Introduction to the Remote Sensing Digital Database

Support material for the textbook:
Remote Sensing Principles, Interpretation, and Applications, 4th edition, 2020

Available for download from the Publisher's website: http://www.waveland.com/Sabins-Ellis/

Comments and Questions?

Contact: James Ellis
jellis@ellis-geospatial.com
https://www.linkedin.com/in/jim-ellis-52b9386/

Remote Sensing Digital Database

Easy access to ready-to-use remote sensing data can be a challenge for instructors and students. We provide a user-friendly, downloadable, Remote Sensing Digital Database (RSDD) with our textbook to help jumpstart lab exercises and to enable students to digitally explore examples discussed in the textbook with image processing and GIS software. Remote sensing examples from the *technology* Chapters 1 to 10, along with images not discussed, are available in this database. The examples demonstrate many of the *applications* discussed in Chapters 11 to 17. The Digital Image Processing Lab Manual that accompanies the textbook uses the RSDD.

The database is organized into chapter folders 1 – 10, each containing images, DEMs, and/or maps that supplement the textbook discussion. Each chapter folder is zipped to expedite downloads. Proposed lab exercises are included in each chapter folder. Instructors are encouraged to download the zip files, and pick and choose exercises that meet their course objectives. Instructors and students can display, process, and interpret images on their computers with free open-source and commercial, image-processing and GIS software as described in Chapters 9 and 10. Step-by-step lab exercises using your remote sensing and GIS software can be developed from the database. Additional images and maps can be integrated into each example to improve the learning experience.

Data courtesy of USGS, NASA, ESA, JAXA, NOAA, Airbus DS, Maxar (DigitalGlobe), JPL, D. Ruiz (QSI), Galileo, and Contra Costa County.

Digital Image Processing Lab Manual

The lab manual that accompanies the textbook uses data in the Remote Sensing Digital Database along with some other data. The lab manual contains the following 12 lab exercises:

Lab 1 Introduction to ENVI – Five Display tools
Lab 2 Landsat Multispectral Processing - Seven Display tools
Lab 3 Image Processing 1 - Five Toolbox tools
Lab 4 Image Processing 2 - Four Toolbox tools
Lab 5 Band Ratios and Principal Components
Lab 6 Georeferencing
Lab 7 DEMs and Lidar
Lab 8 IHS and Image Sharpening
Lab 9 Unsupervised Classification
Lab 10 Supervised Classification
Lab 11 Hyperspectral
Lab 12 Change Detection and Radar

Each lab exercise includes references to discussions, figures, and photos in the textbook. The labs use Harris ENVI image-processing software to provide step-by-step guidance. Self-taught students have the opportunity for a 30-day, free ENVI license to complete the exercises and process other imagery in the database. Each lab averages 15 pages with screen captures of properly configured software menus, questions for the students to answer, and requests for student-processed files to be uploaded to the instructor.

The instructor can add or delete sections in each exercise to accommodate their lab schedule. The instructor can retain the structure and concepts in each exercise while replacing the step-by-step directions designed for ENVI software with instructions specially made for their lab's image processing software. Each lab (except Labs 4 and 8) has a small folder with additional data. The lab manual with accompanying data is available from the Waveland Press website.

Remote Sensing Digital Database – Some Technical Details

1) The database contains 30 examples totaling 6 GB in size.

- 27 have georeferenced images, DEMs, and/or maps with an ArcGIS .mxd project that rapidly loads and displays the files with appropriate symbology and legend organization.
- 2 have files that automatically display in Google Earth, ArcGIS Earth, and other virtual 3D Globes.
- 4 are high-resolution graphics of figures and plates in the textbook.

2) Each Chapter folder has 1 to 6 digital examples organized into subfolders with a label that describes the contents. Figure and/or Plate names are attached to those subfolders that contain remote sensing data corresponding to a figure and/or plate in the textbook. The next slide shows the database structure with subfolder names.

3) Each Chapter folder contains a READ ME file that explains the contents along with a screen capture of the digital data.

4) Each Chapter subfolder contains digital images, DEMs, and/or maps along with a description of the contents, ancillary information on the sensor, licensing guidelines (as needed), and metadata.

5) All the chapter subfolders contain georeferenced data except two subfolders in Chapter 1 that have only raster images of spatial and radiometric resolution.

Remote Sensing Digital Database – File Naming Convention

1) The georeferenced images and DEMs are in standard GeoTIFF format. The GeoTIFF format carries coordinate information so the images and DEMs will be displayed in their correct geographic location with "all" image processing and GIS software. These files are labelled "…GeoTIFF.tif".

2) GeoTiff formats do not carry the wavelengths associated with the multispectral and hyperspectral bands, so tables correlating bands and wavelengths are provided for GeoTIFF images with more than 5 bands.

3) Multispectral data with more than 5 bands and hyperspectral datacubes are in both GeoTiff and ENVI formats (ENVI preserves the band and wavelength information). These files are labelled "…ENVI_.img".

4) Enhanced color images, grayscale images, and hillshade DEMs (24-bit color and 8-bit grayscale raster files) are ready for GIS display and are labeled "…GIS.tif".

