Abstract

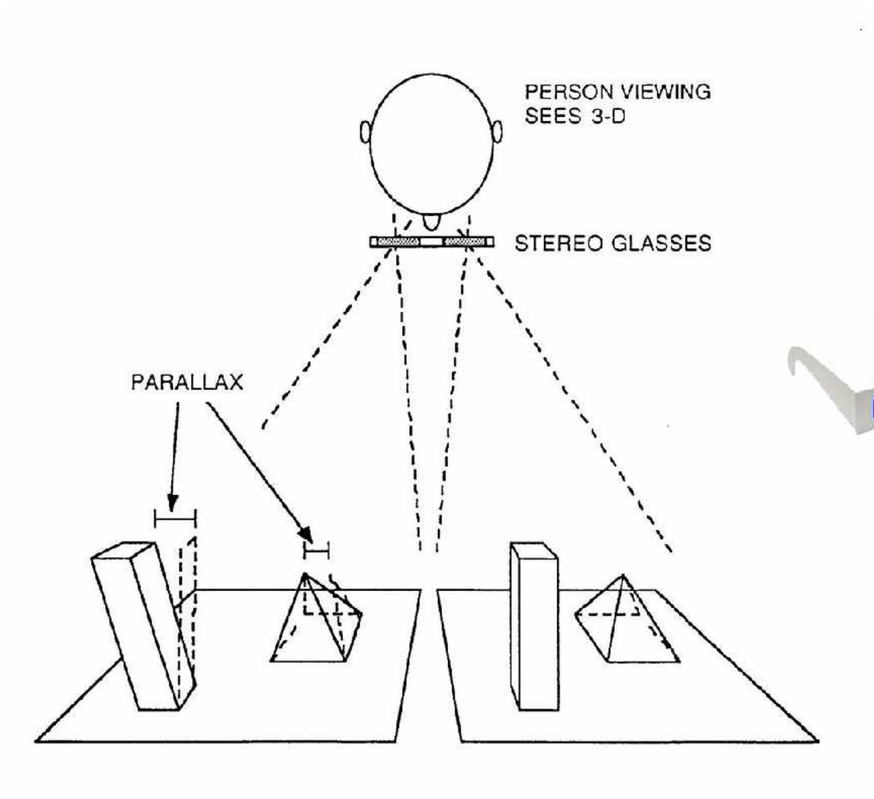
Improving Environmental/Geologic Interpretations with 3D Viewing of GIS layers and DEMs
or
Deriving More Value from Your DEM

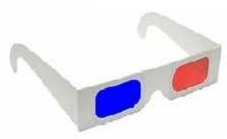
DEMs are readily available to support interpretations of environment and geology. These DEMs have been generated using photogrammetry, IfSAR, and LiDAR. Because most of us perceive the world in 3D, using DEMs to create 3D models makes it easier for us (and our clients, stakeholders, and the pubic) to understand the data we have compiled in our GIS.

Synthetic stereoscopic pairs can be created by draping images or maps on a DEM and offsetting corresponding pixels in the left and right image by an amount equivalent to their elevation. The higher the elevation, the more offset (parallax). Vertical exaggeration can be modified. It can be significantly increased to accentuate subtle topographic features in flat terrain.

The synthetic stereo pairs can be digitally mapped in a GIS using different types of display technologies & glasses, or left-right color images & red/blue anaglyphs can be plotted. Vector lines (proposed pipelines, roads, parcel boundaries, etc.) can be embedded so that they are seen in 3D. Drainage derived from DEMs can be integrated and pollution sources or flood sites more accurately identified. Vegetation patterns that are influenced by slope, aspect, and elevation are interpreted more accurately when viewed in stereo.

Creating Synthetic Stereo





We know the elevation of every pixel in the DEM. We can introduce artificial parallax into the DEM by horizontally offsetting each pixel in one direction by a distance that correlates with the pixel's elevation.

Performing this offset for every pixel in the DEM creates either one new image or two new images that have a systematic distortion that increases with elevation.

The original image (Left image) can remain a Nadir View and all the parallax introduced into a new image (Right image) as shown above. This enables interpreting directly on the original (Nadir) image so the derived map is in the correct map space.

However, most software creates a new Left and Right image, each with equal but opposite parallax built in. This may be easier on the eyes, but your interpreted lines will be less accurately placed.

An inexpensive and versatile way of viewing stereographic images is by creating an anaglyph. The Left and Right images are loaded as Blue and Red in a standard 3-band R, G, B (24-bit) color image.

The viewer wears glasses with a red Left lens and a blue Right lens. The red lens blocks out red light while the blue lens blocks our blue light. The viewer's left eye sees "only" the blue image and his/her right eye sees "only" the red image. The viewer perceives the parallax and vertical exaggeration that was built into the stereo model, and sees 3-D.

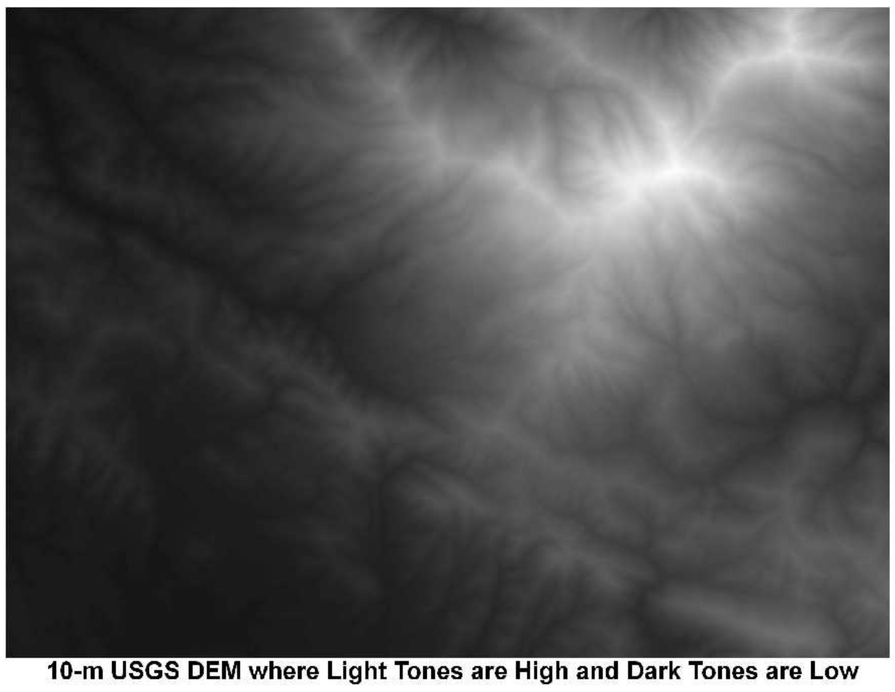
A distinct disadvantage is that the draped image is seen with a purplish cast - the original colors are lost. Anaglyphs can be exported from your GIS as a jpg with jgw for distribution as e-mail attachments so others can see the terrain in 3D and make their own interpretation. Also large paper plots can be made so groups of people (i.e. field teams) can view the 3D image together and better understand the terrain.

