US GeoData
Digital Elevation Models

Digital elevation models

Digital elevation model (DEM) data consist of an array of regularly spaced elevations. U.S. Geological Survey (USGS) DEM data are sold in 7.5-minute, 15-minute (Alaska only), and 1-degree units.

Data production

DEM data for 7.5-minute units are collected by four production methods: (1) the Gestalt Photo Mapper II (GPM2), an automated photogrammetric system designed to produce orthophotos, digital terrain data, and contours in subunits called patches; (2) manual profiling from photogrammetric stereomodels using stereoplotters equipped with three-axis electronic digital profile recording modules, by scanning stereomodels along successive terrain profiles; (3) interpolation of the elevations from stereomodel digitized contours, derived from stereoplotters equipped with three-axis digital recording modules used for compilation of 7.5-minute topographic quadrangle maps; and (4) interpolation from digital line graph (DLG) hypsographic and hydrographic data, collected using scanners, manual digitizers, and automated line followers.

DEM data for 15-minute units are derived from DLG hypsographic and hydrographic data.

DEM data for 1-degree units are collected from topographic map sources, ranging from the 7.5-minute map series to the 1- by 2-degree map series, or from photographic sources by using image correlation systems.

Unit size and file extent

DEM data for 7.5-minute units correspond to the USGS 7.5-minute topographic quadrangle map series for all of the United States and its territories except Alaska.

Portion of a 7.5-minute DEM plot of Tumwater, WA

DEM data for 15-minute units correspond to the USGS 15-minute topographic quadrangle map series in Alaska. The unit sizes in Alaska vary depending on the latitude. Units south of 59° N. cover 15- by 20-minute areas, those between 59° and 62° N. cover 15- by 22.5-minute areas, those between 62° and 68° N. cover 15- by 30-minute areas, and those north of 68° N. cover 15- by 36-minute areas. (All values are latitude-longitude, respectively.)

DEM data are produced by the Defense Mapping Agency in 1- by 1-degree units that correspond to the east or west half of USGS 1- by 2-degree topographic quadrangle map series (1:250,000 scale) for all of the United States and its territories. In Alaska these are west, central, and east files.

All nonstandard quadrangles with neatlines that extend beyond the standard unit size to accommodate overedge boundaries are collected as multiples of the standard unit sizes. These data, therefore, are sold as two 7.5- by 7.5-minute units.

Data characteristics

All DEM data are similar in logical data structure and are ordered from south to north in profiles that are ordered from west to east. However, they differ in geographic reference systems and sampling intervals.

DEM data in 7.5-minute units consist of regular arrays of elevations arranged horizontally on the Universal Transverse Mercator (UTM) coordinate system of the North American Datum of 1927 (NAD 27). These data are stored as profiles with 30-meter spacing along and between each profile. The profiles do not always have the same number of elevations because of the variable angle between true north and grid north in the UTM system.

DEM data in 15-minute units consist of regular arrays of elevations arranged horizontally to the coordinate system of NAD 27. The spacing between elevations along profiles is 2 arc seconds of latitude by 3 arc seconds of longitude. Each profile has 451 elevations.

DEM data in 1-degree units consist of a regular array of elevations arranged horizontally using the coordinate system of the World Geodetic System 1972 Datum. A few units are also available using the World Geodetic System 1984 Datum. Spacing of the elevations along and between each profile is 3 arc seconds with 1,201 elevations per profile. The only exception is DEM data in Alaska, where the spacing and number of elevations per profile varies depending on the latitude. Latitudes between 50° and 70° N. have spacings at 6 arc seconds with 601 elevations per profile, and latitudes greater than 70° N. have spacings at 9 arc seconds with 401 elevations per profile.
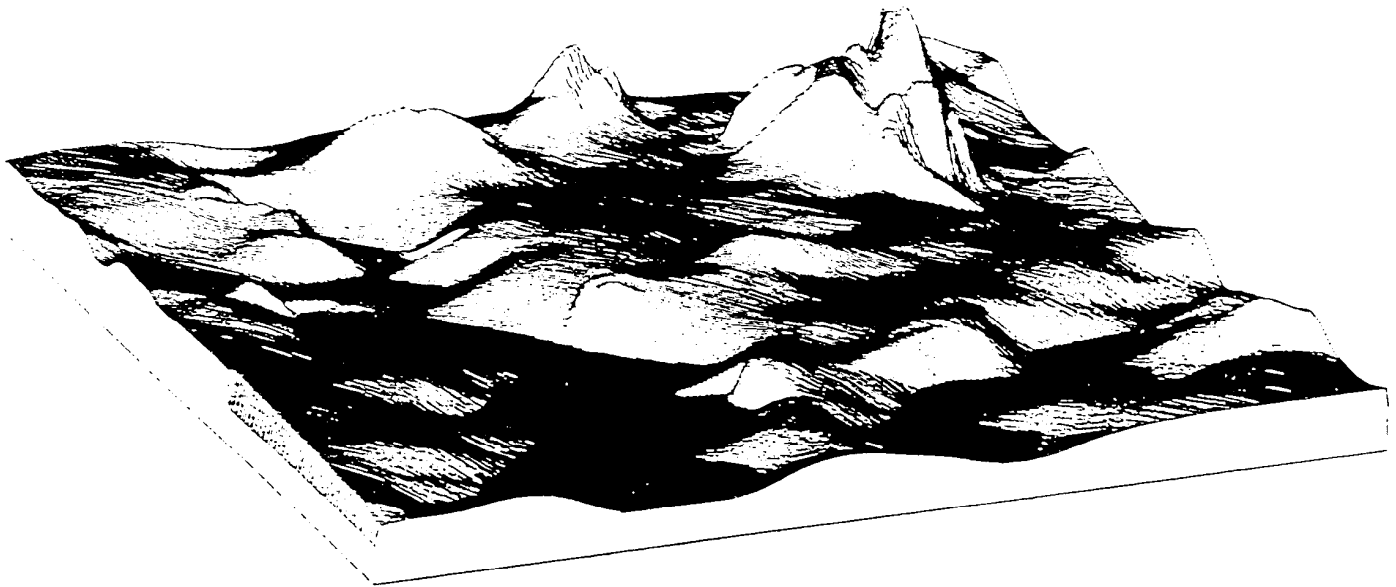
Data records

