GEOMATICS ATLANTIC 2020

Visualizing a Resilient Future

Agenda

CANADIAN INSTITUTE OF GEOMATICS / ASSOCIATION CANADIENNE DES SCIENCES GÉOMATIQUES

Wednesday, November 25th

Newfoundland Standard Time (GMT-3:30)		
09:30	**Supporting Resilient Communities Workshop A** *Small Teams Can Do Big Things!* *GIS Applications in Small Municipalities* Esri Canada	**Supporting Biodiversity Resilience Workshop A** *Introduction to Desktop GIS* *with Conservation Examples* Nature NL
10:15	Break	
10:30	continued	continued
11:15	Break	
11:30	continued	continued
12:30	Break	
12:45	**Technical Primer** *Drone Photogrammetry* Drone to Business	
13:45	Break	
14:00	**Supporting Resilient Communities Workshop B** *GIS and Asset Management:* *Smarter Mapping - Better Decisions* Municipalities NL, College of the North Atlantic, Conservation Corps NL, Nature NL	**Supporting Biodiversity Resilience Workshop B** *Introduction to the Google Earth Engine Platform* *with Real-world Environmental Examples* C-CORE
14:45	Break	
15:00	continued	continued
15:45	Break	
16:00	continued	continued
17:00	Adjourn	
19:30	**Greetings** Des Power, Chair NL Chapter, Canadian Institute of Geomatics	
19:40	**Keynote** *Map of Biodiversity Importance:* *A Collaborative Effort to Identify the Places Most Important for Conserving At-risk Species* Healy Hamilton, Chief Scientist, NatureServe	
20:20	**Keynote** *The Data Boom: How the Explosion of Data is Driving our Technological Future* Nora Young, Host of Spark, CBC Radio	
21:00	Adjourn	

Thursday, November 26th

Newfoundland Standard Time (GMT-3:30)		
08:30	**Opening Address** Eric Loubier, Director General, Canada Centre for Mapping and Earth Observation	
08:50	**Presentations - Technology**	**Presentations - Planning**
10:10	Break	
10:30	**Panel Discussion - Emergency Preparedness, Response and Geomatics**	
11:30	Break	
11:40	**Presentations – Stewardship**	**Presentations - Community**
13:00	Break	
13:20	**Presentations - Modeling**	**Presentations - Protection**
14:40	Break	
15:00	**Keynote** *No Humans in the Loop:* *How Machine to Machine Processing is Revolutionizing Remote Sensing and Geomatics* Joel Cumming, Chief Technology Officer, SkyWatch	
15:40	Break	
16:00	**Presentations - Interpretation**	**Presentations - Responding**
17:40	Adjourn	

Keynote Addresses

Map of Biodiversity Importance: A Collaborative Effort to Identify the Places Most Important for Conserving at-risk Species

Healy Hamilton - Chief Scientist, NatureServe (Arlington, VA)

Through a landmark collaboration, NatureServe has released a portfolio of maps that identify areas critical to sustaining our nation's rich biodiversity. With support from Esri, The Nature Conservancy, and Microsoft's AI for Earth program, NatureServe and their network of natural heritage programs created a comprehensive set of habitat models for over 2,200 at-risk species in the contiguous United States, including those ranked as Globally Critically Imperiled (G1) or Globally Imperiled (G2), or those listed as full species under the U.S. Endangered Species Act. Analyzed in conjunction with protected areas boundaries, these data support mapping areas of high biodiversity importance—an invaluable input to guide effective conservation decision-making.

The Data Boom: How the Explosion of Data is Driving our Technological Future
Nora Young - Host of Spark, CBC Radio

Nora Young is the host and the creator of Spark, CBC's national radio show and podcast about technology and culture. She was the founding host of the CBC Radio arts and pop culture magazine, Definitely not the Opera. As a broadcaster, author, and speaker, Nora explores how new technology impacts both the broader society, as well as our individual lives, and how we, in turn, shape our technologies. Her book, The Virtual Self, on the explosion of data about our behaviours, opinions, and actions, is published by McClelland and Stewart. She is an avid hobby podcaster and radio fan, though her favourite technology is her bicycle.

No Humans in the Loop: How Machine to Machine Processing is Revolutionizing Remote Sensing and Geomatics
Joel Cumming - Chief Operating Officer, Skywatch (Waterloo, Ontario)

Earth observation has come a long way. We've gone from the days of imagery delivered via mail on 9 track tapes to near-real capture, processing, and delivery of billions of pixels of data. The industry that used to require a large number of skilled analysts to interpret satellite imagery is now seeing algorithms replacing eyeball and machine learning uncovering patterns never before predicted. In this keynote, we'll dive into the trend of machine-to-machine processing in Earth observation, the benefits of aggregation and normalization, and the impact on the Earth observation industry as a whole.

Workshops – Wednesday, November 25th

Supporting Resilient Communities Workshop A
Small Teams Can Do Big Things! – GIS Applications in Small Municipalities
Chris North, Lauren Wilson, Esri Canada

GIS can provide amazing capabilities to improve workflows and bring value to a municipality of any size. Given this power, smaller municipalities often assume that you need a big GIS department or complicated software to get into GIS. This workshop will illustrate how a team as small as one person can leverage this power to solve five real municipal challenges using GIS. And all you need is a browser connected to the web and your smart phone!

Supporting Biodiversity Resilience Workshop A
Introduction to Desktop GIS with Conservation Examples
Laura King, Nature NL

Learn to use the desktop software QGIS and see how it can be used for conservation. We'll learn how to install and manage plugins, get basemaps, find and add data from various sources, create shapefiles, design your own maps, and ask conservation-related questions. We will look at some examples using protected areas, species range maps, wetlands, and land use planning, and consider how this package might be useful in your own environmental or conservation projects. Before you attend the workshop, download and install the latest release at qgis.org. (A link for downloading example data will be emailed out to participants.)

Technical Primer
Drone Photogrammetry
J. Carlos Maia, Emanuele Traversari, Drone to Business

For a mapping project to be valuable and useful, a lot must go in it to ensure precision, accuracy, and reliability of the data and of the processing tools. Every one of these steps and, sub steps, are subject to errors. Hence, these inaccuracies could end up being disastrous if not detected and minimized prior to the compilation of the final products. The emerging and fast-growing drone surveying technology, sensors and software can be extremely useful in terms of low-cost, fast-time, faster-logistics and reliable mapping products for a variety of industries. Knowledge of survey-grade tools such as drone and camera, ground control points and state of the art software are important, but especially understanding how to make the best use of it to perform the project according to the final specification.

Supporting Resilient Communities Workshop B
GIS and Asset Management: Smarter Mapping - Better Decisions
Kathleen Parewick, Municipalities NL; Darin Brooks, College of the North Atlantic; Piers Evans, Conservation Corps NL; Laura King, Nature NL

Municipalities in Newfoundland and Labrador are catching up with industry in adopting asset management (AM) planning as a means of supporting smarter decisions by town leaders and staff, and more readily demonstrating priorities come budget time. Municipal asset information is increasingly recorded using GIS. But what if you are one of NL's many small towns and don't have a GIS tech on staff? Fortunately, the AM community of practice here has been growing in the last few years. This workshop introduces some potential partners and emerging tools that will allow even the smallest towns to avail of the power of digital mapping and information management.

Supporting Biodiversity Resilience Workshop B
Introduction to the Google Earth Engine Platform with Real-world Environmental Examples
Masoud Mahdianpari, C-CORE

Google's Earth Engine (GEE) platform is used for large- and small-scale scientific analyses and visualization of Earth Observation (EO) and geospatial datasets. GEE is a cloud computing platform that enables parallelized processing of geospatial data on a global scale using Google's cloud and hosts petabyte scales of over 40 years of remotely-sensed data, such as the entire EROS (USGS/NASA) Landsat catalog, MODIS, Sentinel, NAIP imagery, and precipitation, elevation, sea surface temperature, and CHIRPS climate data. This workshop will introduce GEE cloud computing platform capabilities and online coding using different environmental remote sensing examples, including wetlands, forestry, air quality and COVID-19. Participants will become familiar with different components of GEE, the Data Catalog, learn the fundamental building blocks for online coding, and gain hands-on experience using GEE code editor in this training. No previous coding experience is needed!

Panel Discussion – Thursday, November 26th

Emergency Preparedness, Response and Geomatics
Moderator:
Kathleen Parewick, Community Collaboration & Development Officer, Municipalities Newfoundland and Labrador
Panelists:
Chris North, Director Technology Adoption, Esri Canada
Robert Harris, Geomatics Manager, NB 9-1-1 Bureau, New Brunswick Department of Public Safety
Vince MacKenzie, Fire Chief, Grand Falls-Windsor; Director, Canadian Association of Fire Chiefs Executive Board; 2nd Vice-President, Maritime Fire Chiefs' Association

We've gathered a digital "toolmaker", an emergency management "broker" and a sophisticated but practical frontline user to share their emergency management experiences with emerging technology. Whether it's creating COVID-19 dashboards on the fly, integrating new spatial data tools into ongoing operations, or finding the right balance where the proverbial "rubber meets the road" for first responders, availing of the power of spatial data, digital mapping and information management brings opportunities and challenges.

