Digital Elevation Models of Chignik, Perryville, and Ivanof Bay, Alaska: Procedures, Data Sources, and Analysis

Prepared for the National Tsunami Hazard Mitigation Program (NTHMP) and the University of Alaska at Fairbanks (UAF) by the NOAA National Geophysical Data Center (NGDC)
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Summary

In February of 2014, NOAA's National Geophysical Data Center (NGDC) developed integrated bathymetric–topographic digital elevation models (DEMs) of Chignik, Perryville, and Ivanof Bay, Alaska for the National Tsunami Hazard Mitigation Program (NTHMP) and for the Geophysical Institute at the University of Alaska, Fairbanks (UAF). The nested DEMs will be used to support modeling tsunami generation, propagation, and inundation. The DEMs cover the western portion of the Alaska Peninsula in the Lake and Peninsula Borough on the Gulf of Alaska and update much of the area covered in the Chignik DEMs developed by NGDC in 2008. The communities are located within 100 km of each other and in 2010 had a combined population of less than 300 ("Community Database Online" June 07, 2012). Extents of these DEMs, procedures, data sources, and analysis are described below. The methodologies used by NGDC in developing nested DEMs are described in the NOAA Technical Memorandum-40 for Prince William Sound, Alaska (Caldwell et al., 2011).

DEM Specifications

The Chignik DEMs were built to the specifications listed in Table 1. Figure 1 shows the 1 arc-second Chignik DEM boundary in red and 1/3 arc-second Chignik and Perryville/Ivanof Bay DEM boundaries in green.

Table 1. Specifications for the nested Chignik, Alaska DEMs.

	Coverage	
Cell Size	Chignik, Alaska	Perryville and Ivanof Bay, Alaska
1/3 arc-second	158.34° to 158.58° W, 56.28° to 56.36° N	159.00° to 159.58° W, 55.70° to 56.00° N
1 arc-second	157.98° to 159.58° W, 55.52° to 56.44° N	
Coordinate System	Geographic decimal degrees	
Horizontal Datum	World Geodetic System 1984 (WGS 84)	
Vertical Datum	Mean Higher High Water (MHHW)	
Vertical Units	Meters	
Grid Format	ASCII raster grid	