CalGIS two thousand and seven

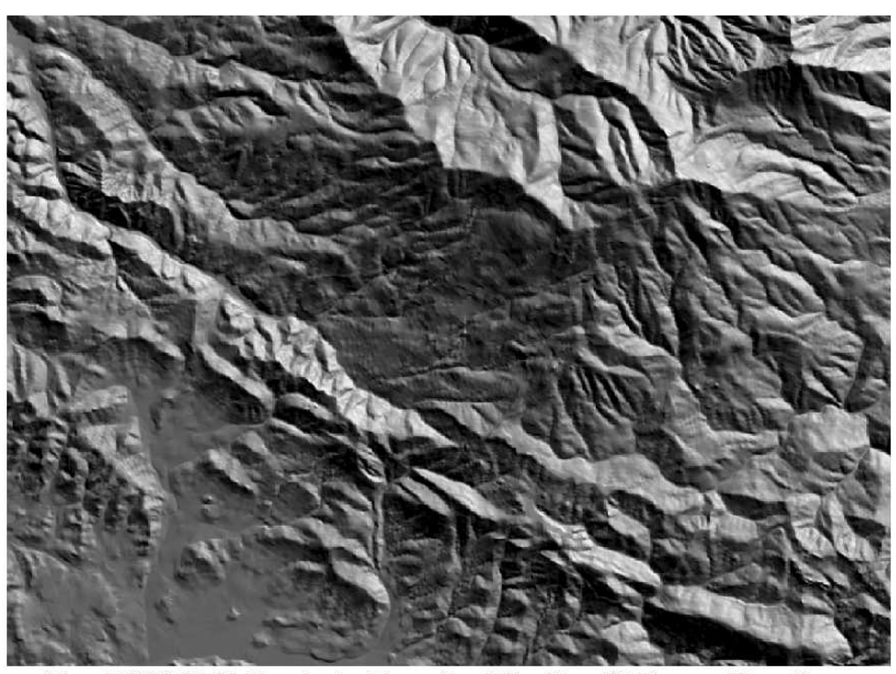
Ellis GeoSpatial

Diablo Valley College

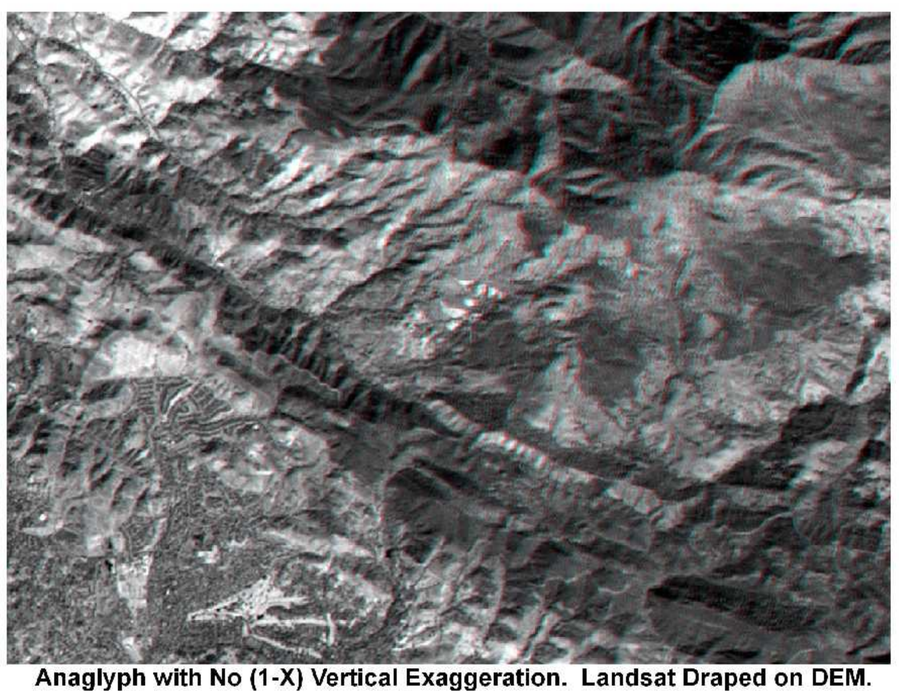
DEM with Derived GIS Layers



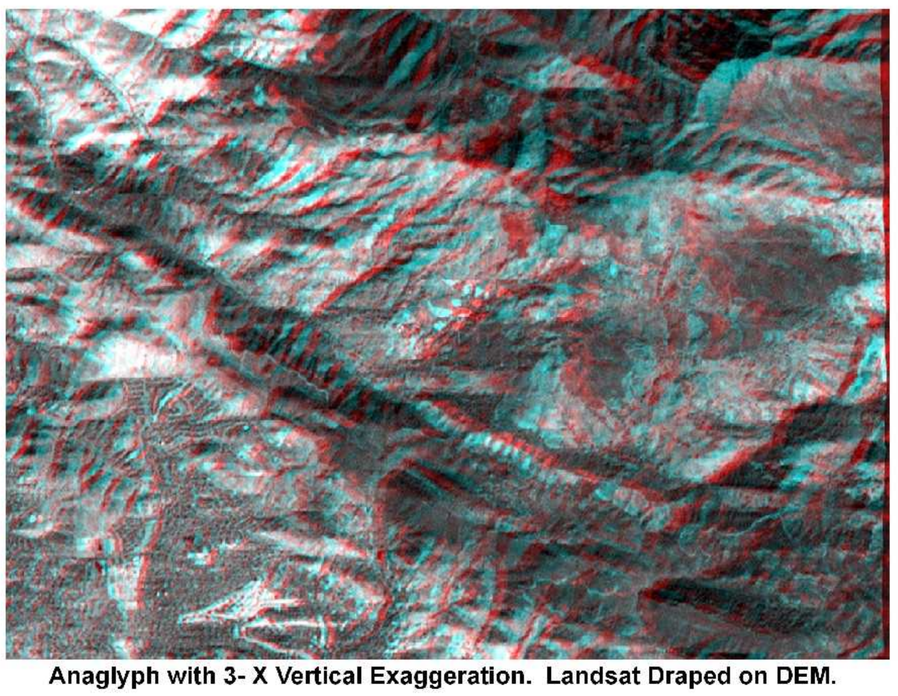
10-m USGS DEM where Light Tones are High and Dark Tones are Low

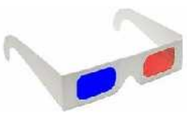


10-m USGS DEM Illuminated from the NE with a 30 Degree Elevation



