

# 2015 GIS Education & Research Conference



Geography & Program in Planning  
UNIVERSITY OF TORONTO



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# Agenda

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<p>8:00 a.m.</p>	<p><b>Breakfast and Registration</b> [GREAT HALL / LOWER GALLERY]</p>
<p>9:00 a.m.</p>	<p><b>Welcome and Introduction</b> [GREAT HALL] Dr. Brent Hall, Director of Education and Research, Esri Canada Alex Miller, President, Esri Canada</p>
<p>9:10 a.m.</p>	<p><b>Current Issues in GIS Education</b> [GREAT HALL] Professor Emeritus Dr. Michael Goodchild, University of California, Santa Barbara</p>
<p>10:10 a.m.</p>	<p><b>Break (provided)</b></p>
<p>10:30 a.m.</p>	<p><b>CONCURRENT SESSIONS 1 (20 PAPERS AND 1 WORKSHOP TOTAL)</b> 5 papers / session – 20 minutes each 5 minutes for questions at the end</p>
	<p><b>3D and Geodesign</b> [1-GH] [GREAT HALL]</p> <p><b>Crowdsourcing / Big Data / Open Data</b> [1-EC] [EAST COMMON ROOM]</p> <p><b>Glaciology / Geology</b> [1-DE] [DEBATES ROOM]</p> <p><b>Physical Processes</b> [1-SD] [SOUTH DINING ROOM]</p>

# Agenda

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	<p><b>Storytelling with Maps Workshop</b> [W3-MU]  <b>[MUSIC ROOM]</b></p> <p>Story maps are web maps that combine text, multimedia, and interactive functions to inform, educate, entertain, and inspire people about a wide variety of topics. By using maps to tell a story, students can become more geographically aware, better understand the interconnectedness that makes the world work, and become better global citizens. Join this workshop to learn how you can create and use story maps in your teaching. We will also use the smartphone app, Snap2Map, which allows the user to create a story map while conducting field research.</p> <p><b>Instructor:</b> Jean Tong, Angela Alexander, Hayleigh Conway (Esri Canada)</p>
12:15 p.m.	<p><b>Lunch (on your own)</b></p>
1:15 p.m.	<p><b>CONCURRENT SESSIONS 2 (12 PAPERS AND 2 WORKSHOPS TOTAL)</b></p> <p>4 papers / session – 20 minutes each  10 minutes for questions at the end</p>
	<p><b>Agricultural Applications</b> [2-SD]  <b>[SOUTH DINNING ROOM]</b></p> <p><b>Applications in Ecology</b> [2-EC]  <b>[EAST COMMON ROOM]</b></p> <p><b>Health and Retail</b> [2-DE]  <b>[DEBATES ROOM]</b></p>
	<p><b>Integrating R with ArcGIS Workshop</b> [W1-SS]  <b>[SOUTH SITTING ROOM]</b></p> <p>R is a statistical programming language that provides access to a large collection of statistical tools for data analysis. In this workshop, you will learn how to use R to extend the capabilities of ArcGIS for Desktop (including ArcGIS Pro) using the new R-ArcGIS Bridge. You will also learn several basic R programming techniques, and how to construct and execute a geoprocessing tool that uses R to perform data analysis.</p> <p><b>Instructor:</b> Cam Plouffe (Esri Canada)</p>

# Agenda

	<p><b>Building Custom Web Apps with ArcGIS Workshop</b> [W2-MU]  [MUSIC ROOM]  Learn about some of the changes that are being made to the ArcGIS API for JavaScript in version 4.0 and how to use the JavaScript API to create your own custom Web apps. Also learn how to create custom widgets that you can use to extend Web apps built using the Developer Edition of the Web AppBuilder for ArcGIS.  <b>Instructor:</b> Krista Amolins, Dr. Michael Leahy, Jonathan Van Dusen (Esri Canada)</p>
2:45 p.m.	<p><b>Break (provided)</b>  [GREAT HALL]</p>
	<p><b>Current &amp; Future Prospects for GIS Employment for Students and New Graduates in Canada</b>  [EAST COMMON ROOM]  Jonathan Murphy, GoGeomatics</p>
3:15 p.m.	<p><b>CONCURRENT SESSIONS 3 (12 PAPERS AND 2 WORKSHOPS TOTAL)</b>  4 papers / session – 20 minutes each  10 minutes for questions at the end</p>
	<p><b>Crime and Emergency Management</b> [3-EC]  [EAST COMMON ROOM]</p> <p><b>Transit Modelling and Accuracy</b> [3-DE]  [DEBATES ROOM]</p> <p><b>Data Integration / Education</b> [3-SD]  [SOUTH DINING ROOM]</p>
	<p><b>Integrating R with ArcGIS Workshop</b> [W1-SS]  [SOUTH SITTING ROOM]</p>
	<p><b>Building Custom Web Apps with ArcGIS Workshop</b> [W2-MU]  [MUSIC ROOM]</p>
4:45 p.m.	<p>Conference closes</p>

# Agenda

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## 3D and Geodesign [1-GH]

(10:30 – 12:15)

1. Illumination Infrastructure Mapping: Learning Web Development through the ArcGIS Framework
2. Visual Acceptance of Library-Generated CityGML LOD3 Building Models
3. Discovering landform processes through creative 3d mapping and diagramming of form, pattern and arrangement
4. Integrating CityEngine and Unity for Immersive Campus Simulations
5. Using CityEngine in the Study of Landscape Architecture

## Crowdsourcing / Big Data / Open Data [1-EC]

(10:30 – 12:15)

1. Cyber-Hate on Twitter: A Geographic Profiling of Digital Hate Speech in Canadian Cities
2. Geocontextualization: Automated VGI Contextualization
3. Models of direct editing of government spatial data: Challenges and constraints to the acceptance of contributed data
4. Prediction Model of Ship Movement Resulting from the Effects of Environmental Covariates
5. CANHUMap: Mapping Canadian International Humanitarian Assistance Projects

## Glaciology / Geology [1-DE]

(10:30 – 12:15)

1. Landsystem analysis of three outlet glaciers of the Vatnajökull Ice Cap, Iceland
2. Mapping the Impacts of Iceland's Katla Subglacial Volcano on the Mýrdalsjökull Glacier
3. Modelling Potential Environmental Effects of Expanding Lake Jökulsárlón in Response to Melting of Breiðamerkurjökull, Iceland, From 1999 to 2014
4. A virtual guide to rocks, fossils and geology
5. Geological Mapping using Machine Learning Algorithms and GIS

## Physical Processes [1-SD]

(10:30 – 12:15)

1. Delineation of Paleowind Direction from Dunes in Simcoe County, Ontario
2. Morphological Interpretations of Glacial Forms by Spatial Analysis in the Area Surrounding Lake Simcoe, Ontario
3. Creating a Map of Terrain Regions for Italy using Digital Elevation Models
4. Detecting spatial and temporal patterns in hydrological conditions across important northern lake-rich landscapes
5. Quantifying Eroded Sediment Volume during Drumlin Formation in Simcoe County

## Lunch (on your own)

(12:15 - 1:15)

## Agricultural Applications [2-SD]

(1:15 – 2:45)

1. Multi-criteria Suitability Analysis for Corn Growth in Southern Ontario
2. Temporally-weighted land use regression: a methodological approach to interpolating soil lead levels using historical data
3. Integrated Spatial Decision Support System for Precision Agriculture
4. Using Esri ArcMap, ArcPad and Python to Identify Croplands in Southeastern Ontario

# Agenda

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## Applications in Ecology [2-EC]

(1:15 – 2:45)

1. Interactions between caribou and snowpack over space and time in Northwest Territories
2. Conservation Planning and Prioritization for the Highly Endangered Lemurs of Madagascar
3. Getting Closure: The Role of Urban Forest Canopy Density in Moderating Surface Temperatures in Large Cities
4. The Early Detection of the Emerald Ash Borer (EAB) Using Advanced Geospatial Technologies

## Health and Retail [2-DE]

(1:15 – 2:45)

1. Identifying City Analogues for Retail Location Decisions
2. Using activity tracking to examine the influence of exposure to unhealthy food outlets on junk food purchasing among children in London, Ontario
3. Examining the influence of contextual environmental exposure on children's free-living physical activity: a novel geospatial approach from the STEAM project
4. Toronto's Second-Hand Clothing Landscape

## GoGeomatics Talk

[EAST COMMON ROOM]

(2:55 – 3:15)

**Current & Future Prospects for GIS Employment for Students and New Graduates in Canada, Jonathan Murphy**

## Crime and Emergency Management [3-EC]

(3:15 – 4:45)

1. Persistence of violent crime hot spots: An ordered probit analysis
2. HazRail App: A Webmap Application for Understanding the Exposure and Appropriate Case of Actions to Rail Transportation Hazardous Materials Accidents
3. Dynamic Modeling of Evacuation Routes for Buildings
4. Crime Analysis and Routing Application for Wilfrid Laurier University's Special Constable Service

## Transit Modelling and Accuracy [3-DE]

(3:15 – 4:45)

