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Satellite Derived Bathymetry Standardisation

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Introduction

- Satellite Derived Bathymetry (SDB)
- Background
- Data Specifications
- Case Studies
- Future Developments

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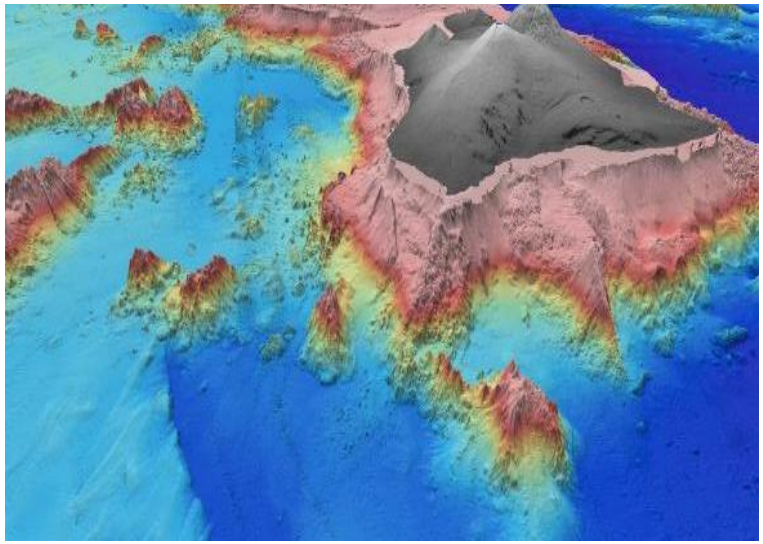
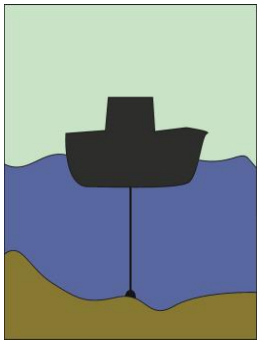
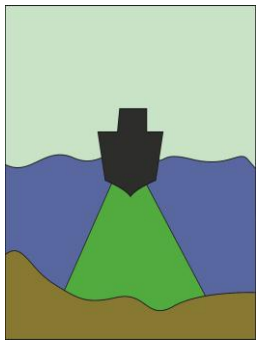
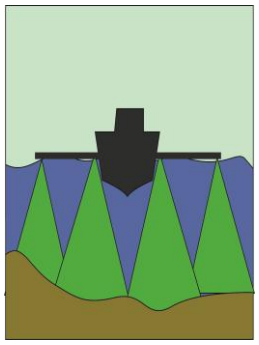
About Proteus

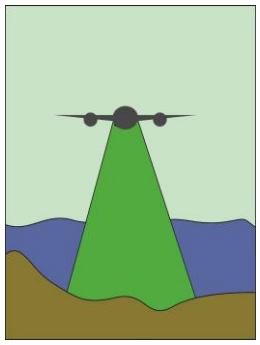
- Formed in UAE 2011
- We specialise in delivering derived products from satellite imagery
- Completed over 30 projects to date all over the world
- Customers include:
  - UKHO, NOAA, AECOM, BP, Aramco, Exxon, Geological Survey Ireland, CH2M, Environment Agency Abu Dhabi