A DEM file is organized into three logical records, types A, B, and C. The type A record contains information defining the general characteristics of the DEM, including its name, boundaries, units of measurement, minimum and maximum elevations, number of type B records, and projection parameters. There is only one type A record per DEM file. The type B record contains profiles of elevation data and associated header information. There is a type B record for each profile. The type C record contains statistics on the accuracy of the data.

Data accuracy

The accuracy of DEM data depends on the source and resolution of the data samples. The accuracy of the 7.5-minute DEM data is derived by comparing linear interpolated elevations in the DEM with corresponding map location elevations and computing the statistical standard deviation or root-mean-square error (RMSE). The RMSE is used to describe the DEM accuracy. The vertical accuracy of 7.5-minute DEM's is 15 meters or better. The 15-minute DEM accuracy is one-half of a contour interval of the 5-minute topographic quadrangle map or better. The 1-degree DEM data have an absolute accuracy of 130 meters horizontally and 30 meters vertically.

US GeoData Sampler

A US GeoData Sampler is available for a nominal charge. The sampler includes the 7.5-minute DEM and the 1:24,000-scale DLG for Tumwater, Washington; the 1:100,000-scale DLG for Tacoma, Washington; the 1:2,000,000-scale DLG for the northwestern States (WA, OR, and ID); 1- by 2-degree land use and land cover data for Seattle, Washington; the 1- by 1-degree DEM for Seattle, Washington East; and the Geographic Names Information System data for the State of Washington.

Ordering instructions

DEM data are written as ANSI-standard ASCII characters in fixed-block format on unlabeled or ANSI labeled 9-track magnetic tapes at a 1,600-bpi or 6,250-bpi density. The logical record length is 1,024 bytes with a physical record size of 4,096 bytes or four logical records. DEM data may be ordered by specifying the unit size, maximum block size, tape density, and tape label and by identifying the sales unit by topographic quadrangle name or unit by topographic quadrangle name or by the southeast latitude and longitude corner coordinates.

The US GeoData Sampler can be ordered in standard or optional ASCII DLG formats, on either one 6,250-bpi or three 1,600-bpi tapes.

The Earth Science Information Center can furnish indexes, price lists, and order forms. Data Users Guides are included with each order.

For further information, contact:

U.S. Geological Survey
Earth Science Information Center
507 National Center
Reston, Virginia 22092
1-800-USA-MAPS

Structure of Digital Data

The Earth Science Information Centers (ESIC) distribute digital cartographic/geographic data files produced by the U.S. Geological Survey (USGS) as part of the National Mapping Program. The data files are grouped into four basic types. The first type, called a Digital Line Graph (DLG), is line map information in digital form. These data files include information on planimetric base categories, such as transportation, hydrography, and boundaries. The second type, called a Digital Elevation Model (DEM), consists of a sampled array of elevations for ground positions that are usually at regularly spaced intervals. The third type, Land Use and Land Cover digital data, provide information on nine major classes of land use such as urban, agricultural, or forest as well as associated map data such as political units and Federal land ownership. The fourth type, the Geographic Names Information System, provides primary information for known places, features, and areas in the United States identified by a proper name.