Presentations – Thursday, November 26th

Newfoundland Standard Time (GMT-3:30)

Session	Time	Speaker	Affiliation	Presentation Title
Technology Moderator Paul Brett, Marine Institute	08:50	Foster, Burns	Teledyne Caris	*Deep Learning for GeoSpatial AI: Land and Water*
	09:10	Noseworthy, Gerard	C-CORE	*Modernizing the discoverability and interoperability of geospatial data using STAC*
	09:30	Ruttgaizer, Ryan	Fugro	*Machine Vision and Augmented Reality for Modern Subsea Positioning*
	09:50	Spears, Tobias	Fisheries and Oceans Canada	*Geographic Information Standards and Canada's role in ISO TC 211- Geographic Information & Geomatics*
Planning Moderator Darin Brooks, College of the North Atlantic	08:50	Cooper, Tom	Memorial University	*The Design, Funding, and Management of Infrastructure in Local Municipalities: Using Data to Develop Better Strategies*
	09:10	McGrath, Heather	Canada Centre for Mapping and Earth Observation	*Influence of policy implementation on population change in Calgary floodplain (1971-2016)*
	09:30	Padilla Ruiz, Marta	Teledyne Caris	*Could DGGS be the 'Geomatics' answer to a resilient future?*
	09:50	Parewick, Kathleen	Municipalities Newfoundland and Labrador	*Unlocking Municipal Potential: On the Power of Data*
Stewardship Moderator Sara Jenkins, Ocean Frontier Institute	11:40	Briggs, Robert	C-CORE	*River ice monitoring: an integrated space, airborne and in-situ sensing approach*
	12:00	Ross, Christopher	Nova Scotia Department of Agriculture	*Monitoring the Nova Scotia Provincial Dykeland System: Nova Scotia Department of Agriculture – Land Protection & Field Services (Engineering)*
	12:20	Scriven, Blair	University of Calgary	*Near-Real-Time Flood Mapping using HAND model and GIS Derived Synthetic Rating Curves*
	12:40	Tilley, Brandon	Memorial University	*Mapping of Coastal Restoration Areas of Interest in Newfoundland and Labrador*
Community Moderator Des Power, C-CORE	11:40	Greig, Mitchell	University of Calgary	*Tracking Barbarians: GIS in Ancient History*
	12:00	Keefe, Jude	University of Guelph	*Mapping Circular Food Systems: Visualizing Food Assets in a Proof-of-Concept GIS Data Model for Waste Reclamation towards a Circular Food Economy in Wellington County, ON, and Annapolis Valley, NS*
	12:20	Kingdon, Robert	University of New Brunswick	*Embracing Remote Learning at UNB*

Modeling Moderator Heather Ward, Stantec	13:20	Alleosfour, Ahmadreza	University of New Brunswick	*Modelling the Baroclinic Conditions of Bay of Fundy – FVCOM Case Study*
	13:40	Arrey, Ivo	University of Venda	*Uncertainty Visualization and Characteristic Space-Time Scales of Soil Moisture Variability in Siloam, South Africa*
	14:00	Gates, Zachary	Memorial University	*Improving Spatial Scalability of Boreal Forest Soil Investigations Using Optimized Ground Penetrating Radar (GPR) Methodology*
	14:20	White, Joanne	Canadian Forest Service	*Establishment of a Remote Sensing Supersite at the Petawawa Research Forest*
Protection Moderator Sherry Warren, C-CORE	13:20	Edwards, Rebecca	Ducks Unlimited Canada	*Ducks Unlimited Canada's Satellite-Based Wetland Inventories in the Western Boreal Forest*
	13:40	Greene, Randal	NatureServe Canada	*Development of the EBAR Automated Species Range Mapping Platform*
	14:00	Nemani, Shreya	Marine Institute	*Predicting the Distribution of Coastal Benthic Communities in Placentia Bay, Newfoundland and Labrador*
	14:20	Piercey, Doug	Canadian Forest Service	*A time-series assessment of habitat composition and connectivity for caribou in Newfoundland and Labrador*
Interpretation Moderator Masoud Mahdianpari, C-CORE	16:00	Bélanger, David	Canada Centre for Mapping and Earth Observation	*Make a detailed 3D representation of the country available to Canadians*
	16:20	De Lisle, Daniel	Canadian Space Agency	*RADARSAT Constellation Mission serving Canadians*
	16:40	Humphry, Chris	Planet	*Seeing Effects of COVID-19 From Space*
	17:00	Werle, Dirk	Ærde Environmental Research	*Early 1920s Vertical Air Photo Missions in the Maritimes: History, Coverage, and Usefulness a Century Later*
	17:20	McKittrick, David	Blue Marble Geographics	*Change Detection using Point Cloud Data*
Responding Moderator Kirk Regular, Marine Institute	16:00	Harris, Robert Lang, Colin Nikias, Clio	Government of New Brunswick, 9-1-1 Bureau	*GeoOperations: GIS for Emergency Management*
	16:20	Hamilton, David	Esri Canada	*Manage & Respond to Threats in the Modern World: How Location Intelligence Builds Resilience*
	16:40	McGrath, Heather	Canada Centre for Mapping and Earth Observation	*An online dashboard of real-time hazard and socio-economic variables for the emergency management community*
	17:00	Harris, Robert	Government of New Brunswick, 9-1-1 Bureau	*GIS for Next Generation 9-1-1*
	17:20	Cooper, Tom	Memorial University	*Why is Critical Infrastructure Important to the Province of Newfoundland and Labrador?*

Presentation Summaries

A time-series assessment of habitat composition and connectivity for caribou in Newfoundland and Labrador

*Doug Piercey1**
1. Canadian Forest Service, Corner Brook, NL, Canada, douglas.piercey@canada.ca

Caribou populations are at various levels of risk throughout Canada and reasons behind the issue can be complex. A multi-partner project is underway to assess historic, current, and predicted caribou ranges, space use, and movement in the province of Newfoundland and Labrador. This will include time-series analysis of habitat characteristics and connectivity in order to determine if there have been changes in use of land cover type and patterns of movement by caribou over the past 40 years and if those changes can be linked to changes in cover type or land use. The project will also complete an assessment of habitat availability and connectivity under a range of climate change scenarios. The goal of this project is to inform decisions related to caribou management and climate change adaptation by combining western science methods with traditional knowledge. The project utilizes open source products for many aspects of the analysis, from the generation of individual animal kernels to the projections of future landscapes to web-based exploration of data. Project partners include NRCan-Canadian Forest Service, NL Department of Fisheries and Land Resources, Qalipu and Miawpukek First Nations, Parks Canada, ECCC-Canadian Wildlife Service, NRCan-Canada Centre for Mapping and Earth Observation, and Corner Brook Pulp and Paper (Kruger).

An online dashboard of real-time hazard and socio-economic variables for the emergency management community

Heather McGrath1, Vincent Decker1, France Labrecque2, Sophie Gratton2, Nick Zachary2, Besjana Osmenaj2*
1. Natural Resources Canada, Canada Centre for Mapping and Earth Observation, Ottawa, ON CA, heather.mcgrath@canada.ca
2. Statistics Canada, Ottawa, ON CA

During a disaster, especially during Covid-19, identifying the areas where emergency response and support are needed most is challenging. In a partnership between Statistics Canada and Natural Resources Canada a joint effort has been put in place to develop a dynamic online dashboard for emergency response. It combines the latest demographic, social and economic data from Statistics Canada along with active flood maps from NRCan Emergency Geomatics Services. Leveraging state-of-the-art technology to combine datasets shared via open data standards, a new web-based tool has been developed to provide science based data to support field decisions during an event. The dashboard quickly highlights many valuable socio-economic variables including total population in the map extent (or selected area), age profiles, family size, language profiles and ethnicity, among others. Limited details on housing in the affected area is also included. Additionally, the operational status and location of communication tower and emergency facilities, including police, fire, hospitals, medical facilities and schools are viewable in this dashboard. To further support emergency response dispatch and activities, connections to provincial services indicating road closures are added. A beta version of this tool was released in spring 2020 and was tested by members of Red Cross and several provincial government organizations. Feedback is being gathered and assessed for version 2, in anticipation of the next flood season.

Canadian Geospatial Community Surveys: Pandemic and Certifications

*Jonathan Murphy1**
1. GoGeomatics Canada, jmurphy@gogeomatics.ca

GoGeomatics Canada will present the results from its most recent surveys of the community. Of the 4,000 + participants who received the survey, sixty five percent of respondents identified as working geospatial professionals, twenty-five percent identified as executives or managers, and the remaining ten precent as job seekers and students. The two surveys to be discussed are “The Canadian Geospatial Certification Survey” and “The Canadian Geospatial Pandemic Survey”. Both surveys seek to better understand the opinions of the Canadian geospatial sector. Jonathan Murphy, the Managing Director of GoGeomatics Canada, will analyse the results and what they might mean for the future. Open discussion is encouraged.