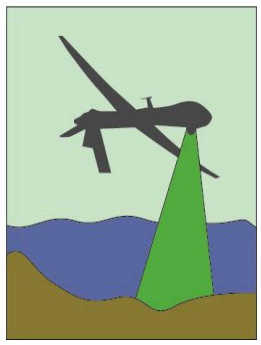


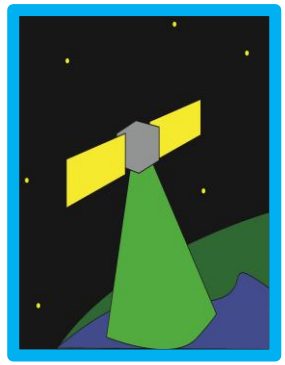












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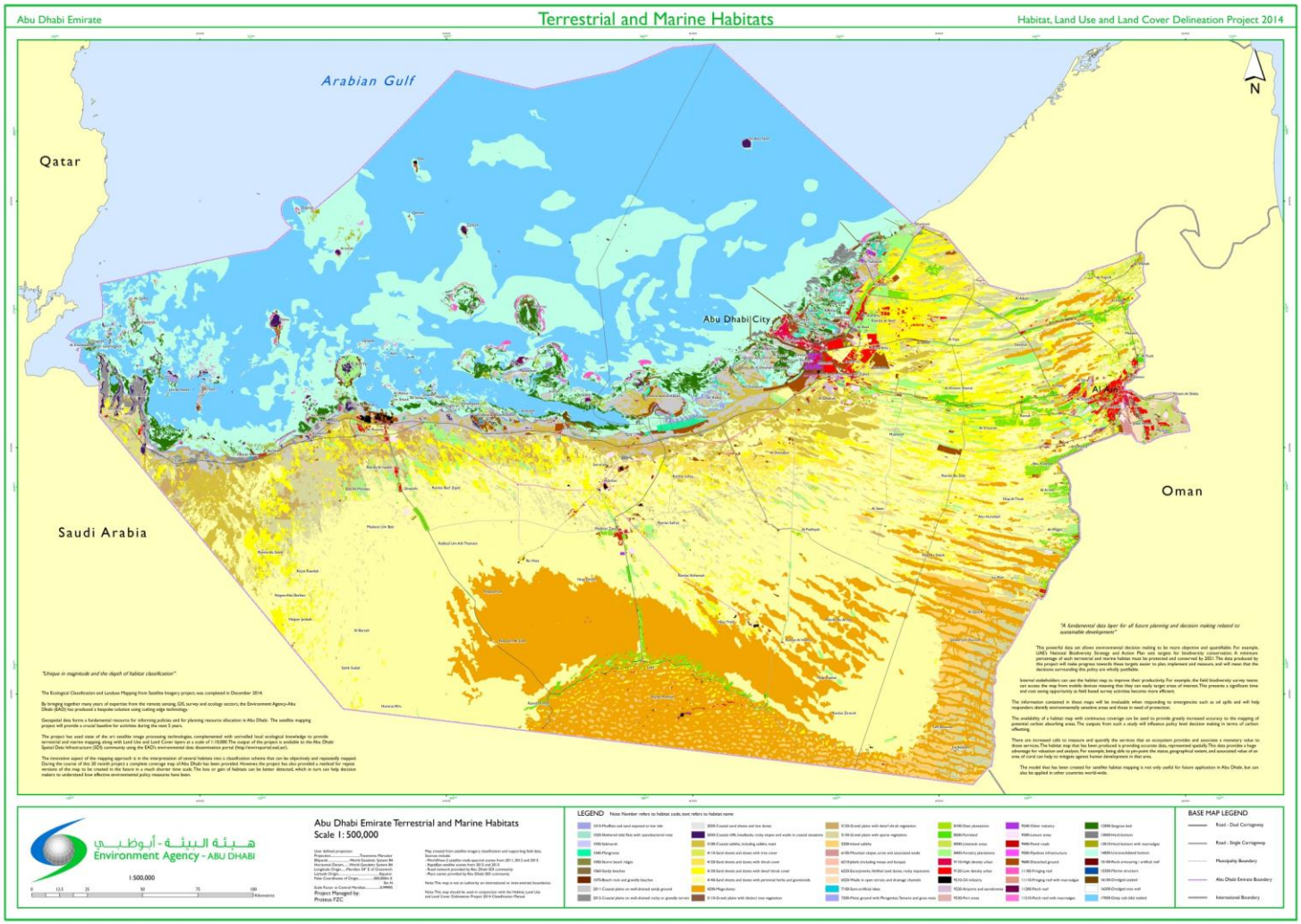
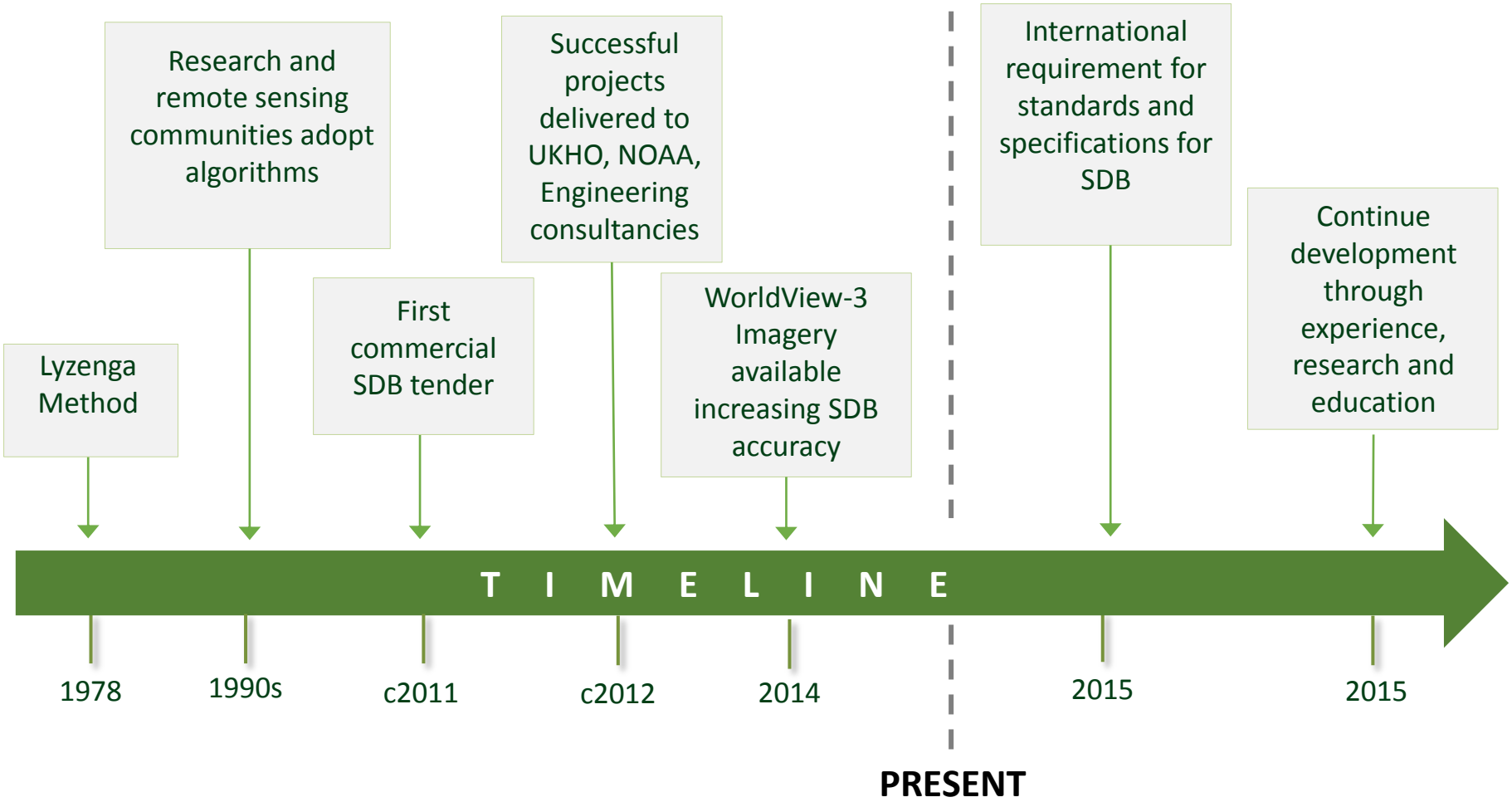
Seafloor environmental mapping - EAD



