S_2d0_2018_NA_170919_215123_ChartDa

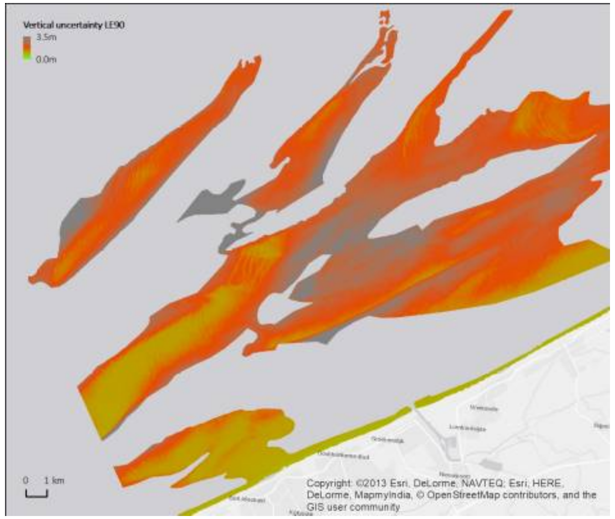
Uncertainties



New SDB file format: XYZV



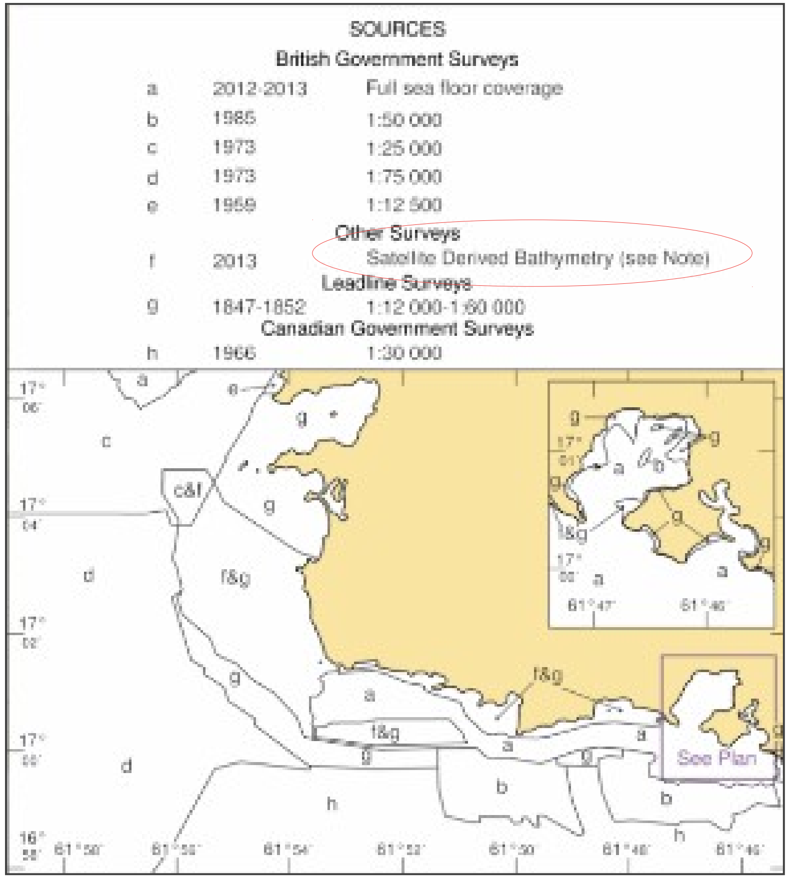


