

USGS Quadrangles in Google Earth

QUADS (<http://www.metzgerwillard.us/quads/>) is a web-based service for visualizing USGS quadrangles in Google Earth that provides an easy-to-use framework for retrieving georeferenced PDF topo maps from the USGS Store. QUADS also includes USGS, or USGS-derived, overlays for grayscale and color shaded relief maps, topographic-bathymetric maps, black-and-white orthophotos, and urban areas color orthoimagery.

QUADS

The principal component of QUADS is a Google Earth network link (Google 2009) that plots the approximate boundaries of more than 59,000 USGS quadrangles (**Figure 1**). For each of these quadrangles, GeoPDF maps (TerraGo 2008, USGS 2008a) may be freely obtained from the USGS Store (USGS

2008f). All quadrangle balloons (**Figure 2**) contain name, state, extent, and date information with a link to the corresponding GeoPDF map. See also USGS (2008e) for a discussion of various map series and USGS (2008d) for a list of topographic map symbols.

Quadrangles are categorized by extent and collected in subfolders. Coverage includes the conterminous United States, Alaska, Hawaii, Puerto Rico, the US Virgin Islands, and portions of Antarctica. The user is prompted to zoom in if there are more than 500 quadrangles in view. If there are no quadrangles within the viewer bounding box, the *Search Results* network link will contain an empty folder named *OutOfRange*.

GeoPDFs were initially produced by the US Army Corps of Engineers Topographic Engineering Center (currently known as the US Army Geospatial Center) using Digital

>> By Thomas G. Davis, PhD, PE, LS and Rollins Turner, PhD

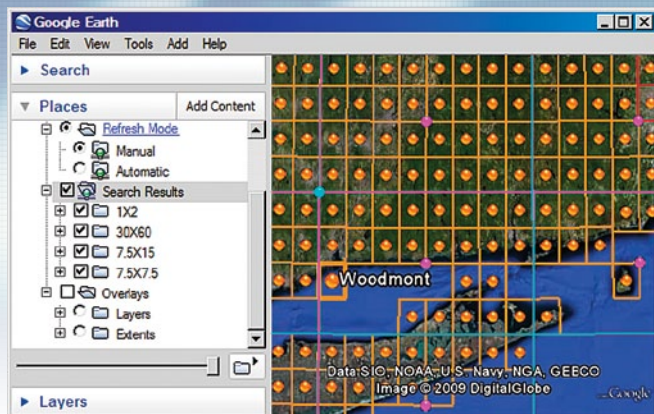


Figure 1 USGS Quadrangles

Raster Graphics (DRGs) with a resolution of 250 pixels per inch (ppi). GeoPDFs produced by the USGS are created from high-resolution (up to 508 ppi) scans of paper maps. The quadrangle balloon GeoPDF download link is preceded by either the designation DRG or MAP to indicate Corps-produced files or USGS-produced files, respectively. File sizes range from 3 to 30 megabytes, most being on the order of 10 to 17 megabytes.

The USGS is engaged in an ongoing effort to scan all existing maps, including historical map versions, and has recently introduced the new Digital Map series (USGS 2009b). The QUADS database will be updated periodically to reflect changes in the USGS map offering.

QUADS is similar in function to the Map Locator (USGS 2008c), a Google Maps application that runs in the user's web browser. The Locator is an outstanding browser application but lacks the robust user interface and flexibility of Google Earth.

Refresh Mode

The *Refresh Mode* network links provide a uniform mechanism to control the *Search Results* and *Layers* network links. When *Refresh Mode* is *Manual*, the contents of the network links are effectively frozen, allowing the user to pan and zoom without prompting a network link refresh. This is particularly useful for inspecting overlays or gaining an overview of network link contents. To initiate a network link:

1. Position the area of interest (AOI) in the viewer.
2. Check the *Search Results* network link (Fig. 1) to display quadrangle placemarks and boundaries, or check one of the *Layers* network links (Figure 3) to display USGS ground overlays.
3. On subsequent uses, reposition the AOI and ensure that the network link is checked and selected. When *Refresh Mode* is *Automatic*, search results are refreshed two seconds after camera movement stops. When *Refresh Mode* is *Manual*, choose *Refresh* from the *Edit* menu, or right-click and select *Refresh* in the context menu.

The *Manual* and *Automatic* network links may be used to stop and start refreshes for the *Search Results* and *Layers* network links. The default refresh mode is *Automatic*. To stop refreshes, check *Manual*; to restart refreshes, check *Automatic*. Canceling an edit of network link properties will disable mode selection for that particular network link.