Not a new technology…



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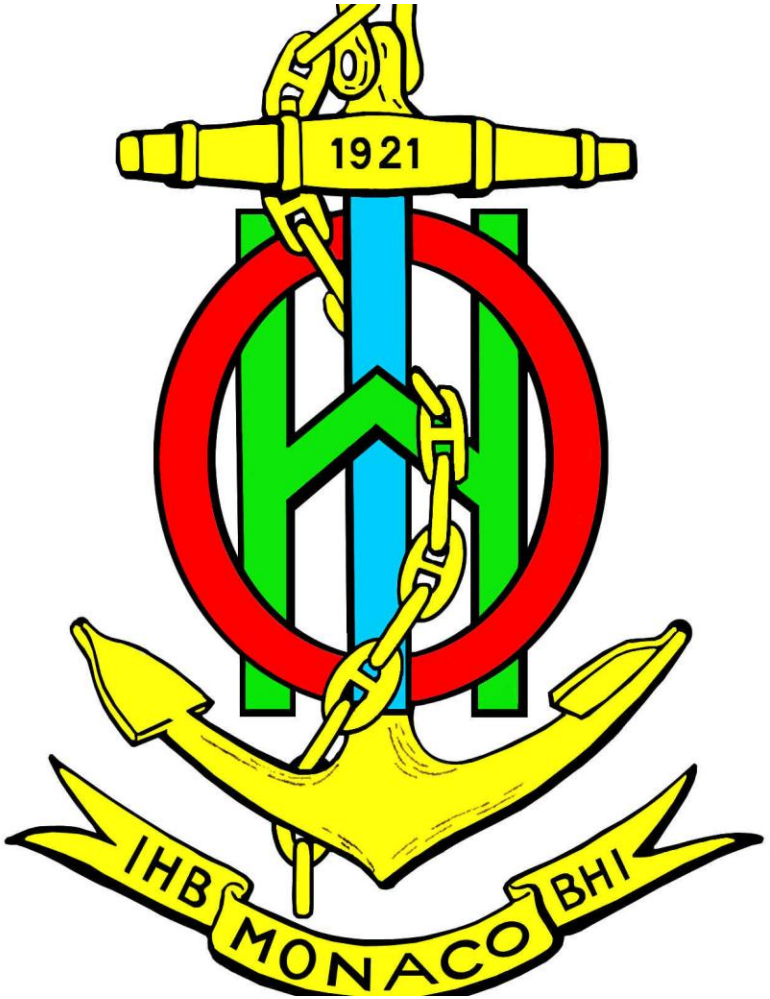
Quote on SDB from IHO “Status report on hydrography & mapping of the world’s seas” Cambridge 2013

“This technique has some limitations for chart production as it does not yet meet the IHO Standards for operational use, but it is very useful where it is the sole source of information and for reconnaissance survey. The latest technological developments indicate the potential for this tool to meet some of the Standards in the near future.”



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SDB deliverables and accuracies

SDB Specifications

Element	Value
Positional accuracy	5 m CE90
Height accuracy (in good water quality)	10% to 15% of depth
Point spacing	2 m
Tidal corrections	Essential to achieve predicted vertical accuracies
Pixel size on sea bed	2 m
Depth penetration	1 to 1.5 x secchi disk
Max depth (Caribbean)	35 m
Max depth (Arabian Gulf)	24 m

SDB Deliverables

Item	Description
Data File(s)	ASCii X,Y,Z files.The Z element can either be relative water depths or reference to a datum of choice.
WorldView-2 Imagery	A 8 channel GeoTiff of the survey area.
MetaData	Associated Meta Data supporting the survey data.
Sea Bed Classification	A GeoTiff and Pdf map illustrating the seabed classifications for the area.
Quality Mapping	A GeoTiff and Pdf map indicating quality.
Geospatial Modeling	A time referenced and colour coded geospatial model.