Anaglyph with No (1-X) Vertical Exaggeration. Landsat Draped on DEM.





Anaglyph with 3- X Vertical Exaggeration. Landsat Draped on DEM.

Improving Environmental/Geologic Interpretations with 3D Viewing of GIS Layers and DEMs

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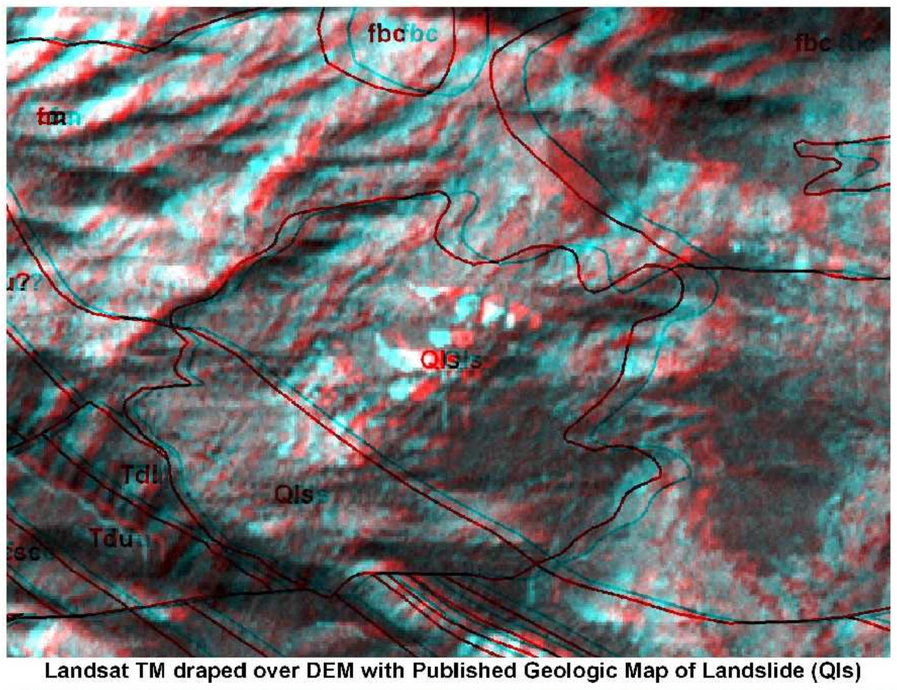
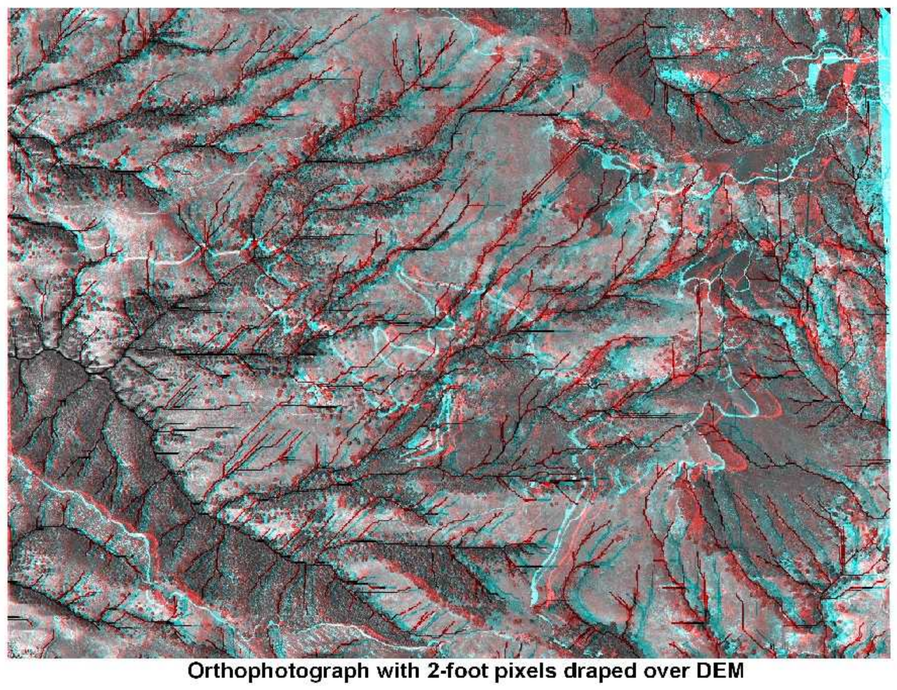
Ellis GeoSpatial & Diablo Valley College

