Monitoring Coastal Change From Space

A case study of applying satellite derived bathymetry in Australia

Heiko Loehr[1] | Evan Watterson[1] | Matthew Harry[2]

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[1]Bluecoast Consulting Engineers

[2]NSW Department of Industry – Lands

Satellite Derived Bathymetry (SDB)

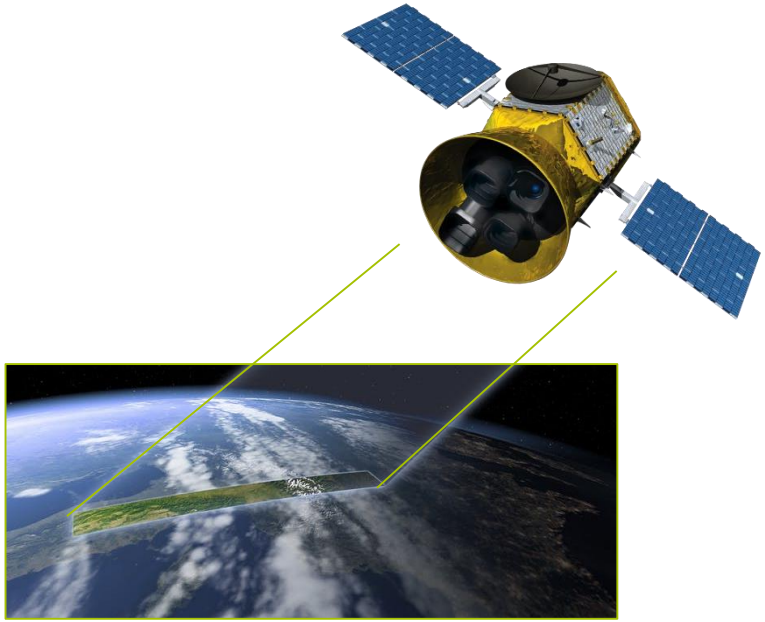
High-resolution **imagery** captured **every WEEK** (2x2 metres)

↓

EOMAP - **bathymetry data conversion**

↓

5 – 10x less expensive than typical survey!



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Satellite Derived Bathymetry (SDB)

Advantages

- **Cost-effective**
- Capturing **large areas** in one snapshot (instantly)
- **Regular capture** of imagery (no matter what)
- **Gridded data** -> high cross-shore and along-shore resolution
- Safe & risk free (**no vessels**, labour etc)
- **Historic database** of over 10 years
- **ACCURATE!**

Limitations

- Requires clear water
- Cloud cover/ glare
- Surface waves/ wave breaking
- Shallow water (down to ~15m depth)
- Minimum image size (25 km^2)

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Pilot study: Can we use this technology in Australia?

- Idea!
- How does this compare to typical survey data (accuracy/validation)?
  - Detect bathymetric changes between subsequent ‘survey’ dates?
    - Automation of analysis and standardised reporting!

- Why?
- Cost-reduction in monitoring of nearshore morphology
  - Monitoring more frequently and of greater spatial areas
    - Better understanding of our coastlines for coastal management & planning