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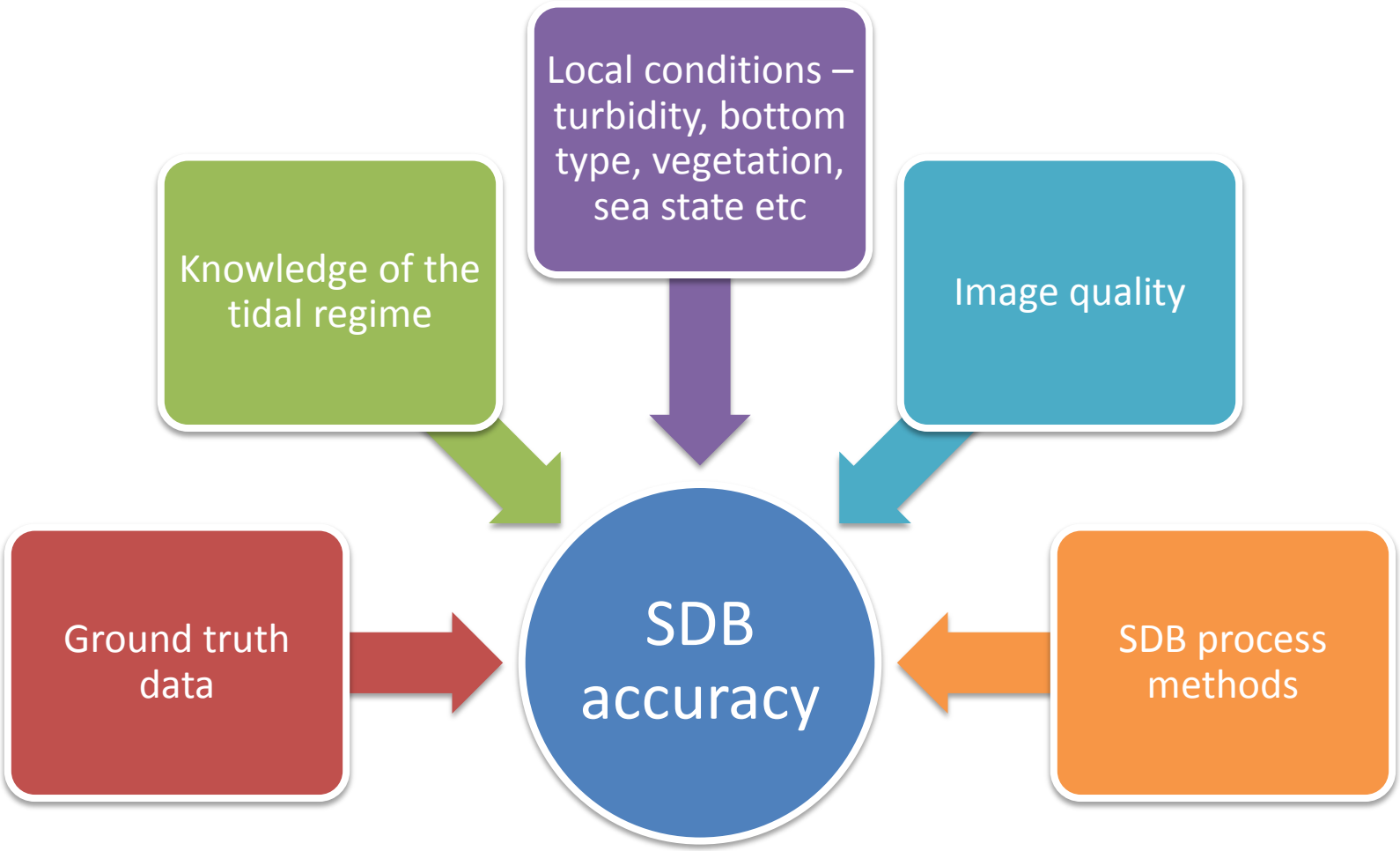
Factors affecting accuracies



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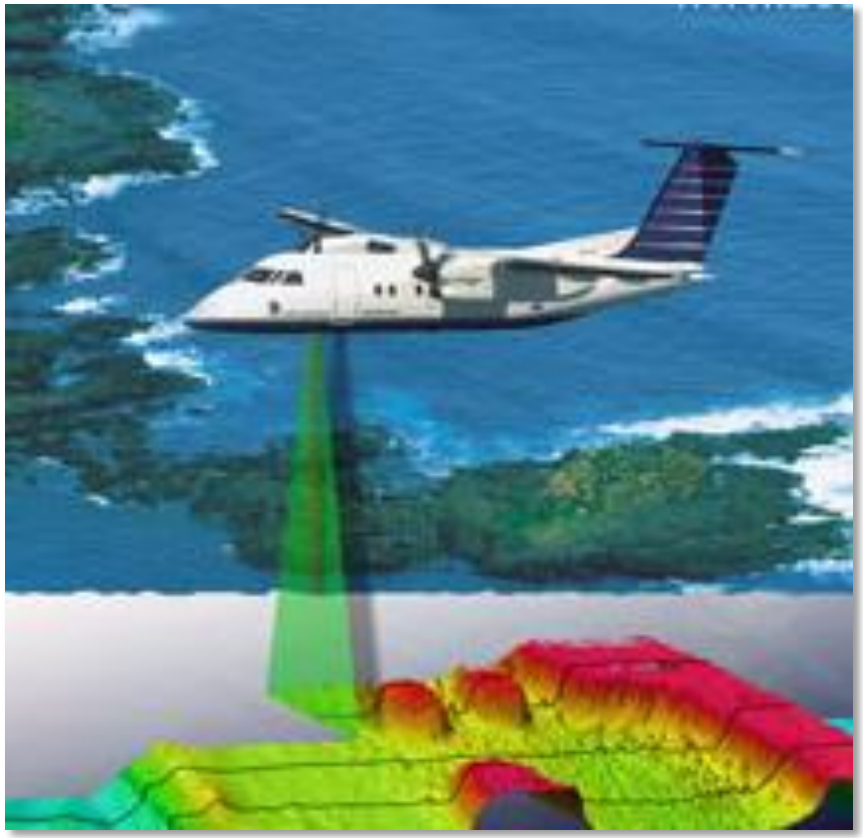
LiDAR specifications and standards

