

Digital Elevation Model of Unalaska, Alaska: Procedures, Data Sources, and Analysis

Prepared for the University of Alaska at Fairbanks (UAF) by the NOAA National Geophysical Data Center (NGDC)

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Summary

In October of 2012, NOAA's National Geophysical Data Center (NGDC) developed an integrated bathymetric–topographic digital elevation model (DEM) of Unalaska, Alaska for the Geophysical Institute at the University of Alaska at Fairbanks (UAF). The 8/15 arc-second DEM will be used to support the university-developed modeling system to simulate tsunami generation, propagation, and inundation. This DEM updates previously developed Dutch Harbor DEM for the area immediately surrounding the communities of Unalaska and Dutch Harbor. The extents of the Unalaska DEM, procedures, data sources, and analysis are described below. The methodologies used by NGDC in developing DEMs are described in the NOAA Technical Memorandum NESDIS NGDC-4 of Dutch Harbor (Taylor et al., 2008).

DEM Specifications

The Unalaska DEM was built to the specifications listed in Table 1. Figure 1 shows the 1 arc-second Dutch Harbor DEM boundary in green and the higher resolution 8/15 arc-second Unalaska DEM boundary in red.

Table 1. Specifications for the Unalaska, Alaska DEM.

Grid Area	Unalaska, Alaska
Coverage Area	166.42° to 166.66° W, 53.80° to 53.94° 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

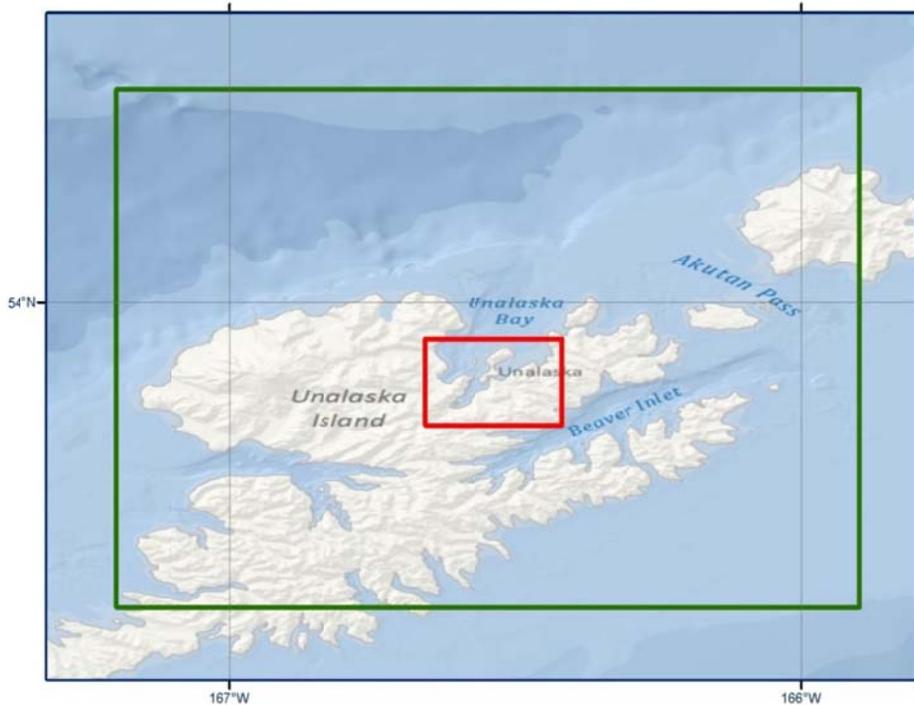


Figure 1. Map image of the DEM boundaries for the Dutch Harbor DEM, in green and the Unalaska DEM in red.

Data Sources and Processing

The digital coastline developed by NGDC for use in the Dutch Harbor DEM was retrieved from archive and edited based on high resolution imagery, U.S. Army Corps of Engineers (USACE) harbor survey drawings, and topographic contour data from the City of Unalaska. 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 Unalaska DEM included NOS hydrographic surveys, NOAA Electronic Navigational Chart (ENC) soundings, USACE harbor survey, and NGDC multibeam survey data (Table 2-4). NGDC used the previously reviewed and corrected NOS hydrographic survey data from the Dutch Harbor DEM (Table 3). Refer to the technical memorandum for processing details. 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 a recently developed small boat harbor in the South Channel of Iliuliuk Bay, Unalaska. In deeper water, NGDC downloaded and gridded at 1 arc-second the multibeam swath sonar data from NGDC's multibeam database (Table 4).