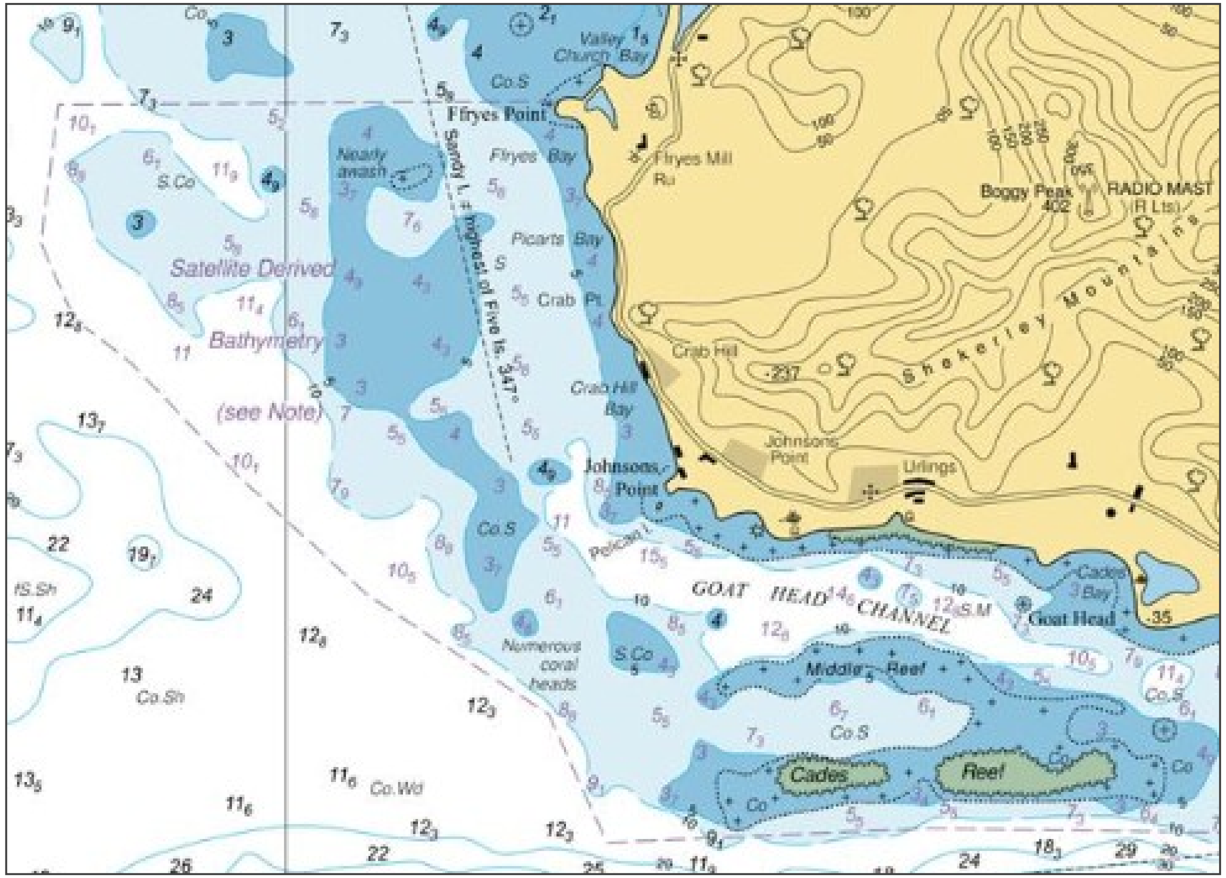


SDB in Charts

Charting

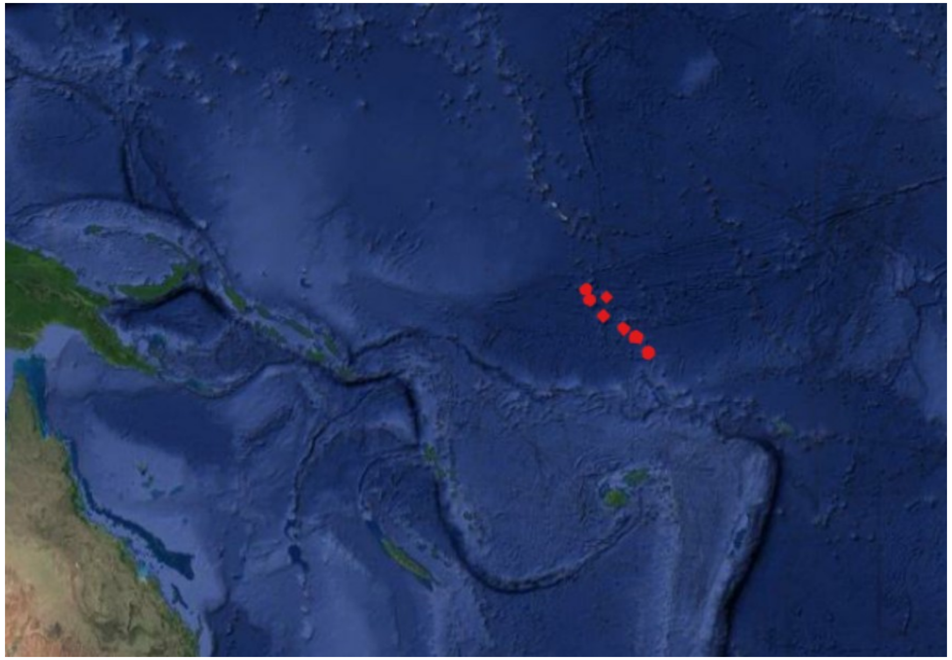
EOMAP’s SDB in chart BA2066, the first UKHO chart which includes SDB data.



