1st Tidal and Water Level Working Group Meeting

Niterói, Brazil. March 30 – April 01, 2009
NATIONAL PRESENTATIONS

BRAZIL

Lt Cdr Rosuita Helena Roso, M.Sc.
rosuita@chm.mar.mil.br
TIDES SECTION
An overview of tides in Brazil...

(Veloso, T. G., 2005)
Tide bore in Brazil…Pororoca
Projects underway at the Hydrographic Center related to Tides

I. To establish LAT as the Brazilian CD:
   I.1. Revitalization of the tidal stations network
   I.2. Upgrade of the Tides System software

II. Modeling tides (Lt Maria Fernanda, M.Sc.)
III. GPS applied for soundings reduction (Lt Cdr Ramos, M.Sc.)
V. Digital tidal currents charts (Lt Cdr Marcelo, M.Sc.)

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Brazilian Chart Datum

For maritime areas

CD = MLWS (Courtier - Balay criterium)

Differences between LAT and MLWS can be significant

In order to perform the IHO Technical Resolutions it’s needed to adopt LAT as the national CD….
Problems must be solved ahead !!

I. Lack of data for that purpose:
   - most of the data is outdated
   - short periods of observation for most of the stations
   - no common “epoch” for all stations

Low cooperation from other national Institutions

II. Necessity of an effective software to process a large amount of data

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I.1. Project to revitalize the tidal stations network

Migrating to digital sensors with automatic data transmission (radar, encoder, pressure)

2002 GLOSS
2008: IBGE/ CHM/ INPE / CVRD
Brazilian permanent tide gauges network:

- **Operating**
  - Ponta do Céu (2007)
  - Vila do Conde (2009)
  - Ponta da Madeira (update 2009)
  - Fortaleza (2008)
  - Suape (2009)
  - Salvador (2002)
  - Barra do Riacho (2008)
  - Tubarão (2008)
  - Macaé (2001)
  - Ilha Fiscal (1965-2009)
  - Cananéia (1954-2009)
  - Ilha Guaíba (2010)
  - Angra dos Reis (2009)
  - São Sebastião (2009)
  - Galheta (2009)
  - Itajai (2007)
  - Imbituba (update 2010)
  - Ponta de São Pedro (2008)
  - Ilha de Fernando de Noronha (2010)
  - Ilha da Trindade (2010)

- **Planned**
  - Ponta da Madeira (change to digital 2009-2010)
  - Ilha da Trindade (2010)

**Digital Tide Gauge Operating / Near-Real Time Data Transmission**

**Analogic Tide Gauge Operating**

**Radar / Encoder to be installed (2009-2010)**
I.2. Project for upgrading Tides System software

Tides System (Franco, 1971)

In 2008 50% of the upgrade was done

- Tide data and HC bank
- “near-automatic” data processing (filters, gap filling, spikes correction, quality flag, etc)
- Harmonic Analysis (Franco (1971))
- Cross Analysis
- Predictions
- National Tide Tables / Implement Digital National Tide Tables
- Mean Sea Level analysis
- Long series analysis
- Extremes analysis

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Purpose:

This study case intends to implement the hydrodynamic modeling as a tool for nautical chart datum determination, sounding data reducing and tide prediction, helping to improve the navigability and the safety of the Amazon estuary region.

Lt. Maria Fernanda Rezende Arentz
maria.fernanda@chm.mar.mil.br
TIDES SECTION
Specific purposes:

- make sensitivity tests in the hydrodynamic model (MH) connected to bathymetric mesh changes;
- set new national CD and LAT for the channel region, following the recommendations of the IHO (2008) and check the spatial variability of these datums;
- Reduce the bathymetric data collected by the Sirius Ship in 2006, with the results of the hydrodynamic modeling;
- Assess the capacity of MH in reproducing the astronomical tide as a new tool for prediction
RIVER DISCHARGE

Amazon estuary

Physical characteristics / numerical modeling

MACRO-TIDE SYSTEM

Mixing process

+ TRADE WINDS
+ NBC
+ WAVES (local & remote)

Tidal propagation limit

~ 1.8 x 10^5 m³ s⁻¹ per year
Motivation: There is an intrinsic difficulty to establish the reference level and to apply sounding reductions, due to the region’s great dimensions, the variability and magnitude of the tides and river discharge which influences water levels and tidal amplitudes.
A numerical model has been implemented and has shown good agreement with the observed tides.
Study area in detail

Point #2

Barra Norte
Guará
Ilha de Maracá

Fundeio 2

Data-Hora

Alturas

Fundeio 2

4/6/06 7:12 4/6/06 9:36 4/6/06 12:00 4/6/06 14:24 4/6/06 16:48 4/6/06 19:12 4/6/06 21:36 5/6/06 0:00

600000 700000 800000 900000
400000
450000
500000
550000
600000
Study area in detail

POINT # 3

Barra Norte
Guará
Ilha de Maracá

600000 700000 800000 900000
400000 450000 500000 550000 600000

Data-Hora

Alturas

Fundeio 3

Fundeio 3 Obs
Fundeio 3 Modelo
Differences in the depth obtained according to the two sounding reduction methodologies.
Conclusions:

- The implementation of a numerical model allowed a continuous fit of the water level, considering the seasonality of the local hydrodynamics. The model has established a better description of tide asymmetry and the variation of the mean sea level - all of them are sources of uncertainties of the currently used methodology.

- The methodology of sounding reduction proposed in this work for a particular depth surveying data (2006) has shown significant differences that call attention for the need to improve the sounding reduction methodology.
THE USE OF HYDRODYNAMIC MODELING IN NAVIGATION AIDS ALONG NORTHERN CHANNEL OF THE AMAZON ESTUARY
GPS applied for Tides

Lt Cdr Alexandre Moreira Ramos, M.Sc.
moreira.ramos@chm.mar.mil.br
GEODESY SECTION
Projects underway : GPS Tides

Evaluation the application of RTG/RTK Tides in hydrographic surveys, in accordance with IHO S-44 standards.

- Application of precise Differential GPS techniques to obtain tides corrections directly from their ellipsoid height trends.

- GPS Positioning Systems:  
  - C-Nav 2050M RTG  
  - Trimble 7400 RTK  
  - NovAtel DL-V3

- Real time measurement removes the need to:  
  - Measure tidal height  
  - Measure heave and squat
GPS Tides application in the hydrographic surveys

Operations

• Determination of the height of Chart Datum relative to WGS-84 ellipsoid (SEP – Vertical Separation);
• GPS antenna height above vessel reference point;
• SEP value was considered constant for entire survey area.

Vertical Separation Model - interpolation process by which the SEP is estimated everywhere in a chart.

- Hydrodynamic model
- Data from coastal tidal stations
- Global Tide Models / Geoidal Models.
GPS Tides – 2006 Tests

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Mean of Differences = -0.007 m
Standard Deviation (68%) = 0.127 m
TPE (95%) = 0.250 m

Mean of Differences = -0.029 m
Standard Deviation (68%) = 0.129 m
TPE (95%) = 0.259 m

Mean of Differences = -0.014 m
Standard Deviation (68%) = 0.126 m
TPE (95%) = 0.248 m

Mean of Differences = -0.051 m
Standard Deviation (68%) = 0.229 m
TPE (95%) = 0.460 m
Thanks!