- In mid 2000's LiDAR was recognised as an alternative technology to MBES for navigation & charting
- Several companies and HO's worked together to produce international standards that would allow LiDAR to contribute to navigation surveys
- These standards were adopted into IHO S-44 hydrographic standards in 2008



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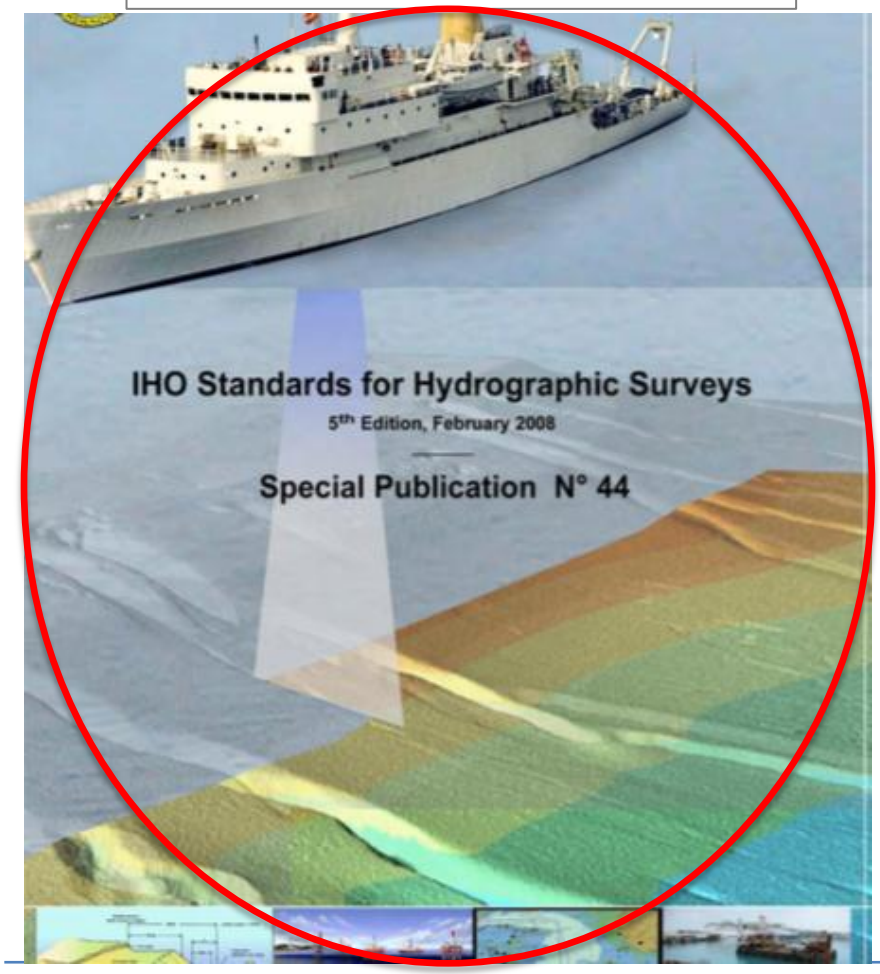
Current standards

IHO S44 standards 2008



IHO S57 Standards 2000

IHO TRANSFER STANDARD
for
DIGITAL HYDROGRAPHIC DATA

Edition 3.1 - November 2000

Special Publication No. 57

Published by the
International Hydrographic Bureau
MONACO

S-57

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Current standards – S44 table

Concession for LiDAR

Reference	Order	Special	1a	1b	2
Chapter 1	**Description of areas.**	Areas where under-keel clearance is critical	Areas shallower than 100 metres where under-keel clearance is less critical but *features* of concern to surface shipping may exist.	Areas shallower than 100 metres where under-keel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas generally deeper than 100 metres where a general description of the sea floor is considered adequate.
Chapter 2	**Maximum allowable THU 95% *Confidence level***	2 metres	5 metres + 5% of depth	5 metres + 5% of depth	20 metres + 10% of depth
Para 3.2 and note 1	**Maximum allowable TVU 95% *Confidence level***	a = 0.25 metre b = 0.0075	a = 0.5 metre b = 0.013	a = 0.5 metre b = 0.013	a = 1.0 metre b = 0.023
Glossary and note 2	***Full Sea floor Search***	Required	Required	Not required	Not required
Para 2.1 Para 3.4 Para 3.5 and note 3	***Feature Detection***	Cubic *features* > 1 metre	Cubic *features* > 2 metres, in depths up to 40 metres; 10% of depth beyond 40 metres	Not Applicable	Not Applicable
Para 3.6 and note 4	**Recommended maximum Line Spacing**	Not defined as *full sea floor search* is required	Not defined as *full sea floor search* is required	3 x average depth or 25 metres, whichever is greater For bathymetric lidar a spot spacing of 5 x 5 metres	4 x average depth
Chapter 2 and note 5	**Positioning of fixed aids to navigation and topography significant to navigation. (95% *Confidence level*)**	2 metres	2 metres	2 metres	5 metres
Chapter 2 and note 5	**Positioning of the Coastline and topography less significant to navigation (95% *Confidence level*)**	10 metres	20 metres	20 metres	20 metres
Chapter 2 and note 5	**Mean position of floating aids to navigation (95% *Confidence level*)**	10 metres	10 metres	10 metres	20 metres

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Current standards – does Satellite Data fit in S44?

