Digital Elevation Model of Barkley Sound, Canada: Procedures, Data Sources, and Analysis

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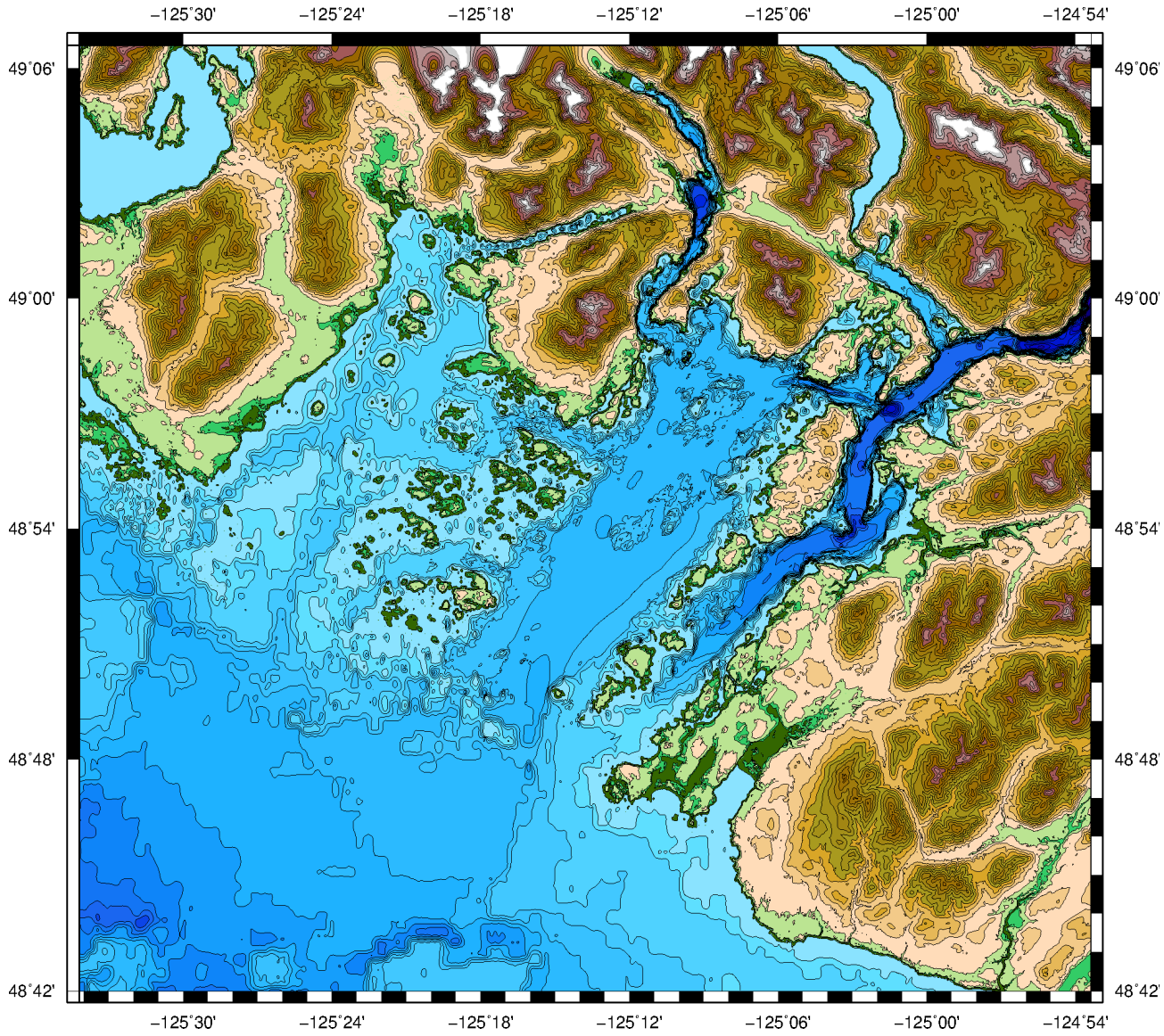
Summary

In December of 2015, NOAA's National Centers for Environmental Information (NCEI) developed a topographic-bathymetric digital elevation model (DEM) of Barkley Sound, Canada (Figure 1) for the National Tsunami Hazards Mitigation Project (NTHMP). The 1 arc-second DEM will be used to support improving the coastal tsunami inundation forecasts, storm surge modeling, community preparedness and hazard mitigation. This DEM covers the coastal area of Barkley Sound, Canada. The extents of this DEM, procedures, data sources, and analysis are described below.

