

Digital Elevation Model of Kaneohe, Hawaii: Procedures, Data Sources, and Analysis

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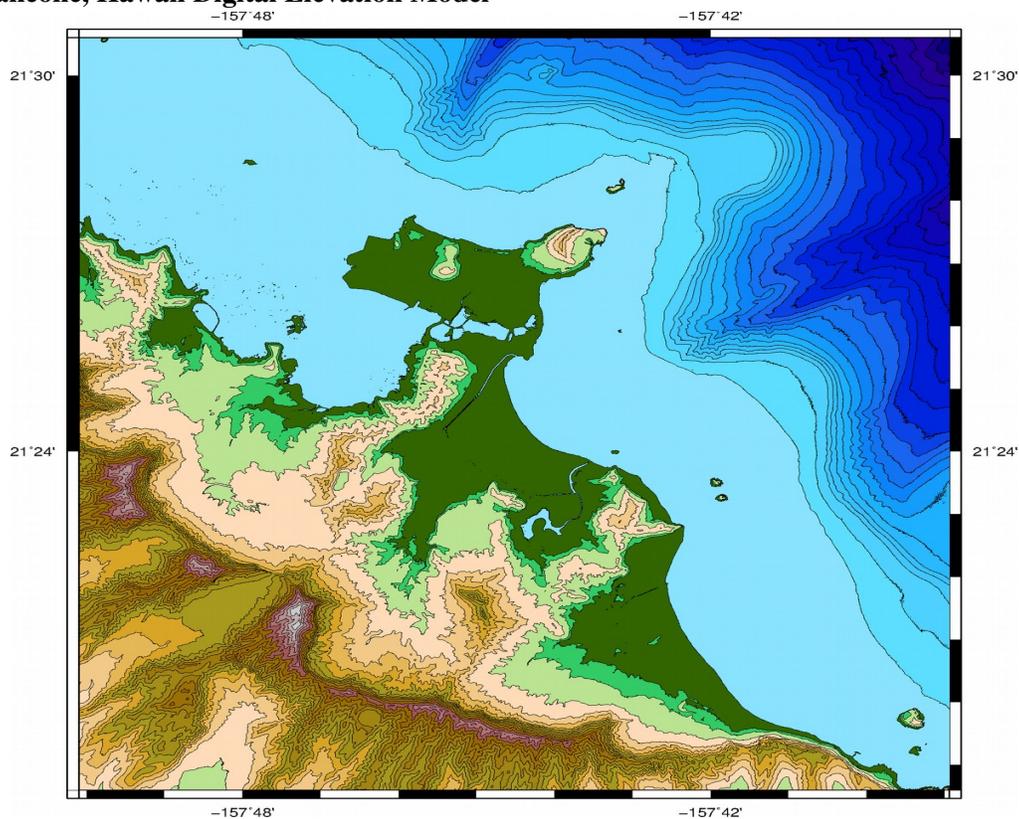
Love, M.R.¹, K.S. Carignan¹, B.W. Eakins¹, M.G. Sutherland¹, M. Lancaster¹

¹Cooperative Institute for Research in Environmental Sciences, University of Colorado Boulder

Summary

In August of 2016, NOAA's National Centers for Environmental Information (NCEI) developed a topographic-bathymetric digital elevation model (DEM) of Kaneohe, Hawaii (Figure 1) for NOAA's Pacific Marine Environmental Laboratory (PMEL). The 1/3 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 surrounding Kaneohe, Hawaii, located on the island of Oahu, in the State of Hawaii (Fig. 2). The extents of this DEM, procedures, data sources, and analysis are described below.

