Thames Tides - Improving Predictions for a Jubilee Year

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Marine Conservancy Manager
Port of London Authority
Overview

- The Thames and the PLA
- Thames Tidal Monitoring
- Requirement for Accurate Predictions
- Harmonic Analysis
- “Thames Tide” Prediction Software
- Case Study: Jubilee Pageant
- Future
River Thames and Estuary

- Well Mixed Macro-tidal Estuary.
- Tidal Limit at Teddington.
- > 7m Tidal Range in Central London.
- Busiest Inland Waterway.
- Second Largest UK Port.
- Susceptible to Meteorological Events.
- Water Levels as Important for Navigation as Flood Defence.
Main Activities on the River

Teddington to Putney

Putney to Thames Barrier

Thames Barrier to Estuary
The Port of London Authority – Key Info

- Statutory Harbour Authority.
- 96 miles of tidal river.
- 400 sq. miles of river/sea bed.
- 30,000 shipping movements per year.
- 10,000 Pilotage acts per year.
- 24/7 365 days a year River Patrol.
- No longer a cargo handler.
PLA Jurisdiction

95 miles: Teddington to the outer Estuary
Hydrographic Responsibilities

**NAVIGATIONAL SAFETY**
- Pilotage
- Marine Services/Salvage
- VTS
- Charts
- Wrecks / Obstructions
- River (Main) Surveys
- Tidal Data
- Tidal Monitoring / Analysis
- Dredging
- Environment
- River Regime
- Planning

**CONSERVANCY**
Hydrographic Department

- Three survey vessels
- 15 Staff: 7 surveyors, Oceanographer, GIS Manager, Tidal Technician.
  - Experience from Port, Offshore Survey and Merchant Marine Sectors.
- Produce 400 surveys per year (25% under contract)
- Multibeam Capability since 2004
  - National and International Recognition in the development of MBES for High Resolution
  - MSc Cat A delivered in conjunction with UCL
PLA – Tidal Team

John Pinder
Port Hydrographer

Alex Mortley
Marine Conservancy Manager

Keith Elliott
Tidal Technician

Support from Navigational Systems Engineers and IT Specialists
Thames Tidal Monitoring

- 14 Real Time Gauges.
- PLA System Complimented by Environment Agency System.
- Monthly Calibration Checks.
- Associated Tide Staffs Regularly Cleaned & Levelled.
Thames Tidal Monitoring
Thames Tidal Monitoring

TELTAS

- Gauge
- Transducer
- Back up Transducer (Estuary)
- Environment Agency System (River)

Telemetry

POLATIDE

- Display
  - PCC Gravesend
  - TBNC Woolwich
  - Hydro Office
  - Website
- Archive
  - SQL Server
  - Off site Backup

Website

Hydro Office

PCC

TBNC

SQL Server

Off site Backup
Thames Tidal Monitoring

Radar gauges (EA)

Pressure Transducers (PLA)
Thames Tides at a Glance

THAMES TIDES IN LAST 24 HOURS
WHERE THAMES SMOOTH WATERS GLIDE

Saturday, 7th April 2012
Sunday, 8th April 2012
Diagram showing Chart Datums in the River Thames

(Between Richmond Lock and Teddington Lock, the maintained level is 1.72m above ODN)
## Tidal Surges

- Surge Forecast computed twice daily by Met Office.