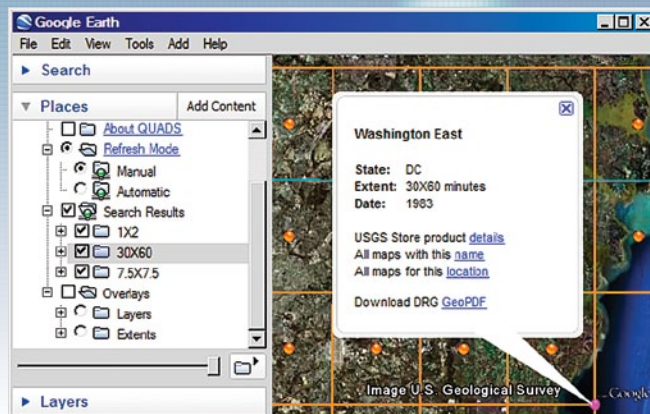


Figure 2 Quadrangle Balloon

Overlays

Overlay layers (Table 1) are implemented as network links that retrieve multiresolution images from an OpenGIS-conformant Web Map Service (WMS) (OGC 2006, Microsoft 2002). All requests are directed first to the QUADS server where bounding box coordinates and target resolution are conformed to service requirements before being passed to the WMS server.

Table 1. Overlay Layers

Layer ¹	Resolution ²	Server ³	Extent ⁴
TopoMaps ⁵	2	TerraServer ¹⁰	TerraServer ¹²
Orthophotos ⁶	1	TerraServer ¹⁰	TerraServer ¹²
UrbanAreas ⁷	0.25	TerraServer ¹⁰	TerraServer ¹²
GrayRelief ⁸	10	EROS ¹¹	USGS NED ¹³
ColorRelief ⁹	200	EROS ¹¹	NationalAtlas ¹⁴

¹ Layers network link name

² Maximum resolution (meters per pixel)

³ WMS server

⁴ Extents subfolder name

⁵ USGS topographic-bathymetric quadrangles (Fig. 3)

⁶ USGS black-and-white orthophoto quadrangles

⁷ USGS color urban areas orthoimagery

⁸ National Elevation Dataset (NED) gray shaded relief map (USGS 2006) (Fig. 4)

⁹ National Atlas color shaded relief map (National Atlas 2008) (Fig. 5)

¹⁰ TerraServer-USA (Microsoft 2005)

¹¹ Earth Resources Observation and Science (EROS) Support Server (USGS 2008b)

¹² Conterminous US, Alaska, and Hawaii

¹³ Conterminous US, portions of Alaska, Hawaii, American Samoa, Guam, and other US territorial islands

¹⁴ Conterminous US, Alaska, Hawaii, Puerto Rico, and the US Virgin Islands

Coverage graticules may be displayed by checking the corresponding *Extents* subfolder. When the viewer bounding box is outside the coverage area, or would otherwise create a server error, the request is not forwarded to the WMS server, and the associated *Layers* network link will contain an empty folder named *OutOfRange*.

Both USGS black-and-white orthophotos and color urban areas orthoimagery are now available in Google Earth 5.0 as part of the *Historical Imagery* feature. These layers are included