Figure 1. Kaneohe, Hawaii Digital Elevation Model



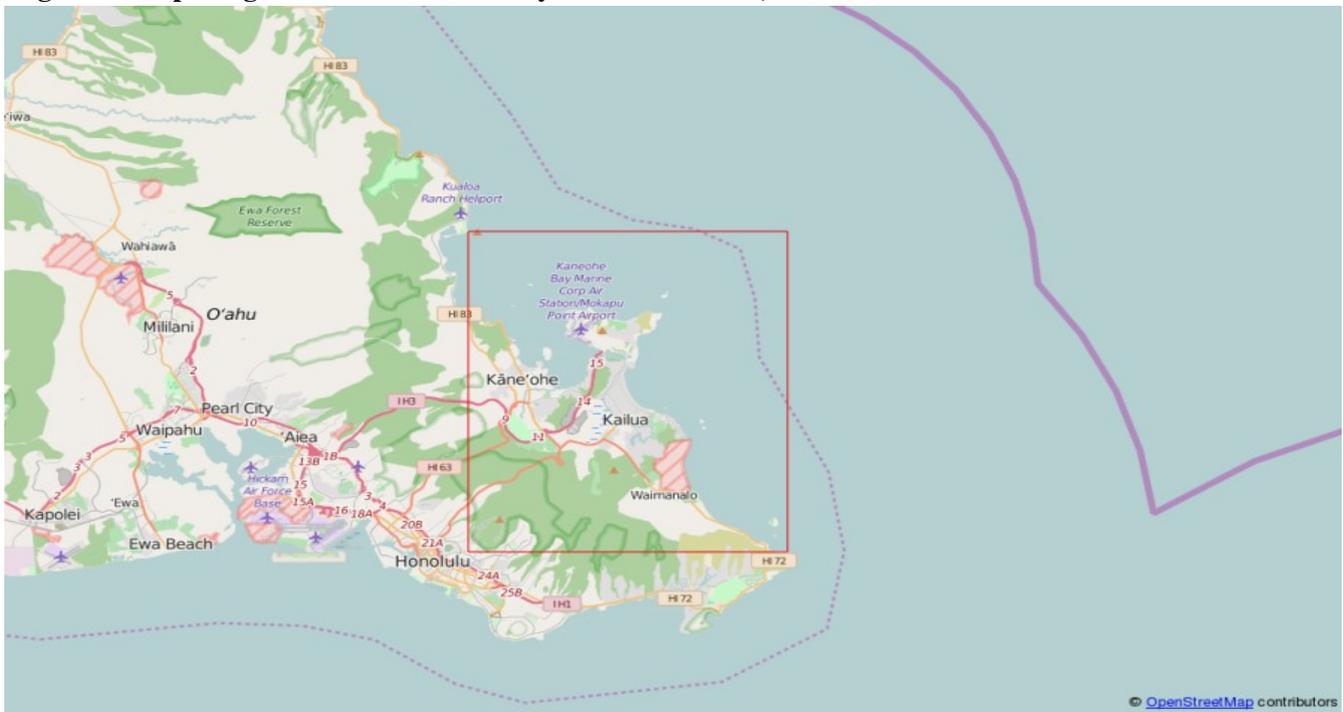
DEM Specifications

The Kaneohe, Hawaii DEM was built to the specifications listed in Table 1. Figure 2 shows the 1/3 arc-second boundary in red. The best available digital data were obtained by NGDC and shifted to common horizontal and vertical datums: World Geodetic System of 1984 (WGS 84) and Mean Sea Level (MSL). Data were gathered in an area slightly larger (~5%) than the DEM extents. This data “buffer” ensures that gridding occurs across rather than along the DEM boundaries to prevent edge effects. Data processing and evaluation, and the DEM assembly and assessment are described in the following subsections.

Table 1. Specifications for the Kaneohe, Hawaii DEM.

Grid Area	Kaneohe, Hawaii
Coverage Area	-157,835° to -157.649° W, 21.31° to 21.51° N
Coordinate System	Geographic decimal degrees
Horizontal Datum	World Geodetic System 1984 (WGS 84)
Vertical Datum	Mean High Water (MHW)
Vertical Units	Meters
Cell Size	1/3 arc-seconds
Grid Format	ASCII raster grid

Figure 2. Map image of the DEM boundary for the Kaneohe, Hawaii DEM in red.



Data Sources and Processing

The digital coastline used in developing the Kaneohe, Hawaii 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 used in the compilation of the Kaneohe, Hawaii DEM included sounding data from the National Oceanic Survey (NOS) as well as composite datasets from the University of Hawaii (Table 2).

Topographic data used in the compilation of the Kaneohe, Hawaii DEM included lidar data obtained from NOAAs Office of Coastal Management (OCM) as well as gridded data obtained from the United States Geological Survey (USGS) (Table 2).

Table 2: Bathymetric and Topographic Data Sources used in compiling the Kaneohe, Hawaii DEM.

Source/Title	Date	Data Type	Resolution	Horizontal Datum	Vertical Datum
2013 NOAA Oahu Topographic Lidar	2013	Topographic Lidar	< 1 meter	WGS84 Geographic	Mean Sea Level (MSL)
2013 USACE NCMP Topobathy Lidar: Oahu (HI)	2013	Topobathy Lidar	< 1 meter	WGS84 Geographic	MSL
University of Hawaii (UH)	2014	Bathymetric Grid	10 meter	WGS84 Geographic	MSL
Multibeam Soundings	2010	Bathymetric Soundings	1 – 10 meters	WGS84 Geographic	MSL
NOS Hydro	1930 - 2010	Bathymetric Soundings	1 meter to several kilometers	WGS84 Geographic	MLLW
USGS NED	2015	Topographic DEM	10 meters	WGS84 Geographic	MSL

The bathymetric data were transformed from their original datums to a horizontal datum of WGS 84 and a vertical datum of MSL prior to DEM development using a constant offset obtained from local tide station data. Topographic data were transformed from their original horizontal datums to a horizontal datum of WGS 84. All topographic data originated in MSL prior to development, so no added vertical transformations were needed.

Table 3: Datums for 1612480, Mokuoloe HI (<http://tidesandcurrents.noaa.gov/datums.html?units=1&epoch=0&id=1612480&name=Mokuoloe&state=HI>).

Datum	Value (m)	Description	Offset to MSL (m)	Offset to MHW (m)
MHHW	1.536	Mean Higher-High Water	.326	.099
MHW	1.437	Mean High Water	.227	0
MSL	1.210	Mean Sea Level	0	-.227
MLW	0.985	Mean Low Water	-.225	-.452
MLLW	0.890	Mean Lower-Low Water	-.32	-.547

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 1/3 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.

MB-System was used to create the 1/3 arc-second Kaneohe, Hawaii 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 'gdreformat' to create the final 1/3 arc-second Kaneohe, Hawaii DEM.

The Kaneohe, Hawaii 1/3 arc-second MHW DEM was generated by adding a constant offset to the MSL DEM (Table 3.).

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

Data-set	Relative Gridding Weight
Generated Bathymetry Surface	1
Lidar datasets	100
Multibeam Bathymetry Data	1
NOS Hydrographic Data	1
USGS NED	10
Composite Surfaces	10

Recommendations

Recommendations to improve the Kaneohe, Hawaii 1/3 arc-second DEM are listed below:

- Conduct bathymetric lidar surveys to fill data gaps around the island of Oahu.
- Conduct high-resolution topographic lidar surveys of inland areas of the island of Oahu.

References

Wessel, P., and W. H. F. Smith, A Global Self-consistent, Hierarchical, High-resolution Shoreline Database, *J. Geophys. Res.*, 101, #B4, pp. 8741-8743, 1996.