LiDAR and *The National Map*

Lori Phillips and Kimberly Mantey, USGS

The National Elevation Dataset is the elevation layer for *The National Map*.

The National Elevation Dataset (NED)

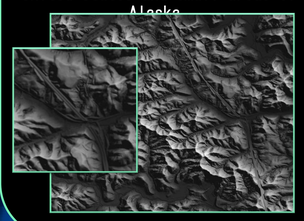
The NED is a seamless dataset composed of the best available raster elevation data of the conterminous United States, Alaska, Hawaii, and territorial islands of the United States. (Gesch, 2007)

The NED data are derived from diverse source data that are processed to a common coordinate system and unit of vertical measure. NED data are distributed in geographic coordinates in units of decimal degrees, and in conformance with the North American Datum of 1[illegible]es are in

NED Resolutions

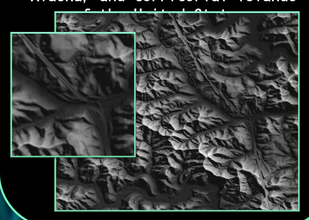
1/9th Arc-Second

NED 1/9th arc-second dataset covers areas of the conterminous United States and small areas of Alaska.



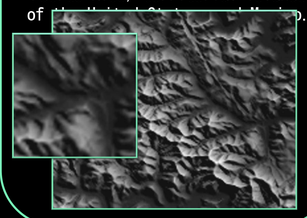
1/3rd Arc-Second

NED 1/3rd arc-second dataset covers the conterminous United States, Hawaii, small areas of Alaska, and territorial islands



1 Arc-Second

NED 1arc-second dataset covers the conterminous United States, Hawaii, small areas of Alaska, Puerto Rico, territorial islands of [illegible]



NED 2-arc-second dataset covers the State of Alaska. Plans are in development for a significant improvement in elevation data coverage of the State, using primarily Interferometric Synthetic Aperture Radar (IFSAR) technology.

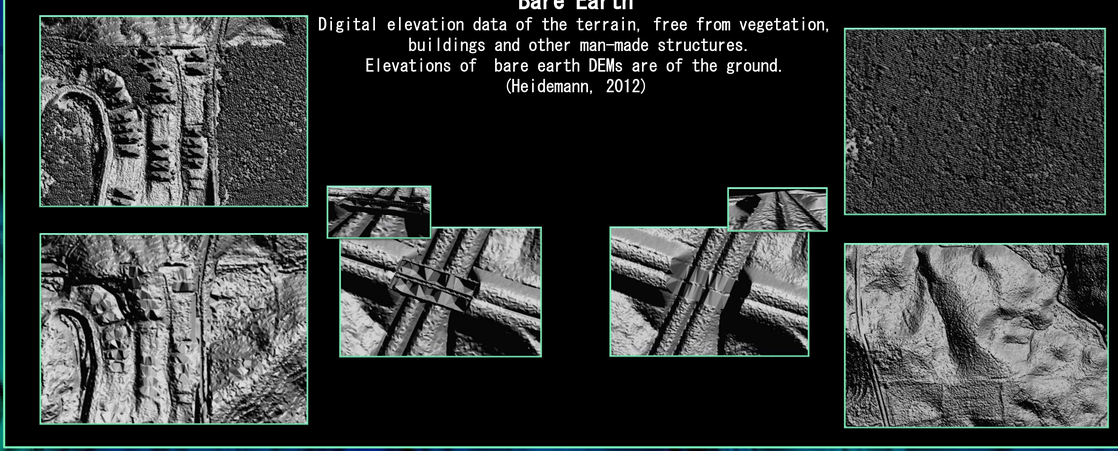
LiDAR derived Digital Elevation Models (DEMs) Criteria for Inclusion in the NED

Lidar has emerged as the preeminent source for elevation data and a host of derivative products. For more than 15 years, lidar technology has matured into a proven mapping tool used for generating bare earth digital elevation models (DEMs) and has become the most common source for new elevation data incorporated into the NED. To maintain consistent nationwide DEM coverage, lidar-derived DEM data intended for *The National Map* are required to meet certain specifications and requirements.

Data Characteristics

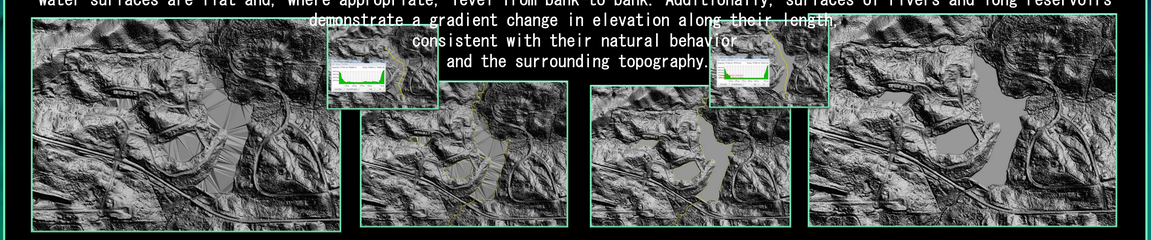
Bare Earth

Digital elevation data of the terrain, free from vegetation, buildings and other man-made structures.
Elevations of bare earth DEMs are of the ground.
(Heidemann, 2012)