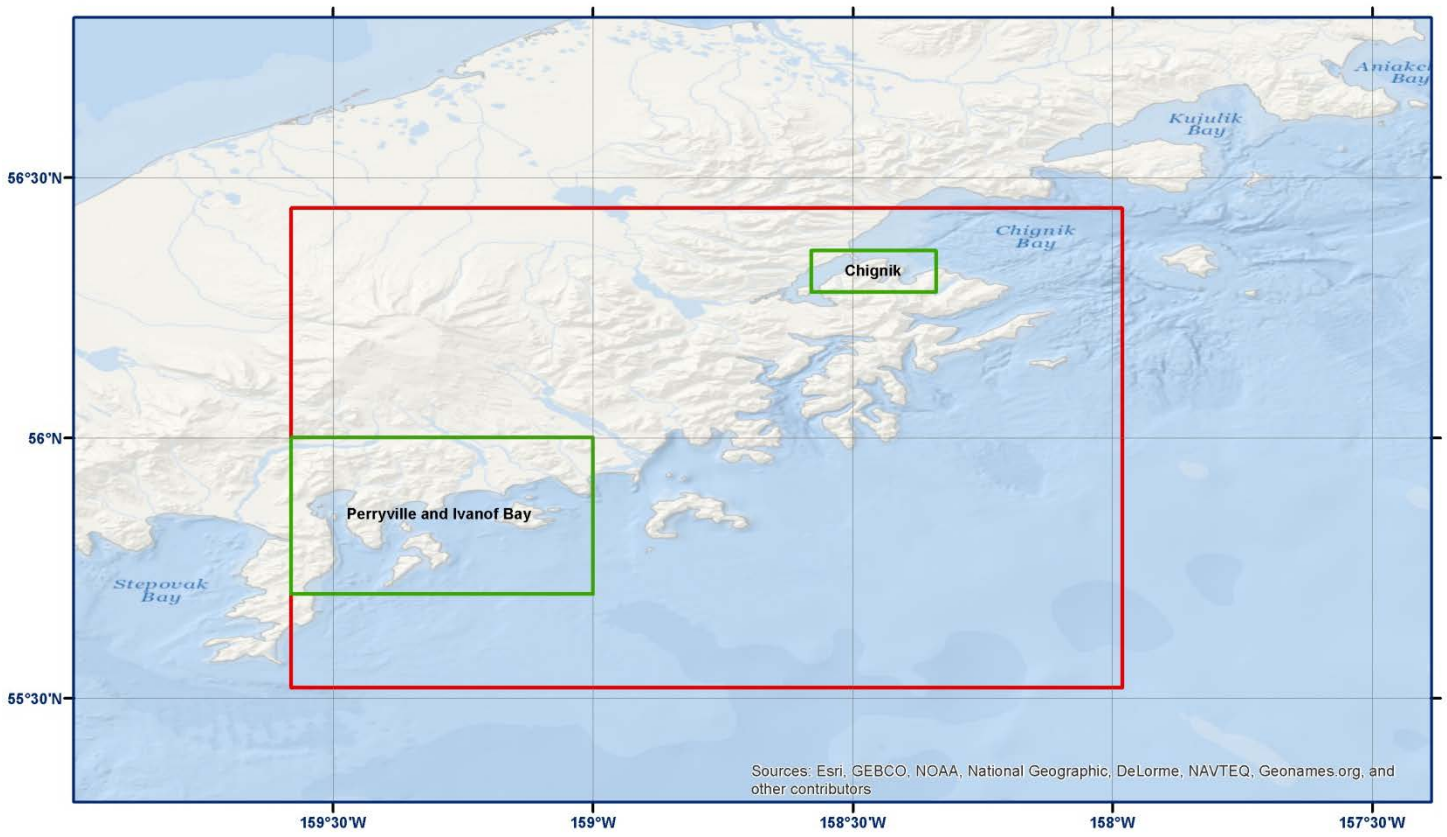

Figure 1. Map image of the boundaries for the 1/3 arc-second nested DEMs in green and the 1 arc-second Chignik DEM in red.

Data Sources and Processing

Digital coastlines 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 coastlines were merged and edited to match ESRI's World Imagery map service (http://www.arcgis.com/features/maps/imagery.html), and topographic data. Figure 2 shows the source and coverage of the datasets used in developing the Chignik DEMs.

