Learning Session: Remote Sensing Technologies for Coastal Mapping

Final Agenda with Abstracts

---

5 November 2015: 0900 - 1700 hrs – Atlantic Standard Time.

Location: Wandlyn Inn, Amherst, Nova Scotia, and virtual participation via WebEx.

0900-0910 – Introduction
0910-0920 – Objectives of the session; participant expectations
0920-0930 – Background document: remote sensing technologies
0930-0955 – Jennifer Wozencraft, Emerging Remote Sensing Applications

> Information extracted from airborne bathymetric LiDAR, topographic LiDAR, aerial photography, and hyperspectral imagery enables quantification of geomorphological, engineering, and environmental characteristics of the coastal zone. Beach geomorphological parameters are the height and volume of sand dunes, the width and volume of beaches, and position of the shoreline. Engineering parameters are navigation channel shoaling, volume of offshore shoals, and condition of coastal structures relative to their design profiles. Environmental parameters include critical habitats like dune vegetation, submerged aquatic vegetation, and wetlands, often expressed in terms of their density, and reflectivity of the seabed. With successive surveys over one location, change rates can be quantified for all the parameters.
>
> These key parameters, in turn, enable some new applications. A coastal dashboard may be generated by indexing parameters of interest to assist management decisions. The parameters may be used to identify sites with similar features to aid in planning processes. Habitat suitability models may be built using parameters extracted from remote sensing data and expert elicitation. LiDAR-derived metrics may be combined with ecological models to estimate the impacts of management decisions at coastal projects. The same metrics may be used to estimate ecosystem goods and services from well-established relationships published in the literature.
>
> This presentation will briefly outline the parameters that may be extracted from airborne bathymetric LiDAR, topographic LiDAR, aerial photography, and hyperspectral imagery to quantify geomorphological, engineering, and environmental characteristics of the coastal zone, and how they are being used in R&D for emerging applications of these parameters.

0955-1020 – Jamie Carter, NOAA's Coastal-Change Analysis Program

> The National Oceanic and Atmospheric Administration (NOAA) Coastal-Change Analysis Program (C-CAP) produces land cover and land cover change products to support coastal management and risk assessment activities in the United States coastal zone. These nationally standardized, raster-based inventories cover coastal intertidal areas, wetlands, and adjacent uplands for the coastal United States. Local high resolution and regional moderate resolution products are generated from multiple dates of remotely sensed imagery and elevation data. High

resolution data products are developed for specific project-based geographies and are often developed in partnership with state and local groups on a case-by-case basis. This presentation will introduce the C-CAP product line, explore technical considerations for high resolution data development, and discuss the future path of the program.

1020-1035 – Break

1035-1105 – Dirk Werle, Coastal Applications of Satellite Radar

The talk will provide an overview and insights into the application of synthetic aperture radar (SAR) Earth Observation satellite imagery for application in coastal-marine areas. Four main topics will be addressed and illustrated. The first one contains a brief outline of (mainly satellite) SAR technology and history pertaining to the application in question. Canada, among other players, continues to play a prominent role in this field of Earth observation. The second topic highlights recent experience with a variety of SAR-specific applications in coastal regions, for example detailed wind field analysis, bathymetry/intertidal area assessment, ship detection and traffic monitoring, pollution detection and monitoring, operational and scientific ice mapping and monitoring, and climate change related issues. Scientific research and development and operational activities are presented and illustrated, including Canadian examples. The third topic examines current satellite SAR system capacities and capabilities for addressing coastal application requirements and user needs in Canada and elsewhere. Current German, European, Japanese, and Canadian SAR satellites and applicability of their data in the context of Atlantic Canada are highlighted. A summary of prospects and hurdles for coastal SAR applications concludes the talk. This includes SAR data access, evolving EO data policies and their impact on current and prospective users; enhanced SAR imaging capabilities, increasing data volumes, and demanding technical issues and know-how that users have to address in order to take advantage of satellite imaging radar capabilities for coastal regions.

1105-1135 – Dr. Vladimir Kostylev, Seabed Mapping Initiatives at NRCan

Seabed mapping is essential for multiple ocean uses from mineral and hydrocarbon resource exploitation to fisheries and sustainable ocean management in general. This is a point that Natural Resources Canada (NRCan) or more precisely Geological Survey of Canada Atlantic (GSCA) located at Bedford Institute of Oceanography in Dartmouth, Nova Scotia, has been proving for the last two decades. Seabed habitat mapping has been on the rise since the wide spread implementation of multibeam mapping technologies. The acoustic signal obtained from multibeam sonar yields georeferenced, three dimensional depictions of seabed morphology and allows interpretation of sediment properties. When used in conjunction with other geophysical instruments and augmented by physical and optical sampling, the technology enables the production of detailed maps of seabed morphology and texture. The precisely positioned multibeam imagery has revolutionised hydrography, marine geoscience, benthic ecology, and habitat mapping, enabling scientists to collect valuable contextual information for habitat management and thereby establish the knowledgebase for implementing integrated ocean management. In this presentation NRCan's seabed mapping initiatives will be presented along with examples of past, current and discussion of future work.