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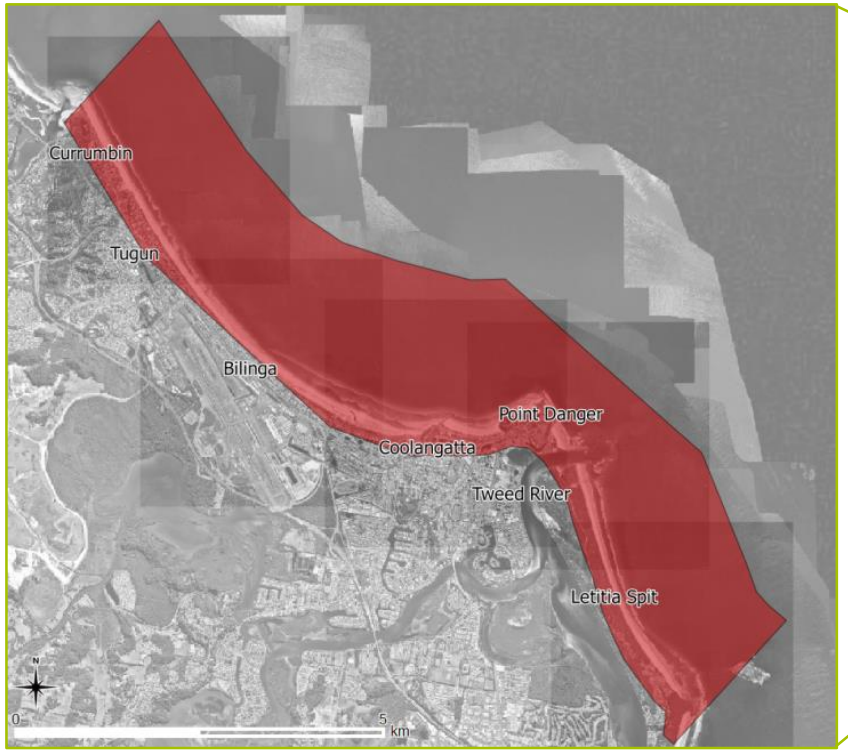
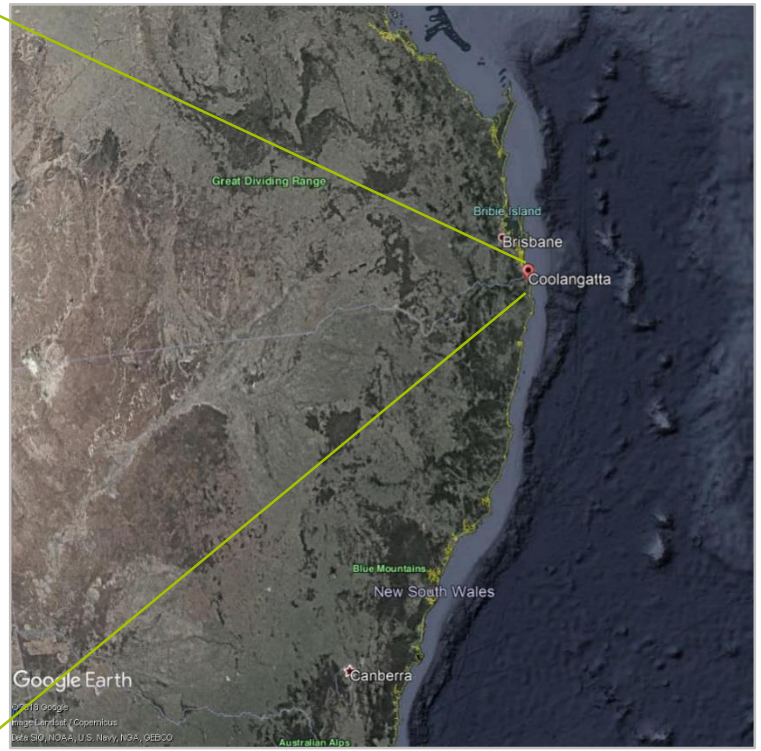
Study Site: Gold Coast (QLD) - Tweed Heads (NSW)





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Pilot study datasets

- **1st July 2016**

2x2 metres gridded satellite derived bathymetry (25 km^2 area)

- **21st July 2017**

2x2 metres gridded satellite derived bathymetry (25 km^2 area)

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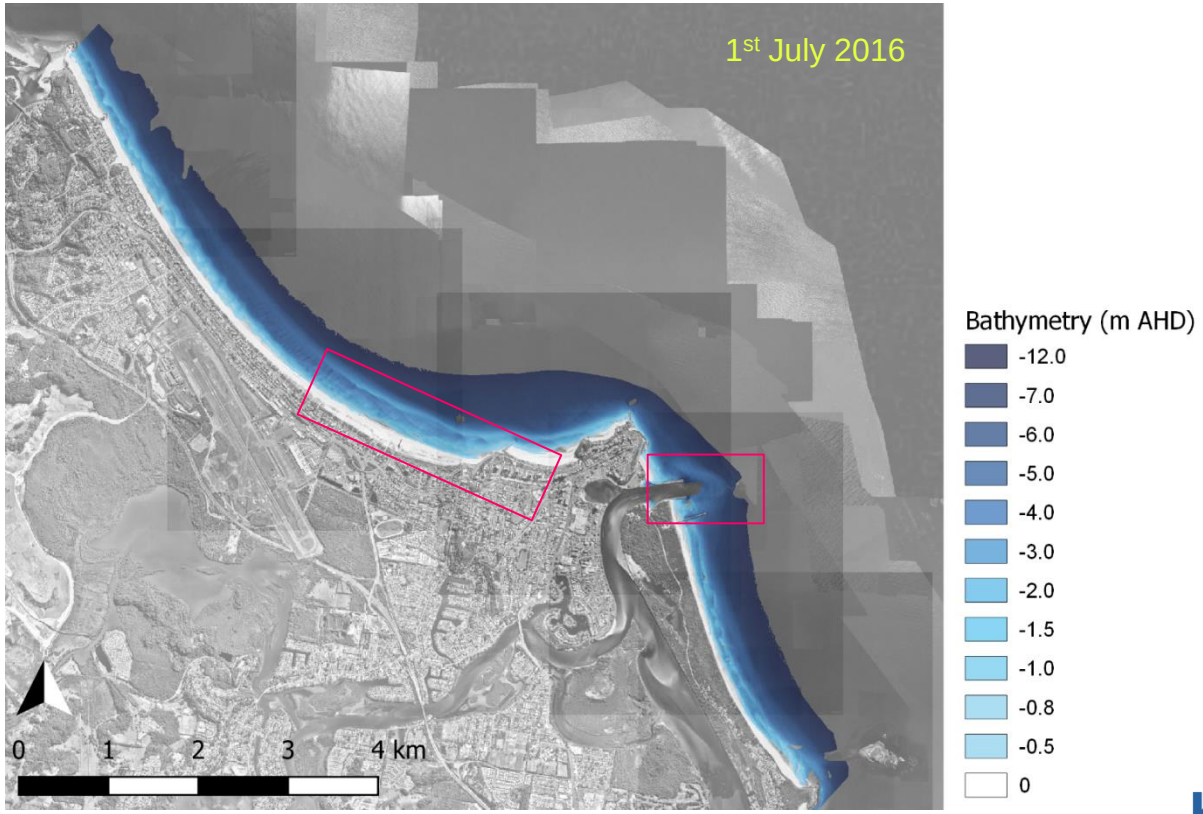
2016 Satellite Derived Bathymetry (2x2 metres)