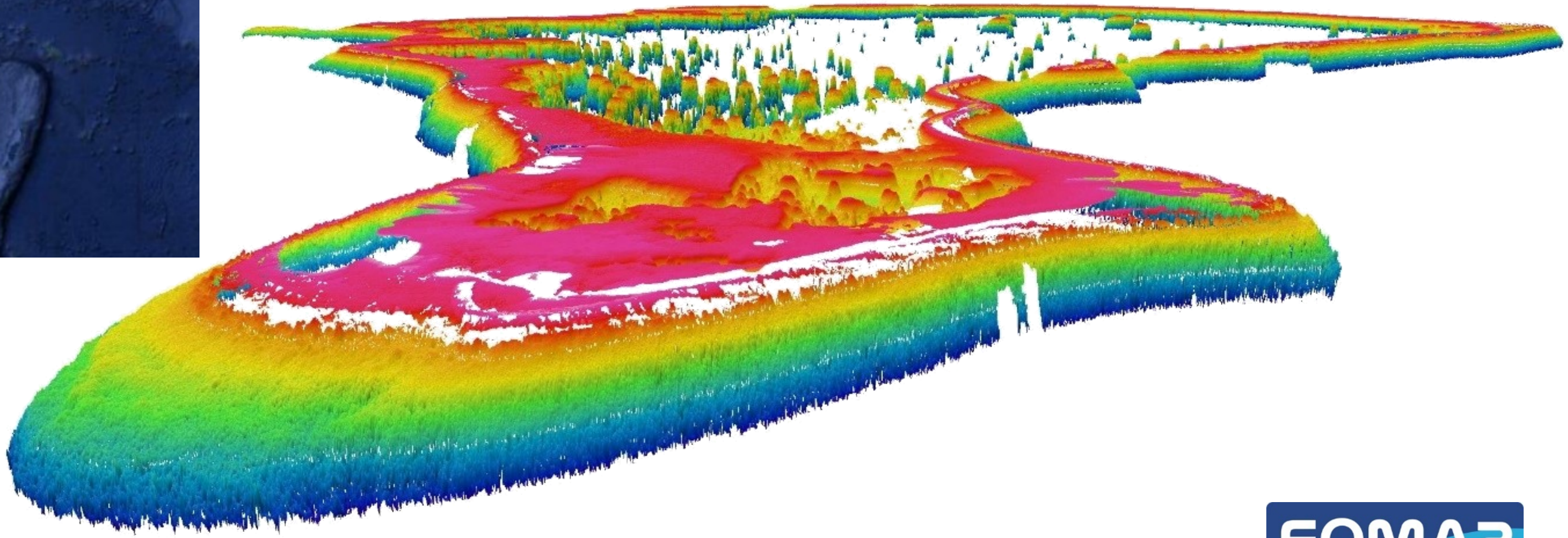


Charting

Tuvalu SDB survey for UKHO



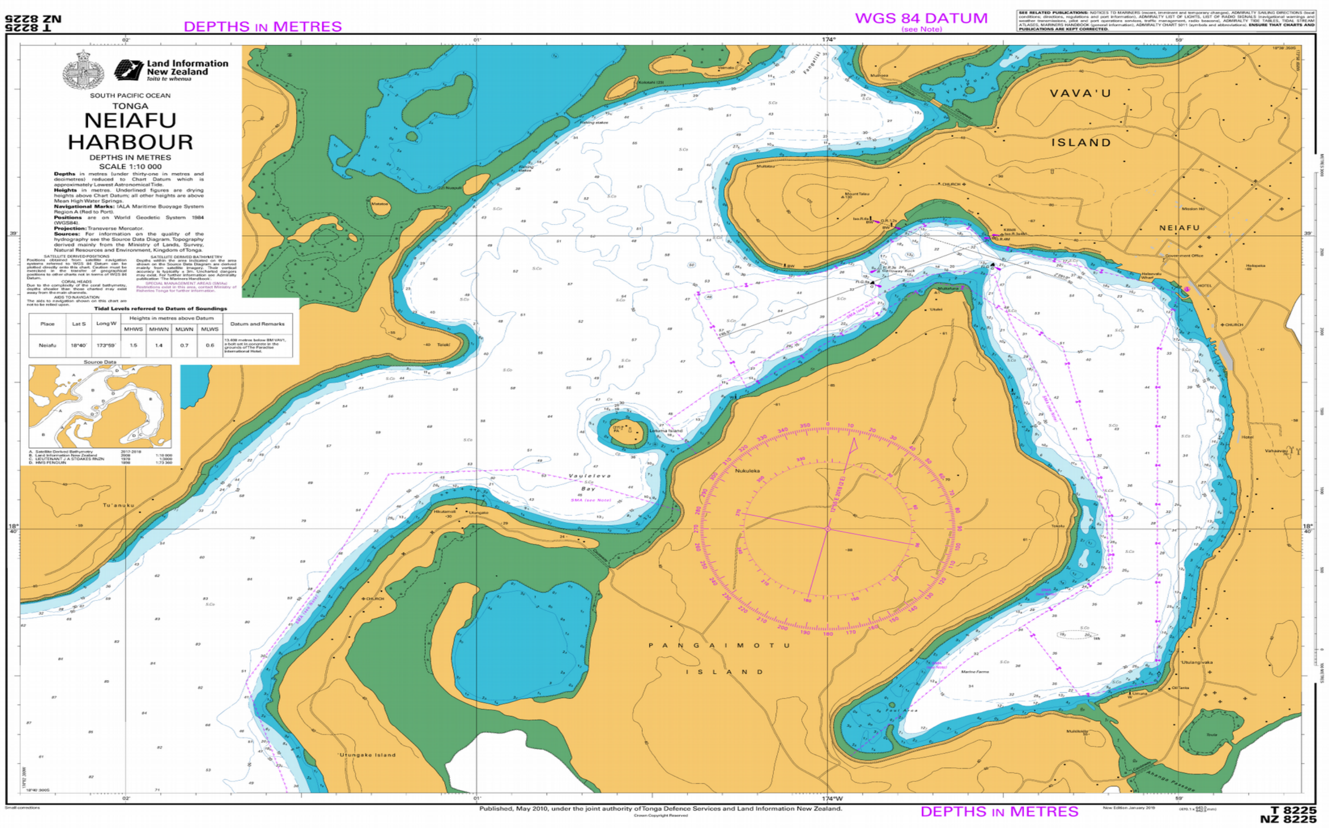
Supporting update of British Admiralty Charts using SDB for 7 atolls of Tuvalu. 11/2017-03/2018

