Digital Elevation Models of Gustavus and Hoonah, Alaska: Procedures, Data Sources, and Analysis

Carignan, K.S.[1], L.A. Taylor[2], B.W. Eakins[1], and M. Love[1]

[1]Cooperative Institute for Research in Environmental Sciences, University of Colorado at Boulder
[2]NOAA, National Geophysical Data Center, Boulder, Colorado

Summary

In September of 2012, NOAA's National Geophysical Data Center (NGDC) developed integrated bathymetric–topographic digital elevation models (DEM) of Gustavus and Hoonah, Alaska for the Geophysical Institute at the University of Alaska at Fairbanks (UAF). The 8/15 arc-second DEMs will be used to support the university-developed modeling system to simulate tsunami generation, propagation, and inundation. These DEMs cover the area immediately surrounding the communities of Gustavus and Hoonah. The extents of these DEMs, procedures, data sources, and analysis are described below. The methodologies used by NGDC in developing DEMs are described in report for Chenega Bay, Alaska (Caldwell et al., 2012).

DEM Specifications

The Gustavus and Hoonah DEMs were built to the specifications listed in Tables 1a and 1b. Figure 1 shows the 8/15 arc-second Gustavus DEM boundary in red and the 8/15 arc-second Hoonah DEM boundary in blue.

Table 1a. Specifications for the Gustavus, Alaska DEM.

Grid Area	Gustavus, Alaska
Coverage Area	135.54° to 135.97° W, 58.33° to 58.49° N
Coordinate System	Geographic decimal degrees
Horizontal Datum	World Geodetic System 1984 (WGS 84)
Vertical Datum	Mean Higher High Water (MHHW)
Vertical Units	Meters
Cell Size	8/15 arc-seconds
Grid Format	ASCII raster grid

Table 1b. Specifications for the Hoonah, Alaska DEM.

Grid Area	Hoonah, Alaska
Coverage Area	135.38° to 135.51° W, 58.07° to 58.17° N
Coordinate System	Geographic decimal degrees
Horizontal Datum	World Geodetic System 1984 (WGS 84)
Vertical Datum	Mean Higher High Water (MHHW)
Vertical Units	Meters
Cell Size	8/15 arc-seconds
Grid Format	ASCII raster grid
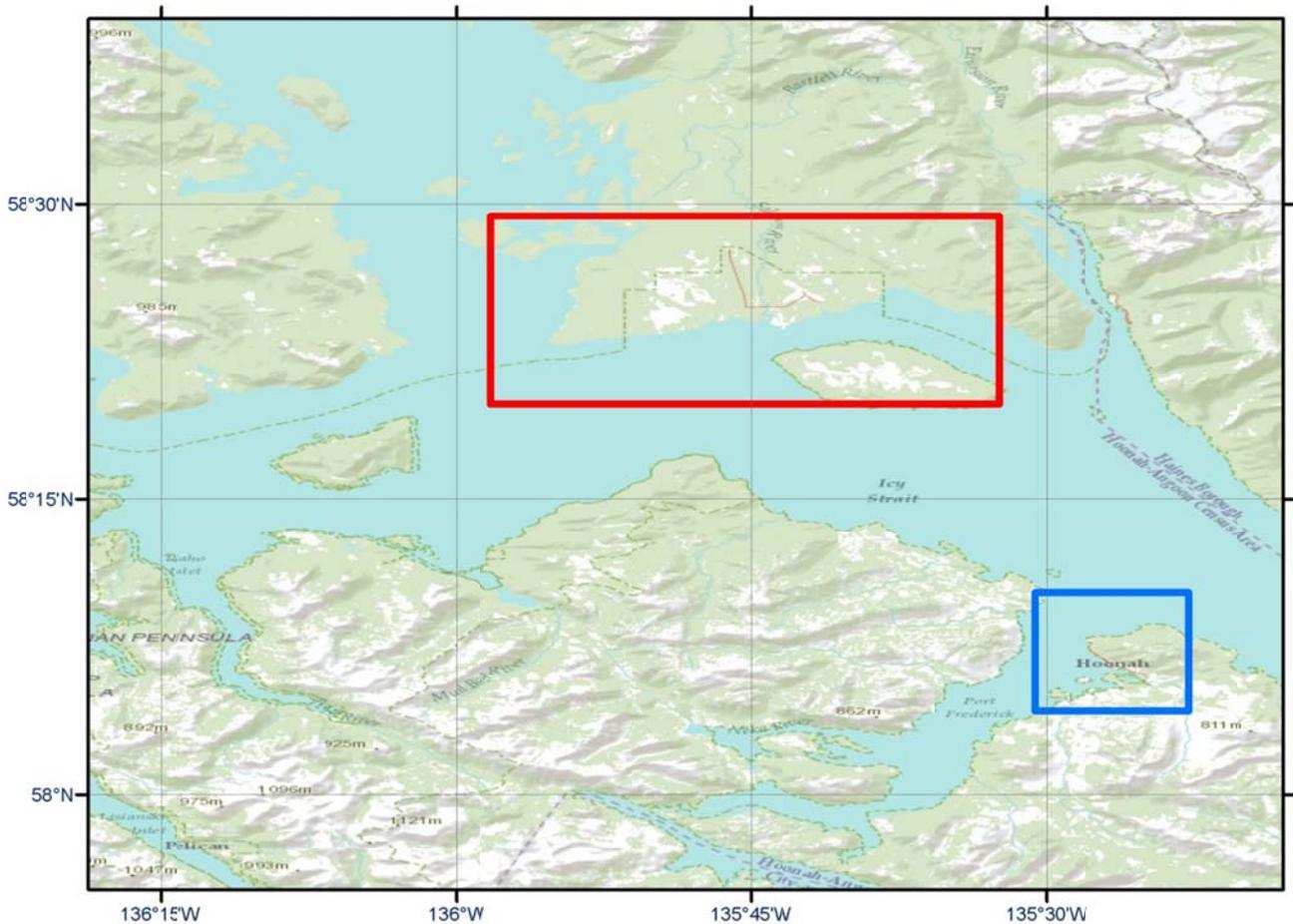
Figure 1. Map image of the DEM boundaries for the Gustavus DEM, in red and the Hoonah DEM in blue.