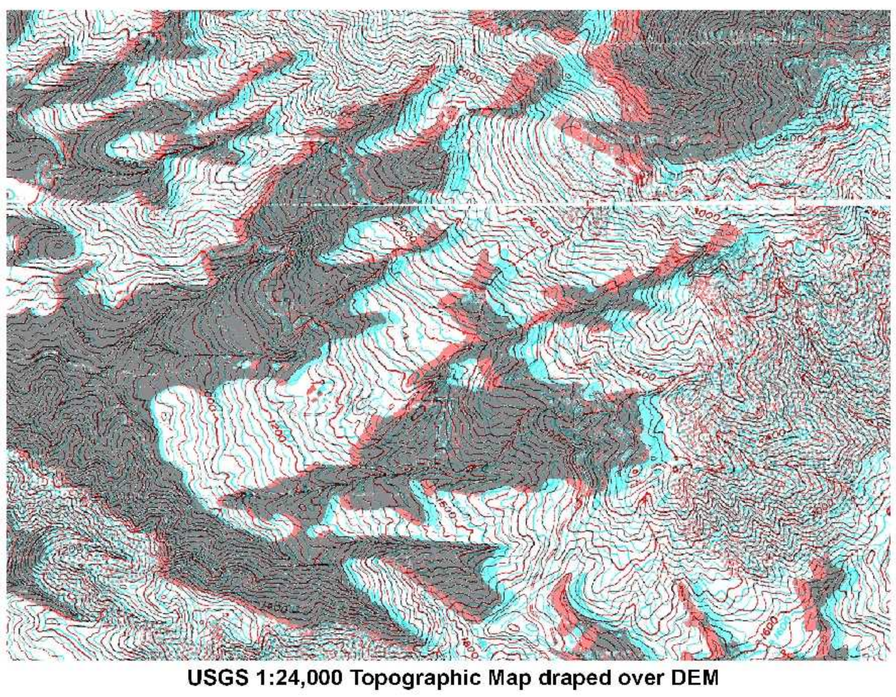
Natural Hazards



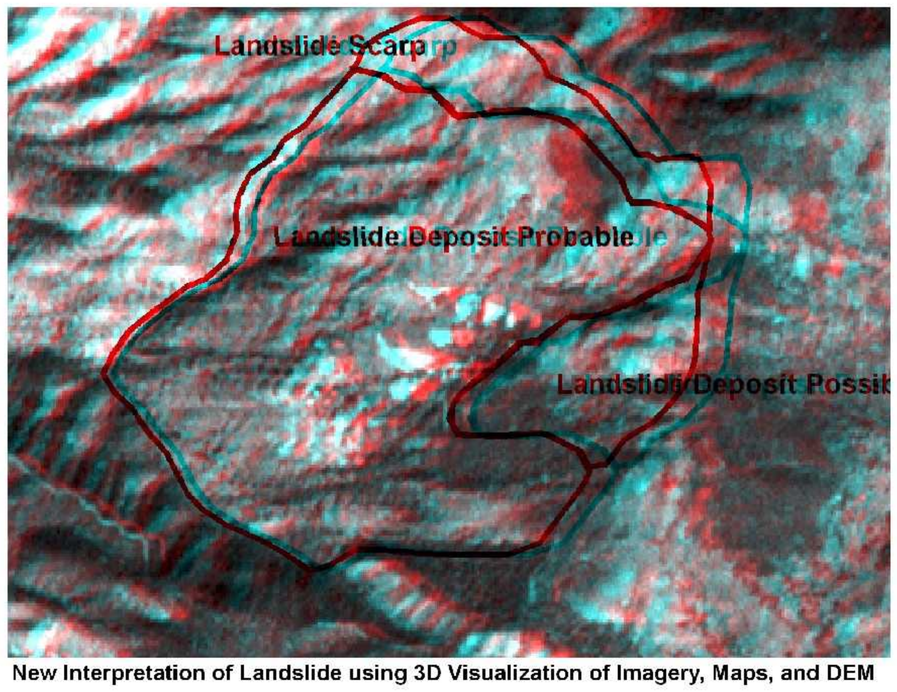
Landsat TM draped over DEM with Published Geologic Map of Landslide (Qls)