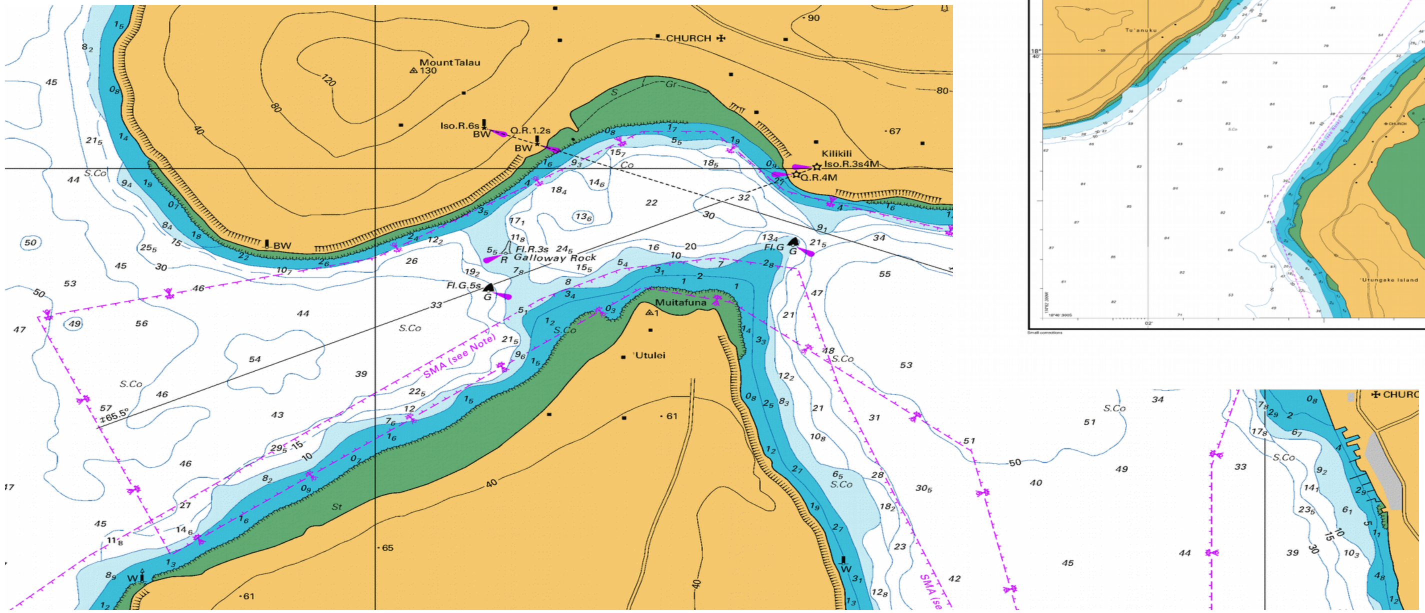


Charting

LINZ PRNI Project

‘Best Available Data’





SATELLITE DERIVED BATHYMETRY

Depths within the area indicated on the area shown on the Source Data Diagram are derived mainly from satellite imagery. Their vertical accuracy is typically ± 3m. Uncharted dangers may exist. For further information see Admiralty publication 'The Mariners Handbook'.

Can be fullfilled with SDB

ZOC [1]	Position Accuracy [2]	Depth Accuracy [3]		Seafloor Coverage	Typical Survey Characteristics [5]
A1	± 5 m + 5% depth	=0.50 + 1%d		Full area search undertaken. Significant seafloor features detected [4] and depths measured.	Controlled, systematic survey [6] high position and depth accuracy achieved using DGPS or a minimum three high quality lines of position (LOP) and a multibeam, channel or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 0.6 ± 0.8 ± 1.5 ± 10.5		
A2	± 20 m	= 1.00 + 2%d		Full area search undertaken. Significant seafloor features detected [4] and depths measured.	Controlled, systematic survey [6] achieving position and depth accuracy less than ZOC A1 and using a modern survey echosounder [7] and a sonar or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 1.2 ± 1.6 ± 3.0 ± 21.0		
B	± 50 m	= 1.00 + 2%d		Full area search not achieved; uncharted features, hazardous to surface navigation are not expected but may exist.	Controlled, systematic survey achieving similar depth but lesser position accuracies than ZOC A2, using a modern survey echosounder [5], but no sonar or mechanical sweep system.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 1.2 ± 1.6 ± 3.0 ± 21.0		
C	± 500 m	= 2.00 + 5%d		Full area search not achieved, depth anomalies may be expected.	Low accuracy survey or data collected on an opportunity basis such as soundings on passage.
		Depth (m)	Accuracy (m)		
		10 30 100 1000	± 2.5 ± 3.5 ± 7.0 ± 52.0		
D	*Worse than ZOC C*	Worse than ZOC C		Full search not achieved, large depth anomalies expected.	Poor quality data or data that cannot be quality assessed due to lack of information.

How to label Satellite-Derived Bathymetry in Charts?

Current ZOC categories are not ideal for SDB evaluation

Alternatives: a matrix approach? separate SDB categories?