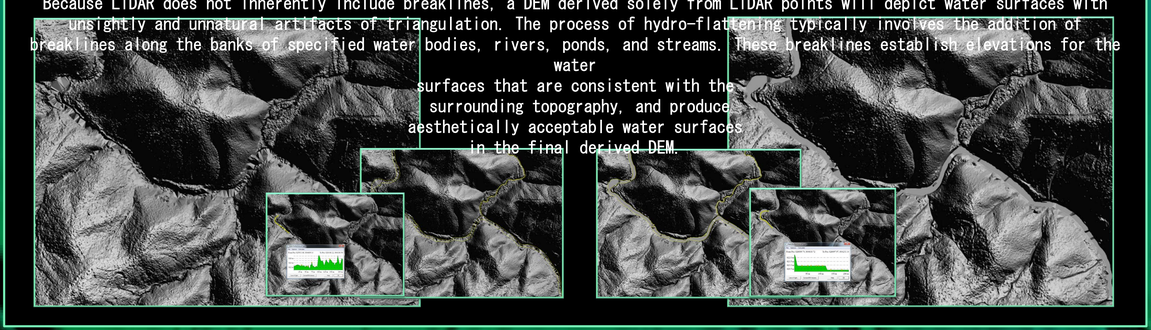


Hydroflattened

LiDAR-derived DEMs must be hydroflattened so that mapped water bodies, rivers, reservoirs, and other cartographically polygonal water surfaces are flat and, where appropriate, level from bank-to-bank. Additionally, surfaces of rivers and long reservoirs demonstrate a gradient change in elevation along their length, consistent with their natural behavior and the surrounding topography.



Because LiDAR does not inherently include breaklines, a DEM derived solely from LiDAR points will depict water surfaces with unsightly and unnatural artifacts of triangulation. The process of hydro-flattening typically involves the addition of breaklines along the banks of specified water bodies, rivers, ponds, and streams. These breaklines establish elevations for the water surfaces that are consistent with the surrounding topography, and produce aesthetically acceptable water surfaces in the final derived DEM.



Vertical Accuracy

Fundamental Vertical Accuracy (FVA)

FVA is assessed against the raw LiDAR point cloud and the bare-earth DEM. FVA checkpoints are LiDAR point class (Graham, 2012) and must be located in flat, clear, open areas where there is high likelihood that a sensor will have detected ground. Checkpoints must be distributed throughout the dataset. A minimum of 20 checkpoints are required; 30 or more checkpoints are preferred. Because of the location of the checkpoints the errors in FVA are assumed to be normally distributed, therefore FVA is reported as $Accuracy_z$, which is as a function of Root Mean Square Error $(RMSE)_z$. (NDEP, 2004) $Accuracy_z$ at the 95-percent confidence level is equivalent to $RMSE_z \times 1.96$.

USGS LiDAR Base Specification 1.0 requires that [illegible]

Supplemental Vertical Accuracy (SVA)

SVA is assessed only against the bare earth DEM for each major LiDAR point class in a project area. Major is defined as any LiDAR point class that covers 10 percent or more of the total project area excluding the ground class. A minimum of 20 checkpoints are required for each LiDAR point class; 30 or more are preferred. Because of the location of the SVA checkpoints, a normal distribution of error cannot be assumed; therefore, SVA is calculated using the percentile method.

USGS LiDAR Base Specification 1.0 requires that SVA <= 36.3 cm, 95th percentile. Depending on vegetation density and point class type, a LiDAR-derived DEM that does not meet this SVA requirement may still be accepted into the NED.

Consolidated Vertical Accuracy (CVA)

CVA is calculated for all the LiDAR point classess combined (including the ground class) in a project area. As CVA is calculated for all the land-cover categories combined, it is highly likely that there will be at least 40 checkpoints. For example, if a dataset contained the following land-cover categories in addition to open, flat, terrain: urban, tall weeds and crops, there would need to be a minimum of 60 checkpoints assessed in the CVA calculation. Like SVA, CVA is assessed only against the bare earth DEM. Due to the fact that some of the checkpoints for CVA are located areas where normal distribution cannot be assumed. Therefore, CVA is also calculated using the percentile method.

USGS LiDAR Base Specification 1.0 requires that CVA <= 36.3 cm, 95th percentile.

More information on vertical accuracy can be found in the National Elevation Elevation Program (NDEP) Guidelines for Digital Elevation Data.

References:

Gesch, D.B., 2007, The National Elevation Dataset, in Maune, D., ed., Digital Elevation Model Technologies and Applications—The DEM Users Manual, 2nd Edition: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, p. 99-118.

Heidemann, Hans Karl, 2012, Lidar base specification version 1.0: U.S. Geological Survey Techniques and Methods, book 11, chap. B4, 63 p. (Also available at http://pubs.er.usgs.gov/publication/tm11b4.)

Graham, Lewis, 2012, The LAS Specification Version 1.4: Bethesda, Maryland, American Society for Photogrammetry and Remote Sensing, 27 p.

National Elevation Program (ed.), 2004, National Elevation Program Guidelines for Digital Elevation Data, [illegible]

Data Credit
National Elevation Dataset
http://ned.usgs.gov/