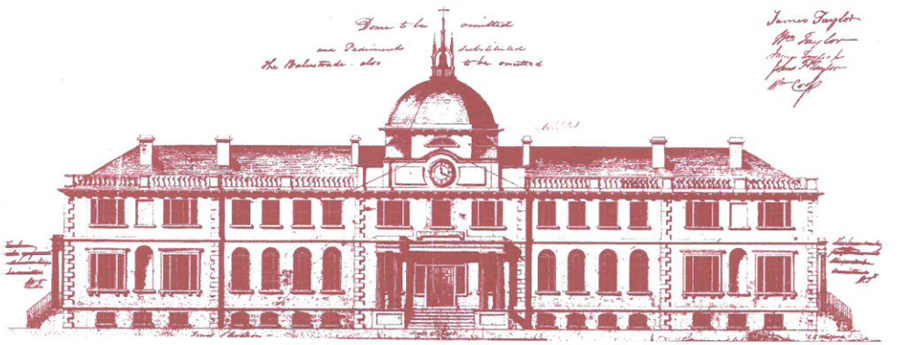
WEB-BASED FLOOD RISK ASSESSMENT –
RAPID, USER-FRIENDLY TOOLS LEVERAGING OPEN DATA

Abstract

Timely and accurate prediction of flood inundation extent and potential negative impacts and consequences is fundamental for the sustainable development of a given region and allows decision makers and the local community to understand their exposure and vulnerability. Complex computer models exist for flood risk assessment and while technologically sophisticated, these programs are intended, first of all, for use by a small number of technical and scientific experts and require considerable processing time and extensive inputs. These existing solutions are generally not well suited for flood prediction in near real-time and often exceed the data available for any given community. This research developed standardized methods, adapted into user-friendly tools which accept limited user input and are based on hydrologic principles and processes and widely accepted risk computation methods, by leveraging open data. The developed flood mapping approaches access, and through a novel data fusion method, creates a better quality digital elevation model (DEM) from multiple open source elevation datasets. This fused DEM is combined with other open source data (e.g., IDF curves, river flow data, watershed boundaries, etc.) to generate a flood inundation surface through two methods: 0D bathtub model and hybrid 1D/2D raster cell storage approach. The 0D model ignores flow rates and changes over time, producing a grid of the maximum spatial extent and depth, calculated as the difference between the terrain elevation and the computed water surface. The hybrid model solves 1D kinematic wave approximation of shallow water equations in the channel and treats the floodplain as 2D flooding storage cells. Water depths from the flood grid are then combined with local inventory data (e.g., building structural type, occupancy, valuation, height of the first floor, etc.) to compute exposure estimates in user friendly MS Office application or via web-based API. The developed methods and user-friendly tools allow non-experts the ability to rapidly generate their own flood inundation scenario on demand and assess risk, thus minimizing the gap between the existing sophisticated tools, designed for scientists and engineers, and community needs to support informed emergency response and mitigation planning.



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

Heather McGrath

IN PARTIAL FULFILMENT
OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

Ph.D. Candidate

Heather McGrath

Graduate Academic Unit

Geodesy & Geomatics Engineering

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March 15, 2017

2:30 p.m.

Forestry/Geology Bldg.
Room 202

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Examining Board:

Dr. Emmanuel Stefanakis (Geodesy & Geomatics Eng.)	Co-Supervisor
Dr. Miroslav Nastev (Natural Resources Canada)	Co-Supervisor
Dr. David Coleman (Geodesy & Geomatics Eng.)	
Dr. John Hughes Clarke (Geodesy & Geomatics Eng.)	
Dr. Paul Arp (Forestry & Environmental Management)	Chairperson

External Examiner:
Dr. David Walker
Faculty of Environment, Earth and Resources
Centre for Earth Observation Science (CEOS)

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

BIOGRAPHY

Universities attended (with dates & degrees obtained):

2014-2017	PhD candidate, University of New Brunswick
2012-2014	MScE, Geodesy and Geomatics Engineering, University of New Brunswick
2000-2001	Advanced Certificate (Marine Geomatics), Center of Geographic Sciences
1994-2000	B.Sc. Geography and GIS (minor), McMaster University

Publications:

Peer-Reviewed Journal Papers:

1. **McGrath, H.**, Stefanakis, E., Nastev, M. (2016), *A Framework for Reduced Complexity Flood Modelling: Leveraging Open Data and Limited User Input (*under Review*)*
2. **McGrath, H.**, Stefanakis, E., Nastev, M. (2016), *DEM Fusion of Elevation REST API Data in Support of Rapid Flood Modelling*. GEOMATICA Vol. 70, No. 4, 2016
3. Nastev, M., Abo El Ezz, A., Nollet, M.J., Smirnoff, A., Ploeger, S.K., **McGrath, H.**, Sawada, M. and Stefanakis, E. (2015) *Methods and Tools for Natural Hazard Risk Analysis in Eastern Canada: Using Knowledge to Understand Vulnerability and Implement Mitigation Measures*. ASCE Nat. Hazards Rev., 10.1061/(ASCE)NH.1527-6996.0000209 , B4015002.
4. **McGrath, H.**, Stefanakis, E., & Nastev, M. (2016). *Rapid Risk Evaluation (ER2) Using MS Excel Spreadsheet: a Case Study of Fredericton (New Brunswick, Canada)*. ISPRS Annals of Photogrammetry, Remote Sensing and Spatial Information Sciences, 27-34. http://www.isprs-ann-photogramm-remote-sens-spatial-inf-sci.net/III-8/27/2016/, doi:10.5194/isprs-annals-III-8-27-2016
5. **McGrath, H.**, Stefanakis, E., Nastev, M. (2015) *Sensitivity Analysis of Flood Damage Estimates: A Case Study in Fredericton, New Brunswick*, International Journal of Disaster Risk Reduction Volume 14, Part 4, December 2015, Pages 379–387, http://dx.doi.org/10.1016/j.ijdrr.2015.09.003

Conference Presentations

1. Nastev, M., Nollet, M.J., Abo El Ezz, A., Carrier, M.-A., Smirnoff, A., **McGrath, H.**, Stefanakis, E., and Parent, M., *Interactive Web-Based Application for Seismic and Flood Risk Assessment,* World Engineering Conference on Disaster Risk Reduction (WECDRR2016), Dec. 5-6, 2016, Lima-Peru.
2. **McGrath, H.**, Stefanakis, M., & Nastev, M. (2016). *Accuracy Assessment of Elevation REST APIs*, Geomatics Atlantic Conference, Sept. 26-28, 2016 Fredericton, NB.
3. **McGrath, H.,** Stefanakis, E., Nastev, M. (2015) *Flood risk assessment using MS Excel spreadsheet: A case study of Fredericton (New Brunswick)*, International Society for Photogrammetry and Remote Sensing, 2016, July 12-19 2016 Prague: http://www.isprs2016-prague.com
4. **McGrath, H.**, Stefanakis, M., & Nastev, M. (2015). *Flood Inundation Maps Using Reduced Complexity Models*. 22nd Canadian Hydrotechnical Conference (CHC), April 29-May1, 2015 Montreal QC, extended abstract: http://registration.cgi-pco.com/CSCEhydro/pdf/abstracts/Session3/3D.zip
5. **McGrath, H.**, Stefanakis, M., & Nastev, M. (2015). *Flood Risk Assessment Using MS Excel Spreadsheet: A Case Study of Fredericton New Brunswick*. 22nd Canadian Hydrotechnical Conference (CHC), April 29-May1, 2015 Montreal QC, (poster)

Several other Conference Papers/Presentations