1. How do different accessibility metrics affect the interpretation of access to healthy food stores for transit and automobile users?
2. Comparison of GPS units and mobile Apple GPS capabilities in an urban landscape
3. Geospatial Estimates of Road Salt Usage Across a Gradient of Urbanizing Watersheds in Southern Ontario
4. Unbundling the Hedonic Price Effects of Rapid Transit and Transit-Oriented Development in Toronto

## Data Integration / Education [3-SD]

(3:15 – 4:45)

1. The Role of Geography as a Key Tool in Integrating Big Data
2. SPIDER "Spatially Indexed Engineering Records"
3. A Land Use/Land Cover Change Geospatial CyberInfrastructure to Integrate Big Data and Temporal Topology
4. Geospatial Niagara: Promoting Geo-literacy and Community Participation through Geography

# Abstracts

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## 3D and Geodesign 1

### Illumination Infrastructure Mapping: Learning Web Development through the ArcGIS Framework

Dennis Sherman, Patrick Lasagna, and Amirali Hajibaba

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Illumination in built-up areas is a critical infrastructure that plays an essential role towards a safe and secure environment. The Illumination Engineering Society of North America articulates numerous criteria that define safe and secure lighting conditions at night time, for a variety of different human built environments. This presentation outlines the development and implementation of a Python based Geoprocessing Toolbox designed to compute, map and analyze the illumination conditions of an as-built environment, and the dissemination of this information through ArcGIS online based web apps. Particular emphasis will be placed on the design process, the accessibility of the ArcGIS web framework to the beginner developer through the use of tools such as the WebApp Builder and ArcGIS online, and the application of the developed framework to the York University Campus. The various illumination maps generated during this project will be presented and discussed.

## 3D and Geodesign 2

### Visual Acceptance of Library-Generated CityGML LOD3 Building Models

Ryan Garnett<sup>1</sup>, Jason T. Freeburn<sup>2</sup>

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The acceptance of 3D building models is critical to all urban 3D visualization projects. Building models that are identified as unacceptable can increase the cost of the project, delay the delivery, and, in some cases, cancel the acceptance of the entire project. A 3D modelling approach of using representative textures and geometry rather than actual photorealistic textures and geometry was conducted to determine whether participants who frequent the building multiple times a week over a period of a year would be able to identify the visual difference. Three focus groups were established and used to evaluate the visual quality of the 3D building models. Participants were asked to rank the visual quality of the building, as well as identifying any geometry, texture, or overall visual quality problems. The participants from the three focus groups did not identify any texture or geometry mistakes present in the building models. The overall visual quality identified by the participants from the three focus groups was above average, suggesting that the 3D modelling approach is an effective means for modelling buildings with high visitation and significance.

# Abstracts

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## 3D and Geodesign 3

### Discovering landform processes through creative 3d mapping and diagramming of form, pattern and arrangement

Nadia D'Agnone<sup>1</sup>

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The ground is constantly changing even if we cannot directly see it. The ground as we see it presently is a mere instant of a much larger geomorphological material process that has evolved over the 4.6 billion year history of the earth. The principles of landscape ecology tell us that the spatial forms, patterns and arrangements found on a site in the present are a direct result of processes of the past. This means that the formal composition of elements found on a site can tell us about the forces and conditions that have shaped them. This is important because it can help us gain a better understanding of the natural environmental conditions of a site prior to intervention, even those conditions hidden deep within geological time. Through the use of creative cartographic techniques of mapping and diagramming, with a specific focus on 3D modelling and rendering, this paper will explain how we can discover more about landform processes simply by analyzing form.

The methodological tool presented in the paper is that of the anamorphic view that traces over the otherwise unseen, invisible, or unperceivable formal visual elements of the ground's forms, patterns and processes. With the cartographic tools of creative mapping, diagramming, and modeling, the visual elements of form, position, scale, composition, value, colour, texture, depth, change, pattern, and movement are marked out in the aerial view, projected on top of a digital topographic model, and then presented in perspective as seen from the ground level view. The above stated operations are enabled by the eidetic visualization techniques that rely on various contemporary digital mapping and modelling technologies. A variety of Esri ArcGIS extensions and tools are explored along with other physical modelling technologies.

The case study presented is Catania, Sicily, Italy. Located near the boundary of the Eurasian and African tectonic plates, a zone of subduction, and the largest active volcano in Europe, the Etnean region where Catania lies is one of the most seismic areas in all of Italy, is changing both rapidly and slowly, and thus an interesting case study for this research.



# Abstracts

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## 3D and Geodesign 4

### Integrating CityEngine and Unity for Immersive Campus Simulations

Michael Luubert<sup>1</sup>, Brent Hall<sup>2</sup>

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This presentation introduces a workflow for creating 3D campus simulations, allowing campus facilities managers, professors, students and visitors to interact with a visual representation of the campus and perform simulations such as shortest path routing. The approach allows for the exploration of campus model data not possible with a traditional GIS. For example, visualizing the sightlines from certain places on campus and seeing subtle terrain changes from ground level can be achieved. Specifically, we present a suite of tools for transforming traditional 2D campus data to a format that can be imported into the Unity Game Engine. Data outlining various types of land cover such as grass and pavement are imported into Unity's terrain engine using ModelBuilder tools. Building exteriors, interior floorplans, sidewalks, roads, and trees points are exported to Unity from CityEngine using the FBX model format.

The workflow begins in ArcMap by preparing the data for geodatabase export to CityEngine. A feature class is created that defines the study area's land cover types, such as pavement, grass, and water. The geodatabase containing the multipatch buildings, interior floor and wall polygons, streets, and tree locations is exported from ArcMap into CityEngine, where the feature data are transformed into 3D models using CGA rule files. A DEM created from the available terrain data is also imported into CityEngine, which is used to position the created models on the terrain. The generated models are then exported to Unity, where the full features of the engine are available to create real-time visualizations, including navigating the campus with a fly through or simulating emergency evacuation scenarios out of a building.

The presentation concludes with the review of a Unity application developed using the campus model to perform shortest path routing between rooms. This application demonstrates Unity's ability to render realistic environments and the extensibility of the platform to perform routing using ArcGIS Server. The described tools and workflow for transforming the GIS data to a Unity scene will be publicly released to enable other universities to create Unity applications for their campuses and specific use cases.

# Abstracts

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## 3D and Geodesign 5

### Using CityEngine in the Study of Landscape Architecture

Adele Pierre<sup>1</sup>

<sup>1</sup> Landscape Architecture, University of Guelph, [apierre@uoguelph.ca](mailto:apierre@uoguelph.ca)

Landscape Architecture is a discipline requiring the collection, analysis and synthesis of many layers of information. Traditionally these layers have been documented on a series of maps, with design decisions made after analyzing the site's opportunities and constraints. GIS has been used by a small number of Landscape Architects to facilitate the process of analysis and to understand the complexities of land use. Upon completion of the design process a 3D model will be generated in order to give the client a clear idea of the final product. This modeling phase is labour intensive, often consuming many hours. With the advent of new geodesign tools the design process has changed significantly; with the ability to integrate data and metrics right into the 3D model the designer can easily make modifications, assessing and comparing outcomes with each iteration.

CityEngine is a powerful geodesign tool allowing large scale modeling in a much shorter time frame than other 3D applications such as Sketchup. Through the use of procedural rules neighbourhoods, cities and regions can be quickly modeled and geo-referenced. While it takes a fair commitment to learn the full capabilities of CityEngine there are some aspects that are relatively simple to learn, and could easily be taught in schools of Landscape Architecture.

A few of these extremely useful skills are:

1. Creating a figure ground from open source data such as OSM or the data portals of city websites.  
Tutorial <https://youtu.be/yu7qSNXQOBI>
2. Generation of 3D building mass from a figure ground using shape files or OSM data.  
Tutorial <https://youtu.be/4N5JCKhqkdY>
3. Sharing models through web scenes.  
Tutorial <https://youtu.be/R3ESrZgji1Y>
4. Creating or modifying existing rules to customize models
5. Obtaining real data on building mass, square footage, zoning, open space etc.

The profession of Landscape Architecture is being transformed through the use of technology, and students are in a unique position to try new software programs, find out their capabilities, and further refine the programs to become ever more useful to the profession.

# Abstracts

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## Crowdsourcing / Big Data / Open Data 1

### Cyber-Hate on Twitter: A Geographic Profiling of Digital Hate Speech in Canadian Cities

Matthew Tenney<sup>1</sup>, Tay Ferrier, Haya Rizvi, Dara Shefska, Victoria Evans, and Harold Burton<sup>2</sup>

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<sup>2</sup>Department of Geography, McGill University, Montreal, QC

The adage “Anyone with a microphone can tell you what they have to say” reverberates a cautionary lesson regarding the trade-off society encounters when freedom of speech meets open mediums of mass communication. The Internet and social media platforms (e.g., Twitter) have provided just this sort of globally-connected forum where people have the ability to broadcast their views to millions of people instantly and effortlessly. In this study, we examine how the analysis of hate speech on Twitter may reveal the seedy underbelly of societal values. Twitter seems to give users a perceived “veil of anonymity” allowing them to voice things that may be difficult to obtain in a face-to-face interaction or socially unacceptable to verbalize in normative culture. This paper presents a study of bigoted content and hate speech language contributed by Twitter users. Human annotated Twitter data was collected through spatial filtering of real-time data streams and classified into a category of hate. For this analysis we considered three categories of hate: misogyny, racism, and homophobia. Racist and misogynistic tweets were clustered in unique and specific areas of the city, demonstrating clusters of different hate speech within the city. We found that racist and misogynistic slurs were often being re-appropriated from their derogatory histories and used to address either the author of the tweet themselves, or in ways that were not directly harmful to the marginalized group. A further step in the analysis resulted in the design of a machine-learning algorithm to automatically “detect” hate speech - using a combination of probabilistic, rule-based, and spatial-based classifiers.