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

<i>Source</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
NOAA NOS	1934 to 1991	Hydrographic survey soundings	< 10 meters to several kilometers	Early Alaska Datums or NAD 83 geographic	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 83 Alaska State Plane 10 (feet)	MLLW
NGDC multibeam	2002 to 2010	Multibeam swath sonar	Gridded to 1 arc-second	NAD 83 geographic	Assumed Mean Sea Level (MSL)

Table 3: NOS hydrographic surveys

<i>Survey ID</i>	<i>Date</i>	<i>Original Horizontal Datum</i>	<i>Original Vertical Datum</i>	<i>Scale</i>
H05684	1934	Early Alaska Datums	MLLW	5,000
H05737	1935	Early Alaska Datums	MLLW	20,000
H05973	1935	Early Alaska Datums	MLLW	40,000
H05977	1935	Early Alaska Datums	MLLW	20,000
H05978	1935	Early Alaska Datums	MLLW	20,000
H05979	1935	Early Alaska Datums	MLLW	20,000
H05980	1935	Early Alaska Datums	MLLW	5,000
H05981	1935	Early Alaska Datums	MLLW	5,000
H06233	1937	Early Alaska Datums	MLLW	40,000
H06234	1937	Early Alaska Datums	MLLW	20,000
H10389	1991	NAD 83	MLLW	5,000
H10391	1991	NAD 83	MLLW	5,000

Table 4: NGDC Multibeam swath sonar surveys

<i>Survey ID</i>	<i>Date</i>	<i>Ship</i>	<i>Source</i>
HLY0203	2002	Healy	Rolling Deck to Repository (R2R) Program
HLY0503	2005	Healy	Rolling Deck to Repository (R2R) Program
HLY06TE	2006	Healy	Rolling Deck to Repository (R2R) Program
HLY0601	2006	Healy	Rolling Deck to Repository (R2R) Program
HLY07TC	2007	Healy	Rolling Deck to Repository (R2R) Program
HLY07TD	2007	Healy	Rolling Deck to Repository (R2R) Program
HLY0701	2007	Healy	Rolling Deck to Repository (R2R) Program
HLY0702	2007	Healy	Rolling Deck to Repository (R2R) Program
HLY08TD	2008	Healy	Rolling Deck to Repository (R2R) Program
HLY08TG	2008	Healy	Rolling Deck to Repository (R2R) Program
HLY08TH	2008	Healy	Rolling Deck to Repository (R2R) Program
HLY0801	2008	Healy	Rolling Deck to Repository (R2R) Program

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 Unalaska, Dutch Harbor #9462620 (Table 5). As no documented information was found, elevation

points for Unalaska Lake were digitized and assigned a value of -0.1 meters based on GPS points provided by UAF.

Table 5: Relationship between MHHW and other vertical datums in the Unalaska region.

<i>Vertical Datum</i>	<i>Difference to MHHW (meters)</i>
MHHW	0.000
MHW	0.087
MTW	0.451
MSL	0.463
MLW	0.815
MLLW	1.098

Topographic data used in developing the Dutch Harbor DEM were not used in the Unalaska DEM. Table 6 lists the updated datasets for the Unalaska DEM. The SRTM topographic DEM were downloaded and provided full coverage of the Unalaska region. Closer to the communities of Dutch Harbor and Unalaska, more accurate GPS points taken by UAF and contour data from the City of Unalaska was used. NGDC digitized additional points based on USACE project drawings as a recently developed small boat harbor in the South Channel of Iliuliuk Bay was not resolved in any of these data. SRTM point elevation values located at the Unalaska airstrip were corrected based on elevation information from www.airnav.com.

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

<i>Source</i>	<i>Date</i>	<i>Data Type</i>	<i>Spatial Resolution</i>	<i>Horizontal Datum</i>	<i>Vertical Datum</i>
City of Unalaska	2008	Vector contours	10 foot contour interval	NAD 83 Alaska State Plane Zone 10 (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 breakwater points		WGS 84 geographic	MHHW

DEM Development

Development of the Unalaska DEM followed procedures documented in NOAA Technical Memorandum NGDC-4 for Dutch Harbor (Taylor et al., 2008). Exceptions being the bathymetric pre-surface was generated at 1/3 arc-second as higher resolution data was available close to the communities, gridding weight was modified to Table 7.

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

<i>Dataset</i>	<i>Relative Gridding Weight</i>
NGDC digitized breakwater	1000
UAF GPS points	100
USACE hydrographic condition survey	100
NOS surveys	10
Extracted ENC soundings	10
City of Unalaska topographic contours	10
NGDC digitized lake elevations	1
SRTM topographic DEM	.1
Coastline	.1
NGDC multibeam swath sonar	.1
Bathymetric pre-surface	.1

DEM Analysis

Once the Unalaska DEM was generated, the grid was compared to the contour data, GPS points and high resolution imagery as no NGA monuments are available for this area. Inconsistencies were evaluated and resolved based on most reliable data available.

Reference

L.A. Taylor, B.W. Eakins, K.S. Carignan, R.R. Warnken, D.C. Schoolcraft, T. Sazonova, G.F. Sharman (2008)
Digital Elevation Model of Dutch Harbor, Alaska: Procedures, Data Sources and Analysis
NOAA Technical Memorandum NESDIS NGDC-4, NOAA, pp. 25.