

## THE CANADIAN OCEAN MAPPING RESEARCH AND EDUCATION NETWORK (COMREN)

By Dr. Ian Church<sup>(1)</sup>, Dr. Sylvie Daniel<sup>(2)</sup>, Dr. Sean Mullan<sup>(3)</sup>, Dr. Michael Purcell<sup>(4)</sup>,  
Jean Laflamme<sup>(5)</sup>, Dr. Anders Knudby<sup>(6)</sup>, Dr. Sunil Bisnath<sup>(7)</sup>, Sean Galway<sup>(8)</sup>,  
and Denis Hains<sup>(9)</sup>

<sup>(1)</sup>COMREN Chair 2020 and Assistant Professor, University of New Brunswick, Canada  
[ian.church@unb.ca](mailto:ian.church@unb.ca)

<sup>(2)</sup>COMREN Vice Chair 2020 and Professor, Laval University, Canada  
[Sylvie.daniel@scg.ulaval.ca](mailto:Sylvie.daniel@scg.ulaval.ca)

<sup>(3)</sup>COMREN Member and Ocean Mapping Instructor, Marine Institute-Memorial University,  
Canada [Sean.mullan@mi.mun.ca](mailto:Sean.mullan@mi.mun.ca)

<sup>(4)</sup>COMREN Member and *Chair, Technology and Environment*, Nova Scotia Community  
College, Canada [Michael.purcell@nsc.ca](mailto:Michael.purcell@nsc.ca)

<sup>(5)</sup>COMREN Member and Director General, Centre interdisciplinaire de développement de la  
cartographie marine, Canada [Jean.laflamme@cidco.ca](mailto:Jean.laflamme@cidco.ca)

<sup>(6)</sup>COMREN Member and Associate Professor, University of Ottawa, Canada  
[aknudby@uottawa.ca](mailto:aknudby@uottawa.ca)

<sup>(7)</sup>COMREN Member and Professor Sunil Bisnath, York University, Canada  
[sbisnath@yorku.ca](mailto:sbisnath@yorku.ca)

<sup>(8)</sup>COMREN Member and Faculty, British Columbia Institute of Technology, Canada  
[sgalway@bcit.ca](mailto:sgalway@bcit.ca)

<sup>(9)</sup>COMREN Senior Special Advisor and *President & CEO*, H2i [www.h2i.ca](http://www.h2i.ca), Canada  
[dhains@h2i.ca](mailto:dhains@h2i.ca)

### Abstract

In Canada, ocean, river, lake and coastal mapping knowledge, capacity building and know-how are strengthened through a network of members from academic institutions and one nonprofit organization. This note highlights the Canadian Ocean Mapping Research and Education Network (COMREN), its purpose and its membership.

### 1. Introduction

To ensure the continued flourishing of humankind, it is essential to develop the global ocean economy sustainably. This will require intelligent decisions based upon comprehensive and accurate information – especially that obtained from the analysis of ocean mapping data. Global warming, climate change, sustainable development, and an innovative blue economy are critical affairs for the world's coastal nations. For instance, marine shipping is the backbone of transnational material trade, and its classification as an essential service throughout the COVID-19 pandemic has been vital to maintaining the societal order of nations during the crisis.

Hydrographic surveying and marine geospatial science being much more than nautical charting for safe and efficient navigation – alternatively referred to as hydrospace science (Hains, 2020) – and autonomous scientific data collection vessels are worldwide growth areas for scientific and technological development within industry and academia. For Canadian academic institutions, this growth has manifested as the development and implementation of ocean mapping teaching and research programs that aid in addressing provincial, territorial, national and international concerns in ocean characterization. For Canada, ocean mapping capacity building, and support for advanced ocean technology industries constitute sound economic strategies.

The Canadian Ocean Mapping Research and Education Network (COMREN), as a knowledge development network (Clark, 1998), will be able to support Canadian economic growth initiatives such as the federally-funded Ocean Supercluster ([oceansupercluster.ca](http://oceansupercluster.ca)). This initiative aims to make Atlantic Canada a global force in the ‘blue economy’ by harnessing emerging ocean technologies in the realms of digital sensors for ocean mapping and monitoring, autonomous marine vehicles, energy generation, automation, marine biotechnology, and marine engineering. Prior to the global pandemic the Canadian government planned for the Ocean Supercluster to have a 10-year GDP impact of at least \$14 billion (CDN) and generate more than 3,000 jobs.