Figure 1. Barkley Sound, Canada Digital Elevation Model



DEM Specifications

The Barkley Sound DEM was built to the specifications listed in Table 1. Figure 2 shows the 1 arc-second boundary in red.

Table 1. Specifications for the Barkley Sound, Canada DEM.

Grid Area	Barkley Sound, Canada
Coverage Area	-125.57° to -124.74° W, 48.7° to 49.11° N
Coordinate System	Geographic decimal degrees
Horizontal Datum	World Geodetic System 1984 (WGS 84)
Vertical Datum	Canadian Geographic Vertical Datum of 2013 (CGVD2013) & North American Vertical Datum of 1988 (NAVD88)
Vertical Units	Meters
Cell Size	1 arc-seconds
Grid Format	ASCII raster grid

Figure 2. Map image of the DEM boundary for the Barkley Sound, Canada DEM in red.

Data Sources and Processing

The digital coastline used in developing the Barkley Sound DEM was generated by editing the Global Self-consistent, Hierarchical, High-resolution Geography Database (GSHHG) shoreline based on the Google satellite imagery layer. The digital coastline was converted into a polygon for use in masking topography and eliminating interpolated data.

Bathymetric data (Fig. 3) used in the compilation of the Barkley Sound DEM included sounding data from the Canadian Hydrographic Survey (CHS) as well as completed datasets from NCEI (Table 2).

Topographic data (Fig. 4) used in the compilation of the Barkley Sound DEM included high-resolution topographic data from GeoBC and the Canadian Digital Surface Model (CDSM) from National Resources Canada (NRC).

Table 2: Bathymetric and Topographic Data Sources used in compiling the Barkley Sound DEM.

Source/Title	Date	Data Type	Resolution	Horizontal Datum	Vertical Datum
GeoBC	2013	Topographic Lidar	~ 1 meter	WGS84 Geographic	CGVD
CHS Multibeam	2001	Bathymetric Lidar	~ 1 meter	WGS84 Geographic	Chart Datum (CD)
ENC	2014	Bathymetric Survey Soundings	1 – 10 meter	WGS84 Geographic	CD
BC Bathy	2011	Bathymetric Surface	50 meter	WGS84 Geographic	CD
CDSM	2011	Topographic Surface	30 meter	WGS84 Geographic	CGVD

The bathymetric data were transformed from their original datums to a horizontal datum of WGS 84 and a vertical datum CGVD2013 prior to DEM development using a vertical transformation offsets provided by CHS benchmarks (Table 3). Topographic data were transformed from their original horizontal datums to a horizontal datum of WGS 84. All topographic data originated in CGVD2013 prior to development, so no added vertical transformations were needed.

Table 3: CHS Benchmark M09C9019 (Port Alberni, B.C.).

Datum Name	Elevation (meters)	Offset to CGVD2013
CD	29.288	-1.826
CGVD28(HTv2)2010	27.245	.217
NAD83(CSRS)2010	9.473	17.989
CGVD2013	27.462*	0

* result calculated using the GPS-H tool provided by the Canadian Geodetic Survey.

Figure 3. Bathymetric data sources used in the Barkley Sound, Canada DEM.