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Current trials to determine standards and confidence levels

Antigua

- Very rigorous trial involving British Royal Navy and UKHO
- 3 different SDB methods used, and each method processed 4 times with various degrees of control = 12 separate deliveries
- DigitalGlobe WV02 newly tasked imagery has been used in conjunction with tide gauges for improved accuracies
- Project evaluation will not be completed for several months and it is not clear at this stage what the outcome will be and how the information will be used.

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Current trials to determine standards and confidence levels

Scilly Isles

- Catapult (Harwell), UK has commissioned a trial to develop a suitable standard for SDB over Scilly Isles, UK
- Using archive WV02 imagery, SDB has been processed & delivered and is being evaluated against LiDAR data by an independent consultant
- Trial evaluation is ongoing to compare results and present to IHO in near future
- Currently unsure how trial will be received by IHO or how the data will be used to determine future standards for SDB

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Results to date

Antigua

So far the following can be concluded:

- SDB appears to be accurate down to 4 or 5 m when compared against MBES
- The 10% vertical accuracy claimed by SDB companies may not be true for depths greater than 5 m – more likely to be 12% to 15%?
- Each different production method produced different results – lack of consistency
- UKHO will be using SDB data in their chart publication here from May 2015

Scilly Isles

Results so far:

- Dynamic area has led to certain features such as sand bars to move over 150 m in 3 years!
- In order to achieve accuracies archive imagery may have to be assessed if appropriate for dynamic areas
- Potential for providing a good indication of depths from 0m – 5m, and a general indication to 20m
- There is an urgent need to create a standard that articulates the uncertainties of SDB.

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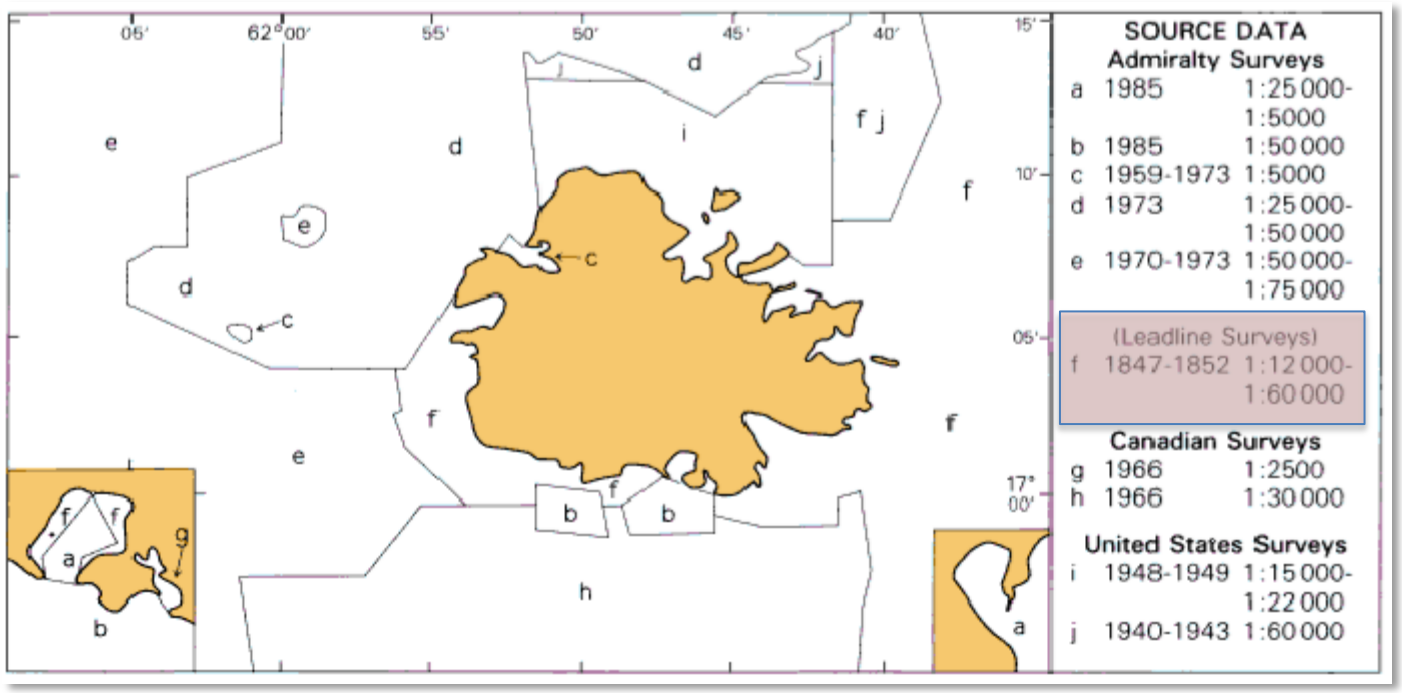
Current trials to determine standards and confidence levels



