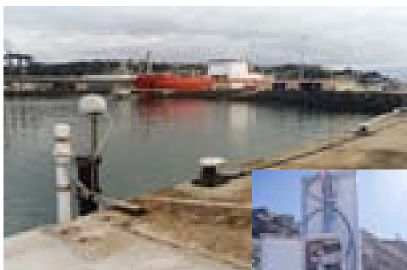
# Development of a Vertical Reference Surface for Hydrography in Coastal Zone: Case Study in Atlantic Canada

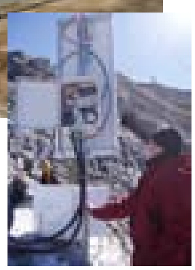

Azadeh Koohzare
McElhanney Consulting Services Ltd (MCSL)
100-780 Beatty St,Vancouver, B.C. V6B 2M1
Email: akoohzare@mcelhanney.com


## Overview:

Traditionally, the depth data are referred to a chart datum and land elevation to a terrestrial vertical datum. This makes it difficult to easily analyse natural events that occur across the land/sea interface, such as tsunami, sea level rise and global warming.



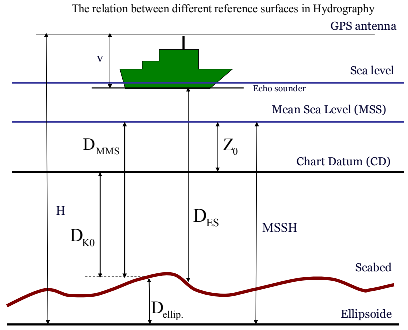
(from Watson et al., 2002)



Instrumentation

Establishing the relationship between various vertical datums, a vertical separation model, will allow easier assimilation of land and maritime data resulting in seamless vertical data (i.e., data referred to a seamless reference surface). However, the creation of seamless data is far more than just joining more than one digital dataset together. Issues such as datum types, projection, temporal changes, and error budgets (including accuracy, scale and generalisation) must be considered (El-Rabbany. A, and R. Adams, 2004). Ignoring these technical concerns will cause geospatial datasets to end up as meaningless and unreliable. In this research, the temporal changes of sea level from the historical tide gauges in eastern Canada are investigated.

The relation between different reference surfaces in Hydrography




$$D_{ellip.} = H - D_{ES} - v$$
$$D_{MMS} = MSSH - D_{ellip.} \qquad (1)$$
$$D_{K0} = D_{MSS} - Z_0$$

The method employed to develop the vertical datum separation model can depend on many factors such as:

- Availability of recent data
- The purpose of the separation model and accuracy
- Extent of the area
- Resources
- The possible link to other local regional and national models.
- Maintenance

Canada Place bathymetric survey

## The rate of sea level changes in tide gauges from differencing method

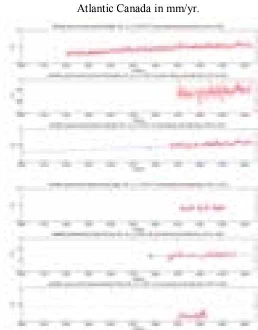
The Pearson Linear correlation coefficient for any pair of series of the records of the tide gauges, $r$, is computed to find out the optimum tree network of tide gauges for differencing.

$$\mathbf{S}^i = (s_1^i, s_2^i, \ldots, s_n^i) \qquad (2)$$
$$\mathbf{S}^j = (s_1^j, s_2^j, \ldots, s_n^j)$$
$$r_{ij} = \sum_k (s_k^i - s^i)(s_k^j - s^j) \Big/ \left[\sqrt{\sum_k (s_k^i - s^i)^2}\sqrt{\sum_k (s_k^j - s^j)^2}\right],$$

(Vaníček, and Carrera, 1993)

The differencing diagram and the location of historical tide gauges in Eastern Canada (Koohzare et al., 2007)

Sea level linear trends and their standard deviations of some of the tide gauges in Atlantic Canada in mm/yr.



| code | Tide gauge | Location Latitude/ Longitude | Velocity based on differencing (mm/yr) in this study |
|---|---|---|---|
| 1 | Halifax, NS | 44º 39´.6 63º 35´.4 | 3.27± 0.05 |
| 2 | North Sydney, NS | 46º 13´.2 60º 15´.0 | 3.42±0.37 |
| 3 | Yarmouth, NS | 43º 50´.4 66 º07´.2 | 4.17±0.18 |
| 4 | Point Tupper, NS | 45º 06´.0 61 º22´.2 | 3.12±0.80 |
| 5 | Pictou, NS | 45º 40´.8 62º 42´.0 | 3.70±0.21 |
| 6 | Boutilier Point, NS | 44º 39´.6 63º 57´.6 | 3.00±1.40 |
| 9 | Saint Jonh, NB | 45º 16´.2 66º 03´.6 | 2.50±0.11 |
| 10 | Shediac Bay, NB | 46º 15´.0 64º 31´.8 | 2.50 ±0.14 |
| 11 | Lower Escuminac, NB | 47º 04´.8 64º 53´.4 | 2.10±0.31 |

Canadian Hydrographic Service is planning to survey WGS84 heights at known tidal locations to directly establish the separation between Chart Datum and WGS84 (Parsons and O'Reilly, 1998). It is necessary to consider the temporal variation of mean sea level in the region when integrating the historical hydrographic data, and establishing the separation between Chart Datum and WGS84..

**Conclusions and Recommendations:**

The temporal changes of sea level should be considered in the development of a separation model using GPS and tide gauge data. According to this study, the monthly mean sea level from most of the Atlantic tide gauges, is rising at ~ 3mm/yr.


**Acknowledgment**:

Part of this investigation was conducted in the Ph.D. dissertation of Azadeh Koohzare at University of New Brunswick (UNB). I would like to acknowledge:

Petr Vaníček, and Marcelo Santos, from UNB.

John Blair, Jim Christie ,Jack Clarke and Glen Bjorgan from MCSL.

The tide gauge data was provided by MEDS (Marine Environmental Data Service)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**Biography of the author:**

Dr. Azadeh Koohzare obtained her doctorate degrees in Geodesy and Geomatics Engineering from UNB. Azadeh has more than 10 years of experiences in geodesy and surveying throughout Canada and internationally. Her education and work experiences concentrate on geodesy, geodynamics, geodetic surveying and deformation monitoring. She is currently the project manager with McElhanney in Vancouver.