## Crowdsourcing / Big Data / Open Data 2

### Geocontextualization: Automated VGI Contextualization

Majuratan Sadagopan<sup>1</sup>

<sup>1</sup>Department of Geography, University of Waterloo, msadagop@uwaterloo.ca

Waterloo, Ontario

Governments are increasingly aiming to increase transparency and engage citizens using web technologies. Collecting feedback from citizens using the web and social media platforms is increasingly becoming a norm. Geotagged citizen feedback is of particular value to urban administrators because it allows municipalities to gather feedback on urban locations and projects. When a geotagged comment is collected, common questions arise that need to be answered to process the data. What is the topic of the comment? Which location(s) does the comment apply to? What time frame does the comment apply to? Is there a common thread to all the comments received? In many cases these questions are trivial to a human who can see the data provided and has an understanding of the context. In contrast, a computer would find it very difficult to answer the questions that need to be answered for data processing. Scholars in the field of GIS have previously raised the idea of using contextual spatial information to address the challenge of processing spatial data (Goodchild & Li, 2012). This work has expanded on these ideas to develop the idea of Geocontextualization. Geocontextualization is the identification of the spatial, semantic and temporal circumstances that surround a spatial datum to attain a better understanding of said spatial datum. The idea of geocontextualization is developed with the goal of improving automated processing of VGI data. The methodology of the geocontextualization solution builds on ideas such as spatial matching, spatial data conflation, semantic heterogeneity and spatio-temporal data. By breaking down spatial data into its core dimensions of attributes, time and space (Yuan M. , 1996), it is possible for machines to make human-like inferences by comparing provided data to existed data. The connection between any two pieces of spatial data along any dimension is termed as a relation. They are identified using statistical tests and they allow machines to deal with ambiguity of spatial data. Geocontextualization is an exciting idea as it can potentially enable cities to acquire actionable information from citizens in near real time, the result is an improved democracy that is more responsive to citizen needs.

# Abstracts

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## Crowdsourcing / Big Data / Open Data 3

### Models of direct editing of government spatial data: Challenges and constraints to the acceptance of contributed data

Peter A. Johnson<sup>1</sup>

<sup>1</sup>Department of Geography and Environmental Management, University of Waterloo, Waterloo, Ontario, peter.johnson@uwaterloo.ca

The current popularity of government open data platforms as a way to share geospatial data has created an opportunity for government to receive direct feedback and edits on this very same data. This research proposes four models that can define how government accepts direct edits and feedback on geospatial data. The four models are; a 'status quo' of open data provision, data curation, data mirroring, and crowdsourcing. These models are placed on a continuum of government control ranging from high levels of control over data creation to a low level of control. Each model is discussed, with relevant challenges highlighted. These four models present an initial suite of options for governments looking to accept direct edits from data end users, and can be framed as a partial realization of many of the principles of open government. Despite the varied potential of these approaches, they generate a shift in locus of control away from government, creating several areas of risk for government. Of these models, near-term interest may focus on data curation and data mirroring as evolutionary, rather than revolutionary steps that expand on the simple provision of open data.

## Crowdsourcing / Big Data / Open Data 4

### Prediction Model of Ship Movement Resulting from the Effects of Environmental Covariates

Ben Friedrich<sup>1</sup>, Steven Roberts<sup>2</sup>

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This study will look at a stochastic model created to predict the varying drift patterns of large ships off the coast of North America. This model will be produced by analyzing the effects of environmental covariates (wind & wave) on anchored ships and generates a predicted location of a ship since its last known location. The predicted location will then be compared to the real location of the ship and then analyzed to determine the error of the model.

The data to be used consists of 3 data sets for the year 2013: AIS (Automatic Identification System) data, HF (High Frequency) radar for determining wave velocity, and HF radar for determining wind direction. AIS data is a tracking system installed on large ships that provides information such as ship velocity, size, and geographic position. AIS data will be used to view the drift paths created from a group of anchored ships over a certain time span. The HF radar data can provide data on the wave velocity and wind direction in an area for a given time and space in a multidimensional data set.

To determine the effects of environmental covariates the HF radar data will be compared against the AIS data of the large ships. By generating vector paths for large tanker ships and comparing them to the velocities of wind and waves a relation can be evaluated. By applying the relation, a predicted location can be determined on a ship given the velocities of the covariates and a time span. By using a method such as Kalman Filtering, a comparison of the predicted location and the real location will illustrate the error in the model. If found to be of high enough accuracy, this information could be applied to multiple applications in ship path prediction and for search and rescue purposes.

# Abstracts

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## Crowdsourcing / Big Data / Open Data 5

### CANHUMap: Mapping Canadian International Humanitarian Assistance Projects

Ali Asgary<sup>1</sup>, Zalma Sahar<sup>2</sup>

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Annually a large number of humanitarian assistance projects are funded by the Canadian Government's International Humanitarian Assistance Program. These projects provide assistance to countries impacted by various types of natural, technological, and human made disasters and emergencies.

While full information and general mapping of these projects is publicly available, we have developed an app that provides more spatial insights and analytical and search capabilities into these projects by an easy to use mapping tool called CANHUMap.

CANHUMap has been developed using ESRI ArcGIS Online Webapp Builder. This app contains about 1600 projects funded by the Canadian Government between 2005 to 2015. CANHUMap enables users to temporally and spatially map, query, and analyze Canadian humanitarian assistance projects by various attributes such as countries, type of assistance, amount of fund provided, executing agencies, start date and end date, status, and link to full project details.

# Abstracts

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## Glaciology / Geology 1

### Landsystem analysis of three outlet glaciers of the Vatnajökull Ice Cap, Iceland

Rebecca E. Lee<sup>1</sup>, John C. Maclachlan<sup>2</sup>, and Carolyn H. Eyles<sup>3</sup>

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Landsystem analysis is a commonly applied methodology for examining spatial variation of landforms and sediments within glacial forefields. This method uses digital data and field studies to define genetically related landform-sediment assemblages known as landsystem tracts to recreate the geomorphological evolution of the region. The landsystems at modern glaciers can be applied to ancient glacial deposits to reconstruct climatic, glaciological and geomorphological aspects of the environment at the time of deposition.

The glacier forefields of three outlet glaciers of the Vatnajökull Ice Cap in southeast Iceland were examined using remote sensing and field techniques to define landsystem tracts and sedimentological characteristics. The glaciers studied (Svínafellsjökull, Skaftafellsjökull and Mosarjökull) are separated by mountain ridges but lie within close proximity limiting variables linked to climate. The three glaciers examined during this field season are examples of temperate glaciers without significant influence from surge-type behaviour or jökulhlaups, large outburst floods.

The initial classification of the landsystem tracts was completed using a Geographic Information System (GIS) to examine LiDAR data obtained from the Icelandic Meteorological Office. A digital elevation model (DEM) was created from the LiDAR data and used to map the spatial distribution and variation of landforms at each of the three glacier margins. The mapped landforms were ground checked in the field (summer 2015) using a portable GIS in conjunction with sketch maps and photographs. Sediment characteristics were recorded using sedimentological logs and surface pits to examine the sediment types associated with the landforms and landsystem tracts. The combination of field data and remotely sensed data has allowed for detailed mapping of the landsystem tracts in the proglacial area of these three glaciers within a GIS.

Though the glaciers lie within close proximity and are sourced by the same ice cap there are distinct variations in landforms in each of the glacial forefields. Differences in the bedrock, topography and ice characteristics of the glaciers results in variation in sediment types, relative relief and distribution of landforms in the proglacial region. This paper will highlight the maps created through this research and future directions.

# Abstracts

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## Glaciology / Geology 2

### Mapping the Impacts of Iceland's Katla Subglacial Volcano on the Mýrdalsjökull Glacier

Chelsi McNeill-Jewer<sup>1</sup>, Lauren Oldfield<sup>2</sup>

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Through the use of collaborative writing groups in the McMaster University upper year course Glacial Sediments and Environments an opportunity arose for undergraduate students to write and submit a paper to the peer-reviewed journal *Cartographica*. Within this process a group of six undergraduate students researched and formulated the potential risks and safety precautions associated with the Katla-Mýrdalsjökull glacier-volcano complex in Iceland. The subglacial volcano Katla and its associated glacier Mýrdalsjökull, near Iceland's southern coast, have the potential to cause catastrophic jökulhlaups, a sudden and substantial release of subglacial and/or proglacial water, through volcanic eruptions and geothermal melting. The resulting jökulhlaups can pose serious threat to human life and cause destruction of property. Ice cauldrons, water-filled ice depressions on the glacier's surface, can be identified through remote sensing and used to infer potential locations and melt rates of geothermal hotspots. This information can be combined to assess the risk of a future jökulhlaup and its impact on the surrounding communities and infrastructure. Furthermore, a map of geothermal hot spots, loss of glacial mass of Mýrdalsjökull and Eyjafjallajökull, and meltwater flow paths of the Mýrdalsjökull glacier were created and analysed. Using geospatial analysis, it was determined that three hazard zones – two towns, Alftaver (to the east) and Vik (to the south), as well as Iceland's main highway, Route 1 'Ring Road' – are directly in the path of potential jökulhlaups originating from the Mýrdalsjökull-Katla complex. Future research should further constrain meltwater flow paths to determine potential flow discharge rates and better delineate areas that have the greatest risk of flooding. As well, this research can be used as an analogue for modern environments and for paleo-environmental reconstruction.