The digital cartographic data files from selected quadrangles currently available from ESIC include the following:

- Digital Elevation Models (DEM's)
  - 7.5-minute
  - 15-minute
  - 30-minute
  - 1-degree

- Digital Line Graphs (DLG's)
  - 1:24,000-scale
  - 1:62,500-scale
  - 1:63,360-scale
  - 1:100,000-scale
  - 1:2,000,000-scale

- Land Use and Land Cover digital data
  - 1:250,000- and 1:100,000-scale Land Use and Land Cover and associated maps
  - 1:250,000-scale Alaska Interim Land Cover

- Geographic Names Information System

The digital data are useful for the production of cartographic products such as plotting base maps and for various kinds of spatial analysis. A major use of these digital cartographic/geographic data is to combine them with other geographically referenced data, enabling scientists to conduct automated analyses in support of various decision making processes.

The information for the following pages on "Structure of Digital Data" was obtained from sections of the DATA USERS GUIDES listed:

DATA USERS GUIDES

1: Digital Line Graphs from 1:24,000-Scale Maps - $2
2: Digital Line Graphs from 1:100,000-Scale Maps - $1.50
3: Digital Line Graphs from 1:2,000,000-Scale Maps - $1.50
4: Land Use and Land Cover from 1:2,000,000-Scale Maps - $1
5: Digital Elevation Models - $1
6: Geographic Names Information System - $1
7: Alaska Interim Land Cover Mapping Program - $1

Data Users Guides 1-7 replace Geological Survey Circular 895 B-G.

7.5-MINUTE DIGITAL ELEVATION MODELS

Characteristics

A 7.5-minute DEM has the following characteristics:

- The data consist of a regular array of elevations referenced horizontally in the UTM coordinate system. The reference datum may be North American Datum of 1927 (NAD 27), North American Datum of 1983 (NAD 83), Old Hawaiian Datum (OHD), or Puerto Rico Datum of 1940 (PRD).

- The unit of coverage is the 7.5-minute quadrangle. Overedge coverage is not provided.

- The data are ordered from south to north in profiles that are ordered from west to east.

- The data are stored as profiles in which the spacing of the elevations along and between each profile is 30 m.

- The profiles do not always have the same number of elevations because of the variable angle between the quadrangle's true north and the grid north of the UTM coordinate system.

- Elevations for the continental U.S. are either meters or feet referenced to the National Geodetic Vertical Datum of 1929 (NGVD 29). Elevations for Hawaii and Puerto Rico are either in meters or feet referenced to local mean sea level. DEM's of low-relief terrain or generated from contour maps with intervals of 10 ft (3 m) or less are generally recorded in feet. DEM's of moderate to high-relief terrain or generated from maps with terrain contour intervals greater than 10 ft are generally recorded in meters.

Profiles for 7.5-minute DEM's are generated by using a UTM cartesian coordinate system as a base. The profiles are clipped to the straight-line intercept between the four geographic corners of the quadrangle--an approximation of the geographic map boundary (neatline).
The resulting area of coverage for the DEM is a quadrilateral, the opposite sides of which are not parallel.

The UTM coordinates of the four corners (bounds) of the DEM's are listed in the type A record, as shown in table 1,*data element 11; the UTM coordinates of the starting points of each profile are listed in the type B record (profiles), table 2,*data element 3. These coordinates describe the shape of the quadrilateral and the variable x, y starting position of each profile. Because of the variable orientation of the quadrilateral in relation to the UTM coordinate system, profiles intersect the east and west neatlines as well as the north and south neatlines.
In addition, DEM's have profile easting values that are continuous from one DEM to the adjoining DEM only if the adjoining DEM is contained within the same UTM zone.

* See Data Users Guide 5 - Digital Elevation Models
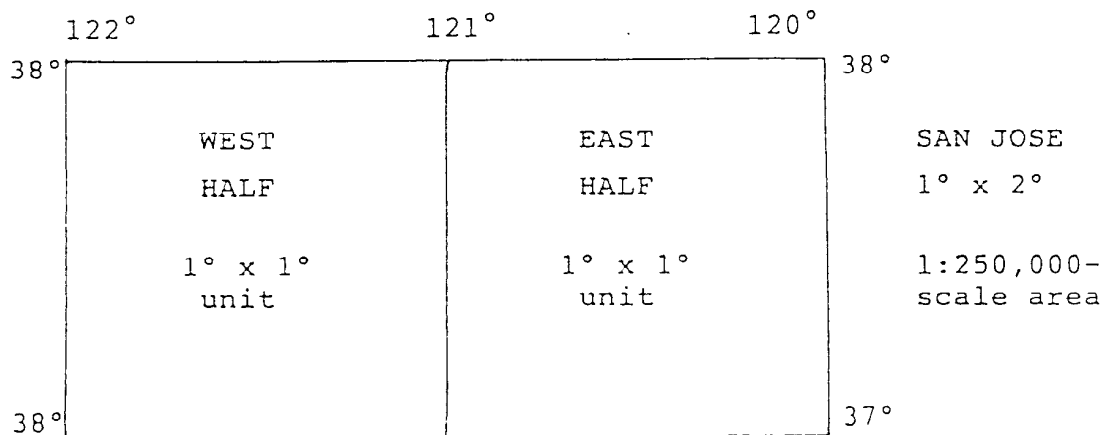
1-DEGREE DIGITAL ELEVATION MODELS