1135-1200 – Peter Nishimura, Impacts of new data upon coastal development on PEI

In 2010, PEI Department of Communities, Land and Environment (DCLE) commissioned work through Natural Resources Canada's Regional Adaptation Collaborative (RAC) to obtain new

coastal data for Prince Edward Island. Two types of coastal data were sought: coastal change data, whereby erosion risk could be assessed, and sea level rise and storm surge data, whereby flood risk could be assessed. Aerial photos from 1968 and 2010 were orthometrically corrected and coastlines were delineated for each of those years. Subsequently, rates of coastal change were calculated by comparing the location of the two coastlines. Using updated climate change scenarios and newly acquired LiDAR data, DCLE has also been able to look at potential flood impacts at various locations on the Island.

The new data has presented DCLE with an opportunity to assess erosion and flood risk at an unprecedented level of detail. The introduction of the data, however, has highlighted several challenges, including data management and analysis, disclosure of risk to current and future property owners, implementation of larger setbacks than those previously used, and the inability to restrict or prohibit development in areas at risk of flooding.

1200-1300 – Lunch

1300-1330 – Dr. Tim Webster, Topo-bathy LiDAR for coastal research in Maritime Canada

The Applied Geomatics Research Group (AGRG) within the Nova Scotia Community College (NSCC) acquired a new shallow water airborne topo-bathymetric LiDAR sensor, the *Chiroptera II*, and flew the first missions in September 2014. The survey areas consisted of several embayments along the Northumberland Strait, an area on the Atlantic coast and two freshwater lakes. Many of the areas are sheltered bays that host shellfish aquaculture farms. The low flow rates associated with these bays promote high volumes of sediment cover and the presence of glacial till along the coast promotes fine grained near shore sediments. These sediments can be re-suspended in the water column during periods of increased wave activity. As a result, one must assess both the current environmental conditions (wind, cloud ceiling height) as well as the water clarity conditions that may be influenced by previous conditions such as strong winds, thus adding additional operational constraints. The reflectance of the seabed also influences the maximum depth achieved. Having multiple study areas to choose from during a bathymetric LiDAR survey campaign allows flexibility to survey areas of optimal water clarity. Results indicate depth penetration of 5-6 m for most of the study sites and the sensor is ideal for differentiating the water surface from the seabed at depths less than 2 m which was problematic in earlier LiDARs. In addition to generating seamless DEMs of the study areas, reflectance of the green laser is used in combination with elevation variables to map submerged aquatic vegetation.

1330-1400 – Jacinthe Cormier, Bathymetric LiDAR activities at Canadian Hydrographic Service – Atlantic

The Canadian Hydrographic Service (CHS) has the authority to conduct hydrographic surveys and to produce and distribute nautical products within Canadian territorial waters. The CHS adheres to rigorous, internationally-recognized standards and guidelines when conducting hydrographic surveys.

CHS seeks to implement an integrated multi-platform approach to Hydrographic surveying in Canada's navigable waters. This allows for the delivery of a flexible, affordable and sustainable hydrographic survey program to meet Canada's foreseeable hydrographic requirements. Airborne Light Detection and Ranging (LIDAR) Bathymetric surveys are part of this multi-platform

approach. In a manner of efficiency, CHS - National has established a Supply Arrangement for as-and-when-required services to conduct Airborne Bathymetric LIDAR surveys throughout Canada and deliver fully processed and verified hydrographic survey data which will be used to update CHS nautical charts.

Over the last few years, CHS Atlantic has been using the service of some companies to aid in getting the work completed. Different experiences will be discussed here with some issues faced during data collection and analysis of processed data before the incorporation of nautical products. LiDAR techniques combined with multibeam data provide a successful way of surveying an area in an efficient manner.

Areas for future needs will be presented as well as possible ways of collaboration between partners in getting access to LiDAR data.

1400-1430 – Dr. Marc Skinner, Developing and Refining Remote Sensing Tools and Methodologies to Map and Quantitatively Monitor Eelgrass Beds

Dr. Marc Skinner is Stantec's Regional Marine Science Lead for eastern Canada and an Adjunct Professor with the Faculty of Graduate Studies at Dalhousie University will discuss developing and refining remote sensing tools and methodologies to map and quantitatively monitor eelgrass beds using satellite and acoustic remote sensing approaches using case studies from various regions.

1430-1500 - John Charles, Climate Change Adaptation Plans and Strategies in Halifax Regional Municipality

Climate change adaptation plans and strategies are being implemented within the context of Halifax Regional Municipality's 25-year Regional Municipal Planning Strategy. This land use planning strategy adopted in 2006 and revised in 2014 recognizes the consequences of climate change and the need for scientific research to inform a comprehensive precautionary and adaptive coastal planning approach to minimize negative impacts of rising sea level. In order to provide accurate flood limit mapping for the Halifax Harbour Plan project, Light Detecting and Ranging (LiDAR) data were acquired in 2007 to produce a high-resolution digital elevation model (DEM). The selection of flood levels for adaptation planning required an understanding of present and future sea-level rise (SLR), vertical land motion, extreme water levels (combined tide and surge), harbour seiche and wave runup. The resulting water levels were applied to the LiDAR DEM to visualise the extent and depth of flooding for a range of plausible events that could occur by the year 2100. These studies provide a scientific basis for a set of conceivable scenarios for a 100-year planning horizon.

