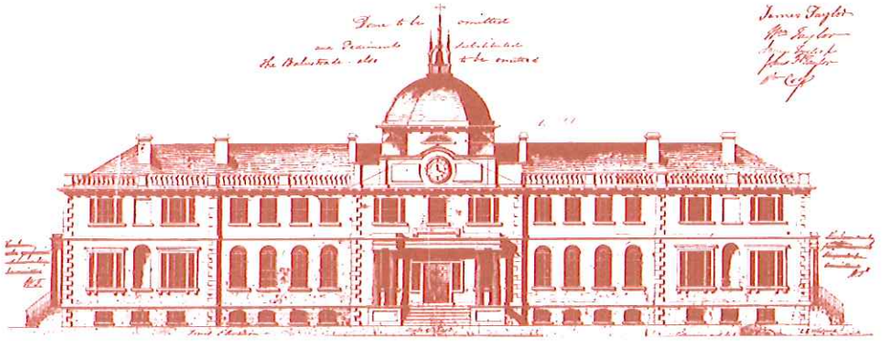
Modelling the Estuarine Circulation of the Port of Saint John: Applications in Hydrographic Surveying

Abstract

A 3D baroclinic hydrodynamic model has been developed to investigate the estuarine circulation within the Port of Saint John, in southern New Brunswick. The model simulates the movement and interaction between fresh waters from the Saint John River and saline waters from the Bay of Fundy over four seasonal periods of river flood stages. An improved understanding of sediment dynamics in the harbour is established from the model output, which is critical for understanding the sources of sedimentation and prediction of dredge requirements.

The model describes both the longitudinal and lateral estuarine flow within the harbour. This allows for improved estimates of sediment flux through the primary channels, which reveals annual variations in the relative contributions of the river and salt wedge borne sediments to harbour sedimentation rates. Integration of the near seabed flow patterns over a tidal cycle explains regions of deposition and erosion of fine grained sediments and corridors of sediment motion through examination of the residual current velocity fields.

The model simulation periods coincide with a dense physical oceanographic observation campaign. The validity of the model output has been verified through statistical comparison to the physical observation data. An innovative practical application of the model output to the assessment and prediction of hydrographic multibeam echosounder depth uncertainty is also examined.



Home of the School of Graduate Studies, Sir Howard Douglas Hall was designed by J.E. Woolford in 1825 and is the oldest university building in Canada still in use.

UNIVERSITY OF NEW BRUNSWICK

SCHOOL OF GRADUATE STUDIES

ORAL EXAMINATION

Ian Church

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

Ph.D. Candidate

Ian William Church

Graduate Academic Unit

Geodesy & Geomatics Engineering

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

April 11, 2014

2:00 p.m.

ADI Studio (HC-25)
Head Hall

~~~~~~

Examining Board:

Dr. John Hughes Clarke (Geodesy & Geomatics Eng.)	Supervisor
Dr. David Wells (Geodesy & Geomatics Eng.)	
Dr. Susan Haigh (Geodesy & Geomatics Eng.)	
Dr. Katy Haralampides (Civil Eng.)	Chairperson

External Examiner:
Dr. Fred Page
Head of Coastal Ocean Research Section
Director of the Centre for Integrated Aquaculture Science
Fisheries and Oceans Canada
St. Andrews Biological Station

The Oral Examination will be chaired by:
Dr. John Kershaw, Acting Associate Dean of Graduate Studies

BIOGRAPHY

Education:

2011 – 2014	PhD candidate, University of New Brunswick, Canada
2011	Diploma in University Teaching, University of New Brunswick,
2006 – 2008	Master of Science in Geodesy & Geomatics Engineering University of New Brunswick
2001 – 2006	Bachelor of Science in Geodesy & Geomatics Engineering (First Division), University of New Brunswick, Canada

Publications and Conference Proceedings:

Brucker S., J. Muggah, I. Church, J.E. Hughes Clarke, T. Hamilton, A. Hiroji, W. Renoud, 2013, *Hydrographic efficiencies of operating an 18 m research platform in the eastern Canadian Arctic.*, Proceedings of the US Hydrographic Conference, New Orleans, 2013

Hughes Clarke, J.E., S. Brucker, J. Muggah, I. Church, D. Cartwright, P. Kuus, T. Hamilton, D. Pratomo and B. Eisan, 2012, *The Squamish ProDelta: Monitoring Active Landslides and Turbidity Currents*, Proceedings of the Canadian Hydrographic Conference 2012, Niagara Falls, Ontario, Canada.

Hughes Clarke, J.E., S. Brucker, J. Muggah, T. Hamilton, D. Cartwright, I. Church and P. Kuus, 2012, *Temporal progression and spatial extent of mass wasting events on the Squamish prodelta slope: Landslides and Engineered Slopes: Protecting Society through Improved Understanding*, Eberhardt et al. (eds), Taylor and Francis Group, ISBN 978-0-415-62123-6, p.1091-1096.

Church, I., John E. Hughes Clarke, Susan Haigh, Reenu Toodesh, 2012, *Modelling the estuarine circulation of the Port of Saint John: Visualizing complex sound speed distribution*, Proceedings of the Canadian Hydrographic Conference, Niagara Falls, Ontario, Canada.

Lastras, G., Canals, M., Amblas, D., Lavoie, C., Church, I., De Mol, B., Duran, R., Calafat, A.M., Hughes-Clarke, J.E., Smith, C.J., Heussner, S., and "Euroleón" cruise shipboard party, 2011, *Understanding sediment dynamics of two large submarine valleys from seafloor data: Blanes and La Fonera canyons, northwestern Mediterranean Sea.* Marine Geology, Volume 280, Issues 1–4, Pages 20–39.

Hughes Clarke, J.E., Brucker, S., Muggah, J., Church, I. and Cartwright, D. 2011, *The Squamish Delta Repetitive Survey Program: A simultaneous investigation of prodeltaic sedimentation and integrated system accuracy*, U.S. Hydrographic Conference 2011

Muggah, J., Church, I., Beaudoin, J. and Hughes Clarke, J.E., 2010. *Seamless Online Distribution of Amundsen Multibeam Data* , Paper S7.2, Proceedings of the Canadian Hydrographic Conference 2010, Quebec, Quebec, Canada.

Church, I., Brucker, S., Hughes Clarke, J.E., Haigh, S., Bartlett, J. and Janzen, T., 2009, *Developing Strategies to Facilitate Long Term Seabed Monitoring in the Canadian Arctic using Post Processed GPS and Tidal Models,* U.S. Hydro 2009, oral presentation, Norfolk, Virginia, USA.

Church, I. and Hughes Clarke, J.E., 2008, *Developing Strategies to Improve GPS Positioning and Tidal Information to Facilitate Long Term Seabed Monitoring in the Canadian Arctic,* ArcticNet Annual Scientific Meeting, poster presentation, Quebec City, Quebec, Canada.

Church, I., Hughes Clarke, J.E., Haigh, S., Santos, M., Lamplugh, M., Griffin, J. and Parrott, R., 2008, *Using Globally-Corrected GPS Solutions to Assess the Viability of Hydrodynamic Modeling in the Bay of Fundy,* P4-2, Proceedings of the Canadian Hydrographic Conference and National Surveyors Conference, Victoria, BC

Several other Publications & Conference Proceedings