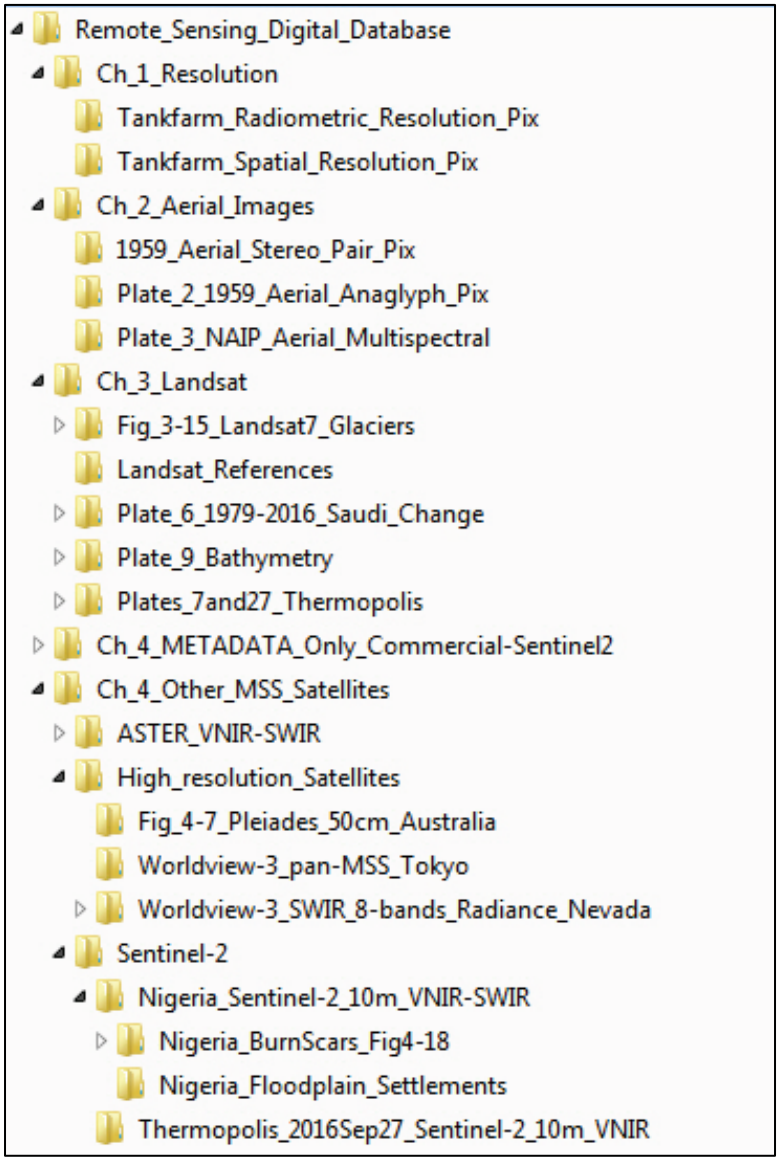
5) As an example, the file naming convention for data in Chapter 3, "Fig_3-15_Landsat7_Glaciers" subfolder is as follows:

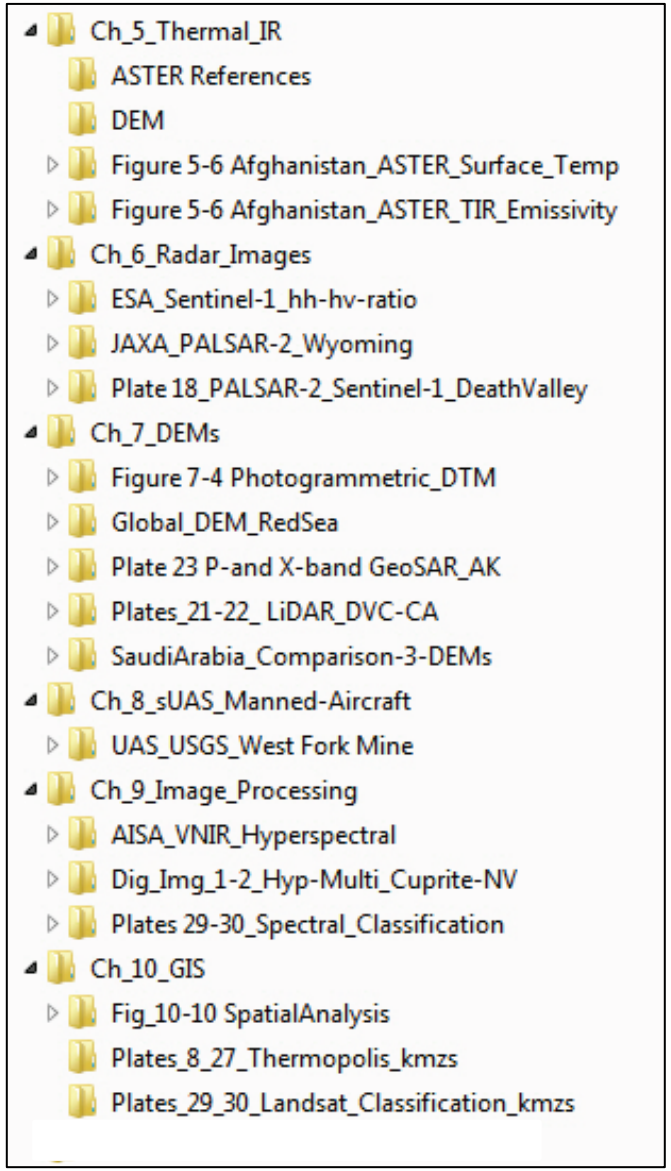
Badakhshan_Landsat7_30Jul2000_CLIP_6-bnd_ice_stack_GeoTIFF