This presentation will focus on the contributions that scientific study can make to the practice of land use planning and the development of land use policies and associated by-laws for adaptation to the challenges of climate change. It will also include some of the contributions this research project has made to the design of coastal infrastructure projects in HRM as well as current private developments taking place along the shores of Halifax Harbour.

1500-1515 – Break

1515-1545 – **Panel** on Drone (UAV) use for remote sensing in the coastal zone

- Dr. Adam Fenech, Tracking Coastal Erosion across Prince Edward Island
    - The UPEI Climate Lab is applying drone technology to tracking coastal erosion across Prince Edward Island. Two drones - the Precision Hawk Lancaster fixed wing, and the Quadcopter Iris - are being used to evaluate modes of coastal erosion monitoring against a vintage LiDAR dataset, a new Telodyne LiDAR Puck dataset flown from the Lancaster, a GPS coastal walk and coastal survey pins. Overall, the methods are being evaluated for their precision in creating a 3D Terrain map and an interactive visualization. Five graduate students are funded at UPEI to undertake this work.
- Robert Starkes, Oil Spill Preparedness and Response Planning in Tidal Inlets
    - Traditional aircraft (fixed wing and helicopters) are used extensively to support oil spill response operations and are proven critical assets. On the leading edge of augmenting these traditional aerial platforms, UAVs are poised as a new tool-in-the-toolbox for oil spill response. Current UAV technology has clear potential and application to effectively support field surveys and tactical operations. UAVs are a discussion topic for oil spill response organizations around the world. To date, ECRC has not used UAVs on an actual response, but have used them to support preparedness activities. In particular, we have contracted commercial UAVs to support response planning in tidal inlets. The quality of the imagery (both still and video) exceeded our expectations and provided key information to support on-site field activities.
- Dr. David K. Cairns, The *Phantom Vision* drone as a Mapping Tool for Aquatic Resource Management
    - Images obtained from a Phantom Vision drone (package price ca. $2,500) in an Irish moss bed in the Basin Head Marine Protected Area, Prince Edward Island, were ortho-rectified, stitched into mosaics, and geo-referenced into GIS layers to produce maps with a horizontal resolution of ca. 2 cm. Low-cost drones have broad potential to assist in aquatic resource mapping and conservation, provided that suitable image processing is applied.

1545-1630 – **Closing Panel**: Perspectives on using remote sensing in the coastal zone.

National perspectives

- Jacinthe Cormier, Canadian Hydrographic Service, Canada
- Jennifer Wozencraft, US Army Corp of Engineers, USA
- Jamie Carter, National Oceanic and Atmospheric Administration, USA

A Provincial perspective

- Reid McLean, Government of New Brunswick

Municipal perspective

- John Charles, Halifax Regional Municipality

1630-1700 – Next Steps - Wrap up

Featured Speaker Biographies

Jennifer Wozencraft

Director, Joint Airborne LiDAR Bathymetry Technical Center of Expertise
Program Manager, US Army Corp of Engineers' National Coastal Mapping Program

Jennifer Wozencraft is a Research Physical Scientist in the Coastal and Hydraulics Laboratory of the U.S. Army Corps of Engineers (USACE) Engineer Research and Development Center, and Director of the Joint Airborne LiDAR Bathymetry Technical Center of Expertise (JALBTCX). At the JALBTCX, she coordinates operations and research and development in airborne LiDAR bathymetry and complementary airborne technologies in support of USACE, Naval Oceanographic Office, National Oceanic and Atmospheric Administration, and U.S. Geological Survey. She also manages the USACE National Coastal Mapping Program, which provides regional scale, engineering-accuracy elevation, depth, and imagery data to support USACE regional sediment management, navigation, environmental restoration, regulatory enforcement, asset management and emergency response activities in the coastal zone. Ms. Wozencraft has worked in the field of airborne coastal mapping and charting for two decades and currently represents the USACE as co-chair of the Interagency Working Group on Ocean and Coastal Mapping. She earned her bachelor's degree from The University of Alabama in mathematics and dance, her master's in marine sciences from the University of South Alabama, and an International Hydrographic Organization Category "A" Certificate through the Hydrographic Science curriculum at The University of Southern Mississippi.

Jamie Carter

Sr. Remote Sensing Analyst, The Baldwin Group, Office for Coastal Management
National Oceanic and Atmospheric Administration

Jamie Carter is a remote sensing analyst with NOAA's Office for Coastal Management (OCM) and serves coastal communities primarily in the Northeast Region. He has a bachelor's degree in Ecology from Tulane University, a master's degree in Physical Geography from Oregon State University, and over 10 years of experience developing and delivering geospatial decision support tools to strengthen coastal management and planning. Jamie's core areas of technical expertise include lidar data analysis and digital image processing for topographic mapping, land cover mapping, and inundation mapping applications. He works closely with a variety of governmental and non-governmental organizations to bring geospatial technologies to bear upon coastal management issues.