### Surge Forecast

Tel: 0870 900 0100 www.metoffice.gov.uk

VTS - Port of London Authority
Forecast Issued on Sunday, 08 April 2012 at 14:45 UTC

Data provided by the Environment Agency

### Surge Forecast for 51° 30’N 001° 03’E

<table>
<thead>
<tr>
<th>Date/Time UTC</th>
<th>Surge Induced Water Level</th>
<th>Surge Current Speed</th>
<th>Surge Current Direction</th>
<th>Tidal Water Level</th>
<th>Tidal Water Speed</th>
<th>Tidal Water Direction</th>
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<tr>
<td>08/1200</td>
<td>-0.18</td>
<td>0.01</td>
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<td>2.10</td>
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<td>0.01</td>
<td>87.80</td>
<td>0.04</td>
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<td>-1.91</td>
<td>0.33</td>
<td>85.70</td>
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</table>

- Not currently integrated into POLATIDE.
Thames Barrier

THAMES BARRIER CLOSURE DATA: [HW / RIVER FLOW]
WHERE THAMES SMOOTH WATERS GLIDE

© 2012 John Bade, John@thames.me.uk

Halcrow, 2011

http://thames.me.uk
North Sea and Channel Tides
Time for Change

- Data historically sent to UKHO for analysis and prediction.
- Data stored digitally since 1994.
- Under prediction of neap high waters affecting cargo loadings.
- Poor secondary port predictions.
- Long term predictions required for river events.
- Limitations of existing prediction software and copyright.
Harmonic Analysis Method

**Table**

<table>
<thead>
<tr>
<th>Location</th>
<th>E</th>
<th>B</th>
<th>F</th>
<th>S</th>
<th>T1</th>
<th>T2</th>
<th>T3</th>
<th>&lt;=</th>
<th>&gt;=</th>
<th>Block of similar values</th>
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<td>10</td>
<td>30</td>
<td>120</td>
<td></td>
<td></td>
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<td>7.5</td>
<td>(30.1, 15.05) (10.01)</td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td>-1.6</td>
<td>6.0</td>
<td>(5.0, 0.02)</td>
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<td></td>
<td></td>
<td></td>
<td>-0.2</td>
<td>6.5</td>
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<tr>
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<td>30</td>
<td>120</td>
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<td>-0.2</td>
<td>7.0</td>
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<td>-0.6</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>-0.6</td>
<td>8.0</td>
<td>(9.1, 5.05) (3.01)</td>
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<td>*Tower Pier</td>
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<td>10</td>
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<td>120</td>
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<td>30</td>
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<td></td>
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<td></td>
<td>-1.4</td>
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<td>(9.1, 5.05) (3.01)</td>
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</table>

**Legend**

- E: Remove value equal to 0.00 (metres)
- B: Barrier Closures
- F: Fluvial Flow
- S: Slope (metres/day)
- T1: First data filter interval (minutes)
- T2: Second Data Interval (minutes)
- T3: Third Data Interval (minutes)
- <=: Min, Removal Below (metres)
- >=: Max, Removal Above (metres)
- Block: Removal of blocks of points satisfying the condition (number of point, of similar value in metres)
- M: The file was manually edited one or more times.
- *: At these three locations Mean Level Analysis described below was also carried out.
Data Preparation

- Filtering
- Sampling
- Manual Cleaning
Data Analysis

• Fourier analysis for known frequencies based on Doodson.
Residual Component Analysis

- Spectral analysis of residuals (Obs - Comp)
Analysis Results

- Calculations of Tidal Levels (LAT, MHWS etc).
- Lowest Tides.
- Highest Tides.
- RMS Error.
- Harmonic Constants.
# Geotide vs Total Tide