Change Detection using Point Cloud Data

*David McKittrick1**
1. Blue Marble Geographics, Hallowell, Maine, US, marketing@bluemarblegeo.com

The rapid increase in the availability of high-resolution lidar and other point cloud datasets has given rise to the use of this data for detecting change in the environment over time. This trend can be attributed in large part to the recent proliferation of Unmanned Aerial Vehicles (UAVs), which are rapidly changing the GIS landscape and are opening the broad field of remote data collection and processing to a wide audience. Continual improvements in airborne technology and the miniaturization of the requisite sensors has cultivated a nimble new branch of the industry that provides cost-effective data collection services virtually on demand. This ability to employ temporal analysis of the geospatial landscape has applications in forestry, agriculture, mining, urban planning, civil engineering, and many other fields.

In this presentation, we will use Global Mapper to explore two scenarios in which change has occurred at different scales, and subsequently we will consider two different procedures for identifying this change. In the first scenario we will look at change at a micro level by comparing two point clouds and highlighting individual points that show a 3D shift over a specified distance threshold. In the second scenario, we will look at a wider area in which the difference between two generated surfaces is calculated and modeled.

Temporal consideration has emerged as an extremely important branch of geospatial analysis and this presentation will effectively demonstrate the accessibility of this procedure.

Could DGGS be the 'Geomatics' answer to a resilient future?

*Marta Padilla Ruiz1,2**
1. Teledyne CARIS, Fredericton, New Brunswick, Canada, marta.padilla@teledyne.com
2. University of Calgary, Calgary, Alberta, Canada

We have been talking about Digital Earth for more than 20 years now, but are we there yet? There is an immense amount of data out there, and although we have made our best efforts to make the data open and accessible, there is still an evident gap for end-users seeking geographic knowledge to make better use of it. Recent worldwide events have clearly shown us how important it is to have analysis-ready information to be able to make important decisions in emergency situations. If we want our future society to be more resilient, we need a holistic view that includes marine, terrestrial and atmospheric data, to be able to act fast and efficiently.

However, combining multiple sources of geospatial information is a well-known problem in Geomatics, where data integration on-demand is a grand challenge. A common framework is required to link large multi-resolution and multi-domain datasets together, and to enable the next generation of analytic processes to be applied. Discrete Global Grid Systems (DGGS) are a form of Earth reference that represents the Earth with a tessellation of nested cells and could present a potential solution for this problem. It partitions the globe in packed hierarchical tessellations, each cell representing a homogenous value, with a unique identifier or indexing. This allows for the use of conventional database query methods to perform complex spatial analysis tasks. Could we imagine a globe visualization of the Earth where all the available information is already integrated and ready to be analyzed quickly?

And although DGGS have been used for over 10 years, there are still challenges to address, especially when dealing with height (or depth) data. For 3D environments, volumetric tessellations of the Earth are needed; and 'Earth' and 'Sea', two entities that have been traditionally separated in Geomatics, need to come together.

Deep Learning for GeoSpatial AI: Land and Water

Burns Foster1, Axel-Christian Guei2*
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2. Teledyne CARIS, Hull, QC, Canada

It is no surprise that advancements in Artificial Intelligence (AI) in recent years, particularly a branch of AI covering Neural Networks dubbed Deep Learning, has had considerable impact on the world as we know it. The broad Geospatial industry is no exception, with many noteworthy achievements in applications for satellite and orthophoto images. What is still emerging, however, is robust and scalable solutions for dealing with large-scale point clouds, generated from remote sensing platforms such as airborne lidar, terrestrial/mobile laser scanners, and acoustic multibeam sonars. These voluminous datasets present unique challenges for Deep Learning, particularly due to the irregular nature of the data produced by these remote sensing systems.

At Teledyne CARIS, we have developed not only a Deep Learning architecture that is flexible enough for a broad range of point cloud classification tasks, but also an entire processing pipeline that works very efficiently on extremely large point clouds. This scalable architecture was developed under a cloud-first strategy, which allows us to make use of the latest advancements in not only AI but also large-scale, cloud-based services. We will explore this exciting new cloud platform, as well as the classification capabilities we have developed on this architecture to date.

Development of the EBAR Automated Species Range Mapping Platform

Randal Greene1, Christine Terwissen1*
1. NatureServe Canada, rgreene@natureserve.ca

NatureServe Canada's ecosystem-based automated range (EBAR) initiative is developing publicly accessible range maps for priority species that:

- Incorporate the best available species observation/occurrence information while honouring any sharing and usage restrictions on those input data.
- Can be reviewed and refined by species experts in an ongoing and efficient manner.
- Provide access to reference information of the underlying occurrence data.
- Are publicly available at no charge.
- Are provided in an electronic format that permits efficient customization and integration by biodiversity experts, organizations and decision-makers.

The GIS platform is built on Esri ArcGIS Enterprise/Server and a PostgreSQL geodatabase running on a Microsoft Azure cloud-based computer and includes:

- Multi-user desktop GIS access to the centralized database.
- Server-based geoprocessing tools for synchronizing species attributes with NatureServe’s central database, importing species "observation" data from a variety of platforms and generating range maps, with publicly available source code.
- The EBAR Reviewer web app for expert review and markup of species ranges, with publicly available source code.

The talk highlights the architectural components and their interconnections, describes challenges and solutions in its development, and in our spirit of openness invites the reader to reach out regarding potential user and technical collaborations.

Ducks Unlimited Canada’s Satellite-Based Wetland Inventories in the Western Boreal Forest

Rebecca EDWARDS1, Michael MERCHANT1, Rebecca WARREN1, Adam SPITZIG2, Alain RICHARD1, Kevin SMITH1, Lindsay MCBLANE1, Daniel FEHRINGER2*
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2. Ducks Unlimited Inc., 3074 Gold Canal Drive, Rancho Cordova, California, United States, 95670.

Ducks Unlimited Canada (DUC) is leading the effort to provide detailed and accurate wetland maps for Canada’s boreal region. The goal of DUC’s wetland inventories are to assist industry, government, first nations, and conservation organizations in developing comprehensive policies and sustainable management practices around wetlands, as well as assess current and future changes in wetland abundance and type in relation to climate and land use change. The wetland inventories follow the Canadian Wetland Classification System (CWCS) and contribute to the Canadian Wetland Inventory (CWI), which is a national framework for mapping wetlands across the country to a standardized data model (shallow open water, marsh, fen, bog and swamp). DUC's Enhanced Wetland Classification (EWC), conforms to the CWI and is comprised of nineteen detailed wetland classes. DUC's wetland inventories commonly involve a machine-learning supervised classification of data using object-based image analysis (OBIA) and a combination of multispectral Landsat or Sentinel-2 imagery, Synthetic Aperture Radar (SAR) imagery (ALOS PALSAR L-band, Sentinel-1 C-band, or Radarsat-1 or -2 C-band), and any pertinent ancillary datasets (e.g. digital elevations models, forest inventories, or fire history). Detailed field surveys used to support the classification process are collected via helicopter, and includes information regarding species presence, species aerial coverage, species height, wetland class and associated site pictures. The field data is split two-thirds and one-third into training and validation data, respectively. DUC's wetland inventories and field data have been used to support many third-party users, including governments and academics. Examples include environmental and biodiversity modelling, wildlife habitat assessments, carbon emission estimates, climate change predictions, support of regional policy development, and indigenous and government land use planning.

Early 1920s Vertical Air Photo Missions in the Maritimes: History, Coverage, and Usefulness a Century Later

*Dirk Werle1**
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The historical and technological developments of powered flight and aerial photography have early connections in the Maritime Provinces of Nova Scotia and New Brunswick. Following the Great War (1914-18) and the outbreak of the Spanish Flu pandemic, a series of pioneering survey missions were initiated in the civilian domain by the Canada Air Board. They used vertical aerial photography as a remote sensing tool to assist conventional ground-based surveying and mapping activities. Coverage of these largely unnoticed air photos offer a unique opportunity for the detection of environmental change at an unusual centennial time scale. The missions of the early 1920s initially relied on military surplus seaplanes and modest budgets for experimental work. Progressively more experienced operators used innovative camera equipment to produce several thousand high-resolution vertical air photos at scales ranging from 1:4,000 to 1:12,000. This presentation outlines scope and illustrates results of the first experiments carried out over Nova Scotia and New Brunswick between 1921 and 1925. It also includes a summary of more systematic air photo coverage during the remainder of that decade. The research is based on archival records and partial reconstruction of the digitized air photos into partial or complete image mosaics. Examples and comparison with recent high-resolution satellite imagery offer insights concerning land use and land cover changes, coastal dynamics, and transformation of urban, rural and industrial landscapes. Experience to-date with these early air photo missions in the Maritimes and newly created mosaics hold promise for further systematic examination and utilization.