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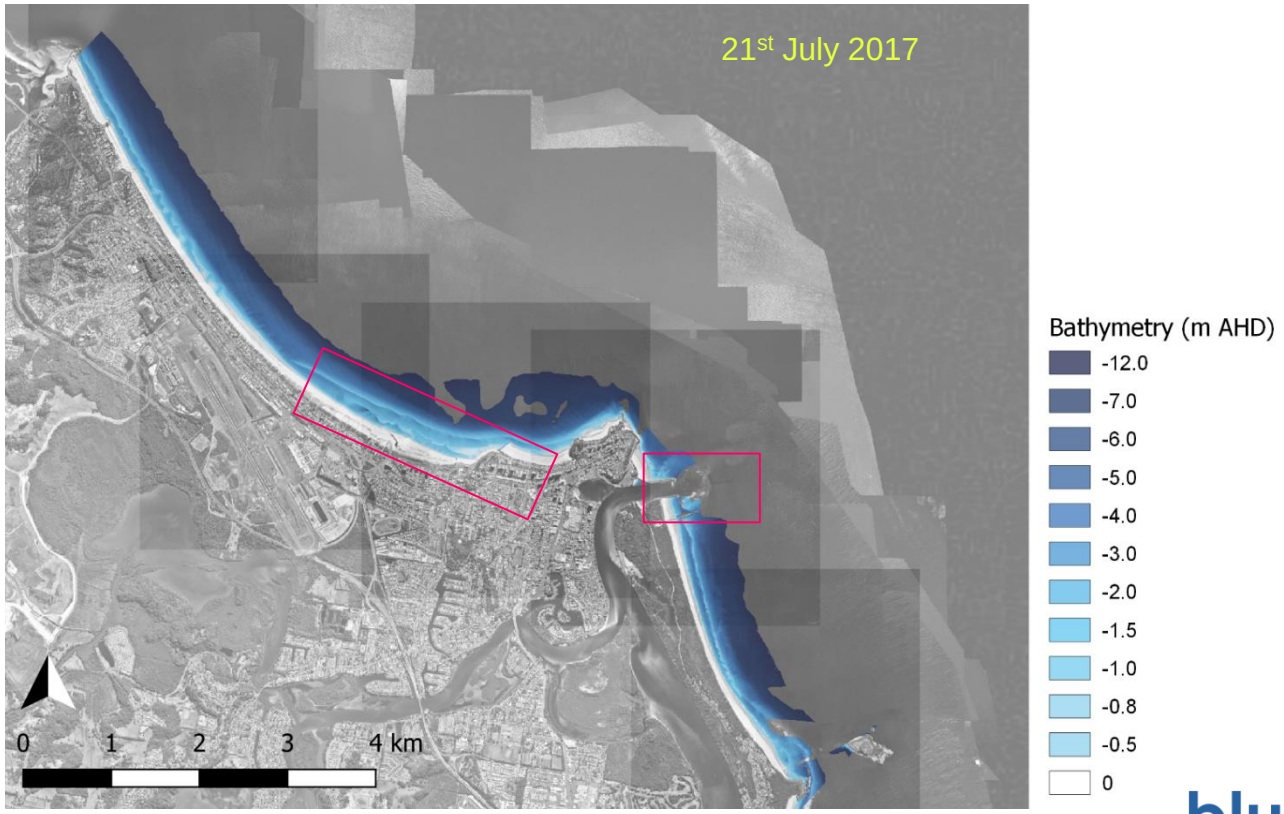
2017 Satellite Derived Bathymetry (2x2 metres)