## Glaciology / Geology 3

### Modelling Potential Environmental Effects of Expanding Lake Jökulsárlón in Response to Melting of Breiðamerkurjökull, Iceland, From 1999 to 2014

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Glacial retreat has been well documented in several studies on the Vatnajökull ice sheet. Breiðamerkurjökull, an outlet glacier from Vatnajökull, has been actively retreating since the end of the Little Ice Age from late-16th century to mid-19th century. There is a strong correlation between the rate of glacial melt from increasing global temperatures and the expansion of proglacial lakes. Jökulsárlón, a proglacial lake associated with Breiðamerkurjökull, has grown significantly from 14,575,689 m<sup>2</sup> to 25,453,798 m<sup>2</sup> between 1999 and 2014 as illustrated in a series of Landsat 7 ETM+ imagery. Climate models predict that global temperatures are expected to continue rising. This will consequently impact the rate of glacial melt and subsequent expansion of proglacial lakes. Using GIS and integrating climate data a model was computed to determine the expansion of the lake. These trends, as seen around the Breiðamerkurjökull-Jökulsárlón area, may evoke serious environmental complications for the Icelandic population in the future. For that reason, it is important to monitor this phenomenon and take precautions where necessary. This will also serve as a modern analogue for future studies on understanding the relationship between outlet glaciers and proglacial lakes responses to climatic change.

# Abstracts

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## Glaciology / Geology 4

### A virtual guide to rocks, fossils and geology

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Geological interpretation and comprehension is optimally achieved with first hand access and exposure to data and materials. However, there are many scenarios where immediate access to meso-scale (<m) and macro-scale (>km) data is unattainable. This is particularly evident for remote regions and educational environments where field visits are often limited. In order to augment conventional geological investigations, we propose the use of 3D digital data of Earth materials, e.g. rocks, fossils, minerals and core samples. The approach followed will facilitate the preservation and global sharing of meso-scale samples in a manner that links and visualizes referential connections, presents the dynamic and interactive nature of geology and promotes transformations between 2D and 3D. The objective of this research is to optimize the data collection process of a 3D close-range (desktop) laser scanner for a variety of meso-scale samples of rocks and fossils used for geological applications. The ultimate goal is to embed the meso-scale samples in an interactive macro-scale environment (GIS). The optimization process for the desktop laser scanner is not trivial as it must be evaluated on a sample-by-sample basis until a sufficiently heterogeneous and significant database of samples is acquired. This work focuses on comparing true samples with digitized models and modifying the scanning process and post-processing to achieve realistic and repeatable models. Parameters tested include target-sensor baselines, resolution of scanned samples and integration into an immersive 3D geospatial environment.

## Glaciology / Geology 5

### Geological Mapping using Machine Learning Algorithms and GIS

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There are several useful applications of remote sensing spectral imagery in Earth sciences such as environmental monitoring, land use, and mineral exploration. Remote sensing paired with geophysical and geodetic data, such as total magnetic intensity, terrain, and geospatial coordinates, can be useful in lithological mapping of inaccessible areas. These data can be used to train Machine Learning Algorithms (MLA) to enhance geological interpretation. MLAs are widely used in image analysis and other statistical pattern recognition applications. This procedure is facilitated through the use of ArcGIS. In this case study, four different MLAs (Naïve Bayes, k-Nearest Neighbour, Random Forests, and Support Vector Machines) are implemented to identify rock types in an area with reliable ground validation information. A classification cross-validation was performed with the MLAs to determine which parameter values yield the best performance for a range of calibration data cluster sizes and distributions within the study area. A classification in this study refers to the assignment of a rock type to an unlabeled data point based on its similarity to digital signatures of data points with known rock types, allowing for a rapid and more objective approach to image analysis. Results were evaluated by comparing the ground validation rock type map to predictions generated by each classification and by locating correctly identified and misclassified data points. Rock type confusions and overall accuracy results showed that Naïve Bayes is the poorest performing MLA for rock type identification, and Random Forests shows the most promise in this application. As expected, MLA performance increases with the number and more uniform distribution of calibration clusters. Overall, this technique can be useful in preliminary site investigations to identify regional trends and areas of interest for secondary surveys, though assigned labels should be assessed critically.



# Abstracts

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## Physical Processes 1

### Delineation of Paleowind Direction from Dunes in Simcoe County, Ontario

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Dune fields that developed along paleolake shorelines in Ontario are a product of paleoenvironmental conditions, which developed as a result of glacially influenced geological processes. In Simcoe County, Ontario, many dune fields were created between 3 and 12 ka, when this area was covered by a series of lakes, bordered by thick sandy beaches. Coastal sediments of the glacial Lake Algonquin and the Nipissing phase of the upper Great Lakes were reworked primarily by paleowind activity and intense periodic storms once lake levels had decreased. This formed dunes, which are now common along the south-eastern coast of Georgian Bay in Simcoe County. Dunes that developed earlier (8–10 ka) have a different average orientation than dunes that developed later (3–5 ka). Various geomorphometric techniques are tested to construct a replicable methodology for determining paleowind direction. Through identification of parabolic dunes, azimuth angles were determined and used to infer the dominant paleowind directions. Dunes on the paleolake Algonquin plain commonly have a north-east to south-west orientation, whereas dunes associated with Nipissing phase shorelines formed via north-westerly winds. These data may suggest changing prevailing winds in the Great Lakes region during deglaciation.

## Physical Processes 2

### Morphological Interpretations of Glacial Forms by Spatial Analysis in the Area Surrounding Lake Simcoe, Ontario

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Drumlins are sedimentary geological features that indicate the final direction of glacier movement; as a result, they are of great interest in understanding past glacial events. In southern Ontario alone, thousands of drumlins have been mapped and interpreted remotely through the use of aerial imagery or topographic maps. These are often paired with digital elevation models (DEMs) and/or contour maps offering detailed information about the area of study. This paper presents the results of a change-detection study that used maps of different vintages of the drumlin-rich area around Lake Simcoe in southern Ontario. Two topographic maps and two DEMs, each with contours at 25-ft (7.6-m) and 10-m intervals, were compared in three regions: (A) the urban region in the city of Orillia, overlying sand plains; (B) the area east of Orillia, on top of clay plains; and (C) the region south-east of Lake Simcoe, overlying till plains. The 7.6-m contour topographic maps and DEMs display comparable levels of detail; however, over time the drumlins appear to erode, likely a product of the underlying sediment in combination with urbanization. The 10-m contour topographic maps display less detail than DEMs of the same resolution, suggesting that the popular topographic maps are not the most reliable method of mapping drumlins.

# Abstracts

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## Physical Processes 3

### Creating a Map of Terrain Regions for Italy using Digital Elevation Models

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Geomorphometric research involving DEMs has focused primarily on the classification of landform elements or well-defined unmixed terrain types. While useful, these classifications do not provide an easy way to visualize relationship between different landforms like maps of terrain regions do. Using the topographically diverse country of Italy as a study area, this research seeks to: i) create an updated and improved terrain region map of Italy; ii) create a tool using Esri technology to automate the approach; iii) examine the impact that DEM products created from different satellite technologies have on the results; and iv) explore the impact that resolution has on the resulting classification map. Morgan & Lesh's (2005) method for creating a map of terrain types was modified and reconstructed in ModelBuilder in order to achieve the first and second objectives. Objectives three and four were accomplished by applying the model to one ASTER DEM and two SRTM DEMs of differing resolution and examining the results. Terrain region maps that accurately reflect Italy's geomorphology were successfully created, and it was found that the DEM product (i.e. ASTER or SRTM) has a greater impact on terrain region classification result than the DEM resolution. The use of coarser resolution DEMs results in more land being assigned to the 'plains,' 'tablelands,' and 'plains with hills or mountains' terrain region types.