Data Sources and Processing

The digital coastline developed by NGDC for use in the Gustavus and Hoonah DEMs was derived from NOAA Electronic Navigational Chart (ENC) #17302 and 17318 then edited based on high resolution imagery and U.S. Army Corps of Engineers (USACE) harbor survey drawings. The high resolution imagery is available as a web map service from Alaska Mapped (http://www.alaskamapped.org/).

Bathymetry data used in the compilation of the Gustavus and Hoonah DEMs included NOS hydrographic surveys, NOAA Electronic Navigational Chart (ENC) soundings, USACE harbor survey, and NGDC multibeam survey data (Tables 2-4). ENC sounding data were extracted from NOAA's Office of Coast Survey (OCS) ENC Direct to GIS online extraction service (http://nauticalcharts.noaa.gov/csdl/ctp/encdirect_new.htm). The USACE Alaska District provided NGDC with hydrographic condition survey data for Hoonah small boat harbor. In deeper water, NGDC downloaded and gridded at 1 arc-second the multibeam swath sonar data from a 2004 Lamont Doherty Earth Observatory (LDEO) survey EW0408.

Table 2: Bathymetric data sources used in compiling the Unalaska DEM.

Source	Date	Data Type	Spatial Resolution	Horizontal Datum	Vertical Datum
NOAA NOS	1939 to 2004	Hydrographic survey soundings	< 10 meters to several kilometers	Unknown, NAD 27 or NAD 83 geographic, or NAD 83 UTM Zone 8 North	Mean Lower Low Water (MLLW)
NOAA OCS	2012	Extracted chart soundings	50 to ~700 meters	WGS 84 geographic	MLLW
USACE	2010	Hydrographic condition survey	1 meter	NAD 27 Alaska State Plane Zone 1 (feet)	MLLW
NGDC multibeam	2004	Multibeam swath sonar	Gridded to 1 arc-second	NAD 83 geographic	Assumed Mean Sea Level (MSL)