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Comparison with typical survey: datasets

- **24th May 2016** Single Beam Echo Sounder (SBES) survey
  - Captured **38 days prior** to Satellited Derived Bathymetry
  - Survey transects every ~40 to 100 metres along-shore
  - Survey points every ~5 to 10 metres cross-shore
  - City of Gold Coast annual coastal survey

- **31st July 2017** SBES survey
  - Captured **10 days after** Satellited Derived Bathymetry
  - Same as above

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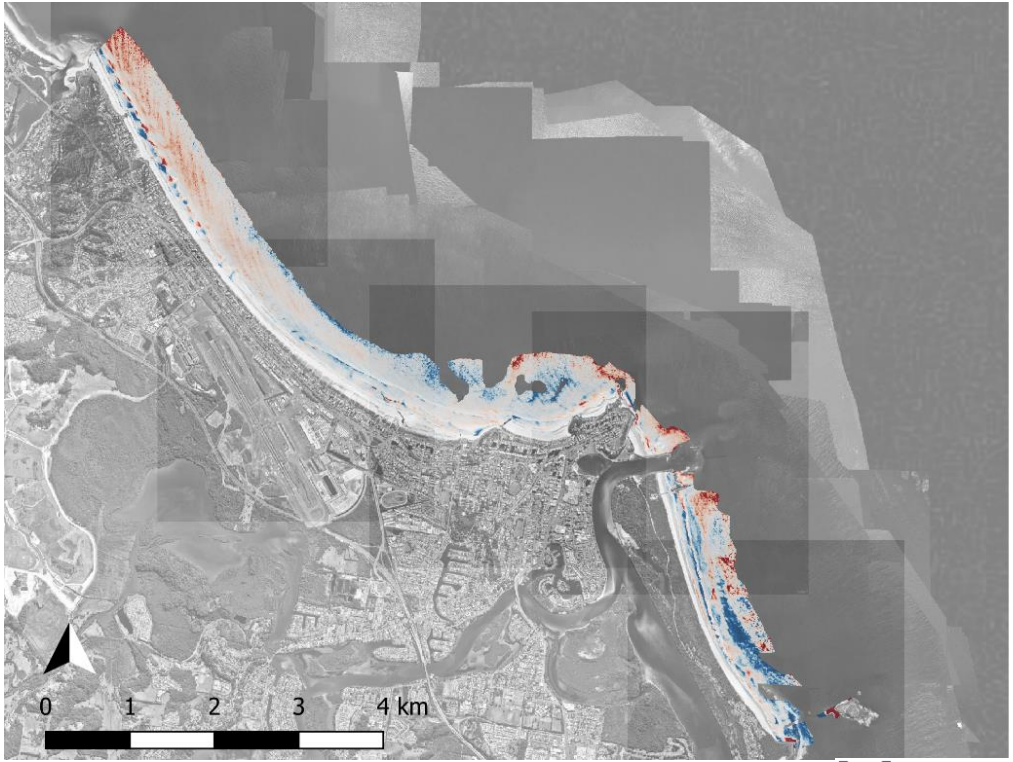
Comparison with typical survey: 2017 data

- Bathymetry difference less than ~0.5 metres
- Some difference due to natural change between survey dates



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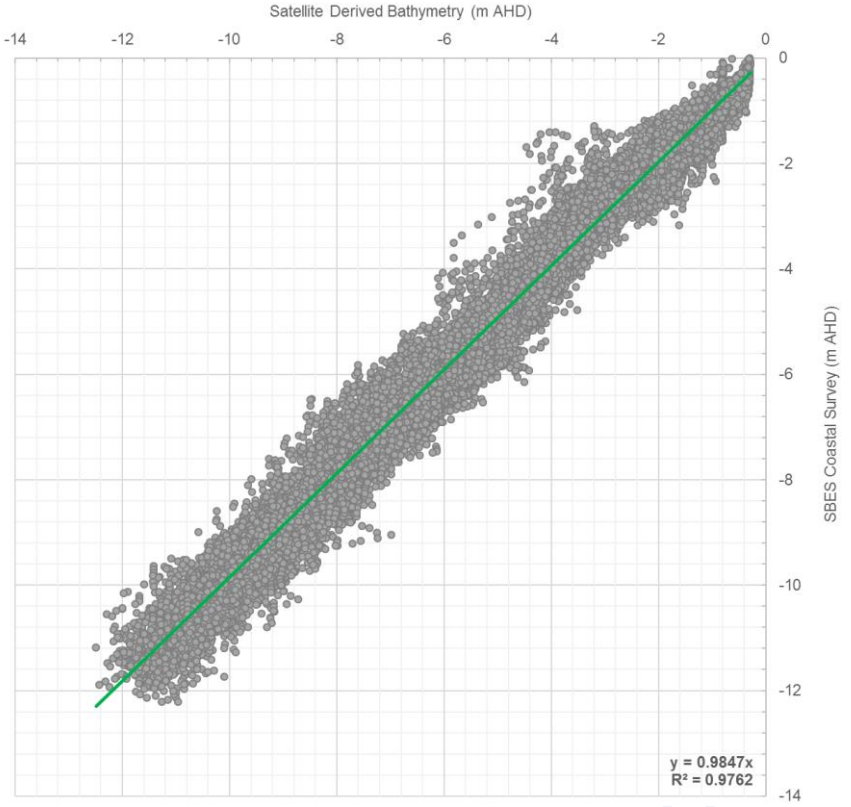
Comparison with typical survey: 2017 data