Embracing Remote Learning at UNB

Robert Kingdon1, Ian Church1, Marcelo Santos1, Shabnam Jabari1, and Michael B. Sheng1*
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Covid-19 has brought challenges and opportunities for Geomatics education in Canada. The Geodesy and Geomatics Engineering Department at the University of New Brunswick (UNB) is taking this year's requirement for virtual teaching as an opportunity for a long-discussed permanent transition to a degree program that can be completed either remotely or in-person. For us, this means that any measures taken to teach remotely this year are not a stop-gap until Covid-19 subsides, but rather a first attempt at quality remote delivery. A solid education is the foundation of resilience, and we hope that by enabling this transition to accessible Geomatics education, we will be a part of the development of a large and future-ready Geomatics industry in Canada.

Some of the main challenges in developing a remotely accessible Geomatics program include: (1) transition to a new and unfamiliar teaching format, (2) implementation of practical field exercises for remote students, (3) building and maintaining student community without a physical presence, and (4) resourcing requirements to support online learning. This paper discusses some of the solutions we are implementing in our attempt to overcome challenges 1 through 3. It reviews our development of an overall GGE Online plan for the current academic year, strategies to support faculty as they become proficient in teaching remote students, implementation of practical exercises through remotely operated instruments and industry partnerships, and collaboration with student leadership to foster community. The effectiveness of these strategies to date and initial lessons learned will also be discussed.

Establishment of a Remote Sensing Supersite at the Petawawa Research Forest

Joanne C. White1, Hao Chen1, Murray E. Woods2,3, Brian Low1, Sasha Nasonova1*
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3. Ontario Ministry of Natural Resources and Forestry, Provincial Services Division, Science and Research Branch, 3301 Trout Lake Road, North Bay, ON, P1A 4L7 (retired)

The Petawawa Research Forest (PRF) is Canada's oldest research forest established in 1918. The PRF is approximately 10,000 hectares in size and represents a complex assemblage of tree species and forest management histories. Extensive remote sensing data holdings have been acquired for PRF from a diverse range of spaceborne and airborne platforms and include both active (lidar, radar) and passive (optical) sensors. PRF also has an extensive collection of ground plot data, providing the requisite reference data to evaluate the capacities of new technologies, algorithms, and approaches. A remote sensing supersite has been established at the PRF, intended to foster innovation in the application of new technologies to support forest management. The supersite is an open data portal with analysis-ready data (ARD) in a common georeferencing system available for download from the National Forest Information System (NFIS) of the Canadian Forest Service. The PRF supersite provides a focus area for investment in research collaboration to address common information needs, increases the societal value of public investments in data acquisition, and provides a common location to rigorously benchmark new methods and technologies for the development of best practices, software tools, and information products. The PRF supersite can be accessed via the following link: https://opendata.nfis.org/mapserver/PRF.html.

Geographic Information Standards and Canada's role in ISO TC 211- Geographic Information & Geomatics

*Tobias Spears1**
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With the growing movement towards open science, digital government, the establishment of the FAIR (Findable, Accessible, Interoperable and Reusable) Guiding Principles for scientific data management and stewardship, global priorities such as the UN Sustainable Development Goals (SDGs), the need for robust standards to support the data lifecycle, ensure interoperability of data from across repositories and systems, continues to grow. As a major player in the global standards arena, the International Standards Organization (ISO) has a major role to play in realizing the objectives of these efforts. The goals of this presentation are to provide a brief overview of ISO, to describe the scope and structure of the ISO Technical Committee on Geographic Information and Geomatics (TC 211), to raise awareness of Canada's participation in TC 211, and to solicit participation in this community by Canadian experts.

GeoOperations: GIS for Emergency Management

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The use of GIS to aid in emergency management continues to evolve and mature. The frequency of emergency events continues to rise in New Brunswick and the use of GIS will be instrumental for agencies in all phases of emergency management. In 2020 the NB Department of Public Safety (DPS) GeoOperations Team experienced some of its greatest

challenges to date. Between supporting the NB Emergency Measures Organization's Provincial State of Emergency and COVID-19 response, providing Emergency Public Information through our public dashboard, and the longest continuous activation to-date, our team has been flexed to support the Province's largest ever emergency operation.
In this presentation we will cover some of the activities and GIS toolsets the NB DPS GeoOperations Team are using to support the Provincial response, including our Common Operating Picture, our public COVID-19 Dashboard, and more. We will explain the history of GeoOperations in NB, our rigorous training program, and explore how the GeoOperations Team is fully integrated into the NB Provincial Emergency Operations Centre and Provincial Emergency Action Committee. We will discuss how we are helping to build a GeoOperations Community of Practice across the province so that GIS practitioners can collaborate and share best practices. Finally, we will shed some light onto some of the other GeoOperations GIS work our team performs which normally stays hidden behind the firewall.
While this presentation will have a lot of content centred around our COVID-19 response it is also hoped that we will present a flavour of a more "normal" year and the types of support the GeoOperations Team provides, including events like winter storms, spring floods, summer fires, and fall hurricanes/tropical storms.

GIS for Next Generation 9-1-1

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One of the most pressing GIS issues in Canada over the next 24-36 months will be the rollout of GIS data as the backbone for Next Generation 9-1-1 (NG 911) Services. Telephone companies, Provincial and Territorial Governments, Data Aggregators, and Data Providers (including local governments and First Nations) will need to work quickly, and collaboratively, to ensure that their data is accurate, complete, and to the defined standard. In this presentation my goal will be to introduce the concept of NG 911, the deadlines which have been defined by the Canadian Radio and Television Committee (CRTC), and the active work, which is happening at a rapid pace across Canada, to ensure that each Province and Territory is ready. I will also take some time to do an introduction to a small handful of related NENA 911 GIS standards and on the work being championed by those here in Canada to "Canadianize" those standards so that they meet the unique, and sometimes challenging, addressing concerns we face across the country. I would also like to present some of the work being done by the NB 9-1-1 Bureau, in its role as a Data Aggregator to get its GIS data ready for NG 911. Finally, it is also my hope to be able close off the presentation with a small list of ways that interested conference attendees can get more information about GIS for NG 911, circulate some common FAQs, and inform them how they can join the conversations taking place now in Canada, and the USA, to contribute to the final shaping of Canada's NG 911 rollout.

Improving Spatial Scalability of Boreal Forest Soil Investigations Using Optimized Ground Penetrating Radar (GPR) Methodology

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Traditional soil sampling methods, including soil pit excavation and coring, restrict the scale of soil inquiry as they are non-continuous and typically limited by conditions of the subsurface and the sampling destruction allowed within study sites. This is apparent in many boreal forest soil investigations. To inform landscape biogeochemical processes, including controls on soil carbon (C) and nutrient stocks, alternative methodology is needed to obtain non-destructive, continuous soil data at relevant, increased scales. Ground penetrating radar (GPR) can be the solution to this problem. GPR systems produce visual radar sections from subsurface reflections of a transmitted electromagnetic (EM) pulse, allowing for imaging, interpretation, and data collection of the forest soils. The goal of this research was to determine the capability of GPR methods to contribute more accurate, spatially explicit estimates of soil C stocks and properties with depth through optimization of GPR operations. Plot scale surveying was conducted within the Pynn's Brook Experimental

Watershed, located in western Newfoundland, along an experimental boreal forest hillslope with soil pit sampling at the top and bottom of the site. Through comparing estimates of various soil properties derived from both soil sampling and GPR methods, including soil horizon thickness, soil texture, bulk density, C and nitrogen (N) content, and soil water content, the accuracy of the GPR estimates are evaluated against ground truth data. Soil property estimates between the GPR and soil data were very similar, showing accuracy in the optimized GPR methodology and promise for obtaining accurate, continuous soil data over plot scales. With GPR shown to accurately estimate these soil properties over a large study site, better calculations of important biogeochemical stocks of C, N, and nutrients can be determined over boreal forest landscapes informed by continuous, spatially explicit GPR soil data that better characterizes the forest soil base.

Influence of policy implementation on population change in Calgary floodplain (1971-2016)
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Most Canadian cities have experienced considerable growth over the past several decades as the population has moved towards a predominately-urban society. This urban growth was set to apply pressure to occupy flood-prone lands for housing, infrastructure and industrial use, thus potentially increasing the risks of urban population towards flood disasters. To mitigate this, various levels of government have implemented programs to map designated flood risk areas, restrict urban development in declared flood zones and control land use activities in these areas. A primary aim of many of these programs was to switch the thinking from structural defences that minimize floods (e.g. dikes, levees, dams, reservoirs) to non-structural measures such as implementing new zoning requirements for building which redirect development away from flood risk areas. In this study, Statistics Canada census enumeration datasets, collected since 1971, are analyzed to view how and where population growth has taken place around the Calgary Census Metropolitan Area (CMA). Population change from one census to the next is compared to the 1-100 year flood map and to the implementation timelines of the City of Calgary Land Use Bylaws, the Alberta Water Resources Act, the Municipal Government Act and two federal programs: Flood Damage Reduction Program (FDRP) and National Disaster Mitigation Program (NDMP). Results indicate a positive correlation, and that the population in designated flood risk areas decreases when these programs are in place. Population in the Calgary CMA has more than tripled between 1971 and 2016, however, the estimated percent of the population living in census areas intersecting the 100-year flood zone has decreased from 19.1% to 10.8%.