## Physical Processes 4

### Detecting spatial and temporal patterns in hydrological conditions across important northern lake-rich landscapes

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Lake-rich landscapes are prominent across northern regions and provide habitat for abundant wildlife and resources for local communities. These important landscapes are sensitive to changes in climate and human activities, although lake water balance responses are non-uniform among regions depending on local catchment conditions. Research presented here highlights analytical approaches that are being used to evaluate spatiotemporal response patterns in lake hydrological conditions at two vast Canadian wetlands: Old Crow Flats (OCF), YK and the Peace-Athabasca Delta (PAD), AB. Both locations are internationally-renowned for their ecological and cultural significance. OCF is a headwater basin where lakes tend to drain into the river network, whereas the PAD contains lakes that are periodically recharged by river floodwaters. Their differing hydrological settings are reflected in landscape-scale assessments of lake water balance variability, derived from analysis of lake water isotope compositions. Results from lakes spanning OCF (n=57) and the PAD (n=60) underscore the importance of spring source waters for maintaining positive lake water balances. Precipitation and runoff comprise most OCF lake input, while river floodwater is an additional source of input to lakes in the PAD. Interpolated water balance maps illustrate that lakes in central OCF receive less snowmelt runoff and are more vulnerable to drying. Lakes in the PAD, outside of the range of flooding, are susceptible evaporative lake-level drawdown. Analysis for OCF incorporates land cover and shrub proliferation maps, which shows strong spatial correspondence between catchments with high proportions of tall shrub, with high snow-holding capacity, and lakes with positive water balances. River water chemistry and isotopic compositions from 22 sites in OCF indicate that subcatchments of OCF export varying proportions of lake water and nutrients. These patterns are being compared to land cover changes to identify potential climate-induced drivers of hydroecological variability. Hourly water level data, collected at five lakes in OCF and 11 lakes in the PAD during 2015, are being used to produce high temporal resolution maps of lake hydrological responses to seasonal meteorological conditions and river input. Knowledge generated from these research programs informs land and water resource management strategies and enhances the capacity of northern community adaptation to ongoing climate and landscape change.

# Abstracts

## Physical Processes 5

### Quantifying Eroded Sediment Volume during Drumlin Formation in Simcoe County

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Despite having been studied for decades, drumlins are still incredibly enigmatic in terms of their formation processes. As a result of the complexity and variability that has been observed in drumlin form and internal composition, several theories have been presented to explain the origin of drumlins. The current understanding focuses on drumlin creation by depositional and erosional processes associated with large subglacial meltwater floods, large-scale deformation of subglacial sediments and instability at the ice-bed contact. These theories necessitate the transport of sediment, either in a single erosional event (subglacial meltwater flood theory) or episodically (deforming-bed theory and instability theory). To support an erosional theory for the formation of drumlins, large volumes of pre-existing sediment would have undergone transport away from a forming drumlin field and been deposited in an alternate location. In this study, two methods in a Geographic Information System were used to calculate the volume of sediment which, if erosional theories of drumlin formation hold true, would have been removed and transported from the Peterborough Drumlin Field in Simcoe County, Ontario. The limitations of both calculation methods and the location of potential sediment sinks were analysed. The range of eroded sediment volume was calculated to be 3.5–8.3 km<sup>3</sup>, which is equivalent in volume to between 30.2% and 71.6% of the Lake Simcoe basin. The high volume of sediment that was estimated in this study will have future implications in the drumlin debate and for the feasibility of an erosional process of formation.

## Agricultural Applications 1

### Multi-criteria Suitability Analysis for Corn Growth in Southern Ontario

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Land use suitability is an approach for identifying a spatial location for a land use activity and its corresponding suitability level. It can integrate specific requirements, preferences, or predictors of a land use activity to generate a suitability score for a location (Hopkins, 1977; Joerin et al., 2001; Collins et al., 2001; Malczewski, 2004; Akinci et al., 2013). Due to the high level of detail that can be incorporated in suitability analysis, it has the ability to assist with crop decision-making and subsequently affect food productivity and food security. This research presents a multi-criteria suitability analysis for corn growth in Southern Ontario based on soil, topography, and climate characteristics. The weight for each criterion will be generated using rank reciprocal method based on scores representing relative criterion importance provided by farmers through survey methods. Considered criteria and corresponding weights will be combined using weighted linear combination method to generate an overall suitability score. Sensitivity analysis will be performed to evaluate the effects of changes in criteria weights on suitability scores. Suitability scores will be mapped and analyzed to quantify the spatial distribution of potential corn growing locations across Southern Ontario. This suitability analysis can facilitate the identification of the best suitable areas for crops and can contribute to effective land-use planning.

# Abstracts

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## Agricultural Applications 2

### Temporally-weighted land use regression: a methodological approach to interpolating soil lead levels using historical data

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In urban areas, soil lead contamination was caused by a wide range of products (e.g. leaded gasoline, lead-based paint, batteries, etc.). Although many products containing lead have been banned for decades, the legacy of soil lead contamination remains. For the last several decades, heavy metal interpolation in the soil sciences has depended on kriging for accurate surface prediction due to its ability to smooth the prediction surface, which is particularly useful in areas where the study area is ubiquitous and land use variables are limited. Heavy metals are often the consequence of mining operations in rural areas distant from urban and suburban development. As a result, kriging is the optimal choice for interpolation in rural areas where sources are limited and the spatial distribution of the dependent variable is likely simplistic. Urban areas add additional complexity, in part because of the long-term, historical use of the land. In order to capture spatial variation of soil lead levels in an urban area, the use of historical data is necessary. Not only is the historical data important, but the temporal characteristics of the data are also important to leverage for better predictive power.

Using lead (Pb) as a case study, this paper will address the complexity of interpolating heavy metals in an urban centre by utilizing a well-developed interpolation method called Land Use Regression (LUR). LUR works by determining how well various land use variables (also known as predictor variables) are able to estimate the spatial variation of the dependent variable by using regression analysis. Further, the paper will extend LUR by utilizing a rich historical dataset for the downtown region of Hamilton, Ontario, Canada as a means to develop a new weighting scheme to generate a better predictive land use regression model than previous attempts.

## Agricultural Applications 3

### Integrated Spatial Decision Support System for Precision Agriculture

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The term Precision Agriculture means the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production (Pierce and Nowak, 1999). As such Precision Agriculture is a technology enabled concept, brought together by the growing need to increase productivity and reduce the environmental impact.

The objective of this project is to develop the tools and techniques to manage crop yield and generate prescription maps for application of agricultural inputs and package them as a "Precision Agriculture Extension" for ArcGIS Desktop. The tools are being developed using C#.Net and integrated in a customized dockable window User Interface within ArcMap. Models were created for the tools to perform analytical functions. Python scripting was used as the general-purpose programming language for geoprocessing. Application extensions have been used to coordinate activities between other components—such as buttons, tools and dockable windows.

A corn field has been initially selected for the pilot study to gather field data which is necessary to validate the models. Soil sampling has been done at regular intervals and lab analysis carried out for physical, chemical and biological properties. Yield estimations have been performed during each harvest season and observations are being used to apply variable inputs for the next growing season. The system is in the final stages of development and other Agriculture sites with different crops have been selected and evaluation of the models is in progress.

# Abstracts

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## Agricultural Applications 4

### Using Esri ArcMap, ArcPad and Python to Identify Croplands in Southeastern Ontario

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The Ministry of Agriculture, Food and Rural Affairs (OMAFRA) works to support the government's efforts to promote a productive agricultural sector for rural Ontario. In doing so, the Ministry is responsible for tracking provincial field crop production and price estimates on an annual basis. Developing innovative ways to effectively update and maintain a polygon framework of croplands could significantly contribute to the advancement of OMAFRA's business objectives. In 2014-2015, a collaborative project team at Fleming College worked to develop an innovative methodology using GIS to provide an end to end solution which included: data collection (heads-up digitizing, field verification) spatial analysis (semi-automated image classification) and cartographic service delivery (online web mapping solution). The study area extended from Lindsay northward to Bobcaygeon and eastward to Omemee, Ontario, an area referred to as the 'Arrowhead'. The polygon framework that was manually created during this project involved the use of Esri ArcMap for heads-up digitization and ArcPad to facilitate crop identification in the field. The areas that were digitized were used as training sites to facilitate the automation of the process of identifying crops in the area using Python script. A web application was also constructed using Esri technology to facilitate an accessible method for OMAFRA Staff, Legislators, Planners and Farmers to query the information contained in the database and calculate useful statistics associated with the crop data. Throughout the course of the project the collaborative project team developed an innovative methodology alongside numerous recommendations for improvements associated with heads-up digitizing, field data acquisition and automation of applied remote sensing analyses using Python to facilitate land use classification and crop identification. This project is an example of how GIS can be used to provide a means to estimate crop type and extent to contribute to the ongoing goals of the Ministry in support of the agricultural sector of rural Ontario.

# Abstracts

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## Applications in Ecology 1

### Interactions between caribou and snowpack over space and time in Northwest Territories

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Northern barren caribou populations have experienced rapid declines in recent years in circumpolar regions. While natural population cycles are expected, the rate of decline in estimated population numbers has been alarming. Several hypotheses have been developed to explain this trend, including changes in environmental conditions that impact access to lichens, their primary food source, to changes in snowpack that impact their ability to move across the landscape and increasing their vulnerability to predators. Disentangling the possible environmental determinants of population decline requires investigating spatial relationships between caribou and snowpack over large spatial and temporal scales. This study exploits satellite-derived estimates of snow-water equivalence and satellite tracking of caribou using telemetry and GPS collars to explore these relationships. Data from both sources were obtained for the period 1996 to 2013. Spatial pattern analysis of caribou seasonal ranges was conducted using kernel density estimation, while seasonal range temporal shifts were examined using the spatial-temporal analysis of moving polygons method. Event types associated with year-over-year contraction and expansion were determined and examined for relationships with SWE metrics such as the timing of peak snowpack and total seasonal SWE. Individual-level analysis of collared caribou was also used to reveal changes in snowpack experienced by each individual animal over time. Such exploratory spatial and temporal analysis of population and individual-level processes provide a synoptic view of the interaction between caribou and their winter environment, revealing significant heterogeneity in the spatial winter ecology of caribou.