Statistical difference between SDB and SBES survey:

- Mean = 0.36 metres
- StDev = 0.46 metres
- RMS = 0.31 metres



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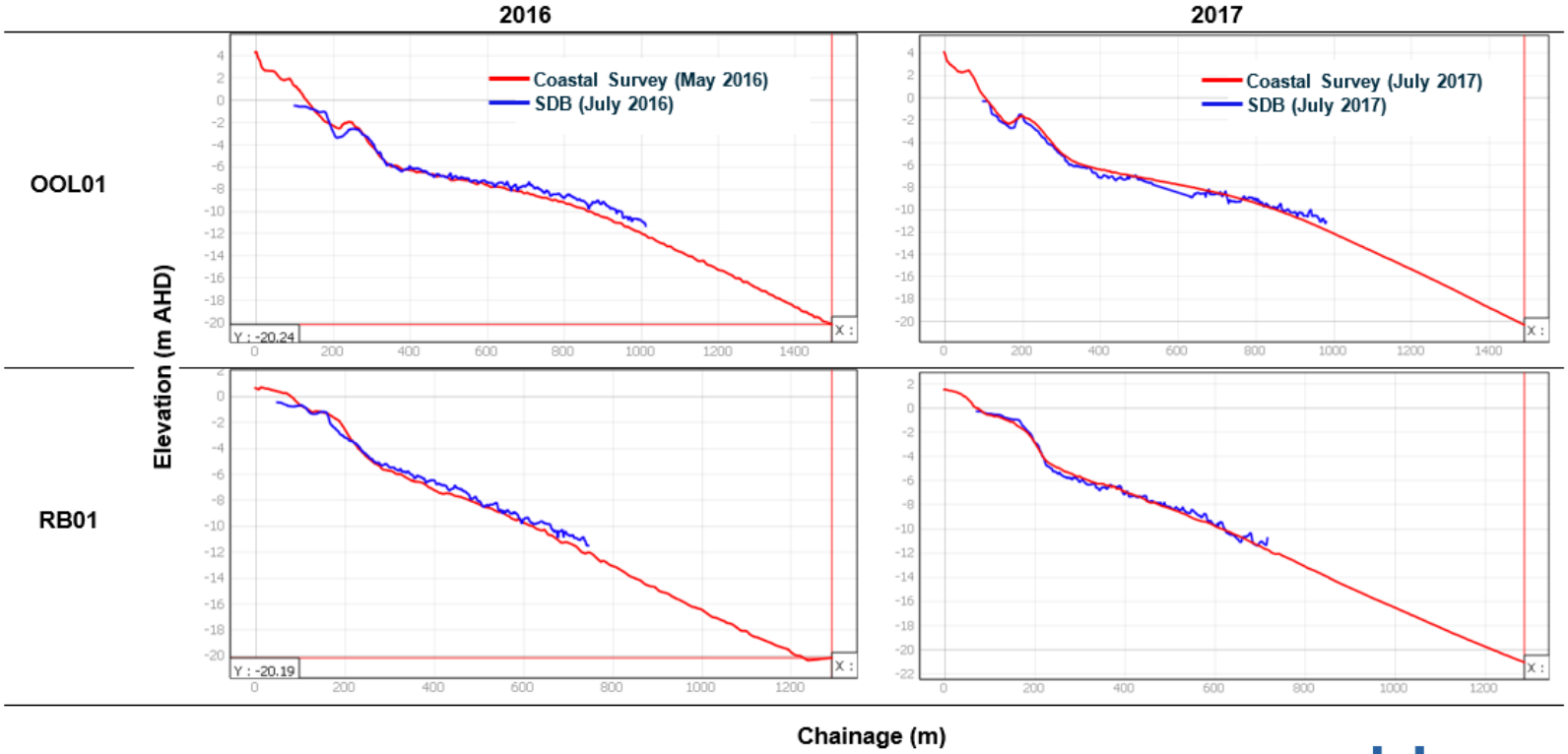
Comparison with typical survey: 2017 data