Machine Vision and Augmented Reality for Modern Subsea Positioning
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With the increasing ability to process data it is possible to run algorithms on images in real time. Fugro has developed a service, called Quick Vision, by which sensor data is used in conjunction with a stream of rectified imagery to allow positioning of subsea assets. This form of Machine Vision is also tied in with video overlay to create Augmented Reality functions.

In the realm of subsea construction and positioning, often there is an operational need to have real time data on assets as they are placed subsea. Generally, position, depth, and attitude are required to place a structure as designed. Quick Vision accomplishes those goals while allowing for improved efficiency, increased spatial awareness and reduces HSE risk. Much of the benefit comes from not having to attach sensors and related equipment to the asset, and not having to retrieve those sensors after installation is complete. This reduces the need for personal to operate in risk sensitive areas and reduces the amount of subsea operations required, which further lowers risk and saves rig/vessel time.

The Quick Vision camera can visualize special sacrificial targets affixed to an asset. The position, depth and attitude of an asset is calculated in real time based on the cameras known position details and the orientation of the target within the cameras view. Even without specialized targets, the algorithms can augment the captured video scene to include heads up information like heights, or heading, or even overlaying 3D shapes as a method of calculating an asset's position details.

This presentation will cover some of the details of how this is accomplished and highlight its usefulness in an evolving industry always looking for a safer and more cost-effective way to operate. Quick Vision can achieve these goals and add a competitive advantage to companies adopting its use.

Making a detailed 3D representation of the country available to Canadians

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The Canadian Centre for Mapping and Earth Observation (NRCan) continues its work to implement the National Elevation Data Strategy. Through this strategy, one of NRCan's goal is to provide Canadians with an accurate three-dimensional representation of the country, in support of government priorities such as flood mapping. Because of the enormous task of obtaining a high-precision and up-to-date national elevation layer, NRCan must work with different entities. Thus, in 2020, NRCan acquires more than 50,000 km2 of new LiDAR data through contracts and partnerships with federal departments, provinces/territories and municipalities.

The data coverage of the strategy now includes 400,000 km2 in the south (from LiDAR), as well as the entire Canadian Arctic (from satellite imagery), all of which is available in an open and free manner through the High Resolution Digital Elevation Model product (HRDEM).

In addition, in the fall, NRCan will make available a continuous mosaic of the HRDEM data. The mosaic will be produced using the most up-to-date elevation data available at NRCan. This mosaic is implemented to facilitate navigation and interaction with the best elevation data in Canada. This mosaic will be disseminated using NRCan's recently implemented Topographic Data Cube, which uses geospatial big data management technologies. These technologies enable the rapid and efficient visualization of high-resolution geospatial data and allow for the rapid generation of dynamically derived products.

Finally, NRCan manages the Federal Airborne LiDAR Data Acquisition Guideline. A new version of the document will be released in Fall 2020, which will include a new appendix on best practices for topobathymetric LiDAR data acquisition. This new version is in line with NRCan's commitment to make it evolve in accordance with advances and trends in the field of airborne LiDAR in Canada and internationally.

Manage & Respond to Threats in the Modern World: How Location Intelligence Builds Resilience

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Esri's vision is to enable resilient communities. Throughout the course of the COVID-19 pandemic we have seen just how interconnected and entwined government public policies are with the economy and the lives of every person in society.

As we move forward, the need for new and enhanced systems to better connect our communities, including all levels of government and businesses are imperative. We can no longer be limited to our local neighborhoods or community governments, and must consider how communities can be greater holistic locations to live, work and play.

While we may be focused on COVID-19 today, we need to realize that the next crisis is tomorrow, and must be equipped to tackle anything including hurricanes, wildfires, earthquakes, pandemics, social unrest, and all the above. How we manage and respond today impacts our communities, and this session will cover how location intelligence plays a key role in making that difference for tomorrow.

Mapping Circular Food Systems: Visualizing Food Assets in a Proof-of-Concept GIS Data Model for Waste Reclamation towards a Circular Food Economy in Wellington County, ON, and Annapolis Valley, NS

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This Masters research presents an application of geospatial technologies to the proposed circular food economy data management strategy in Guelph-Wellington, Ontario, and connects to similar potential in the agricultural region of Annapolis Valley in Nova Scotia. Use of geomatics and spatial methods in this way helps to represent food assets in a manner which proposes a strategy for improved management and reduction of wastes in the regional food system. This project is rooted in sorting industry-standard NAICS codes, correlated with additional descriptions of the business. These sorted groups are assigned various symbology representing the type of food access place they represent, which also identifies the potential type and volume of food waste being generated. Coordination of wastes from involved businesses can minimize the overall volume sent to landfill and/or organics. These singular places can be tracked with volumes of materials flowing through the value stream, and be used to identify successful progress in reclamation.

The proof-of-concept nature of this work aims to identify a potential for transferability of this working model for data on food waste at a regional scale, in communities across Canada. Currently there is work being done to map similar redistribution efforts by the US-EPA, however limited use of GIS in published examples of Smart Cities and/or circular economy pilots in Canada are evidence of a research gap to fill. By comparing Ontario and Nova Scotia data points, this gap is addressed and proposes a way forward for transferring this model beyond the case study of Guelph-Wellington's award-winning five-year proposal. Where there are gaps in service, and unknown volumes of Industrial, Commercial and Institutional (ICI) wastes, the overlap of spatial data presents a unique way of identifying and acting in places which represent inefficiencies in the food system.

Mapping of Coastal Restoration Areas of Interest in Newfoundland and Labrador

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Capelin is a forage fish species that play a key role in Newfoundland and Labrador marine ecosystems. The species tends to spawn on beaches with specific environmental characteristics. Many beaches on the Island of Newfoundland have been modified by humans and are no longer suitable for capelin spawning. Coastal enhancement or restoration work, which could help increase the suitability of beaches for capelin spawning, requires an understanding of beach dynamics and geomorphology to identify suitable sites for enhancement and long-term effectiveness. Three beaches along Conception Bay on the Island of Newfoundland were examined to inform potential future coastal enhancement work. Aerial photos and digital surface models (DSM) of the beaches were acquired at different times using an unmanned aerial vehicle, complemented by field observations. A multi-criteria decision analysis (MCDA) approach was then used to provide a systematic way to prioritize these beaches for enhancement suitability. The MCDA prioritization accounts for capelin spawning preferences and the likelihood of coastal stability, both key considerations in species-specific enhancement projects. DSM and geomorphological data indicate that beaches experience different changes throughout a season, even when they present similar physical characteristics. Adjacent beaches can present very different responses to a specific weather event. Findings demonstrate the key factors influencing beach geomorphology and how it pertains to planning species-specific enhancement projects—building on the idea that enhancement projects require a multi-dimensional approach to understanding in order to plan.

Modelling the Baroclinic Conditions of Bay of Fundy – FVCOM Case Study

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Tidal elevations and currents, and variations in temperature and salinity, are dominant oceanographic processes in the Bay of Fundy, having significant effects on acoustic surveys and aquatic species habitat suitability. Knowledge of these processes can improve navigation safety, oil spill response, and prediction of sediment transport and dynamics. Tidal elevations are used for vertical referencing of seabed mapping data through water level corrections and marine vertical datum establishment. The baroclinic condition assists with defining marine habitats and establishing speed of sound gradients for acoustic ray tracing. To fill in gaps in physical oceanography observations, we have developed a high-resolution three-dimensional Finite Volume Community Ocean Model (FVCOM) of the Bay with 40 vertical layers and 9m to 6km horizontal resolution, including the lower Saint John River estuary, to simulate the tides, currents, temperature and salinity. The model is set to run in barotropic and baroclinic modes, and the open boundary forcing is extracted from Webtide Scotian Shelf model tidal elevations, temperature and salinity from low resolution regional operational models, and water levels for the Saint John River boundary from Environment and Climate Change Canada. The model can resolve the oceanography of the Bay, including gyres and the discharge of the St. John River. Model simulation results are analyzed and validated against observations to evaluate regional open boundary forcing and internal model parameters, such as bottom drag coefficients. The model output is now being integrated with benthic habitat maps in the Bay of Fundy.

Modernizing the discoverability and interoperability of geospatial data using STAC

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The SpatialTemporal Asset Catalog (STAC) specification is a rapidly developing standard being adopted by organizations like NASA and Planet Labs to describe geospatial information with a focus on making it indexable and discoverable. STAC enables the ability to combine metadata from many sources to create large, diverse catalogs of geospatial data.