Orthophotograph with 2-foot pixels draped over DEM

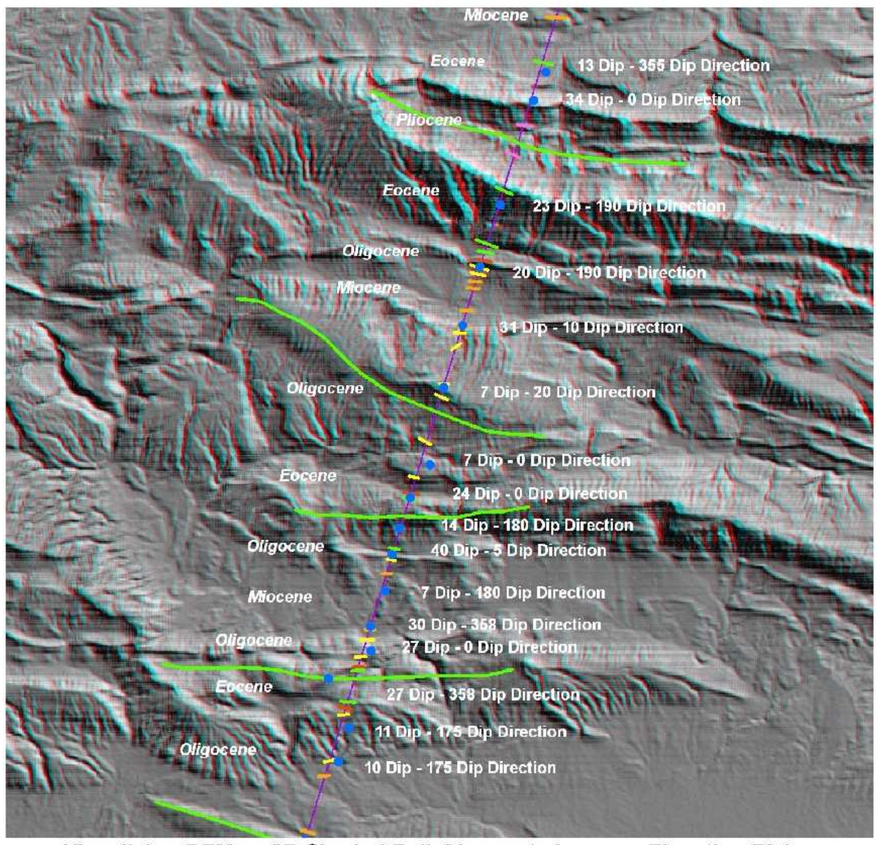


USGS 1:24,000 Topographic Map draped over DEM

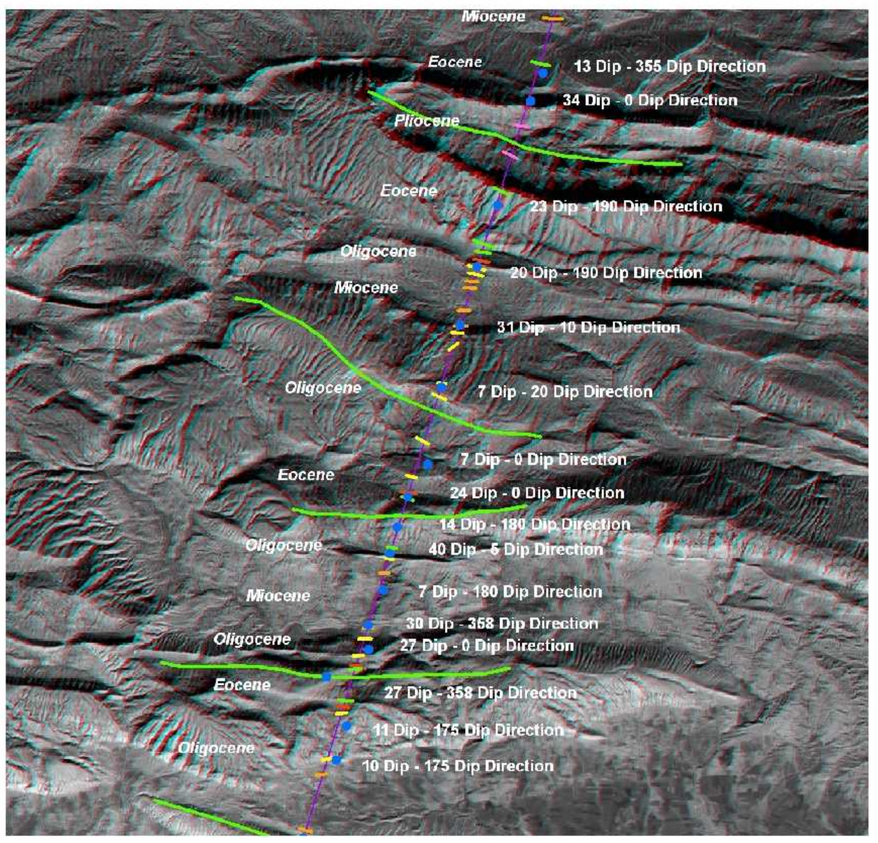


New Interpretation of Landslide using 3D Visualization of Imagery, Maps, and DEM

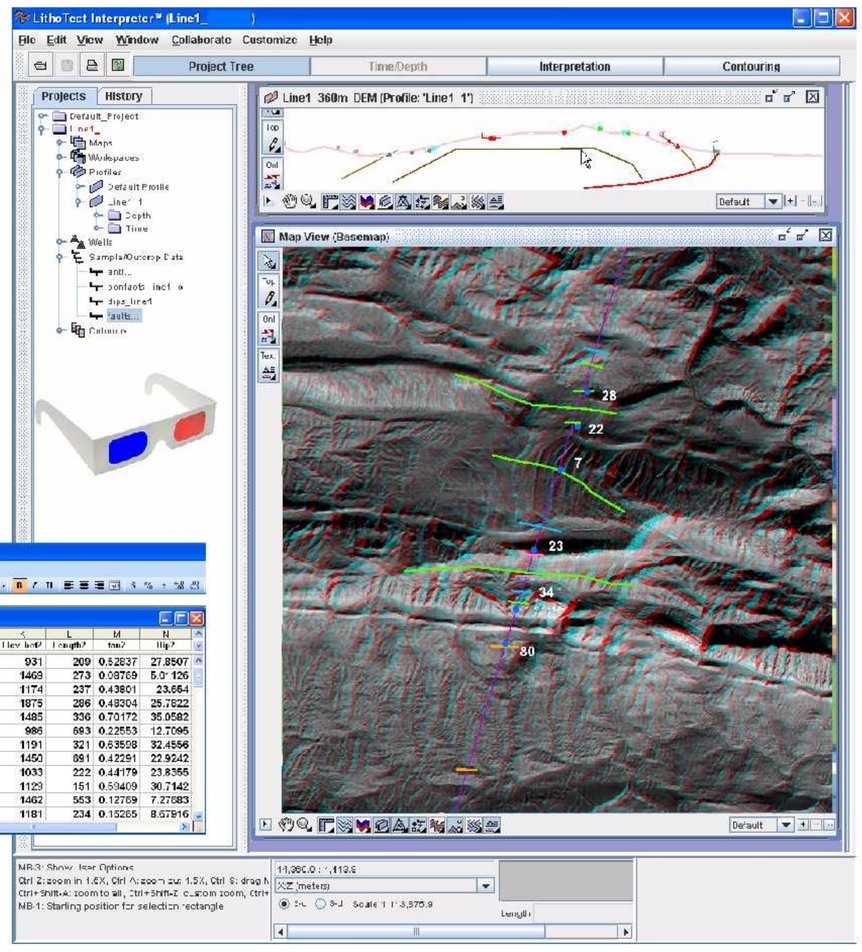
Structural Geology