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Comparison with typical survey: 2017 data

- Differences between survey results minimal
- SDB was achieved down to ~12 metres depth
- SDB data gaps at river mouth (wave breaking & turbidity)

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Morphological change over time

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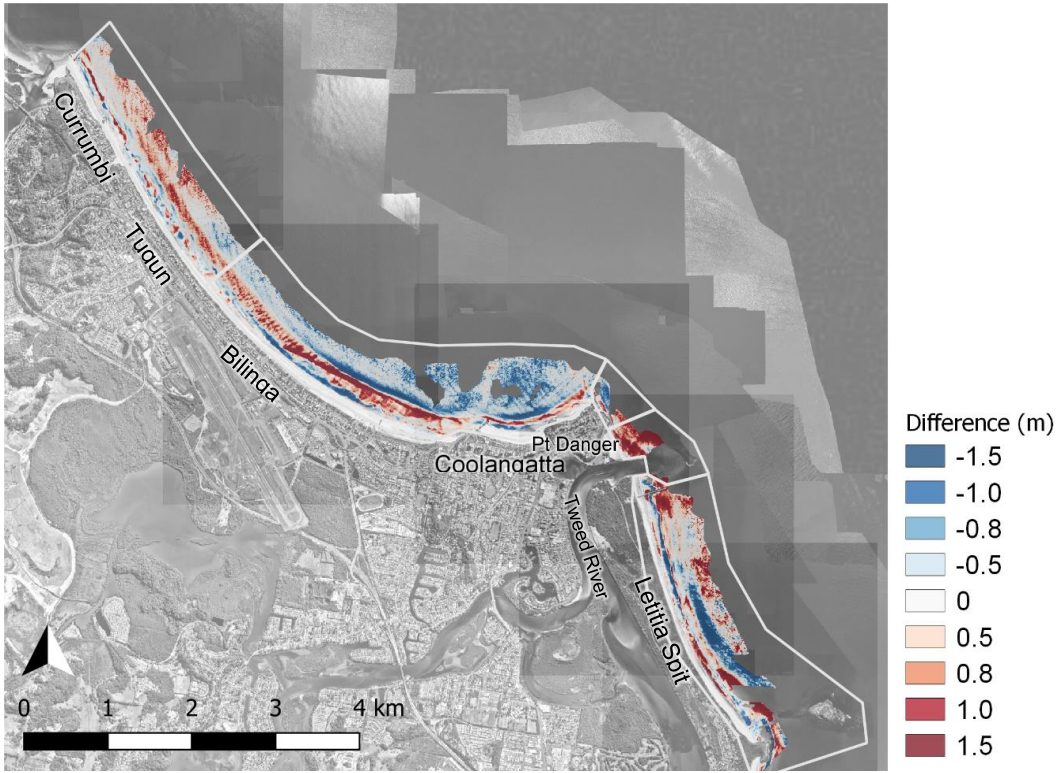
Bathymetric change between 2017 and 2016 SDB

- Automated spatial change analysis
- Change of key morphological features (e.g. nearshore sand bars)
- Clear evidence of cross-shore sediment transport
- Detailed analysis for specified ‘compartments’



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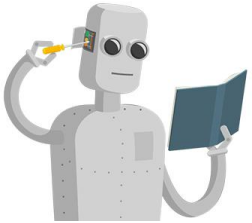
Bathymetric change between 2017 and 2016 SDB

- Automated volumetric analysis results:



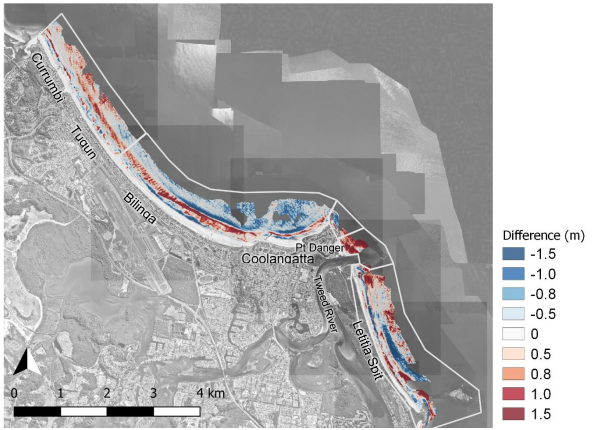
```
import qgis.analysis
import glob, qgis
from PyQt4.QtCore import QFileInfo
from qgis.analysis import QgsRasterCalculatorEntry, QgsRasterCalculator, QgsZonalStatistics
from qgis.core import *
from processing.tools import *

#Initialise QGIS
QgsApplication.setPrefixPath("C:\\Users\\220054\\Documents\\Projects\\SDB\\GIS", True) # Adjust it to your path
QgsApplication.initQgis()

#Select raster file
#rasterfile = qgis.utils.iface.mapCanvas().currentLayer().source()
inpath = "C:\\Users\\220054\\Documents\\Projects\\SDB\\DataFromEOMAP\\"
file1 = "SDB_2016\SDB_AUS_GoldCoast_EOMAP_160701wv2_235650_2m_AHD_geotiff.tif"
file2 = "SDB_2017\SDB_AUS_GoldCoast_EOMAP_170721_234628_170718_235725_2m_AHD_geotiff.tif"

layer1 = QgsRasterLayer(inpath + file1,file1)
layer2 = QgsRasterLayer(inpath + file2,file2)
```