Through funding granted by the NRCAN GeoConnections program, C-CORE is developing Sherlock, an open-source system for improving geospatial search capabilities. Leveraging the STAC specification, Sherlock aims to improve searchability, discoverability, and interoperability of cloud hosted geospatial data. The Sherlock search engine will use spatial, temporal, thematic, and keyword facetted search to allow end users to rapidly search datasets and discover related products.

Sherlock will also demonstrate the principles of cloud native geospatial computing. It will provide a mechanism for the conversion from collections in their native formats into standard cloud formats for inclusion in processing pipelines. Using containerization and on-demand cloud computing, self-contained processors can be hosted rapidly and temporarily to perform data preparation workflows. Modern application architecture utilizing containerized microservices will enable data access in data formats such as cloud optimized GeoTIFF (COG) for raster data, and GeoJSON and Shapefile for vector data.

Monitoring the Nova Scotia Provincial Dykeland System: Nova Scotia Department of Agriculture – Land Protection & Field Services (Engineering)

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Under the Agricultural Marshland Conservation Act, the Nova Scotia Department of Agriculture – Land Protection & Field Services (Engineering) section is responsible for the maintenance of two hundred and forty (240) kilometres of dyke infrastructure and two hundred and sixty (260) aboiteau structures in Nova Scotia. The monitoring of infrastructure and environmental conditions within the intertidal zone is an essential aspect of both maintenance and planning for potential future infrastructure upgrades (i.e. dyke reinforcement, aboiteau rehabilitation/upgrade, dyke realignment, tidal wetland restoration, drainage improvements and dykeland system management plans). Currently, NSDA implements an Operations and Maintenance Program (OMP), including: measuring tidal and freshwater levels at aboiteaux structures and throughout the coastal system; remotely piloted aircraft (RPA) surveys of dyke corridors, borrow pits and agricultural land; topographic and as-built surveys of infrastructure; and condition assessments to evaluate the integrity of dykes and aboiteaux. Geospatial data obtained and created from the OMP is managed through the Nova Scotia Provincial Dykeland System Atlas. The Atlas is a Geographic Information System (GIS) which leverages ArcGIS Online and a suite of ESRI products (e.g. Collector, Survey123, Drone2Map) which significantly improve the efficiency of data collection, management, and analysis to support informed decision making. The goals of monitoring the Dykeland System is to establish baseline conditions to mitigate risks, increase resiliency, and to predict future conditions to best prepare for climate change and sea level rise. Ultimately, NSDA seeks to continually incorporate innovative methods, new technologies, collaborative subject matter expertise and best management practices in the monitoring and long-term management of the Nova Scotia Provincial Dykeland System. This includes utilizing cutting-edge geomatics technologies and software.

Near-Real-Time Flood Mapping using HAND model and GIS Derived Synthetic Rating Curves

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The Height Above Nearest Drainage (HAND) model shows potential for accurately visualizing flood extents through maps in near-real time. These timely flood maps could assist Emergency Managers in facilitating disaster responses and strategies. The HAND model requires water level data (H), yet river gauge stations across Canada often only provide flow data (Q); thus, a relationship between H and Q will be needed.

A synthetic rating curve (SRC), created using river geometry and the Manning's formula, could provide an approximate H given a Q input. A challenge with creating SRCs includes representing how multiple different land covers will slow down flow due to texture and bulky features (i.e. smooth asphalt vs. rocky river channel); this relates to the roughness coefficient (n).

In this study, three methods of representing multiple n values were experimented with (a single n method, a weighted average method, and a minimum-maximum method). A custom ArcGIS tool, the CERC-HAND-D tool, was developed to create the SRCs using all three methods. Control data was sourced from various gauge stations across Eastern and Central Canada in the form of rating curves. Results indicate that CERC-HAND-D creates more accurate SRCs (>80% alignment with the control data acceptance range) in areas with medium to medium-high river gradients ($S>0.002$ m/m), especially using the minimum-maximum n value method. Results also indicate that CERC-HAND-D may not be suitable for areas with low gradients ($S<0.002$ m/m).

Predicting the Distribution of Coastal Benthic Communities in Placentia Bay, Newfoundland and Labrador

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Marine ecosystems rely on effective management to conserve biodiversity and ensure the sustainable use of resources during a period of global change. Mapping seafloor habitats is fundamental to management as they delineate distinct regions of the seabed based on their bio-physical properties. Due to limitations in sampling the seabed continuously, the implicit assumption is that the distribution of identified species assemblages can be predicted based on their relationship to physical features of the seabed, which indirectly represent a preference for certain environmental conditions. This study examines the spatial distribution of benthic communities for two coastal sites in Placentia Bay,

Newfoundland, identified as a ecologically and biologically significant area (EBSA). Spatially-continuous variables describing the physical characteristics of the seabed are composed of acoustic data (bathymetry and backscatter) at 10m resolution and their derived geomorphological attributes including slope, aspect, bathymetric position index, curvature, and backscatter textural features describing measures of seabed roughness. Using a multiple scales approach, these layers range from 10m-210m to recognize the scale-dependent patterns at which organisms select habitats. Ground truthing samples using a drop camera were used to extract information on species occurrence and identify the dominant species assemblages from underwater videos which resulted in five distinct habitat classes. Random forest classification was used to model the response of each class against the terrain variables to produce full-coverage habitat maps. Depth, slope, and textural features at broader scales of 70-90m were the most influential factors affecting the distribution of habitats, and higher diversity was observed in habitats with coarser substrates likely due to higher substrate heterogeneity. The use of geomorphological attributes and textural indices for the classification of seafloor habitat is important to improve our baseline understanding on the spatial distribution of coastal-benthic communities which are expected to undergo variations due to global change.

RADARSAT Constellation Mission serving Canadians

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The RADARSAT Constellation Mission (RCM) is Canada's new generation of Earth observation satellites. Launched on June 12, 2019, the three identical satellites work together to bring solutions to key challenges for Canadians.

The RCM is designed to respond to core needs, which at the highest level can be summarized as:
- Daily coverage of Canada's territorial and adjacent waters for maritime surveillance, including ship detection and monitoring of ice, marine wind, and oil pollution; and,
- Monitoring of all of Canada for disaster mitigation on a regular basis (monthly to twice-weekly) to assess risks and damage-prone areas; and,
- Regular coverage of Canada's land mass and inland waters, up to several times weekly in critical periods, for resource and ecosystem monitoring.

With RCM, much emphasis is put on standard observation scenarios through the use of 'Standard Coverages'. The objective is to provide consistent and predictable SAR coverage for key application over long periods and large geographic areas. 'Standard Coverage' acquisition plans are published and made available to a wider user base outside of the Government of Canada, providing information well ahead of time on the location, time period, and type of beam modes and products to be acquired by RCM. Also, all RCM image products, including those from Standard Coverages, are archived and made available on the Earth Observation Data Management System (EODMS) web portal to the broadest extent possible with the intent of fostering a greater utilization of the data to the benefit of other sectors such as industry or academia.

This presentation provides information on how: 1) to access RCM data, 2) register for coming a vetted user, and 3) visualize Standard Coverage maps.

River ice monitoring: an integrated space, airborne and in-situ sensing approach

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Rivers which develop ice cover over the winter season can be prone to ice-related flood events that can negatively impact communities located by the river. Monitoring the development of the ice, from freeze-up to break-up, and disseminating that data to key stakeholders is a valuable tool to evaluate potential flood risk. Using data collected from satellite systems, from airborne platforms, and from sensors deployed in-situ enables information, at a range of spatial and temporal scales, to be exploited; shortfalls in one method being complimented by strengths in another. We describe such a system that is currently being used on the Churchill River in Labrador, Canada.

Synthetic-aperture radar and visual imagery from earth-observation satellites are used to generate frequent (1-5 days) ice-cover, ice-classification, and change-detection products that cover a river length of approximately 50 km. A helicopter mounted ice-penetrating radar (IPR) system has been developed to provide tracks of ice-thickness data. The helicopter IPR is effective for collecting data along the same section of river in short time-periods (~1 hr). A further benefit is that data can be collected over ice that might be too thin to support manual data-collection. Finally, four recoverable sea-ice thickness buoys have been modified for river ice operations and, after deployment into the river ice, are able to transmit frequent (~6 hrs) in-situ measurements from which ice temperature and ice thickness products can be produced and delivered in near real time.

The maps and products that are derived from these data sources are freely available as PDF and JPG files through a government website and through a browser-based (platform agnostic) geospatial application that enables stakeholders to visualise and analyse the data.