# Abstracts

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## Applications in Ecology 2

### Conservation Planning and Prioritization for the Highly Endangered Lemurs of Madagascar

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Protected areas (PAs) that preserve biodiversity are an integral component of in situ conservation. Assessment of biodiversity resources and their protection within PAs is critical to ensure that conservation targets are met and protection is maximized. Madagascar has been designated the world's single highest priority for primate conservation, and 94% of its species are at risk of extinction. Forest habitat loss is the primary cause of lemur population decline. PAs cover approximately 8% of Madagascar's land area, however, given the high extinction risk to lemurs and the importance of Madagascar as a biodiversity hotspot, it is important to determine if the current PA network represented lemur diversity effectively and how it could be improved in order to protect lemur diversity and ensure their long-term persistence. Two conservation planning models, Marxan and Zonation, were used to identify where to prioritize future conservation efforts.

Lemur species distribution maps were compiled to produce diversity estimates. Species range size and conservation status were used to inform conservation targets (percentage of a species range required to be included in the output). The PA network in Madagascar was assessed for its inclusion of lemur diversity. Marxan was used to generate the minimum expansion scenario necessary to meet all lemur conservation targets. Zonation was used to identify priority areas for conservation while restricting the network to 10% of Madagascar.

The current PA network meets conservation targets for only 30 out of 98 lemur species. The modeled expansion scenario would require a 225% increase (i.e., 16% of Madagascar) to the PA network to meet lemur targets. The top 10% Priority Area meets conservation targets for only 43 of 98 species modeled. There is high congruency between the expansion scenario and the top 10% Priority Area, with 70% of the top 10% Priority Area included within the expansion scenario.

Results suggest that political targets, such as the Durban Vision to preserve 10% of Madagascar within PAs, may be insufficient to adequately protect biodiversity. Assessments of diversity and extinction risk followed by systematic conservation planning can focus conservation efforts by identifying priority areas that maximize protection while minimizing cost.

## Applications in Ecology 3

### Getting Closure: The Role of Urban Forest Canopy Density in Moderating Surface Temperatures in Large Cities

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With a growing number of people living in urban areas, residents are more frequently exposed to stresses related to the built environment including increased surface temperatures resulting from the urban heat island (UHI) effect. This study examines the role of urban trees in moderating microclimatic variation in a densely populated city (Toronto, Canada), specifically the relationship between tree canopy density and surface temperature. By applying parallel aspatial (OLS) and spatial regression (GWR) approaches with satellite derived data describing tree canopy density and surface temperature, this study demonstrates how one dimension of canopy quality (i.e., canopy density) directly contributes to a reduction in the UHI effect at the local scale. Though the model fit differed between the two regression approaches, both exhibited moderately strong explanatory power and demonstrated that observed surface temperature decreases with the increase in area of closed canopy and high-density canopy. These results provide an empirical basis for municipalities to direct attention to tree canopy quality metrics such as increasing the density of existing urban forest stands as a part of municipal tree planting objectives that can more effectively deliver ecosystem services.

# Abstracts

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## Applications in Ecology 4

### The Early Detection of the Emerald Ash Borer (EAB) Using Advanced Geospatial Technologies

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EAB (*Agrilus planipennis* Fairmaire) is an invasive insect species that attacks all species of ash trees (*Fraxinus* spp). It was first found in North America in 2002 and has become established in several states in the United States of America and in Ontario, Canada. The beetle has caused the death of millions of ash trees during the past decade. Despite substantial research and control efforts, the beetle has continued to spread to new areas. The ash trees attacked by EABs typically die within 3 to 5 years and often show serious decline within 2 years. The aggressive nature of EAB infestation makes its early detection critical.

In this project, we established a framework to apply advanced remote sensing data including terrestrial LiDAR, hyperspectral and very high-spatial resolution multi-spectral data to improve species identification, tree health characterization, and early EAB detection. Individual tree crown was first delineated from very high-spatial resolution imagery, and ash trees were then identified using spectral, textural, and structural information derived from hyperspectral, high-spatial, and LiDAR data. To characterize tree health of the identified ash trees, we employed the indicators used by foresters in the field including leaf chlorophyll content, water content, transparency, percentage of fine twig dieback, live crown ratio, and crown vigor rating, and the symptoms related to EAB infestation include epicormic branching, woodpecker damage, and EAB exit holes. A measure for the general health state of a tree were designed based on features derived from hyperspectral imagery (sensitive to leaf chlorophyll content and water content) and airborne very high spatial resolution imagery (related to transparency, percentage of fine twig dieback, live crown ratio, and crown vigor rating). In addition, measures on EAB infestation were derived from terrestrial LiDAR/camera imagery on tree trunks. These measures were then intelligently integrated together by a weighted estimation function based on a prior knowledge. The developed framework and algorithms were tested using data in the Greater Toronto Area (GTA), Ontario, Canada.

## Health and Retail 1

### Identifying City Analogues for Retail Location Decisions

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The applications of spatial analysis and suitability analysis techniques for site selection span multiple disciplines (e.g., ecology, geography, business). In this paper, we conduct a suitability analysis across the entire province of Ontario to identify potential retail locations. During the presentation, we'll touch on the challenges of applying criteria and suitability analysis to the 4.7 million parcels comprising the province of Ontario. A short social survey was used to derive weights for the suitability criteria used and a sensitivity analysis of the most variable criteria weights suggests our results should be met by some caution. Given the uncertainty of site availability/acquisition and sensitivity to criteria weights, we aggregate parcels up to the city level and identify cities (i.e., census metropolitan areas) that share similar distributions of suitable parcels. Using pair-wise comparisons and cluster analysis we identify CMA analogues, which when compared to sales data show distinct differences. Using this approach we create a way to develop analogues for businesses that often seek to find new store locations that are similar to existing successful stores.



# Abstracts

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## Health and Retail 2

### Using activity tracking to examine the influence of exposure to unhealthy food outlets on junk food purchasing among children in London, Ontario

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**Objectives:** This study examines the influence of children's exposure to unhealthy food outlets on junk food purchasing during trips between home and school, with particular attention on how exposure and purchasing differ according to sex, mode of transportation, and direction (to or from) school.

**Methods:** Students (n=654) aged 9-13 years from 25 schools in London and Middlesex County, Ontario completed a sociodemographic survey and then were observed for 2 weeks using GPS to track routes for trips to/from school and activity diaries to identify food purchases. Route and purchasing data were integrated with a validated food outlet database in a GIS and then exposure was measured as the minutes a child spent within 50-metres of an unhealthy food outlet (i.e., fast food restaurants, variety stores). Multilevel logistic regression was used to assess the relationship between exposure and purchasing.

**Results:** Multilevel analyses indicated that children's duration of exposure to unhealthy food outlets between home and school has a significant effect on their likelihood of purchasing junk food. This relationship remains significant when stratifying by sex (girl/boy), trip direction (to/from school), and travel mode (active/car), with the exception of children who travel by bus.

**Conclusion:** Policies and programs that mitigate the concentration of unhealthy food outlets close to schools are critical for encouraging healthy eating behaviours among children and reducing diet-related health issues such as obesity.

# Abstracts

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## Health and Retail 3

### Examining the influence of contextual environmental exposure on children's free-living physical activity: a novel geospatial approach from the STEAM project

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**Background:** There is growing interest in identifying features of the built environment which facilitate or constrain physical activity in children. Recent studies have used accelerometers with Global Positioning System (GPS) loggers to track children's exposure to their environments for physical activity. This study aims to examine how contextual exposure – the nearby micro-environmental characteristics of places experienced by a child – exerts an influence on the proportion of time spent in moderate-to-vigorous physical activity (MVPA) during non-school hours.

**Methods:** As part of the STEAM (Spatial Temporal Environment and Activity Monitoring) project, children aged 9-14 years old (n=466) from London, Ontario wore passive GPS data loggers and accelerometers for 8 days. To delineate micro-environments for evaluating contextual environmental exposures, a tessellated hexagonal grid surface was created in ArcGIS v10.1 and then integrated with multiple built environment datasets. Weighted least squares logit regression for grouped data was used to test whether exposure to each environmental attribute predicted the likelihood of the proportion of time spent in MVPA.

**Results:** Results are sex specific. Contextual exposure to environmental features significant for boys' MVPA include: exposure to parks with sports fields, parks with sports fields and playgrounds, commercial spaces, and institutional spaces. Contextual exposure to environmental features significant for girls' MVPA include: exposure to parks without any built recreational features, recreational spaces, and multi-use pathways.