Compartment	Total erosion (m^3)	Total accretion (m^3)	Net change (m^3) [(-) erosion/ (+) accretion]
Letitia Spit	-534,292	615,600	81,308
Tweed River Entrance (including Duranbah Beach)	-2,106*	205,596*	203,490*
Point Danger	-29,321	23,088	-6,233
Coolangatta to Bilinga	-1,182,248	631,094	-551,154
Tugun to Currumbin	-212,699	532,970	320,272
Total	**-1,960,665**	**2,008,347**	**47,682**



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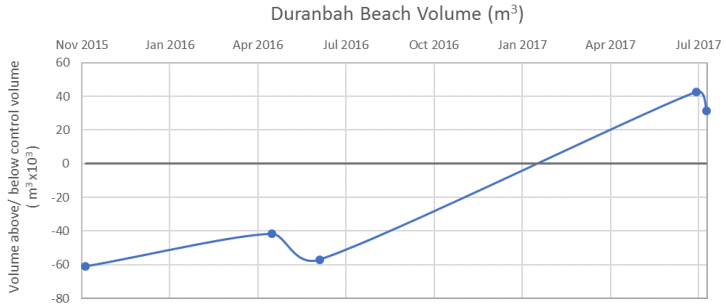
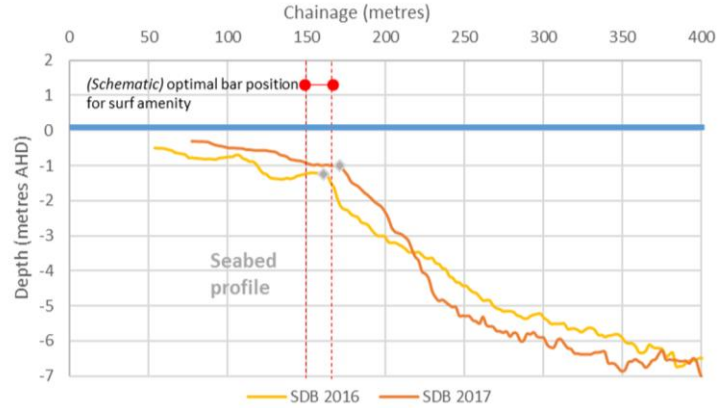
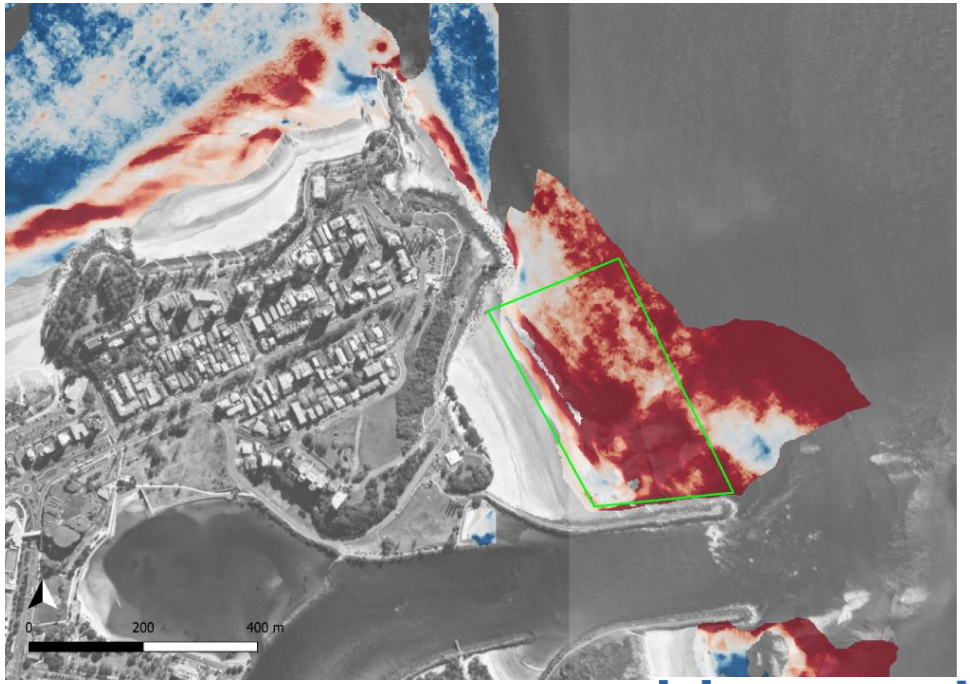
Bathymetric change between 2017 and 2016 SDB