According to the Ocean Supercluster, Canada’s blue economy presently contributes more than \$36 billion to GDP and supports almost 350,000 jobs. COMREN draws on institutional expertise and resources across Canada. As such, the development focus of the network can be leveraged to help geographically separated regions in the country – Pacific, Arctic, Great Lakes & St. Lawrence River, and Atlantic – benefit from potential growth in the global ocean economy, which was forecasted to reach a value of more than 3 trillion dollars globally by 2030, outpacing broader economic growth by nearly 20% (OECD, 2016). Canadian success in the ocean mapping and hydrospace aspects of a post-pandemic ‘blue economic recovery’ will be accelerated by the efforts and the willingness of COMREN members to collaborate on innovative ocean mapping research, teaching, and career development. COMREN is supported through the engagement of interested parties including the Canadian Hydrographic Service (Fisheries and Oceans Canada, 2018).

## 2. About COMREN – a formal knowledge network

The nurturing of knowledge-based networks has been recognised as integral to sustainable development in Canada (Clark, 1998) – helping people, both domestically and internationally, by sharing experiences and seeking solutions to common economic, social and environmental challenges. COMREN, an independent association of academic institutions and a non-profit, recognizes the need to transition from a somewhat ‘open network’ to more of a ‘development network,’ thereby increasing its value to society. Development networks “have a well-defined theme and carefully chosen criteria for participation, exist to create knowledge and to accelerate the application of that knowledge to economic and social development, and have a formal constitution and tight governance (Clark, 1998).” However, for the time being, COMREN members wish to maintain an informal and cooperative governance arrangement.

COMREN was formally established in February 2016 by various educational and applied research stakeholders, each having a number of pre-existing informal connections. By formalizing the association, the intent was to strengthen a pan-Canadian academic, and non-profit, network in ocean mapping, as well to define and coordinate the fundamental objectives and activities to be subsumed by the network. COMREN’s structure is designed to enhance collaboration on research interests and educational activities. The primary COMREN stakeholders are the: Interdisciplinary Centre for the Development of Ocean Mapping (**CIDCO** – *Centre interdisciplinaire de développement en cartographie des océans*), Nova Scotia Community College (**NSCC**), Marine Institute of Memorial University of Newfoundland (**MI**), Laval University (**ULaval**), University of

New Brunswick (**UNB**), University of Ottawa (**uOttawa**), York University (**YorkU**) and British Columbia Institute of Technology (**BCIT**). The membership stretches from the Pacific to Atlantic Oceans, with interests in the Great Lakes-St Lawrence freshwater system, and the Arctic Ocean. COMREN operates in both French and English, Canada's official languages at the national level (**Figure 1**).



**Figure 1** : Location of current COMREN members

### 3. Purpose of COMREN

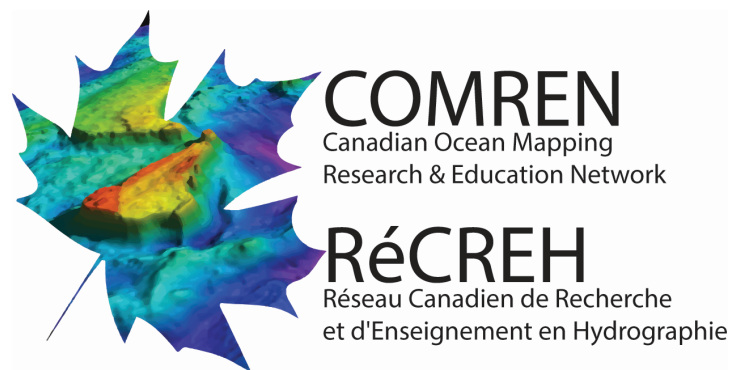
COMREN aims to develop research activities, achieve technology transfer to industry, develop and run educational programs. The network operates in liaison with government agencies and international organizations, to increase Canada's ocean mapping research and education capacity and presence – both domestically and internationally. Central to this is providing opportunities to train Highly Qualified Personnel (HQP) who can help advance ocean technologies and solve problems — both applied and theoretical — with hydrospace science (Hains, 2020) and the ideas of neighbouring disciplines. COMREN can help ensure the connections and incentives needed for HQPs to effectively collaborate and innovate in Canada.