**Conclusion:** Results provide supporting evidence that children's physical activity is influenced by contextual exposure to environments outside the home. Results from this study underscore the need for future research about the spaces that exert contextual influences on physical activity. Interventions and policies that improve children's access to environments supportive of physical activity may be key to promoting healthy lifestyles and reducing childhood obesity.

# Abstracts

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## Health and Retail 4

### Toronto's Second-Hand Clothing Landscape

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The reuse and recycling of old clothing and textiles has been gaining attention due to the concern that a large amount of these materials are being disposed of in landfills, contributing to the growing global waste problem (Ekstrom & Salomonson, 2014). The generation of clothing and textile waste has been accelerating due to trends in consumption, such as "fast-fashion", as well as an overall higher standard of living (Ekstrom & Salomonson, 2014). However, research has shown that up to 95% of these materials can potentially be reused or recycled (H&M, 2015). In light of this potential, both consumers and retailers are active in finding pathways for reusing and recycling clothing and textiles (Gregson, Metcalfe, & Crewe, 2007; Kant Hvass, 2014), producing a complex landscape of second-hand sites in urban areas. Although the City of Toronto does not have a program that collects used clothing and textiles for recycling or reuse, numerous retail and charity organizations provide collection pathways in the city. This paper examines the spatial distribution of the different types of second-hand sites that collect these materials in Toronto. Literature suggests that different types of second-hand shops may exhibit different spatial patterns (Livingstone 2011), some of which reflect the distribution of customers and some the distribution of clothing donors. Data for this study were collected by searching the Yellow Pages, Google and the City of Toronto website to identify the locations of almost 200 consignment stores, second-hand clothing stores, vintage clothing stores, charity stores, and drop-off boxes. We found that some types of stores were distributed randomly across the city while others were unevenly distributed and depended on neighbourhood income. We also identified clustering of some types of stores as did Alexander (2008) in his study of charity shops in the UK. These findings are a first step for developing a greater understanding of the circular economy for clothing and textiles in Toronto and for increasing awareness about existing opportunities for reuse and recycling.

# Abstracts

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## GoGeomatics Talk

### Current & Future Prospects for GIS Employment for Students and New Graduates in Canada

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Jonathan Murphy, Managing Director of GoGeomatics Canada, will discuss the current climate for human resources in the Canadian geomatics community. Most recently a change of government has raised the hope the Federal government will begin to hire in greater numbers. Deficit spending at both the federal and provincial level not seen for over a decade could change the landscape for GIS jobs in Canada. In addition what has the collapse of the price of oil meant for geomatics employment in Canada? The energy sector in Canada has long been the driver for the majority of geomatics jobs. How will students face the current challenges in regards to obtaining employment in GIS. Over the past few years Canada has seen an increase in the number of specialist geomatics programs as well as an increase in class sizes of current programs. How will the ever increasing number of graduates find rewarding employment commensurate the education and training they have obtained?

## Crime and Emergency Management 1

### Persistence of violent crime hot spots: An ordered probit analysis

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The temporal persistence of geographical hot spots of crime is recognized as a crucial indicator of consistent problem areas and socio-economic deprived neighborhoods. For this reason, insights into the factors that contribute to this persistence can provide valuable insights to inform focused crime prevention efforts. The current literature regarding longitudinal analysis of crime hot spots so far has not adequately addressed the mechanisms that perpetuate or interrupt persistent crime hot spots, and relatively little is known about the geographical structural determinants of cross-sectional crime patterns.

In light of this, this paper investigates the factors associated with the persistence of violent crime hot spots in Columbus, Ohio, from 1994 to 2002. First, the spatial scan statistic is used to detect yearly crime hot spots in the nine year period under study (1994-2002). This is done at the Census block group level, and nine hot spot maps are generated, one for each year. Second, in order to better capture the magnitude of the persistence of hot spots, we present a measure called cluster membership which counts the frequency (i.e. the number of years) a block group belongs to hot spots by overlaying hot spot maps in nine years. Third, to explore the neighborhood structural determinants of cluster membership, an ordered probit regression model is used to estimate the relationship between cluster membership and a set of social disorganization variables and routine activity variables.

This study fills a gap in the literature by using an ordered probit model to identify structural correlates that drive the persistence of hot spots. The results indicate that socio-economic forces, identified from a synthesis of social disorganization theory and routine activity theory, significantly correlate with persistent patterns of violent crime hot spots. This gives evidence that a combination of the two ruling spatial theories of crime provides an applicable framework to an understanding of the temporal dimension of violent crime hot spots.

# Abstracts

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## Crime and Emergency Management 2

### HazRail App: A Webmap Application for Understanding the Exposure and Appropriate Case of Actions to Rail Transportation Hazardous Materials Accidents

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The number of hazmat train derailments has increased in recent years mostly due to an increasing trend in transportation of crude oil by rail. The devastation in Lac-Mégantic and unfortunate demise of 47 people following explosions triggered by the derailment of tank cars containing highly flammable crude oil, brought into focus, risks posed to communities by the transportation of hazardous materials (HazMat) by rail, particularly through highly populated urban areas.

However, despite the attention, the extent to which risk communication is effected is subject to debate. Although various measures have been suggested and are being implemented to reduce and mitigate train derailments and their impacts, public awareness and education regarding potential exposure to and preparedness for responding to accidents involving hazardous materials play a crucial role.

Unlike many disasters, train derailments occur without warning and therefore appropriate immediate responses at all levels are very important. To facilitate public understanding of their exposure and appropriate course of actions in case of hazardous material accidents, we have developed an app using ESRI ArcGIS Online Web App Builder. Hazardous materials captured in the application and immediate actions follow the list of more than 600 Toxic Inhalation Hazards (TIH) found in the Emergency Response Guidebook.

# Abstracts

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## Crime and Emergency Management 3

### Dynamic Modeling of Evacuation Routes for Buildings

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The most common building evacuation approach currently applied is to have evacuation routes planned prior to the emergency events. These routes are usually the shortest and most practical path from each building room to the closest exit. This approach is not adaptive to the hazard intensity, location, or behavior. Moreover, there is no user interaction with the evacuation method.

In this presentation we address two main tasks: a) the modeling of the spatial hazard caused by a hazardous event leading to determination of the optimal evacuation route; and b) The generation of a 3D visual representation of the model output.

A node and vector network is created to model the traversable paths of the building interior and exterior. The dynamic hazard is modeled through user inputted variables including the hazard location(s), intensity, path, and behaviour. The hazard is modeled with fronts of varying intensity with a source point following a path.

Four criteria are used to rank the alternatives (possible evacuation routes); these are the distance, risk level, congestion, and visibility. A multicriteria decision making (MCDM) approach is used as well as the analytical hierarchy process (AHP) to integrate and weigh the criteria into one cost value assigned to the alternatives.

Two user modes are available for use, one for the evacuee to input their location(s) and receive the optimal evacuation route, another mode for first responders to input their own location as well as the rescue target location to find the optimal path to reach the target.

The optimal evacuation route, hazard extent is determined and displayed in a 3D environment and can be animated for easier viewing. The modeling and 3D visualization were performed using Esri's ArcScene.

# Abstracts

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## Crime and Emergency Management 4

### Crime Analysis and Routing Application for Wilfrid Laurier University's Special Constable Service

**Mary-Louise Byrne<sup>1</sup>, Kendra Chalmers<sup>2</sup>, Cristain Dan Veres<sup>2</sup>, Brodie Elder<sup>2</sup>, Ryan Eldred<sup>3</sup>, Sarah Lidster<sup>2</sup>, Shawn Morgan<sup>2</sup>, Johanna Romero<sup>4</sup>, Pam Schaus<sup>1</sup>, Rachel Schaus<sup>2</sup>, Grant Simpson<sup>1</sup>, Xiaochen (Christina) Xing<sup>2</sup>**

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In 2015, with the goal to improve campus safety, students from Fleming College's post-graduate program in GIS assisted Wilfrid Laurier University's (WLU) Special Constable Service to design and implement a web map application to visualize the WLU campus building floorplans and grounds at Waterloo, Ontario. The application reduces response time for emergency personnel visiting WLU. The web application provides room and building locations, vehicle and pedestrian routes on campus grounds and into building interiors, as well provides WLU special constables analysis capabilities for historical incidents in 2013.

The solution produced is a mobile web application published to ArcGIS Server with data stored on an enterprise geodatabase. This was displayed using a custom user interface designed using Geocortex Essentials from Latitude Geographics. The application is available to any secured device, including the WLU Special Constable's in-vehicle mobile workstations.

Previously WLU relied on a special constable escorting external emergency personnel to navigate the internal campus. The mapping solution provides an easy-to-use solution to improve spatial awareness and can be easily shared with external entities. Additionally, University Special Constables can view 2013 emergency incidents on an interactive campus map which provides insight into spatial and temporal patterns to help plan for improved safety of campus users.

# Abstracts

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## Transit Modelling and Accuracy 1

### How do different accessibility metrics affect the interpretation of access to healthy food stores for transit and automobile users?