Visualizing DEM as 3D Shaded Relief Image to Improve Elevation Picks

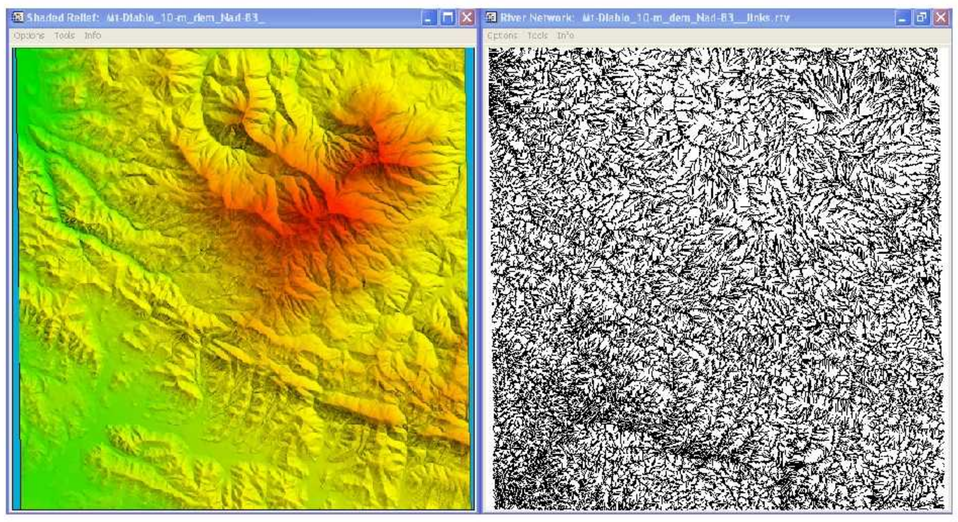


Landsat Draped over DEM Demonstrating Increased Perception of 3D Detail

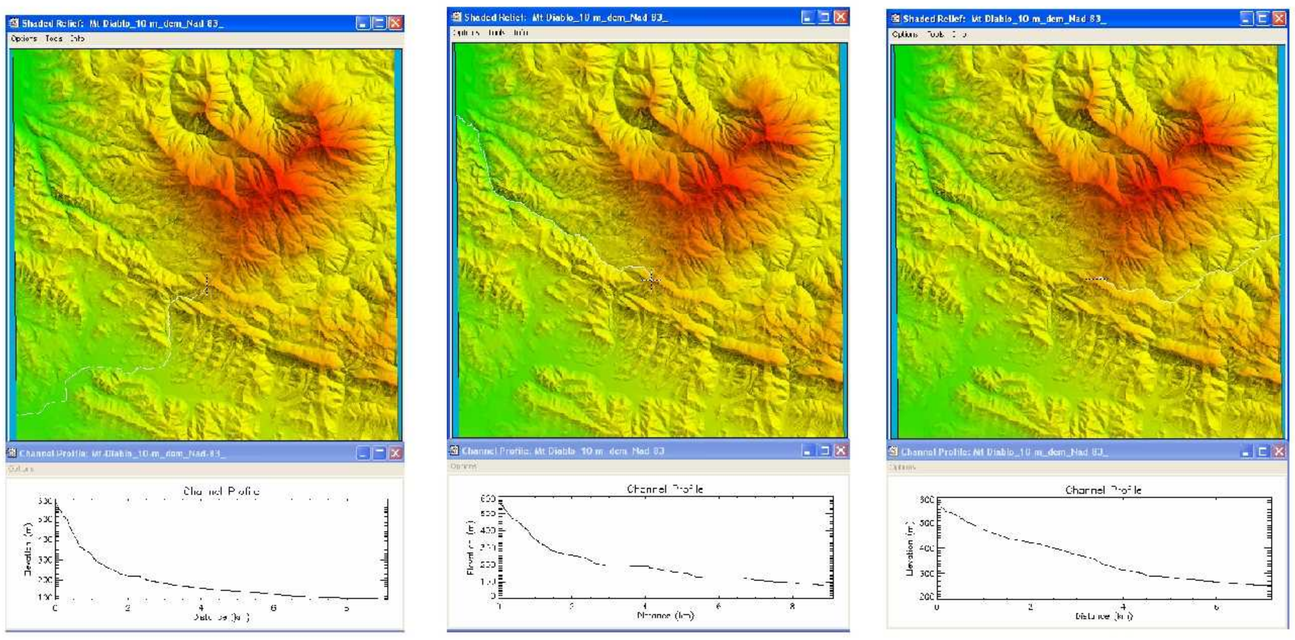


Supporting Subsurface Cross-Sections with Strike & Dip Measured from 3D Visualization of DEM & Images