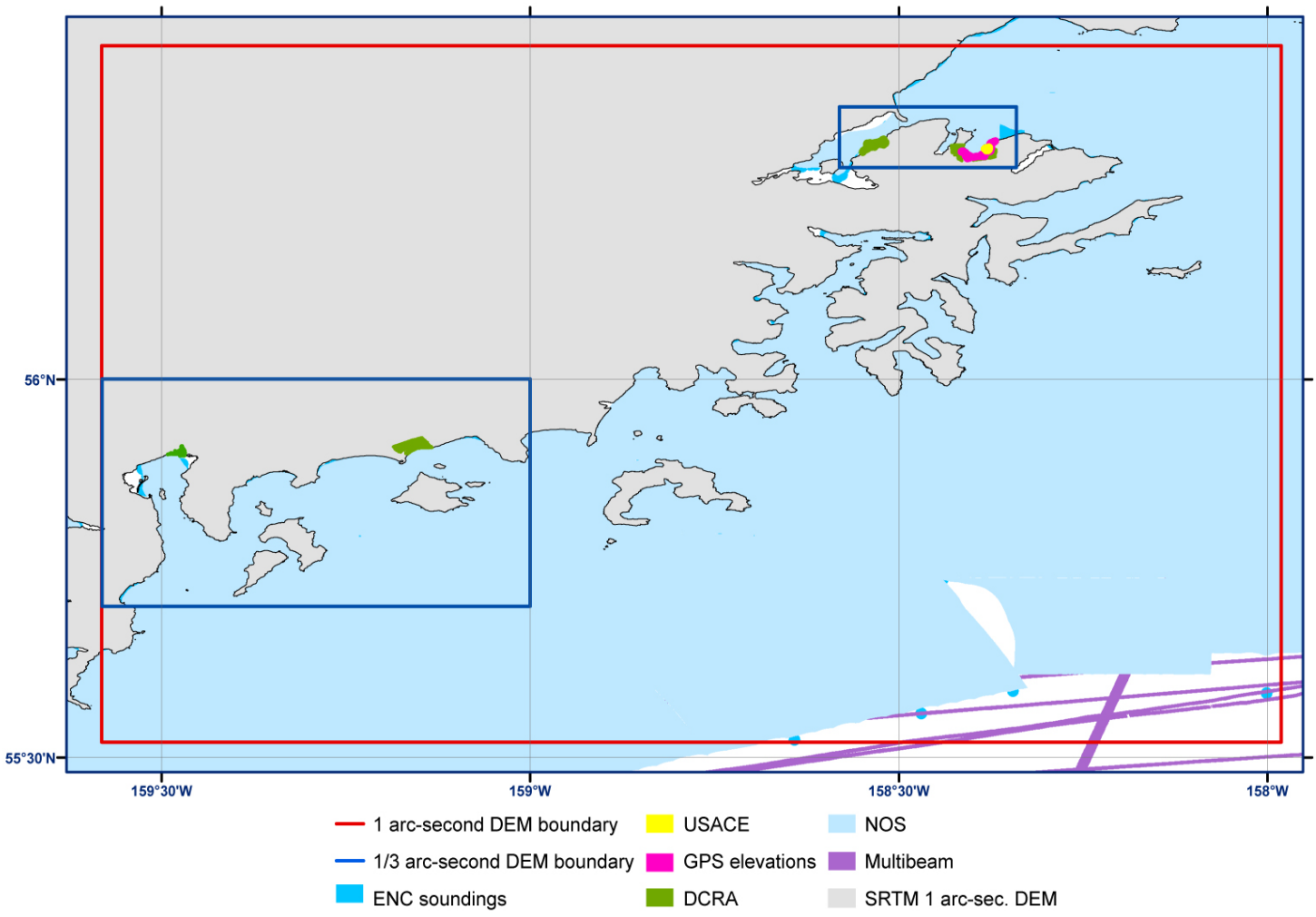

Figure 2. Source and coverage of the datasets used in compiling the Chignik DEMs.

Table 2 lists the bathymetry data used in the compilation of the Chignik DEMs including NOS hydrographic surveys (Appendix A), NOAA Electronic Navigational Chart (ENC) soundings, USACE harbor survey, and NGDC multibeam survey data (Appendix B). 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 Chignik Harbor. NOS hydrographic survey data were downloaded from NGDC. Multibeam surveys were downloaded from NGDC as 1 arc-second gridded data and converted to point data. The multibeam data was edited in *QT Modeler* removing overlapping data and eliminating errors in data collection.

Table 2: Bathymetric data sources used in compiling the Chignik DEMs.

Source	*Date*	*Data Type*	*Spatial Resolution*	*Horizontal Datum*	*Vertical Datum*
NOAA NOS	1915 to 2006	Hydrographic survey soundings	1 meter to several kilometers	Unknown, Early Alaska Datums, NAD 1927, NAD 83, or NAD 83 UTM Zone 4	Mean Lower Low Water (MLLW)
NOAA OCS	2004 to 2012	Extracted chart soundings	1:38,730 and 1:1,023,188	WGS 84 geographic	MLLW
USACE	2010	Hydrographic condition survey	6 meters	NAD 83 AK State Plane Zone 6 (feet)	MLLW
NGDC multibeam	2008 to 2011	Multibeam swath sonar	Gridded to 1 arc-second	NAD 83 geographic	Assumed Mean Sea Level (MSL)

Bathymetric data were transformed to WGS 84 and MHHW as needed and where recent, higher resolution data exists, older data were deleted. NOS hydrographic survey H11064 was filtered to remove suspect elevations. Vertical datum transformations were based on the average differences of vertical datums at three NOAA tide stations (Table 3) because the time period for the Chignik station was only one month.

Table 3: Relationship between MHHW and other vertical datums at regional tide gauges.

	Difference to MHHW (meters)			
Vertical Datum	**Chignik #9458917**	**Alitak #9457804**	**Sand Point #9459450**	**Avg. Diffs**
MHHW	0	0	0	0
MHW	0.245	0.245	0.216	0.235
MTL	1.263	1.661	1.007	1.310
MSL	1.29	1.685	1.023	1.333
MLW	2.281	3.076	1.798	2.385
MLLW	2.722	3.556	2.204	2.827

The bathymetric data were converted to xyz format before combining with the coastline data to generate bathymetric pre-surfaces at 1/3 arc-second and 1 arc-second. These bathymetric surface grids were converted to xyz format before incorporating in their respective final DEMs.