Badakhshan_Landsat7_30Jul2000_CLIP_6-bnd_ice_ENVI

Badakhshan_Landsat7_30Jul2000_CLIP_543_GIS

Remote Sensing Digital Database Folder Structure



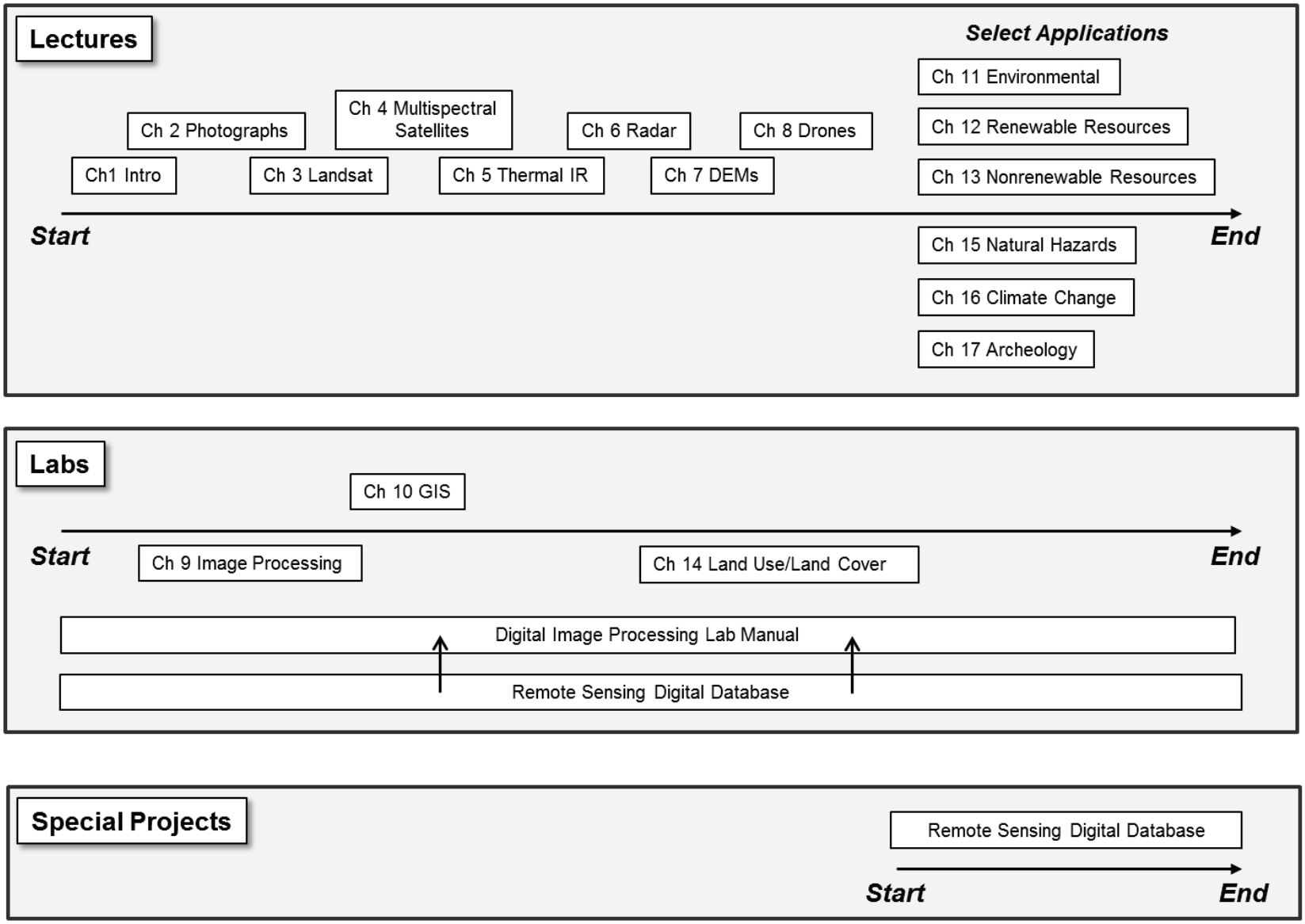


F.F. Sabins & J.M. Ellis, 2019, Remote Sensing – Principles, Interpretation, and Applications, 4th Ed., Waveland Press, Inc.

J. Ellis – 5June2019

6 GB of remote sensing data available for download and educational use.

A proposed course schedule that integrates the Textbook Chapters, Digital Image Processing Lab Manual, and the Remote Sensing Digital Database is shown below.



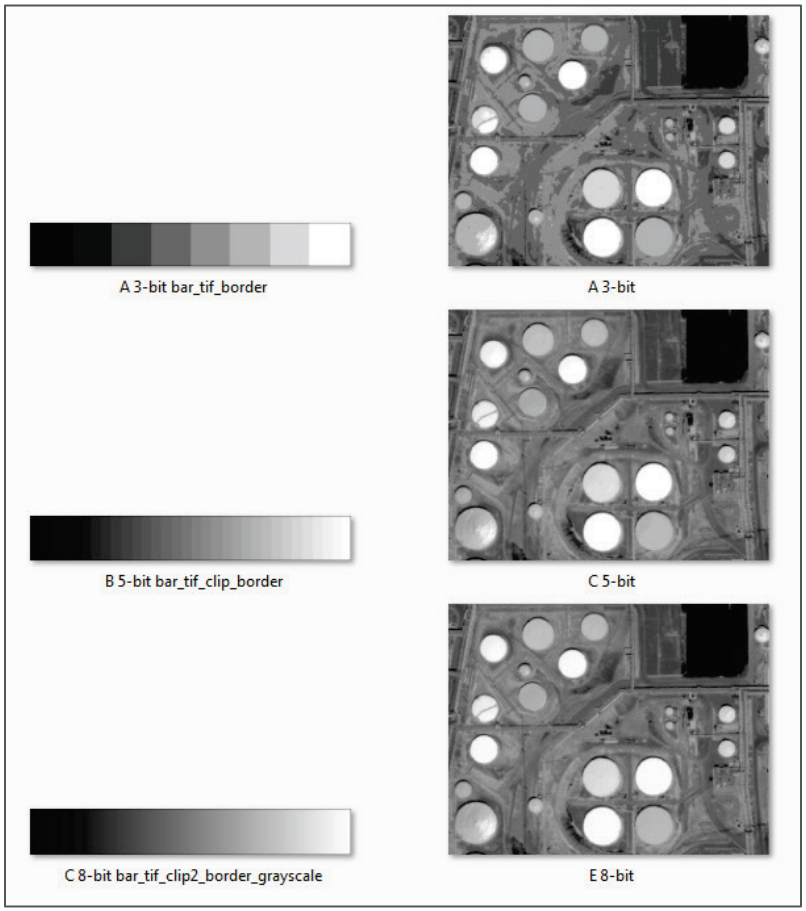
Remote Sensing Digital Database Examples