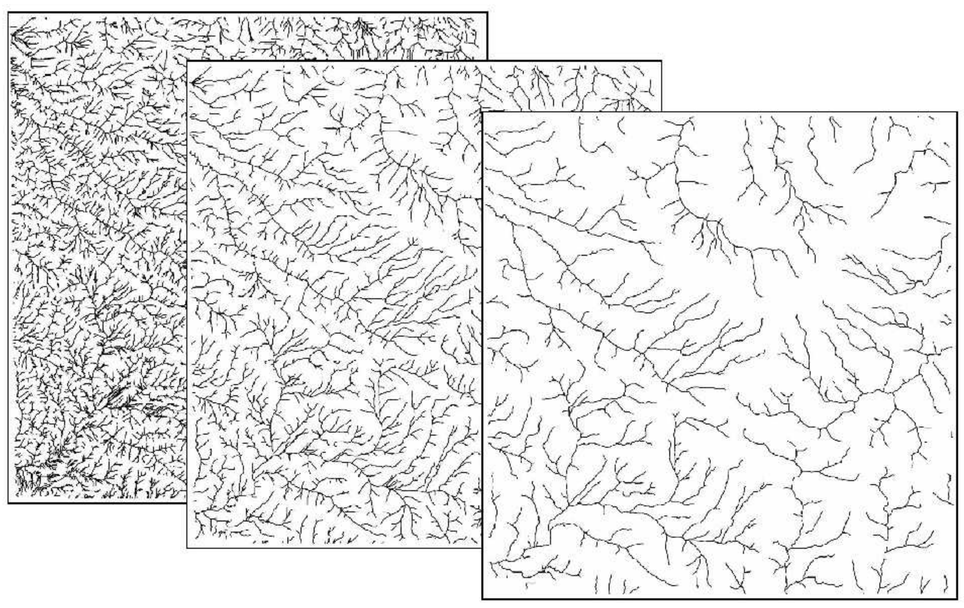
New Drainage Maps

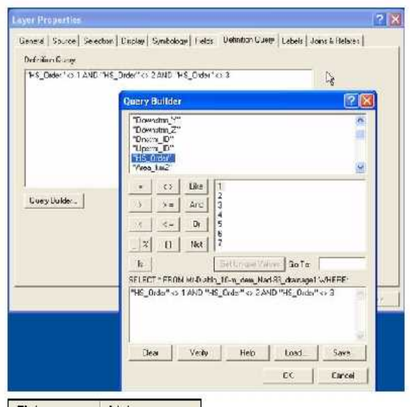


Color-Coded & Shaded DEM with Derived Drainage



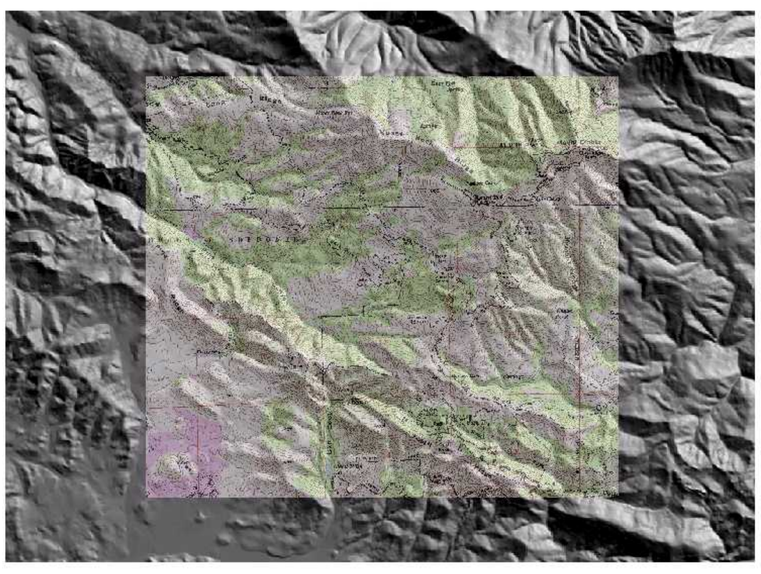
Mapping Different Flow Directions from a Point Source

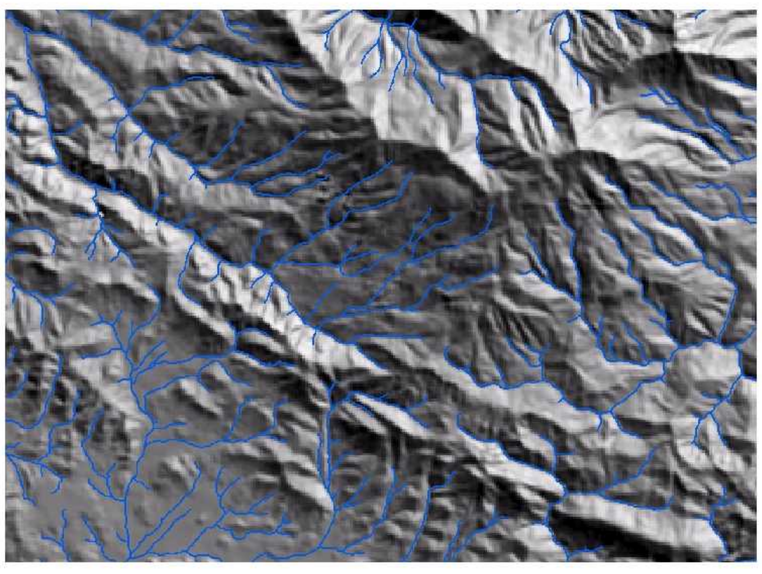




Field	Value
FID	5063
Shape	Polyline
Downstrm_X	123964
Downstrm_Y	3767128
Downstrm_Z	393
Dnstrm_ID	2457694
Upstrm_ID	2478255
HS_Order	4
Area_km2	166.3913
SL_Len_km	0.936
Length_km	1.0553
Drop_m	3
SL_Slope	0.003205
Slope	0.002843
Tot_Len_km	271.7113
Max_Len_km	48.304
Relief_km	0.09
Net_Diam	30
Sinuosity	1.1275
Drain_Dens	1.633
Source_Den	0.5108