(current survey standards also not ideally suited)

To date, agencies have taken a pragmatic approach:
‘Satellite-Derived Bathymetry’

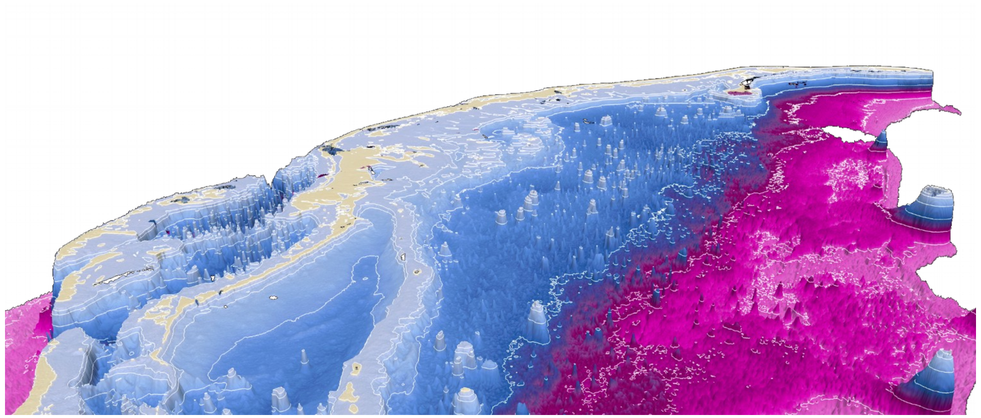
Let’s take the next step.

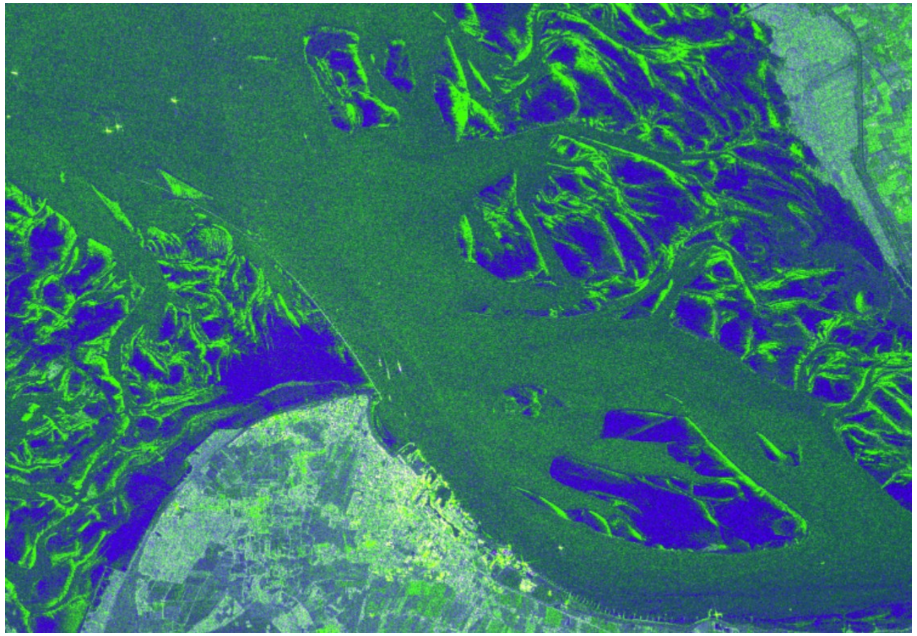
Monitoring change

Monitoring change

Frequent observation and mapping of shallow water, in order to identify changes of seabed in time.