Topographic data used in developing the Chignik DEMs are listed in Table 4. Alaska's Division of Community and Regional Affairs (DCRA) provided topographic CAD data of the three communities. The CAD files were converted to GIS format using ArcGIS. CAD data of Ivanof Bay was originally referenced to a local grid which

required separate reprojecting before conversion to a GIS format. UAF provided GPS elevation points which were converted to MHHW. The USACE harbor survey also provided detailed topographic coverage of the jetties within Chignik harbor. The SRTM DEM provided full topographic coverage at 1 arc-second. The void filled version was used to eliminate the need for additional low resolution data patches. Vertical datum transformations were based on the NOAA tide stations (Table 3). All topographic data were converted to xyz format for the final gridding process.

Table 4: Topographic data sources used in compiling the Chignik DEM.

Source	*Date*	*Data Type*	*Spatial Resolution*	*Horizontal Datum*	*Vertical Datum*
DCRA	2001 and 2003	CAD	< 1 meter	NAD 83 Alaska State Plane Zone 6 (feet) or local grid	Assumed MHW
SRTM void filled	2001	Topographic DEM	1 arc second	WGS 84 geographic	EGM96 (Earth Gravitational Model 1996)
USACE	2010	Hydrographic condition survey	6 meters	NAD 83 AK State Plane Zone 6 (feet)	MLLW
UAF	2013	GPS elevation points		WGS 84 geographic	MLLW

DEM Development

Development of the Chignik DEMs followed procedures documented in NOAA Technical Memorandum NGDC-40 for Prince William Sound, Alaska (Caldwell et al., 2011). Exceptions being the bathymetric pre-surfaces were generated at 1/3 and 1 arc-seconds. The following data were used in the bathy surface but not the final grids, pre-1990 NOS survey data, and ENC sounding data. Gridding weight was modified to Table 5.

Table 5: Data hierarchy used to assign gridding weight in MB-System.

Dataset	*Relative Gridding Weight*
USACE hydrographic survey	1000
UAF GPS points	1000
DCRA extracted topographic points	100
NOS surveys (no pre-1990)	10
Coastline	1
SRTM DEM	.1
Bathymetric pre-surface	.1
NGDC multibeam swath sonar	.1

DEM Analysis

The completed Chignik DEMs were compared to nautical charts, topographic maps, and high resolution imagery. Inconsistencies were evaluated and resolved based on most reliable data available.

Acknowledgement

The authors thank Anne Dollard (USACE, Alaska District) and George Plumley (State of Alaska, Division of Community and Regional Affairs, DCRA) for providing data used in developing the Chignik, Alaska DEMs.

Reference

Caldwell, R.J., B.W. Eakins, E. Lim (2011). Digital Elevation Model of Prince William Sound, Alaska: Procedures, Data Sources and Analysis. NOAA Technical Memorandum NESDIS NGDC-40, NOAA, pp. 41.

State of Alaska; Department of Commerce, Community, and Economic Development; Division of Community and Regional Affairs, "Community Database Online." Last modified June 07, 2012. Accessed January 21, 2014. http://commerce.alaska.gov/cra/DCRAExternal/.

Appendix A: NOS Surveys

Survey ID	*Date*	*Scale*	*Original Horizontal Datum*	*Original Vertical Datum*
H03796	1915	100000	Unknown	Mean Lower Low Water (MLLW)
H04389	1924	20000	Unknown	MLLW
H04510	1925	20000	Unknown	MLLW
H06880	1943	120000	Unknown	MLLW
H07169	1946	80000	Unknown	MLLW
H07170	1946	20000	Unknown	MLLW
H07923	1953	20000	Early Alaska Datums	MLLW
H07924	1951	20000	Early Alaska Datums	MLLW
H07927	1951	40000	Early Alaska Datums	MLLW
H07928	1951	40000	Early Alaska Datums	MLLW
H07996	1952 to 1953	20000	Unknown	MLLW
H07997	1953	20000	NAD 1927	MLLW
H08000	1953	40000	NAD 1927	MLLW
H10557	1994	10000	North American Datum 1983	MLLW
H10693	1996	10000	North American Datum 1983	MLLW
H10694	1996	10000	North American Datum 1983	MLLW
H10695	1996	10000	North American Datum 1983	MLLW
H10696	1996	20000	North American Datum 1983	MLLW
H10697	1996	10000	North American Datum 1983	MLLW
H10697A	1997	10000	North American Datum 1983	MLLW
H10698	1996	10000	North American Datum 1983	MLLW
H10699	1996	10000	North American Datum 1983	MLLW
H10701	1996	20000	North American Datum 1983	MLLW
H10701A	1997	20000	North American Datum 1983	MLLW
H10702	1996	10000	North American Datum 1983	MLLW
H10705	1996	10000	North American Datum 1983	MLLW
H10759	1996	10000	North American Datum 1983	MLLW
H10760	1997	10000	North American Datum 1983	MLLW
H10761	1997	10000	North American Datum 1983	MLLW
H10762	1997	10000	North American Datum 1983	MLLW
H10765	1997	10000	North American Datum 1983	MLLW
H10767	1997	10000	North American Datum 1983	MLLW
H10768	1997	10000	North American Datum 1983	MLLW
H10770	1997	10000	North American Datum 1983	MLLW
H11021	2002	40000	North American Datum 1983	MLLW
H11064	2001	10000	North American Datum 1983	MLLW
H11065	2001	10000	North American Datum 1983	MLLW
H11066	2001	40000	North American Datum 1983	MLLW
H11191	2003	10000	North American Datum 1983	MLLW
H11192	2003	10000	North American Datum 1983	MLLW
H11193	2003	10000	North American Datum 1983	MLLW
H11194	2003	10000	North American Datum 1983	MLLW
H11195	2003	10000	North American Datum 1983	MLLW
H11229	2003	10000	North American Datum 1983	MLLW
H11230	2003	10000	North American Datum 1983	MLLW