The overall goals set out for COMREN are to: collaborate on ocean mapping research programs, from innovation in underlying technologies to implementing challenging applications; to interact with federal, provincial, territorial and international agencies and industry; and to be a focal point for research and education on ocean mapping in Canada and abroad. The network looks to promote ocean mapping research within Canada, and worldwide; to facilitate cooperation between educational institutions and instructors, and to develop and enhance training programs in Canada recognized by the International Federation of Surveyors (FIG), International Hydrographic Organization (IHO), and International Cartographic Association (ICA); and to facilitate student exchanges, graduate research co-supervision, and internships.

For membership in COMREN, institutions must demonstrate an active participation in ocean mapping research and/or education, and willingness to work as a pan-Canadian team. COMREN members commit to: participating in an annual workshop and periodic meetings; establishing and

communicating research priorities; encouraging scientific capacity building methods and activities in ocean mapping; facilitating collaboration and information exchange between COMREN member researchers; and promoting COMREN activities through dissemination of COMREN achievements.

A priority for COMREN is to work closely with Fisheries and Oceans Canada - Science, the Canadian Hydrographic Service (CHS), Natural Resources Canada (NRCan), and other interested hydrographic offices and mapping agencies around the world, to identify and engage in leading-edge ocean mapping initiatives such as surveying through the utilization of Autonomous Surface Vehicles (ASVs), underwater vehicles, shallow water multibeam sonar surveys with associated backscatter analyses, satellite-derived bathymetry, Marine Spatial Data Infrastructure (MSDI) design, the implementation of hydrospatial data management strategies, and educational program development.



**Figure 2 :** COMREN Logo

The members of the network bring a combination of unique, complementary and overlapping expertise, capacity and equipment. These resources, both human and capital, when brought together, maximize Canada's potential for innovation and ambition in ocean mapping. It is envisioned that COMREN members can partner in competitive bids for research funding, or collaborate on ventures for industry, government, international development, and education. With the support of federal, provincial and territorial governments, the network is building capacity for ocean mapping in Canada for global benefit.

#### 4. The eight COMREN members



**Figure 3 –** CIDCO Logo

The "*Centre interdisciplinaire de développement en cartographie des océans*" or Interdisciplinary Centre for the Development of Ocean Mapping (**CIDCO**) is a non-for-profit organization that was founded in 2002, with the objectives of developing new technologies, tools and methodologies for ocean mapping. Through partnerships with the academic sector, the public sector and the industry, CIDCO is a collaborative hub for research and development organization dedicated to

improving state-of-the-art technology in marine geospatial (Hydrospatial) data acquisition, processing and management. Topics of interest at CIDCO include the automation of hydrographic systems calibration, automated data processing, automated quality assurance, artificial intelligence applied to marine geomatics, and autonomous surveying technologies. CIDCO also offers an IHO-FIG-ICA certified Category B programme in Hydrographic Surveying recognized across-the world through, among others, several capacity building programs. CIDCO is an expert contributor to the International Hydrographic Organization (IHO) Crowd-Sourced Bathymetry Working Group (CSB-WG) as an expert contributor. More information at: [www.cidco.ca](http://www.cidco.ca)



*Figure 4 – NSCC Logo*

The Nova Scotia Community College (NSCC) is committed to building Canadian Nova Scotia's economy and quality of life through education and innovation. Serving the province through a network of 13 campuses, the College offers over 120 programs in five academic schools, reflecting labour market needs and opportunities in Nova Scotia. NSCC's Applied Research department helps the College realize its mission by working with industry partners to grow their businesses. This direct engagement with industry helps drive Nova Scotia's economy, enhances quality of life and builds innovation capacity. Oceans research is one of five focus areas of applied research at NSCC. Within this focus area, research is conducted in the field of ocean floor mapping using the latest ocean technologies such as acoustic remote sensing methods, and seafloor sampling and imaging technologies. The maps generated deliver spatial information for use in a variety of applications ranging from sustainable fisheries to marine protected area management. More at: [www.nsc.ca](http://www.nsc.ca)



