The Normal Baseline

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UK Hydrographic Office
The normal baseline for measuring the breadth of the territorial sea is the low water line along the coast as marked on large scale charts officially recognised by the coastal state

UNCLOS Part II Article 5
Scope

- Source data of the low water line
- Quality of charting
- Alternative baselines
- Assessing baseline accuracy
- Improving baseline accuracy
- The normal baseline in limits and boundaries
The Low Water Line

- One of the largest and most obvious features on a chart
- Not a very significant feature for the mariner today
Historically, the single most important feature on a chart
For LOS, the baseline is very significant for generating maritime zones, enforcing national jurisdiction and calculating boundaries.
Surveying the Low Water Line

- The GPS effect
- Where does the low water line come from
  - Most data 18-19 century
  - Work for warships in peace
  - Control using horizontal sextant angles
  - Lead Line sounding
  - Shooting rays
  - Sketching
  - Sea sense
  - Local knowledge
Datums and Control

- Established Land Survey networks
  - Extend network to the coast
  - Secondary marks to control sounding vessels
  - Tertiary marks to work close inshore
- Make your own datum
- GPS exposes the inaccuracies
- Putting them right is not so simple
Accuracy and Errors

- Visual fixing on 3rd or 4th order control
- Sounding errors
- Tidal errors
- Graphic plotting of results on survey scale
- Symbolising low water line to represent nature of shore line
- The ravages of time
- Visual local fit to a compilation grid [worst case]
- Digitising errors when building the model
- 18/19th century baseline good to 40m at best
The Normal Baseline

- For defining limits and boundaries, we take the charted low water line as precise.
- Probably the most inaccurate feature on a modern chart.
- The most difficult and expensive to survey accurately.
- Why not change to something more easy?
Alternatives

- A feature that is well surveyed, well understood and easily checked
- Rules out the low water line on all counts
- Alternatives:
  - A series of straight baselines
  - The 10 metre contour
  - The High Water Line
  - Better surveys of the low water line
How bad is it?

- Check some areas of relevant coast
- Very little of our coastline is relevant to either limits or boundaries
- Use a crude filter to pick critical headlands
Select contributing base points

12M Radius

12M max
Improving the baseline model

- The only option is to gather new survey data. Alternatives for this are:
  - Fix individual base points by GPS
  - Bathymetric Survey to sound the low water line at HW
  - Aerial Photography at LW
  - Satellite imagery
  - LIDAR survey to map the zero isobath
Satellite imagery

Robin Cleverly
UK Hydrographic Office
Nigeria: SPOT data (20m)
Southern Spain: Quickbird (60cm)
Bora Bora, Tahiti (Quickbird)
Satellite radar

- Measures surface texture
- No water penetration
- Independent of weather
Landsat Acquisition Archive

Daytime full scenes acquired globally
29 June 1999 through 30 June 2003

- 1 - 14
- 15 - 32
- 33 - 51
- 52 - 71
- 72 - 91
Spatial Resolution

Commonly used satellites:

- Landsat ETM 15-30-60m
- ASTER 15-30-90m
- SPOT 10-20m
- SPOT V 2.5-10m
- IRS 5.8m
- EROS 1.8m
- Ikonos 1-4m
- Quickbird 0.6-2.4m
- Aerial photography 25-50cm*

*dependent on altitude - much higher resolutions can be acquired for special purposes
Water Penetration

- Blue penetration up to 20m in clear water
- No penetration by infrared
- Quantitative measurement difficult
Landsat ETM
Colour composite

Bands 123:BGR

Sulawesi
Colour composite
Land mask

Sulawesi

Bands 123:BGR; 5:R
## Costs per sq km

<table>
<thead>
<tr>
<th>Satellite</th>
<th>Pixel size</th>
<th>Footprint</th>
<th>Cost/scene</th>
<th>Cost/km²</th>
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<tbody>
<tr>
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<td>15m</td>
<td>185x170km</td>
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<td>5-10km</td>
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## Usage of satellite data

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<td>&lt;5,000</td>
<td>25cm</td>
<td>Aerial photo</td>
<td>~$100</td>
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</table>
Satellite data: pros and cons

- Cheap
- Up-to-date
- Near global coverage
- Relatively accurate reference to WGS84 (without ground control)

- Not acquired at low water (only exceptionally)
- Not admissible for definition of normal baseline?
LIDAR

- Light Detection And Ranging

Or more generally

- Airborne Laser Hydrography
What’s the Attraction?

Shallow water boat operations suffer from:
- Slow progress
- Dependence on Mother ship
- Reduced swathe width
- Single beam in shallows
- Weather restrictions

ALL THESE MAKE BOAT OPS EXPENSIVE

The advantages of Airborne Laser Hydrography (ALH) are:
- Swathe width remains fixed
- Seamless data from shoal depths to low elevations
- Performance improves in shallow water
- Fast progress
- Minimum presence on ground
**How does it work?**

Initial laser pulse Tx from aircraft.

Surface return Rx at aircraft. Infra-red channel.

Bottom Return Rx at aircraft. Blue-green channel.

Time difference equals water depth.
Comparison of characteristics of shallow and deep detection waveforms

Shallow Water:
- Lack of beam spreading
- Small footprint
- Bottom return well-defined

Deep Water:
- Beam spreading
- Large “footprint”
- Low SNR

Effective footprint is about ½ depth
Scan width is adjustable
150 kts at 300m alt. gives a 150m swath with 4m spot spacing
Penetration is about 2.5 x secchi depth
Depth Measurement

- ± 1-2 cm
- Reflectivity of bottom
- Weak return in deep or poor conditions
- ± 10-20 cm for elevations

- Surface Return
- Tide
- Bottom Return
- Chart Datum
Planning

- Swath width is about 150m
- Look for off-lying low tide elevations
- Monitor progress and change the plan
- Coverage about 25M² per 6 hour mission
- Consult field experts when defining the project
- Mobilisation about $250k [#]
- Cost about $750 per km² [#]
- LADS in Australia, SHOALS in USA
- Not enough competition

# Figures for Shoals [Fugro] working in USA
Working with the baseline

- A vector model of the baseline is required to make use of modern GIS
- The Normal Baseline is the largest component for most states
- Different levels of data capture for different purposes
- A dynamic database
- Source data
Summary

- The normal baseline is not well charted
- Check it
- It may be good enough
- Improving is not easy
- Satellite imagery is cheap but imprecise
- ALH is precise but not cheap
- Build a digital model to make use of GIS
QUESTIONS ?