Organized by Chapter

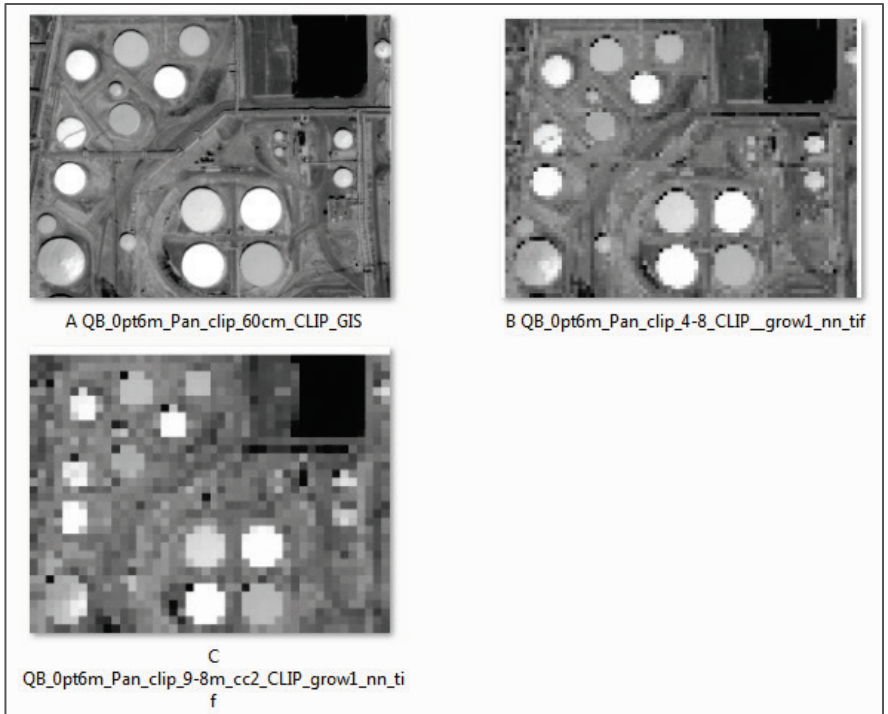
The following slides are computer screen captures of:

- **27 georeferenced examples displayed in ArcMap,**
- **2 examples displayed in virtual 3D globes, and**
- **4 grayscale and color pictures.**