- Automated volumetric analysis results:



- Profile evolution:





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Can we use Satellite Derived Bathymetry to monitor morphological change?

Yes. Possibly even better than with typical survey data

(Due to **cost-effectiveness** and **high spatial resolution** (2m) in both cross-shore AND along-shore direction -> **better representation of bathymetric features**)

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Key findings

- SDB compares well to typical survey data
  - Differences in bathymetry were around 0.3 metres
- Data gaps where wave breaking occurred and water was not clear
- Assessing morphological change over time is possible

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Further developments

- Automation of complete process from data capture to standardised report at regular intervals -> expert interpretation as add-on
- Subscription type service to clients at revolutional pricing
- Machine learning algorithms for detection and tracking of bathymetric ‘features’
- Integration with other analysis and visualisation tools (e.g. https://middleton-egfhp3bk5.now.sh/)

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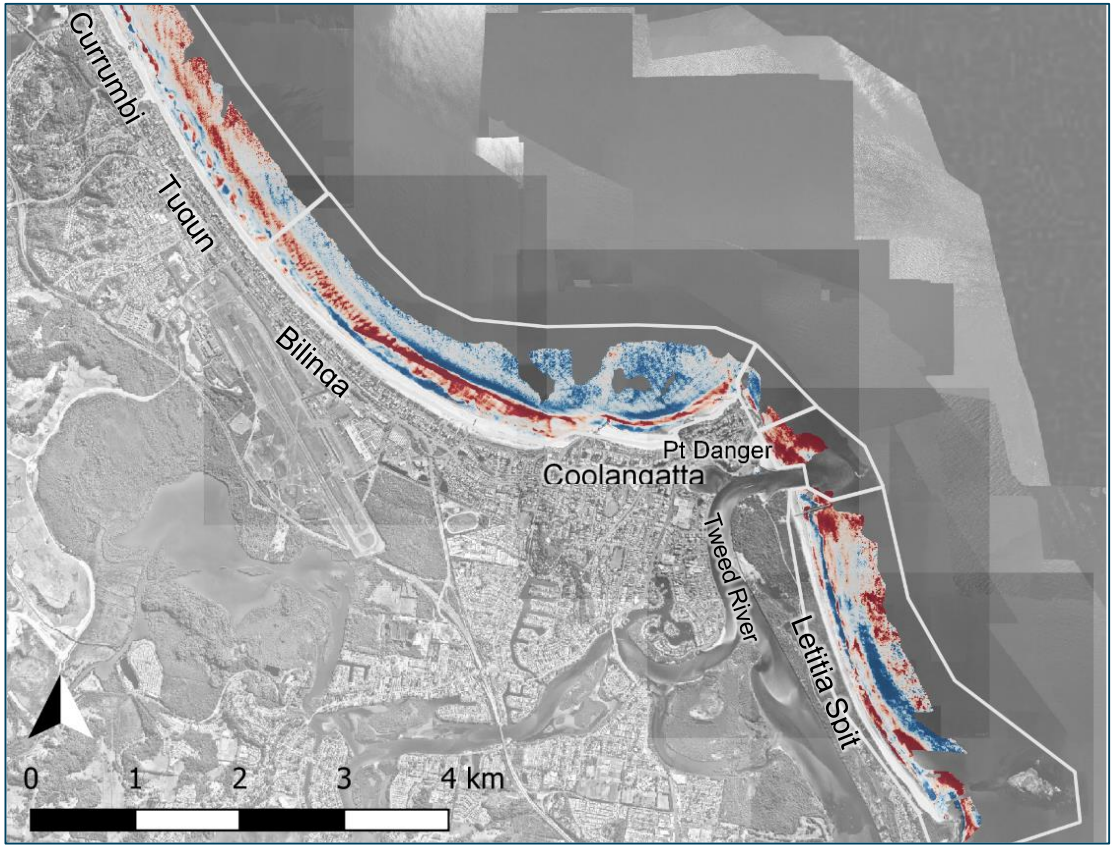
Thank you! Any Questions?



Contact:
Heiko@bcoast.com.au

bluecoastconsulting.com.au

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