The Design, Funding, and Management of Infrastructure in Local Municipalities: Using Data to Develop Better Strategies

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The design, funding, management of infrastructure is a challenge for organizations both large and small. Beyond size, when place-based issues such as demographics, geography, and climate are also considered strategic decisions around infrastructure are further complicated. The following study based on the municipalities in the province of Newfoundland and Labrador in Canada, explores good practice and provides recommendations to improve municipal infrastructure with the challenges of using data to develop better strategies. Municipalities, as organizations, are an interesting area of study because they are multifaceted, social-purpose entities with governance, strategic, and financial concerns, similar, but different to those of the private sector. Moreover, as with any organization, they are required to be managed, controlled, and financed. The data that they collect, manage, and store is critical not only for their operations but also the wider field of strategic thinking. How they address their most important, and yet basic, strategic questions, specifically how, why, and when to invest in infrastructure, is important both for public policy and management research. The data that underlies these decisions is explore and a taxonomy is presented that is of use to both GIS practitioners and policy makers.

Tracking Barbarians: GIS in Ancient History

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There is untapped potential for the use of geospatial technology in the study of the past. This presentation will focus on some of the specific uses of GIS and geospatial analysis in the research of ancient history. It will discuss how techniques like biome modelling, least cost paths, and viewsheds can completely change perspectives on barbarian raids on the Eastern Roman Empire. Mitchell Greig's research is utilising these techniques to understand the military culture and perspective of Slavic warrior groups.

It will also discuss the significant opportunities in the field for people interested in history. For over a century, historians and archaeologists have been publishing spatial information about coin hoards, and other archaeological material, but the broad interpretations have usually lacked the rigour of an introductory college course on geographic statistics. Also, there has been work on massive multi-year projects collecting topographic data that have rarely been analysed by the tools of our trade.

The study of history will have a more robust (and resilient!) future if it includes people with a geographic perspective and the technological skills to use it.

Uncertainty Visualization and Characteristic Space-Time Scales of Soil Moisture Variability in Siloam, South Africa

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Variability of hydrologic processes occurs over many orders of magnitude, from pore-scale flow processes up to the global cycling of water and energy, from rain splash effects during less than a second up to changes in the hydrologic water balance over centuries and more resulting from climate fluctuations and geomorphologic processes. Soil moisture is spatially and temporally variable due to complex interactions between geologic, topographic, vegetation, and atmospheric variables. Correct representation of sub-grid soil moisture variability is crucial in improving land surface modelling schemes and remote sensing retrievals. We analyzed soil moisture data recorded with multi-capacitance neutron probes at 10 different locations to a depth of 180 cm at increments of 30 cm for an experimental field site (~24 km2) from 2011 to 2014 in a semi arid-setting. Their empirical means and empirical covariances, spatio-temporal covariograms and semivariograms, empirical orthogonal functions and their associated principal-components time series, including a spatio-temporal canonical correlation analysis was performed to determine whether characteristic scales exist and, if so quantify them to include their uncertainties. Given that these uncertainties are indexed in space-time, we demonstrate a computationally efficient method to visualize both the soil moisture data and their uncertainty simultaneously in multiple dimensions. Preliminary analyses show that soil moisture data in the area exhibit non-stationarity in space for the given surface heterogeneity, exhibiting shorter-scale variability at deeper depths especially beyond the root zone but are also not fractal as there is a break in the variogram. The proposed framework can be used in a geostatistical framework to make predictions of soil moisture under similar terrain conditions.

Unlocking Municipal Potential: On the Power of Data

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The Newfoundland and Labrador (NL) municipal sector exists in a data void. Municipalities are constantly working with pieces of data and reflecting upon how they impact their operations and governance, yet this information is not consistently connected nor modelled to larger trends to support municipal decision-making and sector development more generally.

Over the last two decades, Canadian municipalities have been called upon to implement better practices under successive Federal-Provincial Gas Tax Agreements: Integrated Community Sustainability Plans, standardized Public Sector Accounting Board (PSAB) approaches, and, most recently, municipal asset management (AM) planning. These requisite engagements, however, have varied from municipality to municipality, and across provinces and territories. Variations are attributed to provincial guidelines, human and financial resources at the municipal level, and data.

This presentation looks more closely at what we are calling the municipal data dilemma in the NL context. While data are required, seemingly ad nauseum, they are not in one place, nor are they easily accessible in the format required. As a membership organization engaged in and working with municipalities on a host of data-heavy priorities, MNL regularly contends with these data collection, collation and analysis challenges. The reality of the NL municipal sector is that it is largely comprised of smaller, rural municipalities: 75% have fewer than 1,000 people; 50% have fewer than 500 people; and, 50% of municipalities have no community plan. 75% of these towns have a single staff person and, in many cases, this position is not full-time. Human resource capacity, especially in data collection and handling, is weak. With the added fiscal and operational burdens of the ongoing COVID-19 response, the sector's significant infrastructure deficit,

and the need for timely action on everything from climate change adaptation to Wastewater System Effluent Regulations, the frailties of Newfoundland and Labrador's current system and capacity of local government are laid bare. We ponder this dilemma and offer solutions to unlock municipal data potential.

Why is Critical Infrastructure Important to the Province of Newfoundland and Labrador? Exploring the Role of Data and GIS in Determining Critical Infrastructure

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Most of the critical infrastructure we see in the province of Newfoundland and Labrador is interlinked. This means that the continuity of supply of critical infrastructure often depends on the availability of other critical infrastructure services. Some of this is infrastructure is owned and operated by municipalities in Newfoundland and Labrador.

The degree and complexity of these linkages is increasing as Newfoundland and Labrador becomes more reliant on shared information systems and convergent communication technologies, such as the internet. The information and data, both from GIS and other sources, that are necessary to understand these linkages and the degree of criticality is vitally important for a wide range of stakeholders.

There are a range of threats or hazards that can damage or destroy critical infrastructure and disrupt the continuity of essential services–including natural disasters, pandemics, accidents, negligence, criminal activity, and terrorist attack. Understanding what, where, role, as well as other information data is essential in determining the notion of 'criticality' and it's capture by municipalities and other relevant stakeholders.

It takes a broad-based effort to look after Newfoundland and Labrador's critical infrastructure. This responsibility is shared between owners and operators of critical infrastructure, municipalities, the provincial government as well as the Canadian Government. There are effectively four benefits of engaging in an improved approach to dealing with municipal infrastructure:

1. A strong and effective business – municipality partnership;
2. Enhanced risk management of the operating environment;
3. Effective understanding and management of strategic issues; and
4. A mature understanding and application of municipality/organizational resilience.

The session outlines good practices in managing critical infrastructure as well as what were the findings of examining the current critical infrastructure in the province of Newfoundland and Labrador. It explores how and what information and data needs to be captured to help better define 'critical' infrastructure. Specific recommendations are also given as to how best to assess and manage critical infrastructure at a municipal level.

Speaker Biographies

Ahmadreza Alleosfour received a master's in physical oceanography and is now doing a Ph.D. under the supervision of Dr. Ian Church, at the Department of Geodesy and Geomatics, University of New Brunswick.

David Bélanger holds a Bachelor's degree in Geomatics from Laval University. He is the project manager of the National Elevation Data Strategy for NRCan's Canada Centre for Mapping and Earth Observation. The objective of the strategy is to make a detailed 3D representation of the country available to Canadians in support of Government priorities, through collaboration with federal agencies, provinces, territories, private sector and international partners.

Rebecca Edwards received her MSc degree in geography from Queens University in 2016. During her graduate degree, she worked as a teaching and research assistant with the laboratory for remote sensing of earth and environmental systems. She is currently a remote sensing analyst for Ducks Unlimited Canada's Boreal Program. Her current focus is on advancing remote sensing techniques to develop wetland inventories. Her research interest include northern landscapes, time series analysis, change detection, and land cover mapping.

Zachary Gates is a M.Sc Candidate in Earth Sciences (Geophysics) at Memorial University of Newfoundland (MUN). Zachary has previously completed a Joint B.Sc (Hons) degree in Physics and Earth Sciences at MUN in 2019 while researching with the Biogeochemistry of Boreal Ecosystems Research Group (B-BERG). As a member of B-BERG since Winter 2016, Zachary has worked on boreal forest research projects throughout various sites in Newfoundland and Labrador. Work in these projects has included bedrock/till sampling, soil pit excavation for sampling and analysis, and ground penetrating radar surveying of boreal forest soils. Currently, Zachary is working on research for his thesis, "Investigating Soil Properties and Deep Soil Carbon Stocks Along Boreal Forest Hillslopes Using Ground Penetrating Radar (GPR)", with a focus on optimizing forest GPR methodology to increase spatial scalability of boreal forest soil surveying, improving accuracy in soil carbon stock estimates, and mapping soil property changes along boreal hillslopes.

Randal Greene has been facilitating decisions for over 25 years. Applications have ranged from management information for healthcare, tourism and telecommunications, to real-time situation awareness for marine navigation and surveillance. He now concentrates on geographic information systems (GIS) for systematic conservation planning, natural resource management and related applications through his consultancy Feaver's Lane.

Mitchell Greig is a M.A. student at the Dept. of Classics and Religion at the University of Calgary. He is also a professional geospatial software developer, having worked in industries like hydrogeology, land survey, forestry, and mining. He received a B.A. (Hons.) in History from Memorial University of Newfoundland in 2010 and a GIS Applications Specialist Post-Diploma from the College of the North Atlantic in 2011. After building databases and geospatial web applications professionally for nearly a decade, he enrolled to apply GIS in graduate school to study early Slavic and nomadic cultures.