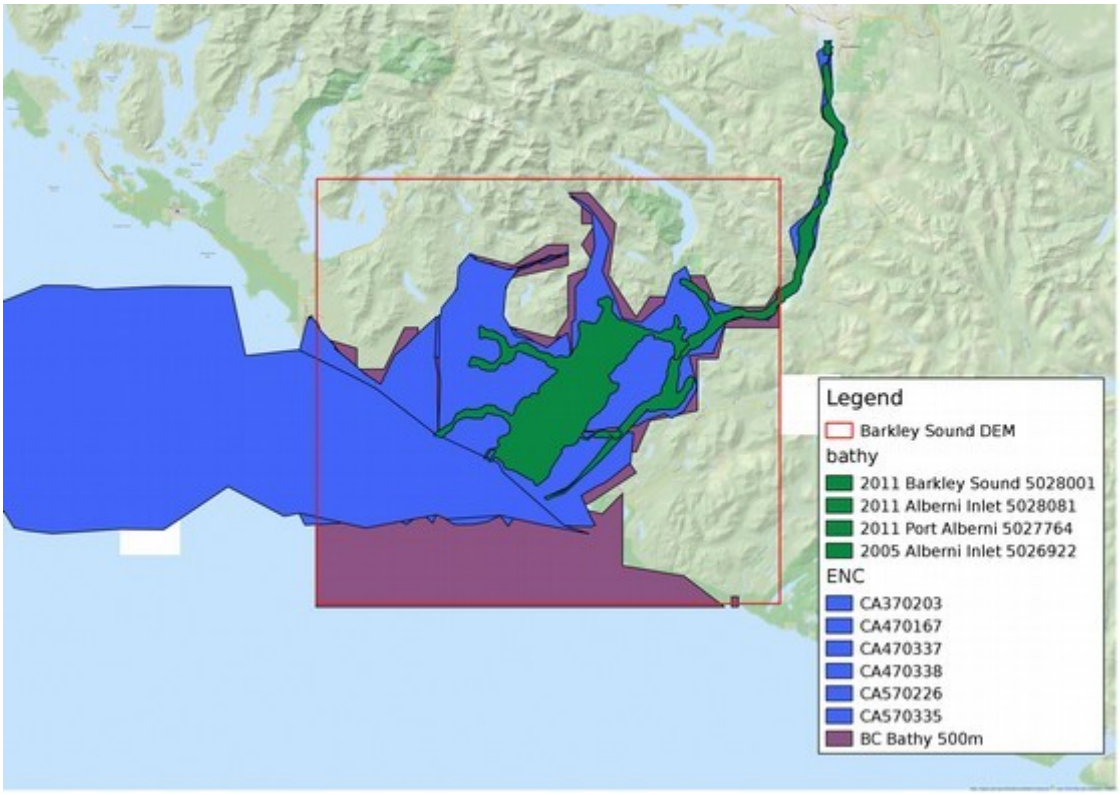
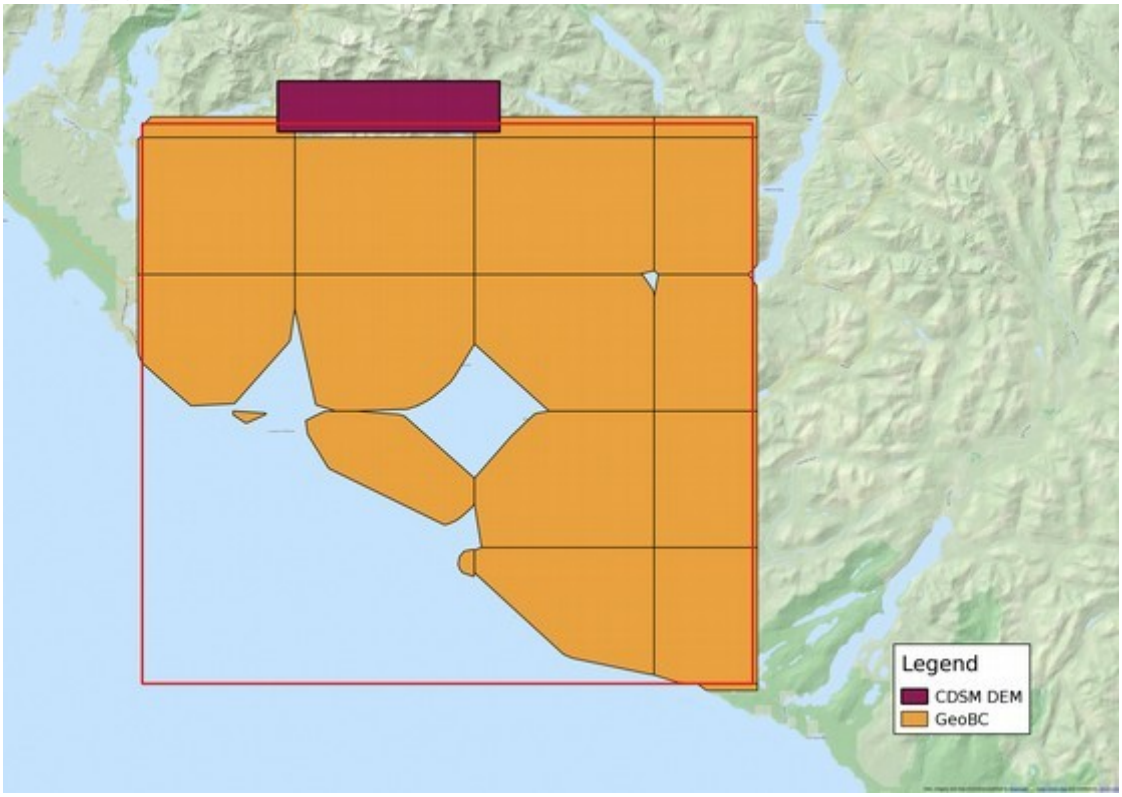