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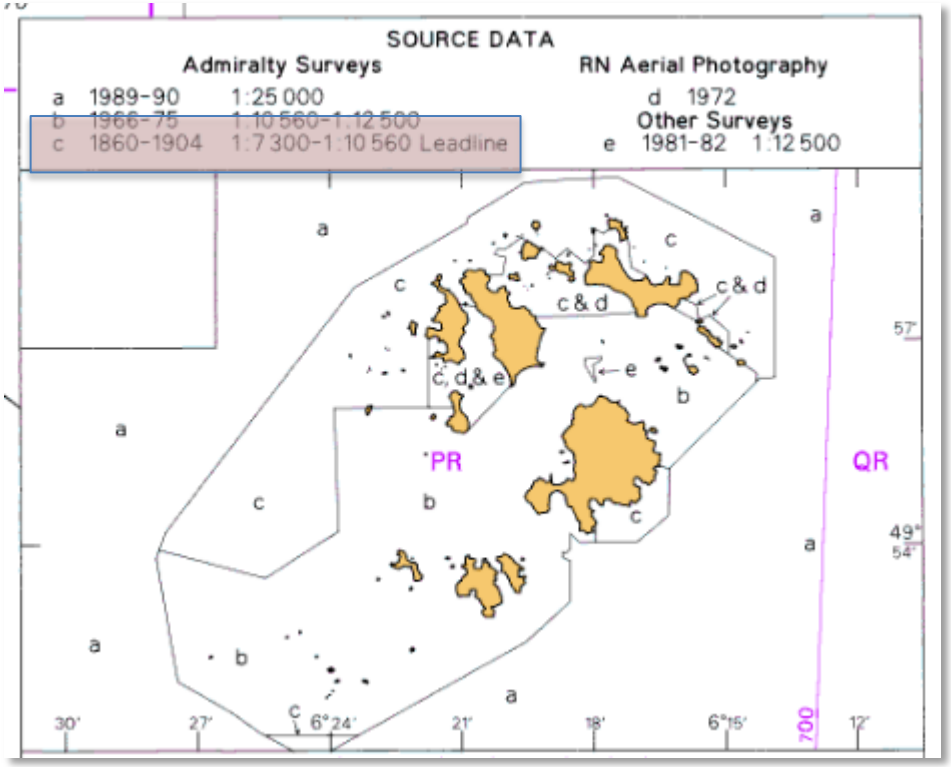
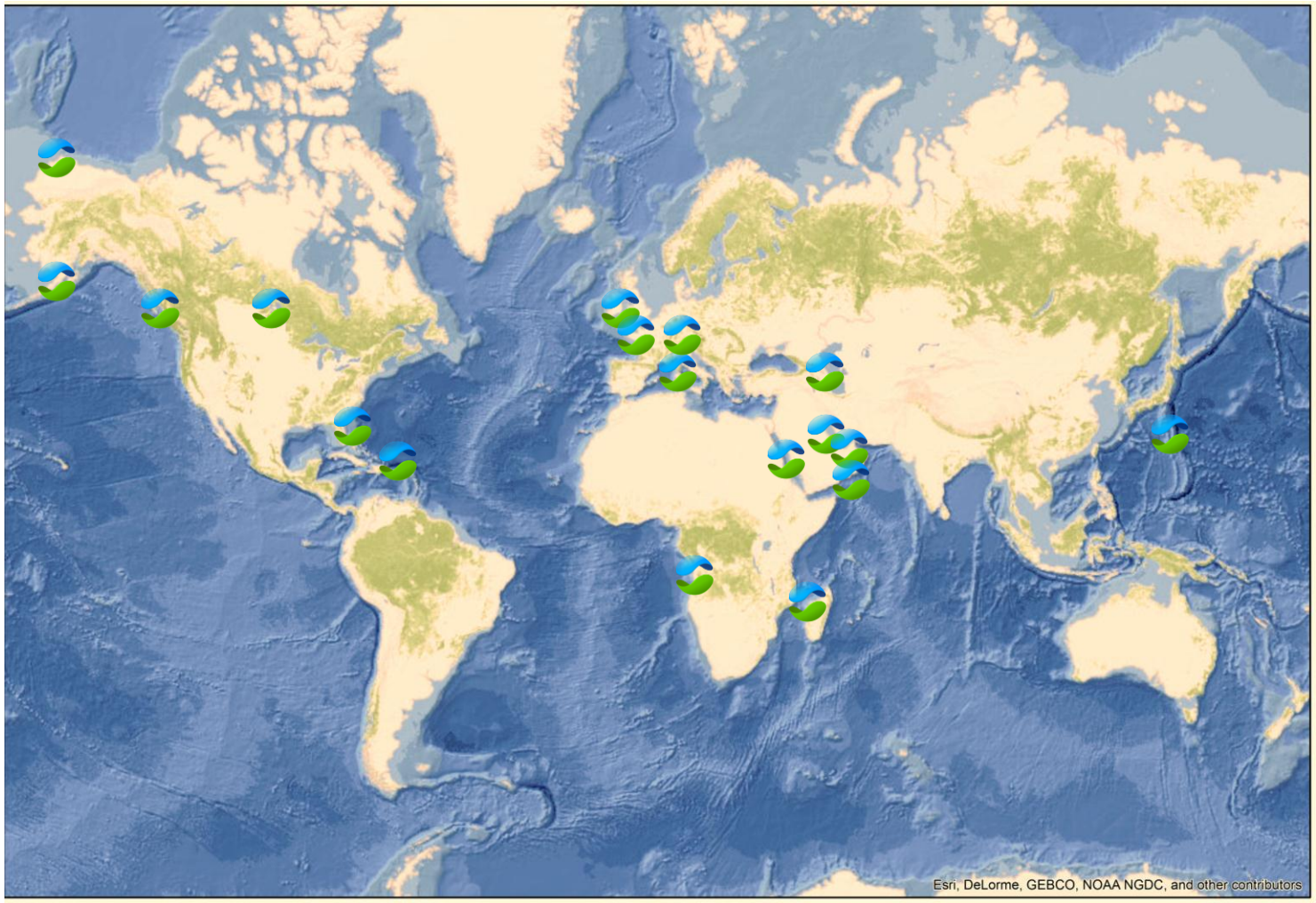


