



Partial image of a digital orthophoto of Washington, D.C.

A digital orthophoto quadrangle (DOQ) is a computer-generated image of an aerial photograph in which displacements caused by terrain relief and camera tilts have been removed. It combines the image characteristics of a photograph with the geometric qualities of a map.

Producing a Digital Orthophoto

The following items are required to produce a digital orthophoto:

- (1) a minimum of three ground positions that can be identified on the photograph to be rectified,
- (2) camera calibration parameters, such as the calibrated focal length and the coordinates of the camera fiducials,
- (3) a digital elevation model (DEM), and
- (4) a digital image produced by scanning an aerial photograph with a precise, high-resolution scanner.

The digital image is rectified to generate an orthophoto by processing items 1 through 3 for each image picture element (pixel) using rigorous photogrammetric equations on a high-speed computer. The finished product is a spatially accurate image with planimetric features represented in their true geographic positions.

A DOQ can be incorporated into any geographic information system (GIS), which can manipulate raster images. It functions exceptionally well as a cartographic base for displaying, generating, and modifying digital planimetric data.

Characteristics of a Standard Digital Orthophoto

The standard digital orthophoto produced by the U. S. Geological Survey (USGS) is a black-and-white or color-infrared digital image map. Each DOQ covers 3.75-minute of longitude and 3.75-minute of latitude. It is referenced to the North American Datum of 1983 and is

cast upon the Universal Transverse Mercator projection. Each pixel represents 1 square meter on the ground. Every DOQ has between 50 and 300 meters of overedge image beyond the primary and secondary quadrangle corner ticks. This overedge facilitates tonal matching and mosaicking of adjacent images.

Image mosaicking techniques can be used to combine two or more rectified images into one. For example, a 7.5-minute DOQ can be produced by mosaicking four 3.75-minute DOQ's.

The standard DOQ is formatted with an ASCII keyword header, followed by a series of 8-bit binary image data records. The radiometric image brightness values are stored as 256 gray levels. The file size of a black-and-white digital orthophoto can approach 55 megabytes.

The header record provided in the DOQ contains a wide range of descriptive information about the image data,

including photographic source type, date, software systems used to create the DOQ, and the production date of the DEM metadata used in the orthophoto rectification process. Primary and secondary datum coordinates for the upper left pixel are included in the header record to allow users to spatially reference other digital data with the DOQ.

Accuracy Requirements

The accuracy and quality of USGS digital orthophotos must meet National Map Accuracy Standards at 1:12,000 scale for 3.75-minute quarter quadrangles and at 1:24,000 scale for 7.5-minute quadrangles. Accuracy and quality depend on the following:

- photographs that meet National Aerial Photography Program standards, which are quarter-quadrangle centered. The photographs are exposed at a flying height of 20,000 feet above mean terrain and are taken using a wide-angle camera;
- a DEM with the same area coverage as the digital orthophoto that is equal to or better than a level-1 DEM having a root-mean-square error in elevation no greater than 7 meters;
- a highly accurate image scanning process that employs a scanning aperture between 7.5 and 30 micrometers (μm). A 1:40,000-scale image scanned with a 25- μm aperture produces a ground sample distance of 1 meter; and
- identifiable ground control positions with coordinates acquired from ground surveys or aerotriangulation.

Uses for Digital Orthophotos

A digital orthophoto can be used for various applications. The DOQ serves as an excellent cartographic base upon which associated digital layers can be overlaid. The accuracy and extraordinary detail provided by the DOQ allow users to evaluate their data for accuracy and completeness, make real-time modifications to their data, and even generate new files. Other applications include vegetation and timber management, routing and habitat analysis, environmental impact assessments, emergency evacuation planning, flood analysis, soil erosion assessment, facility management, and groundwater and watershed analysis.

Obtaining Digital Orthophoto Quadrangles

DOQ files are available from the USGS National Digital Cartographic Data Base. These uncompressed DOQ files can be obtained from the USGS Earth Science Information Center on a variety of media, including 8-mm tape, CD-R, 9-track tape, and 3,480 cartridge tape.

DOQ files are also distributed on CD-ROM in compressed (JPEG) format. Each CD-ROM contains complete DOQ coverage for an individual county. In addition to the image files, each CD-ROM includes compression and decompression software for DG/UX and MS-DOS users. It also includes C-language makefiles that can be compiled for use on other systems.

Each DOQ on the CD-ROM consists of a binary image file and an associated metadata file. The metadata file includes descriptive information, such as file identification, data sources and dates, data storage, coordinate systems and datums, and image compression.

DOQ county CD-ROM's may not be available for all areas. Check with any Earth Science Information Center for availability.

Information

For more information on digital orthophotos, contact any Earth Science Information Center.

For information on other USGS products and services, call 1-800-USA-MAPS, e-mail: esicmail@usgs.gov, or fax 703-648-5548.

The EARTHFAX fax-on-demand system is available 24 hours a day at 703-648-4888.

The address for the USGS home page is <URL: <http://www.usgs.gov/>>