Smarter survey strategies: e.g. continous survey & charting solution





SDB in hydrographic surveys

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Optimise survey efficiency; reducing costs, time and risk

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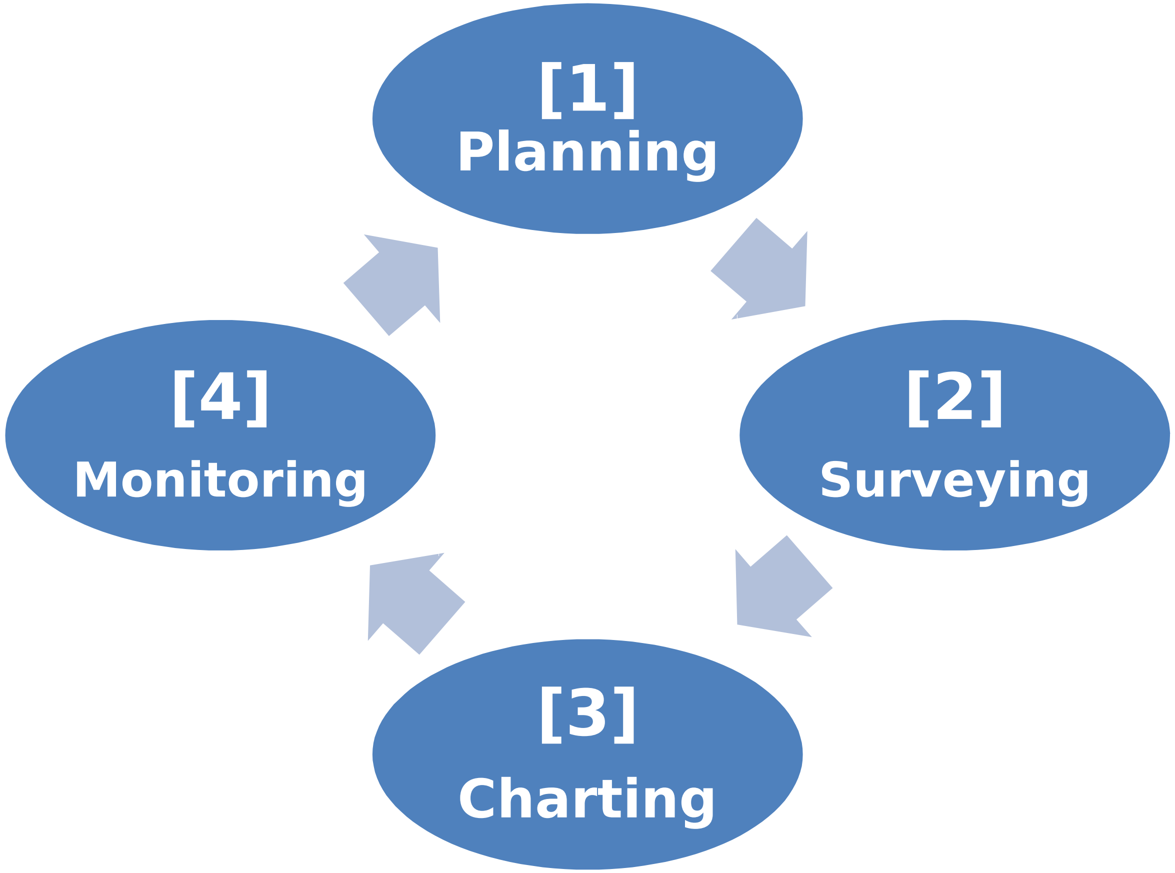
Integrated survey approach: complementary technologies.

Regular monitoring of seabed change



Integration of SDB in charts

A very low cost option

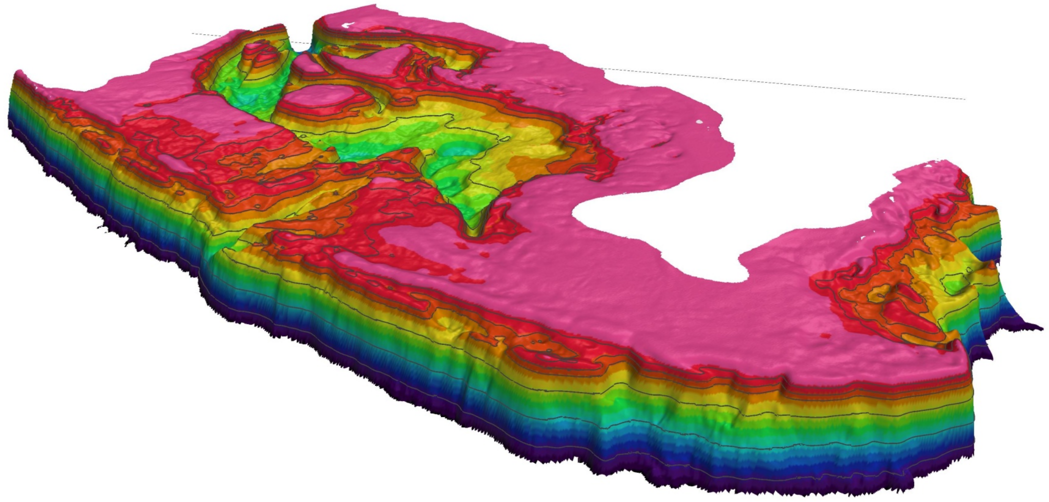
1. Implement band ratio algorithm
(e.g. GEBCO Cookbook)