Worldwide interest



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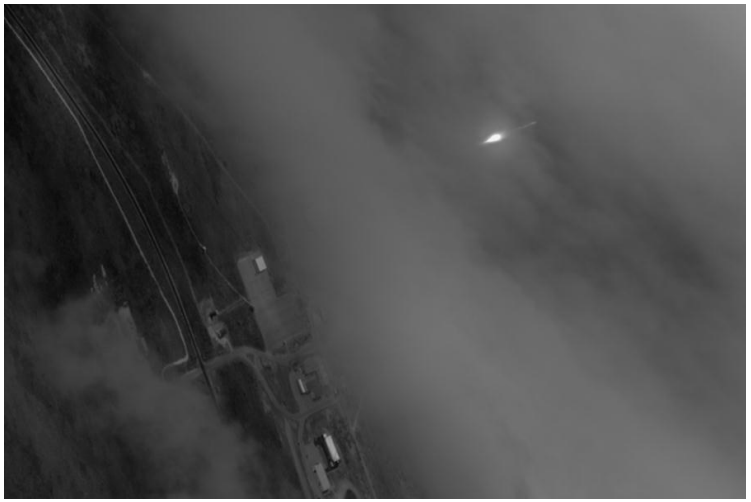
WorldView-3



WorldView-3

Main instrument:

Panchromatic

+ 8 multispectral bands

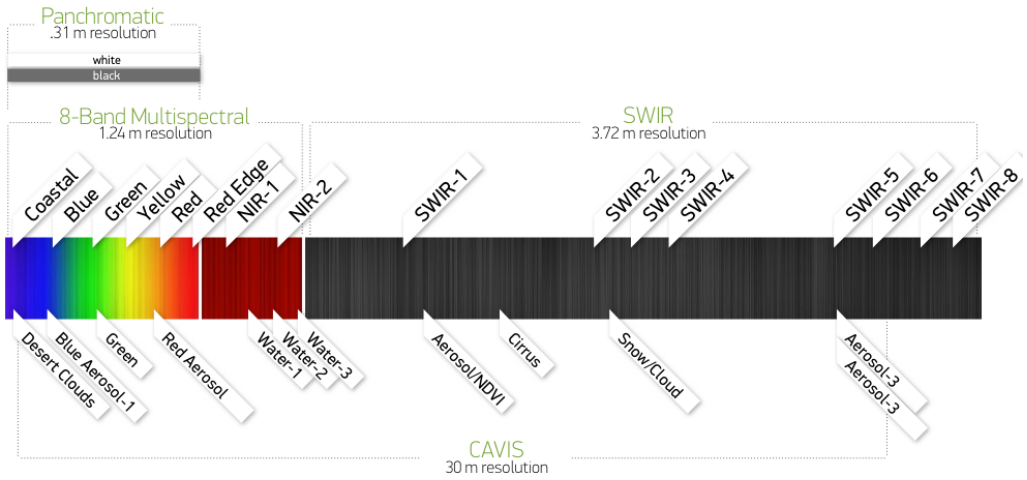
Secondary instruments:

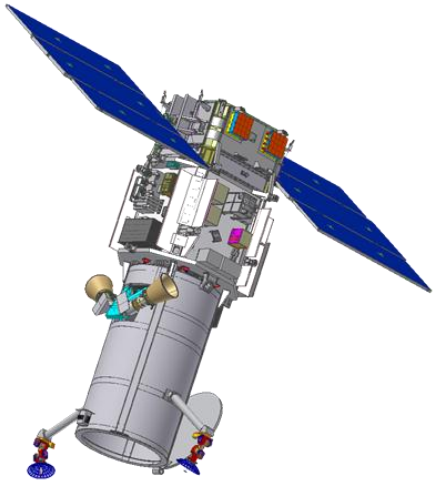
8 SWIR bands

+ 12 atmospheric correction bands

Resolution:

.31 meter, <3.5 m CE90





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Conclusions and thoughts

- SDB should be treated as another “tool in the box”.
- Adoption of an SDB standard is crucial if SDB is to be used for navigation and charting
- Preferably, inclusion should be non equipment specific i.e. not specifically for SDB but for any technology
- Personal observations:
  - There appears to be a lack of cohesion between HO’s to pursue a common path for development of international standards
  - Lack of consistency in production methods may hamper the standardisation process?
  - Not only is the vertical accuracy an issue but overcoming the confidence levels could be a major factor for standardisation
- It would be beneficial for all if SDB was standardised and accepted by HO’s!

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