1-Degree DEM (3- x 3-arc-second data spacing). Provides coverage in 1- x 1-degree blocks. Two products (three in some regions of Alaska) provide the same coverage as a standard USGS 1- x 2-degree map series quadrangle. The basic elevation model is produced by or for the Defense Mapping Agency (DMA), but is distributed by USGS in the DEM data record format.

Characteristics

A 1-degree DEM has the following characteristics:

- The product consists of a regular array of elevations referenced horizontally on the geographic (latitude/longitude) coordinate system of the World Geodetic System 1972 Datum (WGS 72) or the World Geodetic System of 1984 (WGS 84).

- The unit of coverage is a 1- x 1-degree block. Elevation data on the integer degree lines (all four sides) correspond with the same profiles on the surrounding eight blocks.

- Elevations are in meters relative to NGVD 29 in the continental U.S. and local mean sea level in Hawaii and Puerto Rico.

- The data are ordered from south to north in profiles that are ordered from west to east.

- Spacing of the elevations along each profile is 3 arc-seconds. The first and last data points are at the integer degrees of latitude. A profile will therefore contain 1,201 elevations.

- Spacing between profiles varies by latitude; however, the first and last data points are at the integer degrees of longitude. North of 50° degrees N and south of 70° N, the spacing is 6 arc-seconds with 601 profiles per product. For the remainder of Alaska north of 70° N the spacing is 9 arc-seconds with 401 profiles per product.

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For U.S. 1:250,000-scale 1 degree by 2 degree areas, you need
to order TWO 1 degree by 1 degree DEM units:  EAST HALF and
WEST HALF.  They are TWO separate DEM units with TWO separate
costs: $7 for each half for a total of $14 for the entire area,
if you are ordering six or more units.
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        122°              121°            120°
   38° ┌────────────────┬────────────────┐ 38°

            WEST              EAST             SAN JOSE

            HALF              HALF             1° x 2°


            1° x 1°           1° x 1°          1:250,000-
            unit              unit             scale area



   38° └────────────────┴────────────────┘ 37°
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For ALASKA 1:250,000-scale DEMs, some areas require THREE units:
EAST HALF, CENTRAL HALF and WEST HALF, if you want the entire area.
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ALASKA DIGITAL ELEVATION MODELS

- The product consists of a regular array of elevations referenced horizontally to the geographic (latitude/longitude) coordinate system of NAD 27 or NAD 83.

- Elevation data on the quadrangle neatlines (all four sides) share edge profiles with the surrounding eight quadrangles.

- Elevations are in meters or feet relative to NGVD 29.

- The data are ordered from south to north in profiles that are ordered from west to east.

Characteristics

7.5-MINUTE Alaska DEM's have the following characteristics:

- The unit of coverage corresponds to four basic quadrangle sizes for 1:24,000- and 1:25,000-scale graphics (depending on latitude):

Cell size limits

7.5 x 18 minutes	State of Alaska north of 68° N latitude
7.5 x 15 minutes	Between 62° N and 68° N latitude
7.5 x 11.25 minutes	Between 59° N and 62° N latitude
7.5 x 10 minutes	State of Alaska south of 59° N latitude

- The longitudinal limits of these cells are computed east and west of the -150 degree meridian. The north-south cell limits conform to even multiples of 7.5 minutes of latitude.

- The data are collected with a 1- x 2-arc-second spacing in latitude and longitude, respectively. The first and last data points along a profile are at the integer degrees of latitude. A profile will therefore contain 451 elevations.

Characteristics

15-MINUTE Alaska DEM's have the following characteristics:

- The unit of coverage corresponds to four basic quadrangle sizes for 1:63,360-scale graphics (depending on latitude):

Cell size limits

15 x 36 minutes	State of Alaska north of 68° N latitude
15 x 30 minutes	Between 62° N and 68° N latitude
15 x 22.5 minutes	Between 59° N and 62° N latitude
15 x 20 minutes	State of Alaska south of 59° N latitude

- The longitudinal limits of these cells are computed east and west of the -150 degree meridian. The north-south cell limits conform to even multiples of 15 minutes of latitude.

- The data are collected with a 2- x 3-arc-second spacing in latitude, and longitude, respectively. The first and last data points along a profile are at the integer degrees of latitude. A profile will therefore contain 451 elevations.