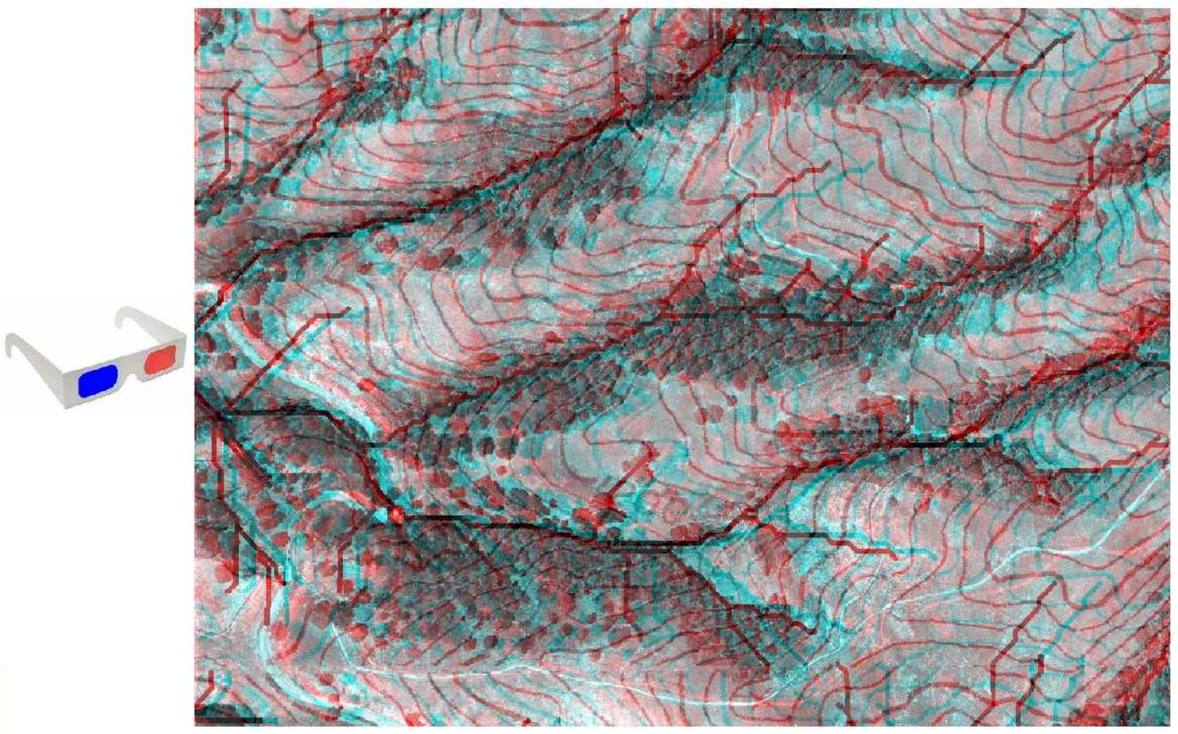
Pruning Drainage Density



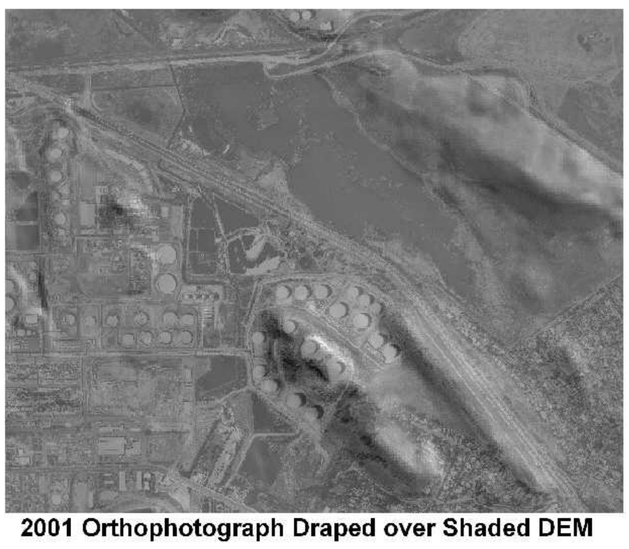


USGS 1:24,000 Topo Map Compared with Major Drainage from DEM

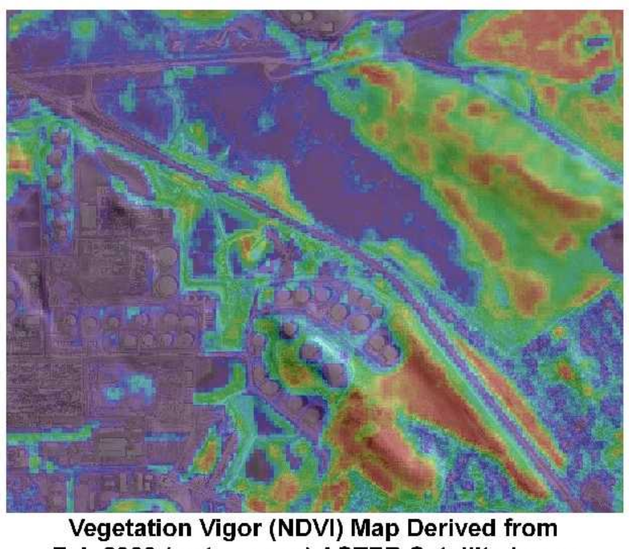
Vegetation



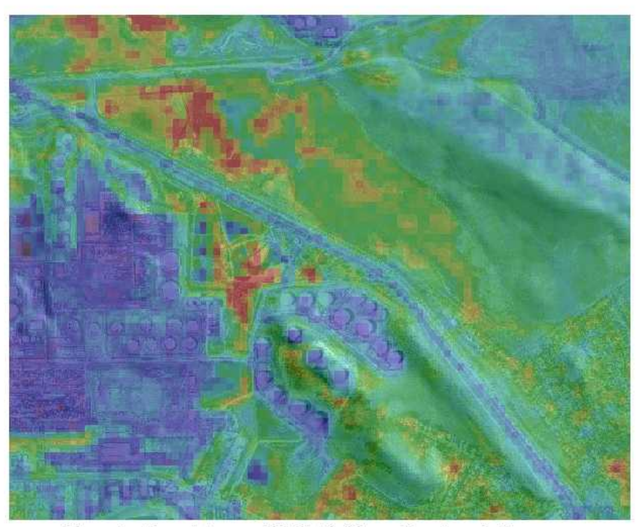
Stereo Viewing with Derived Streams and Contours Embedded in Aerial Photograph Improve Interpretation and Understanding of Oak Tree Distribution



2001 Orthophotograph Draped over Shaded DEM



Vegetation Vigor (NDVI) Map Derived from Feb 2003 (wet season) ASTER Satellite Image



Vegetation Vigor (NDVI) Map Derived from Oct 1999 (dry season) Landsat TM Image

Vegetation Vigor with DEM and Season

Acknowledgements: The Mt. Diablo Examples are from DVC's Geography 162 Introduction to Remote Sensing Lab. Anaglyphs are created with Leica IMAGINE 9.0. Drainage is developed with RIVIX, LLC's RiverTools v. 3.0 software. Heads-up mapping of anaglyphs (creating new shapefiles with attributes and metadata) is done with ESRI's ArcGIS 9.2.