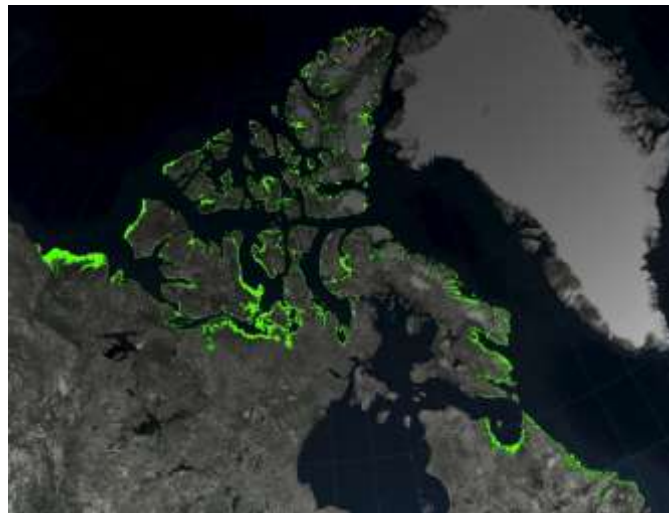


Satellite Derived Bathymetry is Coming of Age

by Jonathan Hendry, Project Coordinator

On a wet and dismal winter evening in Plymouth, we gathered for a presentation which spirited us away to the even bleaker remoteness of the Canadian Arctic, the location for research and contractual work being carried out by TCARTA to develop techniques for charting vast swathes of shallow Arctic coastal waters used satellite remote sensing methods alone.

Jonathan began by illustrating both the magnitude of the challenge and the strategic importance of finding an economic way of charting Canada's northern waters, driven by rapidly increasing maritime demands on access to the region as the ice recedes. By example, he cited sea freight through the NW Passage, of course, but also increased fishing, ocean research, mineral resource exploitation and tourism.



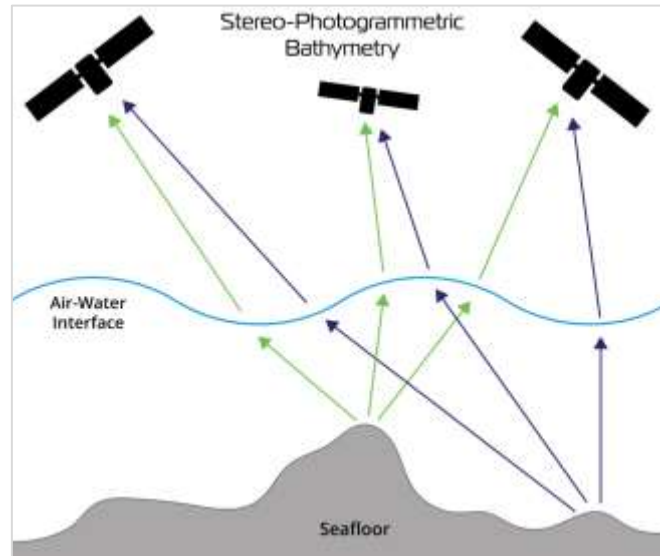
Approximately 40% of the world's coastline is Canadian

Remoteness is certainly the key word here and it is the crux of the challenge. While new waterways begin to open up along thousands of miles of coastline, there are virtually no harbours or airfields from which to base terrestrial survey operations thus making them prohibitively expensive. Remote sensing cannot yet be used to chart the deep water passage routes, but techniques TCARTA is developing do make charting of the shallower coastal waters possible. This, in turn, opens up access to bays which may be developed as harbours to support many of these new maritime activities, including surveys in deeper waters.

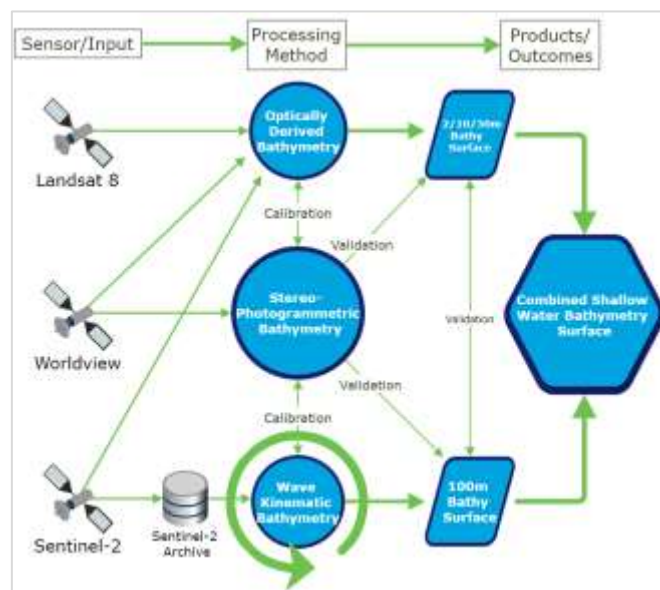
As became clear during the presentation, this is a key business driver for TCARTA, and the reason why governments with responsibility for the navigability of their EEZs are prepared to fund TCARTA's world-leading expertise. Jonathan explained that their hydrographic aim must be to provide data which meets international standards. Client acceptance of the quality of their deliverable (x, y, z and u) is therefore their principal challenge.

Satellite-Derived Bathymetry (SDB) in northern Canada has the advantage of large area coverage and, generally, clear water conditions when imagery is available. However, environmental conditions, coastal sea ice, low sun angles and other difficulties such as degraded geoidal models and remote tidal information, coupled with the fact that there is very little existing ground truth data against which to verify results, present many obstacles to be overcome.

Apart from direct Landsat-8 and Sentinel-2 SDB (height/depth relative to the geoid), TCARTA also use high resolution Worldview satellite data. Overlapping (optimally, eight) images which, with appropriate angle of incidence (AOI) corrections, allows height/depth determination of identified seabed objects and thus photogrammetric registration of the images to derive satellite photogrammetric bathymetry (SPB). This they have compared with LiDAR to 30m depths and shown it to be accurate to about $\pm 4.66\%$ of water depth, consistently more reliable than direct SDB alone.



However, early SPB was very resource-hungry in terms of man-hours. Consequently, TCARTA has gone a lot further in developing algorithms to 'teach' image scanning computers to automatically select identifiable seabed targets, and to register and correctly geo-reference satellite imagery for photogrammetric mapping of the seabed. Going further still, in a jointly-funded research project focussing again on the potential of machine learning, TCARTA is involved in what they describe as a multi-modal approach. This looks to combine the advantages of Sentinel-2 and Worldview satellite systems with a third process, using Sentinel-2 imagery to observe sea wave kinematic effects where such parameters as wave refraction can be used to help derive seabed contours.



We thank Jonathan for his excellent presentation which illustrated many interesting examples of how well this is all progressing, opening our eyes to the economic benefits of using the approach in other areas of the world and leading to a lively group discussion. The full presentation can be found at www.ths.org.uk [Downloads](#).