Figure 4. Topographic data sources used in the Port Alberni, Canada DEM.



DEM Development

After the bathymetric data were transformed to common horizontal and vertical datums, they were visually reviewed for consistency and errors. Where more recent, higher resolution bathymetric data existed, older data were superseded. The edited and evaluated bathymetric data were then converted to ASCII xyz format using GDAL then gridded at 1 arc-second using Generic Mapping Tools (GMT). The GMT 'surface' tool was used to generate a bathymetric surface which provided full data coverage of the DEM area. The surface was then clipped using the digital coastline to create the final bathymetric DEM. The final bathymetric DEM was then converted to ASCII xyz format for use as input in generating the final DEM.

After the topographic data were transformed to common horizontal datums, the areas of overlap were visually reviewed for consistency and errors. Upon inspection the GeoBC topographic data were further processed to remove all erroneous data points which were located over water bodies using custom lidar processing tools.

MB-System was used to create the final 1 arc-second Barkley Sound DEM. MB-System is an NSF-funded open source software application specifically designed to manipulate submarine multibeam sonar data, though it can utilize a wide variety of data types, including generic xyz data. The MB-System tool 'mbgrid' was used to apply a tight spline tension to the xyz data, and interpolate values for cells without data. The data hierarchy used in the 'mbgrid' gridding algorithm, as relative gridding weights, is listed in Table 4. The resulting binary grid was converted to an Arc ASCII grid using the GMT tool 'grdreformat' to create the final 1 arc-second Barkley Sound CGVD2013 DEM.

Table 4: Data hierarchy used to assign gridding weight in MB-System

Data-set	Relative Gridding Weight
CHS Multibeam	100
Bathymetric Surface	10
GeoBC	1
ENC	.1

Generating NAVD88 DEM

The Barkley Sound 1 arc-second NAVD88 DEM was generated using constant offsets provided by CHS benchmarks (Table 3) and transformation parameters provided by NOAAs VDatum software. The final CGVD2013 DEM was transformed to a NAD83 Ellipsoidal datum using a constant offset. The NAD83 Ellipsoidal DEM was then transformed to NAVD88 using VDatum software.

Recommendations

Recommendations to improve the Barkley Sound, Canada 1 arc-second DEM are listed below:

- Conduct bathymetric lidar surveys of near-shore coastal areas.
- Conduct high-resolution bathymetric surveys in the deep water areas off the coast.

Acknowledgments

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References

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