2. Collect some in situ depth data
(range of depths and substrate types)

3. Use free (good quality) satellite imagery:

- Landsat 8: 30m resolution, online USGS portal

- Sentinel 2: 10m resolution, online ESA portal



Three more things

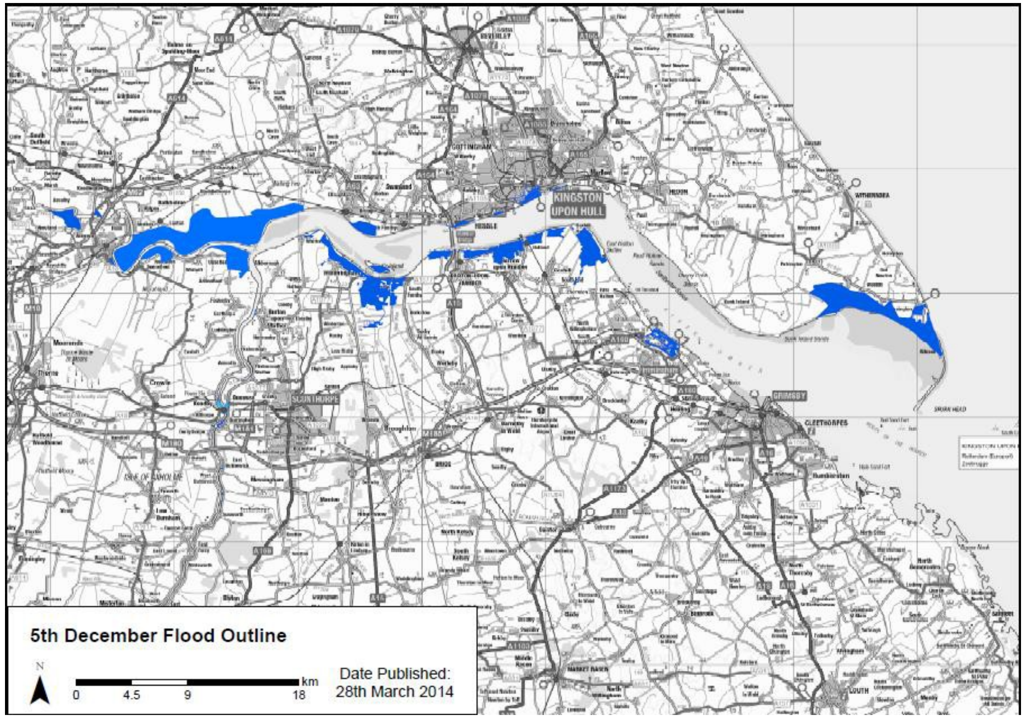
1. Storm surge and inundation: hydrodynamic modeling portal

Consortium to develop EU proposal for easy-to-use, online portal for up-to-date hydrodynamic modeling

Seeking countries/organisations to express formal interest and nominate location(s).

No cost or obligations in return for free access to portal containing your location.

Deadline: next week.



2. SDB capacity building

Training: understanding SDB technologies, production, requirements (e.g. tender specifications), standards, integration into surveys and charts > SDB certification?

Initial, enthusiastic response from Thomas Dehling chair of IHO CBSC.

To be elaborated at Genoa, 2019.

Expressions of interest to CBSC (or EOMAP) welcome.

3. SDB Day 2019, May 14-16
Sunshine Coast, Australia
www.sdbday.org

Government, Defence, Industry, Academia

Thank you

Magnus Wettle
wettle@eomap.com