<table>
<thead>
<tr>
<th>Location</th>
<th>GeoTide</th>
<th>TotalTide with UKHO HC</th>
<th>TotalTide with GeoTide HC</th>
<th>GeoTide v TotalTide with GeoTide HC</th>
<th>GeoTide v TotalTide with UKHO HC</th>
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</thead>
<tbody>
<tr>
<td>Margate</td>
<td>0.264</td>
<td>0.277</td>
<td>0.277</td>
<td>0.053</td>
<td>0.064</td>
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<tr>
<td>Walton</td>
<td>0.248</td>
<td>0.272</td>
<td>0.256</td>
<td>0.057</td>
<td>0.104</td>
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<tr>
<td>Herne Bay</td>
<td>0.283</td>
<td>0.291</td>
<td>0.305</td>
<td>0.075</td>
<td>0.076</td>
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<tr>
<td>Shivering Sands</td>
<td>0.292</td>
<td>0.328</td>
<td>0.309</td>
<td>0.066</td>
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<td>Southend</td>
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<td>0.265</td>
<td>0.263</td>
<td>0.078</td>
<td>0.092</td>
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<tr>
<td>Coryton</td>
<td>0.253</td>
<td>0.276</td>
<td>0.283</td>
<td>0.087</td>
<td>0.099</td>
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<tr>
<td>Tilbury</td>
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<td>0.267</td>
<td>0.288</td>
<td>0.092</td>
<td>0.106</td>
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<tr>
<td>Silvertown</td>
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<td>0.291</td>
<td>0.297</td>
<td>0.106</td>
<td>0.131</td>
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<tr>
<td>Tower Pier</td>
<td>0.256</td>
<td>0.277</td>
<td>0.282</td>
<td>0.108</td>
<td>0.146</td>
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<tr>
<td>Richmond Lock</td>
<td>0.589</td>
<td>0.743</td>
<td>0.609</td>
<td>0.161</td>
<td>0.601</td>
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</tbody>
</table>
Primary or Secondary Ports?

Based on London Bridge (Time & Height Diffs).

Based on Harmonic Constants (from observations).
Sea Level Rise?

Southend MSL

Southend Mean Tide Levels 1929 - 2009
Predictions

- Available online up to 5 years in advance.
- Harmonics sent to UKHO for inclusion in Total Tide and for publication in ATT.
- Annual Port and Tide Information Book.
- Thames Tide Prediction Software launched in January 2012.
Thames Tide Functionality

- Easy to operate predictions per gauge.
Thames Tide Functionality

- Tide Tables – 3 Month View
Thames Tide Functionality

- Local Time Zone, Vessel, Location and Print Settings can be Configured.
• Flotilla of 1000 vessels from Hammersmith to Greenwich on 3rd June 2012.

• Flotilla will pass under 14 bridges and travel at 4 knots.

• Avenue of sail downstream of Tower Bridge.

• Royal Barge to convey the Queen and Royal Family.

• Vessel the “Amazon” also took part in Queen Victoria's Diamond Jubilee Pageant in 1897.

• Oldest boat in procession was built in 1740.

• Largest boat is 65m long and 42m high.

• 14 miles of bunting and 3 miles of mooring chain.
Case Study: Jubilee Pageant

- Some vessels constrained by both water and air draught.
- Careful passage planning required.
- Ten minute predictions produced for organisers.
- Numerous practise events prior to pageant.
- Low speed event so river flow had to be taken into account to maintain critical timings.
Case Study: Jubilee Pageant

- Coincides with a Thames Barrier closure with reverse head!
- Different approach required to water level prediction.
- 1D and 2D hydrodynamic modelling.
- Water level stabilises a few hours after closure to around ODN.
- Minimal residual flow dependant on input at Teddington and underspilling at the Barrier.
Case Study: Jubilee Pageant

- Ultimate test of predictions.
- Live tides will be broadcast for critical locations to monitor levels against predictions.
- EA's Westminster gauge feed into POLATIDE.
Future

- Sea level rise.
- Increased storminess i.e surges.
- New tidal monitoring system.
- Continued analysis to maintain accurate predictions.
- Harmonic analysis of water density, salinity and temperature?
Take Home Messages

- Thames is a busy commercial river with complex tidal regime.
- PLA operate a complex tidal monitoring system which compliments EA system.
- Detailed and ongoing harmonic analysis has resulted in improved accuracy of predictions.
- Predictions now more widely distributed and integrated with new and existing prediction software.
- Used for passage planning of major river events as well as commercial shipping movements.
- Meteorological conditions can play a big part in observed water levels so important to still maintain a real time system.
- Predictions and observations only as good as those who maintain the systems.
Questions

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