Survey ID	*Date*	*Scale*	*Original Horizontal Datum*	*Original Vertical Datum*
H11231	2003	10000	North American Datum 1983	MLLW
H11232	2003	10000	North American Datum 1983	MLLW
H11233	2003	10000	North American Datum 1983	MLLW
H11260	2004	10000	North American Datum 1983 UTM Zone 4	MLLW
H11261	2005	10000	North American Datum 1983 UTM Zone 4	MLLW
H11262	2005	10000	North American Datum 1983 UTM Zone 4	MLLW
H11263	2005	20000	North American Datum 1983 UTM Zone 4	MLLW
H11264	2005	10000	North American Datum 1983 UTM Zone 4	MLLW
H11265	2005	40000	North American Datum 1983 UTM Zone 4	MLLW
H11266	2004	10000	North American Datum 1983 UTM Zone 4	MLLW
H11325	2004	40000	North American Datum 1983	MLLW
H11459	2005	10000	North American Datum 1983	MLLW
H11460	2005	10000	North American Datum 1983	MLLW
H11461	2005	10000	North American Datum 1983	MLLW
H11462	2005	10000	North American Datum 1983	MLLW
H11463	2005	20000	North American Datum 1983	MLLW
H11464	2005	10000	North American Datum 1983	MLLW
H11465	2005	40000	North American Datum 1983	MLLW
H11476	2005	10000	North American Datum 1983 UTM Zone 4	MLLW
H11477	2005	10000	North American Datum 1983 UTM Zone 4	MLLW
H11478	2005	10000	North American Datum 1983 UTM Zone 4	MLLW
H11479	2005	10000	North American Datum 1983 UTM Zone 4	MLLW
H11483	2005	135000	North American Datum 1983 UTM Zone 4	MLLW
H11484	2005	100000	North American Datum 1983 UTM Zone 4	MLLW
H11517	2006	10000	North American Datum 1983 UTM Zone 4	MLLW
H11518	2006	10000	North American Datum 1983 UTM Zone 4	MLLW
H11519	2006	10000	North American Datum 1983 UTM Zone 4	MLLW
H11520	2006	10000	North American Datum 1983 UTM Zone 4	MLLW
H11521	2006	20000	North American Datum 1983 UTM Zone 4	MLLW
H11522	2006	20000	North American Datum 1983 UTM Zone 4	MLLW
H11523	2006	20000	North American Datum 1983 UTM Zone 4	MLLW
H11524	2006	20000	North American Datum 1983 UTM Zone 4	MLLW
H11587	2006	40000	North American Datum 1983 UTM Zone 4	MLLW

Appendix B: NGDC Multibeam Surveys

Survey ID	*Date*	*Ship*	*Source*
HLY08TC	2008	Healy	UNOLS R2R
HLY08TI	2008	Healy	UNOLS R2R
HLY0901	2009	Healy	UNOLS R2R
HLY09TC	2009	Healy	UNOLS R2R
HLY09TE	2009	Healy	UNOLS R2R
HLY1104	2011	Healy	UNOLS R2R
MGL1110	2011	Marcus G. Langseth	UNOLS R2R