Radiometric resolution pictures



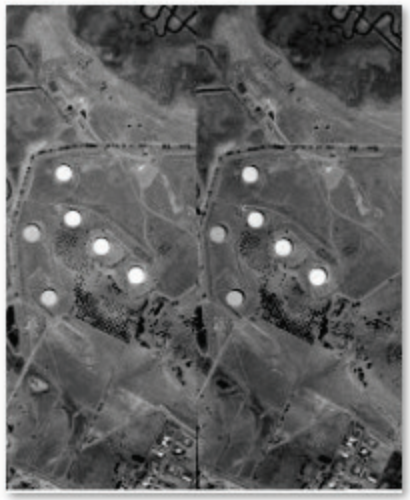
Spatial resolution pictures



Oil Tanks, Martinez, California. Courtesy D. Ruiz, QSI

Chapter 2: Aerial Photography

Stereo pictures



1959_stereopair_2-2-inch_separation

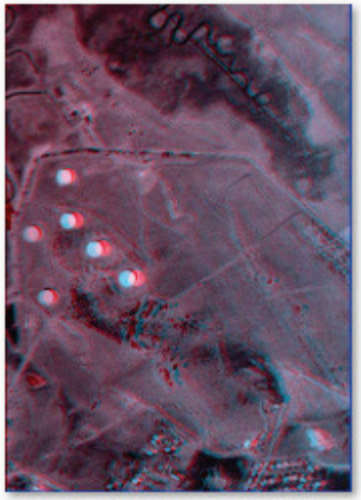


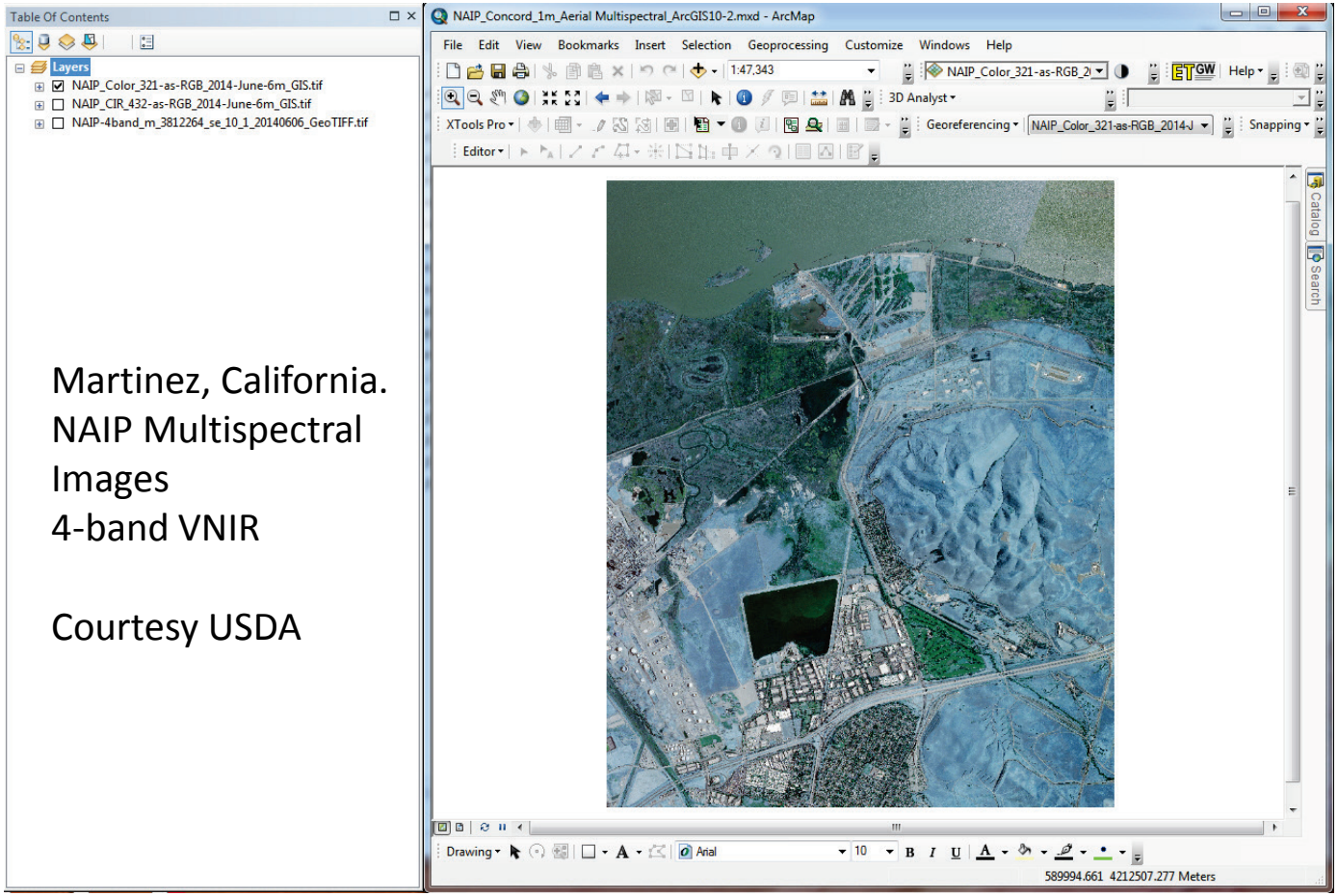
Plate 2· Airphoto Stereo



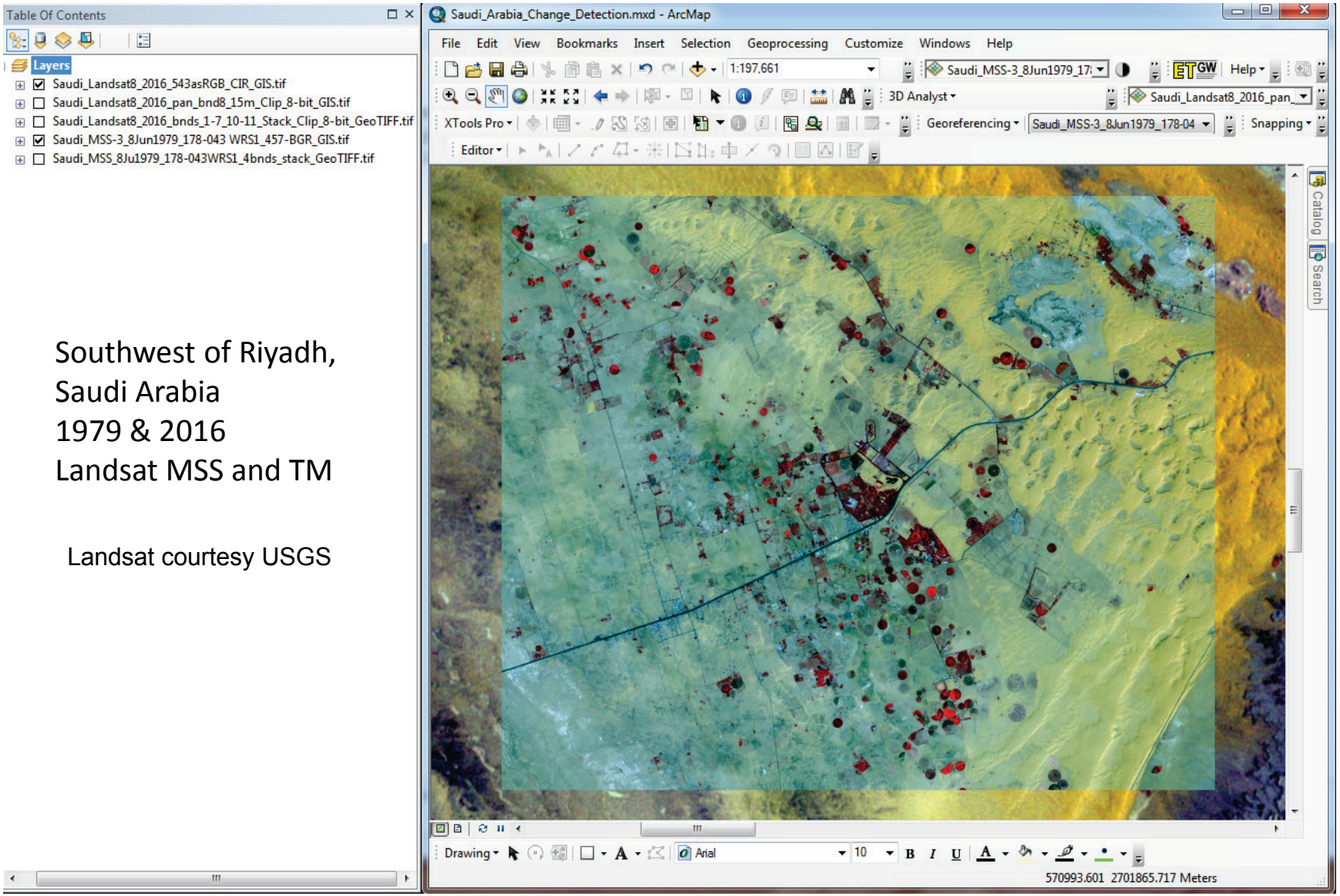
Courtesy D. Ruiz, QSI

Martinez, California.
NAIP Multispectral Images
4-band VNIR

Courtesy USDA