Robert Harris has a Bachelor of Arts Degree (Geography and Atlantic Canada Studies) from Saint Mary's University and an Advanced Diploma in GIS from NSCC-COGS. He is the Geomatics Manager of New Brunswick 9-1-1 Bureau at the Department of Public Safety, Chair of the New Brunswick Branch of the Canadian Institute of Geomatics, Co-Chair of the CRTC Emergency Services Working Group task (TIF 92) on NG9-1-1 Mapping (GIS) & Addressing Considerations, Chair of the New Brunswick GeoOperations Community of Practice working group, and participant of NENA working groups for NG9-1-1 GIS Data Stewardship, NG9-1-1 GIS Data Model v2, and CLDXF-Canada Data Standard.

Colin Lang received a B.Sc. in Earth Sciences from the University of Alberta in 1997 and has worked with GIS in the following fields: Forestry, Environmental Consulting, Civil Engineering, Urban Planning and Emergency Management. He is on the executive of the New Brunswick Branch of the Canadian Institute of Geomatics.

Vince MacKenzie is a fire services advocate, commentator (@FirechiefVince), instructor, columnist and speaker on leadership, the administration of composite and volunteer fire departments and the importance of social media and emergency management (SMEM) in small community contexts. Vince has been a member of his central Newfoundland municipality's fire department since 1983. He also serves as his town's Emergency Management Coordinator. In addition to his current executive roles on both the national and Atlantic region Fire Chiefs' associations, he sits as Vice-Chair of the provincial NL911 Board of Directors. He's a five-term past-President of the Newfoundland and Labrador Association of Fire Services and has been an enthusiastic participant in the international Canada-US Enhanced (CAUSE III and IV) resiliency exercises exploring existing and emerging interoperable technologies.

Dr. Heather McGrath is a geospatial scientist with Natural Resources Canada. Prior to NRCan, she gained industry experience as a trainer for GPS and Surveying equipment and was involved in the collection and processing of marine data, including multibeam, bathymetric LiDAR, and underwater acoustic positioning. She completed her PhD at the University of New Brunswick, and collaborated with NRCan Geological Survey of Canada to develop and apply a new approach to rapid flood mapping and risk assessment. McGraths' current research focus at NRCan is in the development of methods and implementation techniques to promote the interoperability and accessibility of flood mapping and flood risk information, and open-source, web-based tools to increase awareness of flooding and for communication of flood risk.

David McKittrick is Training and Outreach Manager at Blue Marble Geographics in Hallowell, Maine. A graduate of the University of Ulster in Northern Ireland, McKittrick has spent over 30 years in the field of GIS and mapping, focusing on the application and implementation of spatial technology within a wide variety of industries and vertical markets. McKittrick has designed and delivered hundreds of GIS training classes, seminars, and presentations and has authored dozens of articles and papers for numerous business and trade publications.

Shreya Nemani is a MSc student in the geography department at Memorial University, involved in a baseline study to characterize benthic habitats for select coastal sites in Placentia Bay, NL, Canada. This project is in collaboration between the 4D Oceans lab at the Marine Institute, Memorial University and Fisheries and Oceans Canada.

With over 20 years of experience in geomatics, **Chris North** is an accomplished GIS professional who brings an in-depth understanding of enterprise GIS and technology trends to the company. He has a Masters degree in GIS from the University of Edinburgh, Scotland, and an undergraduate degree in geography from Queen's University in Kingston, Ontario. Chris is also a graduate of the Cartography Program at Sir Sandford Fleming College, Ontario. He is the recipient of several industry awards and continues to be involved with many industry groups.

Clio Nikias received a B.A in Geography from Carleton University and an Advanced Diploma in GIS from NSCC-COGS. She is as a Geomatics Analyst with the New Brunswick 9-1-1 Bureau and is part of the GeoOperations team. Clio has previously worked in both private and public sector positions across Canada.

Marta Padilla Ruiz is a Cloud Developer at Teledyne CARIS, where she is part of the New Product Initiatives team. Her expertise lies in Web and Cloud development, being an Amazon Certified Developer Associate. She is also a PhD student in Geomatics Engineering at the University of Calgary, where she is investigating the qualities and advantages of DGGS applied to marine geospatial data. She was a member of the Ocean Mapping Group at the University of New Brunswick, where she obtained her MScEng in Geodesy and Geomatics Engineering and worked as a Research Assistant. Prior to coming to Canada, she completed a bachelor's degree in Geomatics Engineering at the University of Jaen, and a MScEng in Topography and Geodesic Engineering at the Polytechnic University of Madrid. Her research interests are focused on DGGS and the development of the new generation of Geomatics applications, combining her programming and geospatial skills.

Kathleen Parewick is a community planner and facilitator who supports Municipality Newfoundland and Labrador's extensive sector advocacy, policy and practice-related efforts through research, content development, outreach and education activities for the organization's 275 member municipalities. While her involvement with the Geomatics Atlantic network began in connection with the municipal asset management (BAM! NL) program she has been leading since 2016, she looks forward to spatial data capture and usage playing an even bigger role in local governance across the province.

Doug Piercey is a GeoInformatics Analyst with Natural Resources Canada – Canadian Forest Service in Corner Brook, Newfoundland and Labrador where he has worked since 1999. Prior to this, he worked as a GIS Technician with Corner Brook Pulp and Paper. Doug is from Corner Brook, NL and holds a BSc in Geography from Memorial University and an MSc in GIS from City University, London, UK. Research interests include the development of decision support tools, socio-ecological modeling, geovisual analytics, the use of drone-based imagery, and web-based GIS. Currently Doug is lead on multi-partner project assessing caribou habitat in Newfoundland and Labrador and co-lead of a regional integrated assessment of potential impacts of climate change in Newfoundland (ACCESS-NL).

Christopher Ross is an Engineer with the Nova Scotia Department of Agriculture – Land Protection & Field Services (Engineering) section focusing on the operations and maintenance of the Nova Scotia Provincial Dykeland System. Christopher completed an Advanced Diploma in Geographic Information Systems (GIS) through the British Columbia

Institute of Technology (BCIT) and obtained a Bachelor of Environmental Engineering from Dalhousie University. Christopher has been working for the last three (3) years on various projects relating to upgrades of the Provincial Dykeland System infrastructure and plays a key role within the Departments $50M Dykeland System Upgrades Project (DSUP) funded under the Disaster Mitigation Adaptation Fund (DMAF).

Ryan Ruttgaizer is a graduate of College of the North Atlantic's Geomatics Engineering Technology program. Ryan works with Fugro Canada providing expertise in subsea construction and positioning activities. As a member of Fugro's offshore team, Ryan has been performing a wide variety of tasks operating many different surface and subsea positioning technologies. Fugro's Quick Vision technology is Fugro's latest offering with Ryan recently taking sensor specific training on the system in the UK.

Blair Scriven's academic research has involved utilising GIScience and spatial analysis to study a variety of topics, including tourism, ecology, risk analysis and flood mapping. Currently, I am a Graduate Student at the Department of Geomatics Engineering at the University of Calgary, working on earning a M.Sc. in GIScience and Land tenure. Previously, I was an Undergrad Student at the University of Guelph and earned a B.Sc. in Environmental Geomatics. Additionally, I have contributed to conservation efforts with Conservation Halton and ran academic workshops for Students On Sustainability at the University of Calgary.

With over 20 years' experience in the public service in a variety of roles, **Tobias Spears** currently manages a multi-disciplinary team supporting data stewardship related work in Fisheries and Oceans Canada and participates in international activities in support of the World Meteorological Organization and Inter-governmental Oceanographic Commission. As a member and new chair of Canada's mirror committee to ISO TC 211, standards development and alignment, and engaging the expert and user communities are priority work areas for advancing the work of ISO TC 211 in Canada.

Dirk Werle is a geoscientist with a Master of Science degree in Physical Geography and Remote Sensing from McGill University. He has been a managing partner at ÆRDE Environmental Research in Halifax, Canada, since 1987. Throughout his professional career he worked as an Earth observation applications expert with several Canadian Government Departments and the Canadian Space Agency. His recent research interest is focused on the early days of aerial photography and historical aspects of remote sensing.

Dr. Joanne White is a Research Scientist with the Canadian Forest Service specializing in remote sensing for forest inventory and monitoring. She received her Doctor of Science degree from the Department of Forest Sciences at the University of Helsinki, Finland and has published more than 170 peer-reviewed publications. Dr. White is recognized as a global expert in the application of lidar data for forest inventory, leading the development two best practices guides and contributing to national lidar acquisition standards. Dr. White is also an Adjunct Professor in the Faculty of Forestry at the University of British Columbia and serves on the Editorial Boards of Remote Sensing of Environment and Current Forestry Reports.