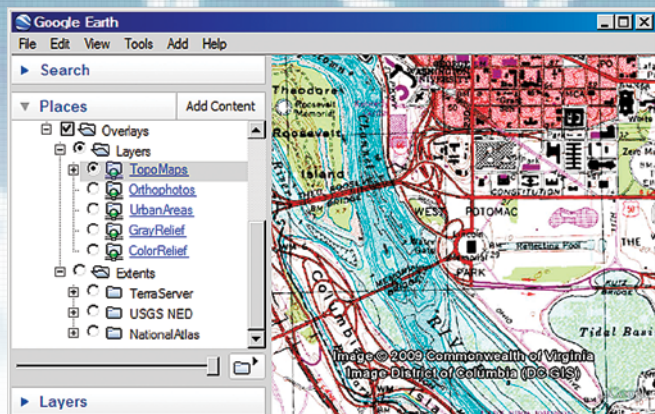


Figure 3 USGS Topographic Quadrangles

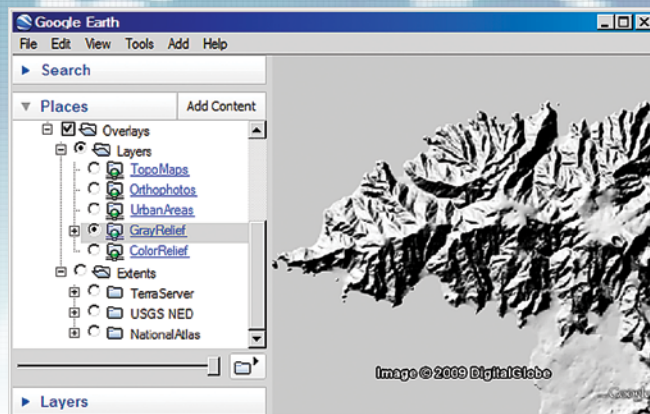


Figure 4 National Elevation Dataset Grayscale Relief

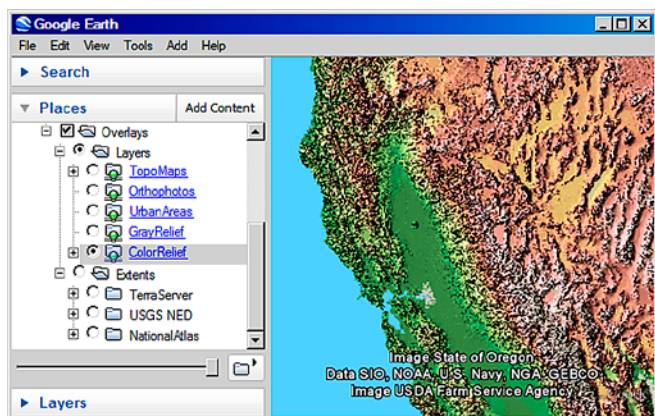


Figure 5 National Atlas Color Relief

in QUADS for a complete treatment of the WMS offering from TerraServer-USA.

Relief maps (Figures 4 and 5) achieve a three-dimensional appearance by determining an intensity for each pixel based on the terrain gradient and illumination from a light source in the northwest. See USGS (2009a) for a complete list of WMS layers available from the EROS Support Server.

Conclusion

QUADS provides user-friendly, graphically oriented access to a wealth of publicly available geospatial information maintained by the USGS and Microsoft Corporation. Metzger & Willard, Inc. is pleased to make QUADS freely available to anyone having Google Earth installed on a computer with an Internet connection.

Tom Davis has worked in land surveying and design automation for 26 years and has held dual registration as a civil engineer and land surveyor for 15 years. He received his PhD in Civil Engineering from the University of South Florida where he taught for 6 years prior to joining Metzger & Willard, Inc. as Vice President of Surveying in 2004.

Rollins Turner is an instructor in the Department of Computer Science and Engineering at the University of South Florida in Tampa.

Acknowledgments

The authors wish to thank the following individuals for their help in implementing or testing QUADS: Steve Skelton, Jeff Wendel, and Andy Orona, USGS; Scott Brown, LS, George F. Young, Inc.; and Kemp Morris, PSM, Morris Surveying, Inc.

References

- Google, Inc. (2009). "KML Reference." (<http://code.google.com/apis/kml/documentation/kmlreference.html>)
- Microsoft Corporation (2005). "TerraServer-USA." (<http://terrasservice.net/>)
- Microsoft Corporation (2002). "TerraService.NET: An Introduction to Web Services." (<http://research.microsoft.com/pubs/64154/tr-2002-53.pdf>)
- National Atlas of the United States (2008). "Color United States Shaded Relief." (<http://nationalatlas.gov/mld/srld48i.html>)
- Open Geospatial Consortium (2006). "OpenGIS Web Map Server Implementation Specification." (http://portal.opengeospatial.org/files/?artifact_id=14416)
- TerraGo Technologies (2008). "TerraGo Desktop." (<http://www.terragotech.com/desktop.php>)
- United States Geological Survey (2009a). "GIS Resources." (<http://hdds.usgs.gov/EO/gis.php>)
- United States Geological Survey (2009b). "A New Generation of Maps." (http://nationalmap.gov/digital_map/)
- United States Geological Survey (2008a). "About GeoPDF Maps." (http://store.usgs.gov/locator/about_digital_maps.html)
- United States Geological Survey (2008b). "Earth Resources Observation and Science." (<http://edc.usgs.gov/>)
- United States Geological Survey (2008c). "Map Locator." ([http://store.usgs.gov/b2c_usgs/usgs/maplocator/\(uiarea=2\)/.do](http://store.usgs.gov/b2c_usgs/usgs/maplocator/(uiarea=2)/.do))
- United States Geological Survey (2008d). "Topographic Map Symbols." (<http://edc2.usgs.gov/publists/booklets/symbols/topomapsymbols.pdf>)
- United States Geological Survey (2008e). "USGS Maps." (<http://edc2.usgs.gov/publists/booklets/usgsmaps/usgsmaps.php>)
- United States Geological Survey (2008f). "USGS Store." (<http://store.usgs.gov/>)
- United States Geological Survey (2006). "National Elevation Dataset (NED)." (<http://ned.usgs.gov/>)