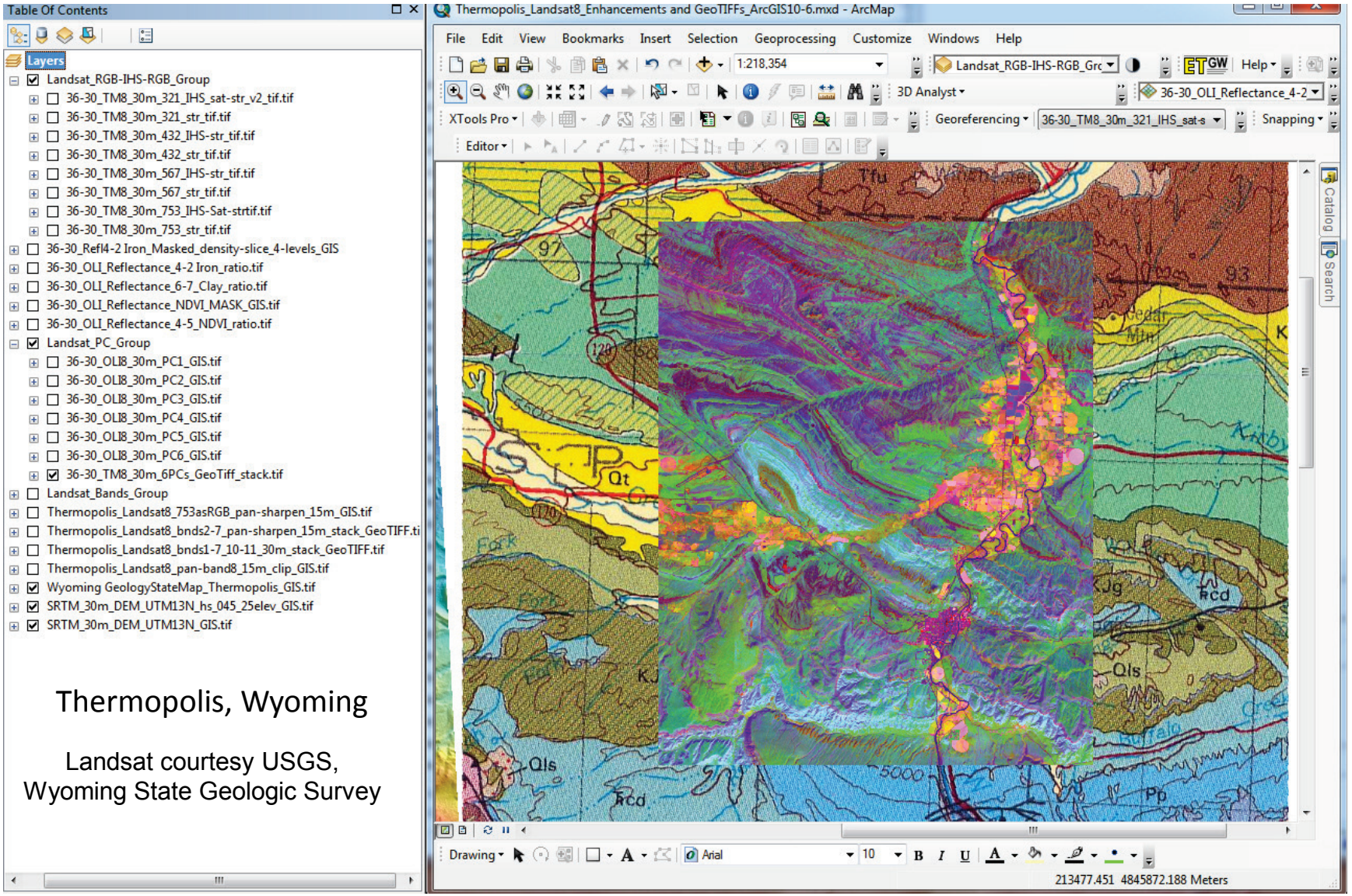
Chapter 3: Landsat



Southwest of Riyadh,
Saudi Arabia
1979 & 2016
Landsat MSS and TM

Landsat courtesy USGS

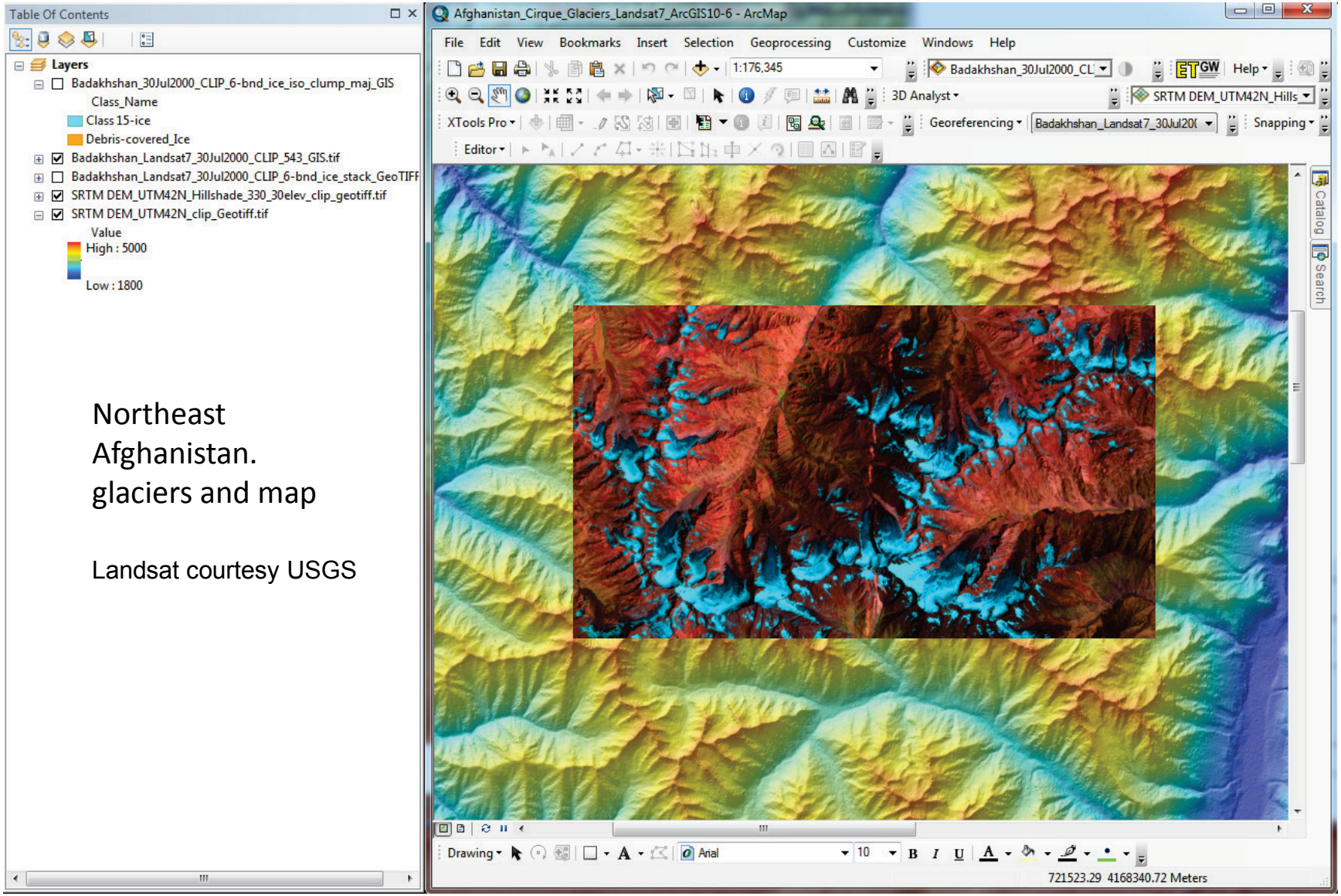
Chapter 3: Landsat



Thermopolis, Wyoming

Landsat courtesy USGS,