*Figure 5 – MI Logo*

The Marine Institute of Memorial University of Newfoundland is a world-class centre of advanced marine technology, education, and training. Initially conceived as the College of Fisheries, Navigation, Marine Engineering and Electronics in 1964, the Marine Institute (MI) has developed into Canada's leading fisheries and marine institute. MI is now one of the most respected centers for marine learning and applied research in the world. It offers over twenty programs, many with an applied focus, ranging from industrial and technical certificates, to diplomas, to bachelor's, master's, and doctoral degrees. The institute also runs a variety of short courses and industrial response programs designed to provide students with the knowledge and skills required for work-force success.

MI contains three schools – the School of Fisheries, the School of Maritime Studies, and the School of Ocean Technology, which hosts the Ocean Mapping Program. These centres lead the MI, both nationally and internationally in applied research and technology transfer, and in training for a variety of industry clients. In fall 2020, MI is launching two course-based applied ocean mapping graduate programs with a foundational curriculum based on the FIG-IHO-ICA marine surveying (nautical cartographer) competencies: a master's degree, and a postgraduate diploma.

MI International (MI<sup>I</sup>) is the focal point for international initiatives at the Marine Institute. The department's primary areas of focus are international consulting and project management, building international institutional partnerships, and supporting international student recruitment and

services. Through MII, the Marine Institute engages in development projects, contract training, and consultancies across the globe. For over 30 years, MII has successfully implemented more than 200 projects in over 50 countries, making the Marine Institute one of the most internationally active institutes in Canada. More at: [www.mi.mun.ca](http://www.mi.mun.ca)



*Figure 6 : Laval University Logo*

**ULaval/SCG and CRDIG:** The Department of Geomatics Sciences at Université Laval, which has celebrated its centenary year in 2007, offers a complete and diversified education at both undergraduate and graduate levels in geomatics. Apart from its four graduate programs, two undergraduate programs (4 years /120 credits) are currently offered by the Department: 1: Bachelor's degree in geomatics sciences (B.Sc.A.) : the only program in Quebec that allows access to the *Ordre des arpenteurs-géomètres du Québec (Association of Quebec Land Surveyors)*; 2: Bachelor's degree in geomatics engineering (B.Eng.): the only program in Quebec to train geomatics engineers. More than 350 students are currently enrolled in these programs, including 275 undergraduates, about 50 graduates and more than 30 students in short programs (15 credits). With a team of 14 professors, along with leading-edge infrastructure and installations, the Department offers educational programs that are aligned with the most recent geomatics advances and the labour market expectations. Centre for Research in Geospatial Data and Intelligence (CRDIG) is among the largest of its kind in the world and supports leading-edge scientific research in the geospatial field. Its members actively collaborate with the community in order to apply their research activities in innovative ways for the benefit of society, in three privileged areas of application: marine and fluvial environments, intelligent cities and communities, natural resources and human activities. Established in 1989, CRDIG's mission is to increase scientific knowledge in the geospatial field. This knowledge is used to design and implement advanced and innovative methods and technologies that are at the heart of data science. More at: <https://www.scg.ulaval.ca/> and <https://crdig.ulaval.ca/>



*Figure 7 : UNB Logo*

**UNB/GGE:** The Department of Geodesy and Geomatics Engineering at the University of New Brunswick (UNB) in Fredericton provides education and research programs at the undergraduate, Master's and PhD level in the fields of GNSS, Geodesy, GIS, Big Data Analytics, Remote Sensing and Ocean Mapping.

Founded in 1785, UNB is Canada's oldest English-language university, and is New Brunswick's premier research institute and largest university. There are two main campuses, located in Fredericton and Saint John, with vibrant and growing undergraduate and graduate programs offered in both locations. UNB is responsible for 75% of New Brunswick's publicly funded research and has a rich history of research partnerships.