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Research on access to healthy foods often emphasizes the spatial proximity of residents to food stores, like supermarkets, as a way to gauge overall accessibility. Much of the literature has focused on locating the closest facility, assuming that access to one food store is sufficient. However, given evidence that access to multiple healthy food stores can improve diets, this paper examines how closest facility measures differ from cumulative opportunity accessibility measures across space in Hamilton County, Ohio, home to the medium-sized U.S. city of Cincinnati. Differences in access between automobile and transit riders, using realistic travel time costs (that account for transit schedules, walking time, and transfers) are also considered. Results demonstrate that the two types of accessibility measures produce different accessibility geographies and that there are disparities in access for those dependent on transit. These findings indicate that planners and policy makers should carefully consider whether access to one supermarket opportunity is enough, and pay special attention to the mode residents rely upon to access food.

## Transit Modelling and Accuracy 2

### Comparison of GPS units and mobile Apple GPS capabilities in an urban landscape

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The research tests the accuracy of two consumer grade GPS devices and two GPS-enabled Apple i-devices within an urban landscape. Data collection is an integral component to many GIS mapping projects, specifically within a community-based GIS mapping project. Access to reliable and spatially accurate data is key to the success of GIS mapping projects that require data collection. The relative low cost and availability of consumer grade GPS units and Apple i-devices with GPS capabilities are abundant, making the devices very attractive to community-based mapping projects. The comparison of four receivers utilized 15 locations, occurring over an 8-week period. Overall results indicated that the Garmin 78sc GPS receiver provided the greatest relative accuracy within an urban landscape, with the four devices mean relative accuracy ranging from 3.65 metres to 6.50 metres. The Apple i-devices maintained a relative accuracy and reliability for the needs of community-based mapping approaches, such as those being used for urban stormwater management.



# Abstracts

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## Transit Modelling and Accuracy 3

### Geospatial Estimates of Road Salt Usage Across a Gradient of Urbanizing Watersheds in Southern Ontario

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Chloride (Cl) salts, while an effective de-icing agent, have significant environmental consequences to local aquatic ecosystems. Chloride has been recognized as a pollutant of concern in Canada by the Canadian Council of Ministers of the Environment, especially in urban areas. In many waterways, Cl concentrations have been increasing since the early 1990s, often exceeding national water quality guidelines, resulting in negative ecological effects for many aquatic organisms. Determining accumulated Cl levels in urban and urbanizing watersheds requires accurate estimates of road salt application. Complex jurisdictional control over salt applications requires a geospatial approach for calculating Cl inputs. Our study site will be 12 subwatersheds with salt accumulation issues across a gradient of urbanization: 7 in the Lake Simcoe area (considered first), 3 in Toronto, and 2 in Hamilton Harbour. The goal of this study is to develop a geospatial protocol for combining information on road salt applications and road network areas to improve the accuracy of watershed-scale Cl storage estimates. First, geospatial shapefiles will be used to calculate "lane-lengths" for each subwatershed as managed by each governmental jurisdiction predominantly in ArcGIS. Second, road salt application data from various sources was reviewed and refined due to inconsistencies in order to determine quantities and rates of application. Third, this "cleaned" data is evenly allocated for each layer to these lane-lengths, then refined based on managerial/operational inputs, and summed to the impacted subwatershed of concern. Lastly, statistical analysis of the relationships between salts/solids distributed and various predictive factors in order to compare intra- and inter-watershed spatiotemporal patterns as they relate to climatic patterns (i.e. weather based around nearby Environment Canada stations and urbanization measures based on ENVI classification). A specific subwatershed (Lovers Creek) is used as a sample subwatershed in preliminary statistical analysis; scatterplots and regression results relating weather data as predictors of salt application data are included. Next steps include using more location-specific weather data (Road Weather Information Systems), refining jurisdictional boundaries, and reviewing operator inputs. Results will become the input for mass balance equations that calculate how salt allocation contributes to chloride accumulations across the various areas.

## Transit Modelling and Accuracy 4

### Unbundling the Hedonic Price Effects of Rapid Transit and Transit-Oriented Development in Toronto

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Theory posits that rapid transit projects that increase accessibility and reduce transportation costs should result in a localized land value uplift (LVU) benefit for parcels of land near a station. A rich history of research has tested this hypothesis, generally operationalizing transit accessibility indirectly through a parcel's distance from a transit station. However, a growing body of research has also demonstrated LVU effects from transit-oriented development (TOD) as individuals sort themselves into locations that best match their preferences and willingness to pay. In an age of coordinated land use and land use planning for rapid transit, this bundle of goods results in separate and potentially self-reinforcing drivers of LVU in transit station areas that measures of proximity alone cannot isolate. In response, the present paper utilizes spatial hedonic methods to capture LUV, but in contrast to previous studies, it incorporates a spatial clustering method that distils station area TOD contexts into a latent categorical variable that captures heterogeneous TOD submarket effects. Interactions between these submarkets and a distance variable reveals significant capitalization of transit and TOD into the value of single-detached homes in Toronto, though this capitalization differs by station type and time period.

# Abstracts

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## Data Integration / Education 1

### The Role of Geography as a Key Tool in Integrating Big Data

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Much data is available for analysis, research and policymaking—and much of it is geo-referenced. But much of these data are not used together because they cannot be integrated into a single database. A solution has been widely available in the private sector and by governments that use small units of geography as the integrating strategy. This approach has been used since 1975 in an industry variously called geodemography, micromarketing and customer analytics, and it works well. Here, demographic, socioeconomic, behavioural and attitudinal data are created or integrated for many purposes, a major one being marketing. Indeed, segmentations systems like PRIZM5 from Environics Analytics make this kind of analysis straightforward.

This approach is based on three ideas:

1. The first law of geography, which for our purposes states most data that relate to people or households are positively spatially auto-correlated at a small geographical scale.
2. The notion that “birds of a feather flock together”, so knowing a person’s neighbourhood reveals a great deal of information about those residing there.
3. When privacy is critical, one can use small-area attributes as reasonable estimates for the attributes of the residents.

The developed world is increasingly concerned about privacy. In Canada, it is not legal to share most data on people or households; data with addresses or detailed geographical coordinates are also problematic. However, data for small areas such as 6-digit postal codes and dissemination areas can be used to understand the people or households residing there. Using data from large Canadian surveys, different data types or variables such as household incomes, presence of children, use of blue box and thousands of other variables can be assigned to small areas and used as the statistical observations in integrated analysis.

This approach is especially important now in a world celebrating the big data revolution. With so much data available but few ways of integrating them for meaningful social science applications, geography can serve an important role that is poorly understood – even by many geographers, in permitting data integration. This new role for geography should be appreciated, taught and studied further.

## Data Integration / Education 2

### SPIDER “Spatially Indexed Engineering Records”

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The SPIDER System has been developed for City of Hamilton staff and selected outside users to provide access to scanned records from the engineering vault. SPIDER is an acronym for “Spatially Indexed Engineering Records”. The intention of this system is to enable users’ virtually unlimited digital access to the engineering records that exist in the vault and other record libraries. Record indexing has taken many forms over the years; there were Card indexes, plan-based indexes, spreadsheets, databases and now SPIDER. One recurring issue in research is finding correct records. Unfortunately in the past there were many records indexed by street name, or some other indicator, that has now changed. This leads to “orphaned” records that are not easily found in regular searches. The thrust of SPIDER is to spatially locate these records using an intuitive GIS based application. By locating the records correctly geographically we decrease the dependence on other features to be able to locate the record. The main search tool is the selection of an area on the map and allowing the system to drill through our database and return the results.

# Abstracts

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## Data Integration / Education 3

### A Land Use/Land Cover Change Geospatial CyberInfrastructure to Integrate Big Data and Temporal Topology

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Big data has shifted spatial optimization from a purely computational-intensive problem to a data-intensive challenge. This is especially the case for spatio-temporal Land Use /Land Cover Change (LUCC) research. In addition to greater variety, for example from sensing platforms, big data offers datasets at higher spatial and temporal resolutions; these new offerings require new methods to optimize data handling and analysis.

We propose a LUCC-based Geospatial CyberInfrastructure (GCI) that optimizes big data handling and analysis, in this case with raster data. The GCI provides three levels of optimization. First, we employ spatial optimization with graph-based image segmentation. Second, we propose ST Atom Model to temporally optimize the image segments for LUCC. At last, the first two domain spatio-temporal optimization is supported by the computational optimization for big data analysis. The evaluation is conducted using DMTI (DMTI Spatial Inc.) Satellite Streetview imagery datasets acquired for the Greater Montreal area, Canada in 2006, 2009, and 2012 (60cm spatial resolution, RGB image). Our LUCC-based GCI builds a bridge among LUCC, spatio-temporal modelling, and big data.

## Data Integration / Education 4

### Geospatial Niagara: Promoting Geo-literacy and Community Participation through Geography

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Since January 2013, Geospatial Niagara has been engaging K-12, post-secondary, post graduate students and citizens in the importance of geo-literacy, geographic education and geo-volunteerism throughout the Niagara region.

June 2014 saw the organization gain official not-for-profit status and expand its connections and collaborations.

This presentation introduces the beginnings of Geospatial Niagara, spotlights four major ongoing projects:

- i. TreeOcode Niagara
- ii. The Niagara Minecraft Project
- iii. Day of Geography
- iv. The Niagara Aspiring Geoparks Project

and highlights the community and educational partnerships created to promote geo-literacy and community participation through geography.

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