Table 3: NOS hydrographic surveys

Survey ID	Date	Original Horizontal Datum	Original Vertical Datum	Scale
H11358	2004	NAD 83 UTM Zone 8 North	MLLW	10,000
F00451	1999	NAD 83 UTM Zone 8 North	MLLW	10,000
H10883	1999	NAD 83	MLLW	10,000
H10318	1990	NAD 83	MLLW	10,000
H10319	1990	NAD 83	MLLW	20,000
H10333	1990	NAD 83	MLLW	10,000
H10334	1990	NAD 83	MLLW	20,000
F00339	1989	NAD 83	MLLW	10,000
H10258	1988	NAD 27	MLLW	10,000
H10268	1988	NAD 83	MLLW	10,000
H10271	1988	NAD 83	MLLW	10,000
H10257	1987	NAD 27	MLLW	10,000
H10231	1986	NAD 27	MLLW	20,000
H09990	1982	NAD 27	MLLW	10,000
H10010	1982	NAD 27	MLLW	10,000
H09990	1981	NAD 27	MLLW	10,000
H09987	1981	NAD 27	MLLW	10,000
H09847	1979	NAD 27	MLLW	20,000
H09848	1979	NAD 27	MLLW	20,000
H09638	1976	NAD 27	MLLW	5,000
H08815	1964	NAD 27	MLLW	10,000
H08816	1964	NAD 27	MLLW	20,000
H06855	1943	Unknown	MLLW	5,000
H06457	1939	Unknown	MLLW	20,000

Bathymetric data were transformed to WGS 84 and MHHW as needed and where more recent, higher resolution data existed, older data were edited. Vertical datum transformations were based on the NOAA tide station located in Hoonah #9452438 (Table 5).

Table 5: Relationship between MHHW and other vertical datums at the Hoonah, Port Fredrick, AK tide station.

Vertical Datum	Difference to MHHW (meters)
MHHW	0.000
MHW	-0.284
MTW	-2.196
MSL	-2.172
MLW	-4.108
MLLW	-4.594

Topographic data used in developing the Gustavus and Hoonah DEMs were provided by the State of Alaska, Division of Community and Regional Affairs (DCRA), UAF, and NASA (Table 6). NASA's SRTM topographic DEM data were downloaded and provided full coverage of the DEM regions. UAF provided GPS data of a selection of points in Gustavus and Hoonah, particularly near the harbors and docks. This was the most recent data available. Topographic survey data from DCRA were also available for the town of Gustavus. NGDC digitized additional points based on USACE project drawings for the harbor in Hoonah as the jetties were not resolved in any of the other topographic data. Additional elevation points were digitized for small sections along the coastline where the SRTM data did not extend to the coastline using elevation information from IKONOS Satellite derived DEM for Glacier Bay National Park and Preserve (GLBA). Elevation points were also digitized for new shoreline features, or where smaller features were not resolved in the 1 second SRTM DEM. Elevation points for the Hoonah airstrip were digitized using elevation information from www.airnav.com.

Table 6: Topographic data sources used in compiling the Unalaska DEM.

Source	Date	Data Type	Spatial Resolution	Horizontal Datum	Vertical Datum
DCRA	2011	DTM points	Varies from < 5 meters to 30 meters	NAD 83 Alaska State Plane Zone 1 (feet)	Assumed MSL
UAF	2012	GPS elevation points		WGS 84 geographic	MHHW
SRTM vers.2	2000	Topographic DEM	1 arc second	WGS 84 geographic	Assumed MSL
NGDC	2012	Digitized elevation points	< 5 meters	WGS 84 geographic	MHHW

DEM Development

Development of the Gustavus and Hoonah DEMs followed procedures documented in NOAA Technical Memorandum NGDC-56 for Chenega Bay, Alaska (Caldwell et al., 2012). Exceptions being the bathymetric pre-surface was generated at 1/3 arc-second and data gridding weight is listed in Table 7.

Table 7: Data hierarchy used to assign gridding weight in MB-System.

Dataset	Relative Gridding Weight
UAF GPS points	1000
NGDC digitized elevations	1000
USACE hydrographic condition survey	100
SRTM topographic DEM	100
NOS surveys	10
Extracted ENC soundings	1
DCRA topographic points	1
Bathymetric pre-surface	1
Coastline	0.1
NGDC multibeam swath sonar	0.1

DEM Analysis

Once the DEMs were generated, the grids were compared to UAF GPS points and high resolution imagery and the three NGA monuments available for this area. Inconsistencies were evaluated and resolved based on most reliable data available before re-gridding.

Reference

Caldwell, R.J., L.A. Taylor, B.W. Eakins, K.S. Carignan (2012). Digital Elevation Model of Chenega Bay, Alaska: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-56, NOAA, pp. 26.