The Ocean Mapping Group was established as part of the Department of Geodesy and Geomatics Engineering at UNB in 1988 in response to a national need to develop advanced ocean mapping capabilities. It draws upon faculty and staff with expertise in the fields of hydrography, geographical information systems, digital image analysis, interactive computer graphics and 3-D

data visualization. The research of the Ocean Mapping Group is focused on developing new and innovative techniques and tools for the management, processing, visualization and interpretation of ocean mapping data. More at: <http://www.omg.unb.ca/> and <http://gge.unb.ca/>



*Figure 8 : BCIT Logo*

For more than 50 years, the British Columbia Institute of Technology (BCIT) has been training the experts, innovators, and professionals who shape our economy – across BC and around the world. Through our unique applied education model, BCIT students gain the technical skills, real-world experience, and problem-solving ability needed to embrace complexity and lead innovation in a rapidly changing workforce. Our curriculum is developed through close consultation with industry and delivered by instructors who have direct, hands-on experience in their fields. Land Surveying and Mapping courses have been offered at BCIT since it was established in 1964.

The BCIT Geomatics Department offers a two-year Diploma in Geomatics Engineering Technology with the choice of either pursuing a career in industry upon graduation or continuing for a further two years of study toward a Bachelor of Science in Geomatics. The curriculum for the Bachelor's degree is designed to meet the requirements of the Canadian Board of Examiners for Professional Surveyors (CBEPS) which regulates academic qualifications for Land Surveyors in Training in several provinces. Courses include Geodetic Positioning, Geospatial Information Systems, Advanced Satellite Positioning Techniques, Cadastral Surveying, High Precision Surveying, Remote Sensing, Advanced Digital Mapping and Hydrographic Surveying.

For more information, visit: [www.bcit.ca/geomatics](http://www.bcit.ca/geomatics)



*Figure 9 : uOttawa Logo*

uOttawa: The Department of Geography, Environment and Geomatics at the University of Ottawa is a hub of research and teaching activity for a wide variety of areas including ocean mapping. The research and teaching interests in the Department are as diverse as the nature of geography itself, and we offer training in geomorphology, climatology, biogeography, human, social and cultural geography as well as GIS and remote sensing. The Department is home to recognized experts in the field, including Research Chairs in Glaciology, Environment, Society and Policy, and features a CFI lab for Shallow-Water Earth Observation. As such the Department has substantial expertise in satellite-based ocean mapping, including foci in the areas of satellite-derived bathymetry, seafloor habitat mapping, and land- and sea-ice in the Arctic. More at: <https://arts.uottawa.ca/geography/>



*Figure 10 : YorkU Logo*

The Department of Earth and Space Science and Engineering at the Lassonde School of Engineering at York University offers several unique and world-class graduate (MSc, PhD) and undergraduate programs, including the Geomatics Engineering program (BEng) established in 2001 and the Geomatics Science stream (BSc) established in 2016. The Geomatics Engineering

program is accredited by the Canadian Engineering Accreditation Board (CEAB), the Association of Ontario Land Surveyors (AOLS) and The Canadian Board of Examiners for Professional Surveyors (CBEPS) Level-2.

Teaching and research related to COMREN themes and activities include: Global Navigation Satellite Systems, Multi-sensor-integrated navigation, Hydrography, Manned and Unmanned Mobile Mapping Systems, Physical and Space Geodesy, Remote Sensing and Photogrammetry, GIS and Spatial Data Infrastructures, Aerial and Terrestrial Laser Scanning, Digital Terrain Modelling, 3D Modelling and Visualization, Survey Law, and Geomatics Sensor Systems development and integration. Faculty members perform world-leading research in many of these subdisciplines, focussed on technology solutions and positive societal impact. More at: <https://esse.lassonde.yorku.ca>

## 5. Conclusion and future directions

COMREN is a vibrant, proactive, committed and collaborative network of academic institutions and one nonprofit. The organization is not incorporated and does not currently constitute a legal entity, but it is a genuine network of partners willing to work together on challenging projects. The pan-Canadian members of COMREN will share knowledge, implement joint research and education projects, and strengthen Canada's ocean mapping capacity in order to serve the world.

Canadian and international collaboration in hydrography, ocean-seabed mapping, coastal geospatial, and hydrosatial data projects are welcomed by COMREN. Projects and proposals can be developed and funded using the COMREN "banner" through a COMREN member willing to ensure the coordination of duties and administrative obligations. Such projects or proposals could involve all members of COMREN or a subset; and might involve additional collaborators from anywhere in the world. A typical project will involve at least 2 official COMREN members and can be expanded as needed to maximize outcomes.

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