Wyoming State Geologic Survey

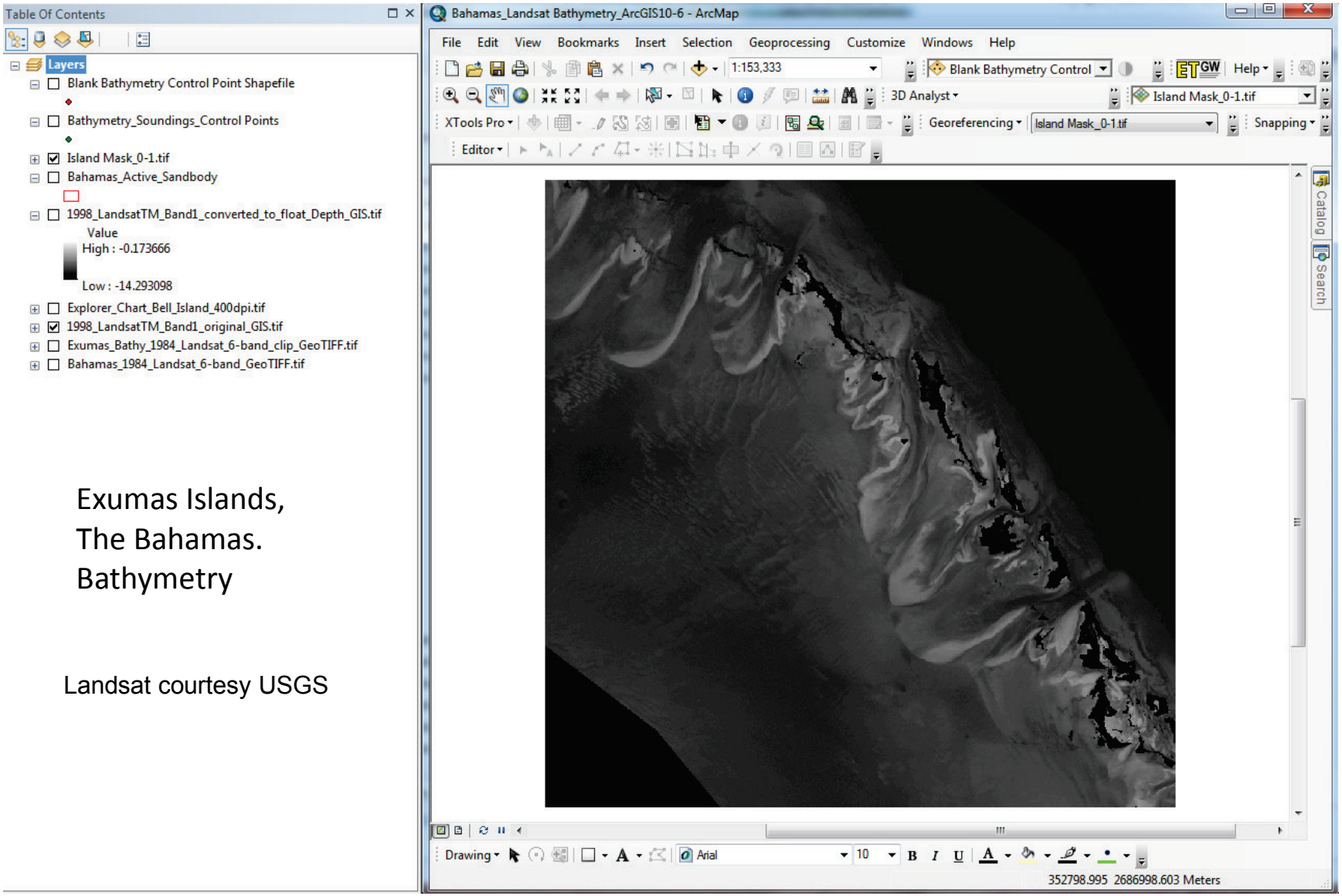
Chapter 3: Landsat



Northeast Afghanistan. glaciers and map

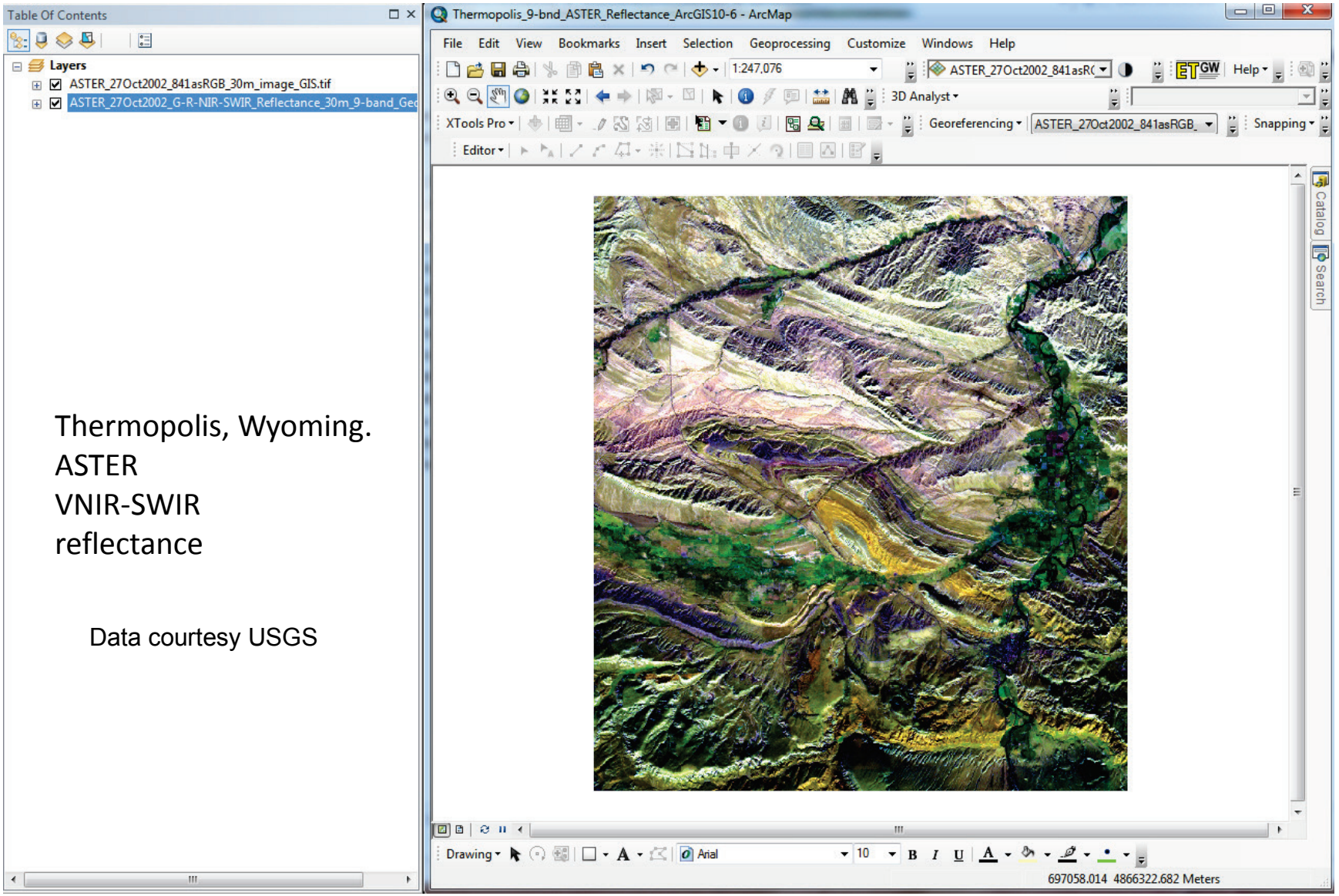
Landsat courtesy USGS

Chapter 3: Landsat



Exumas Islands,
The Bahamas.
Bathymetry

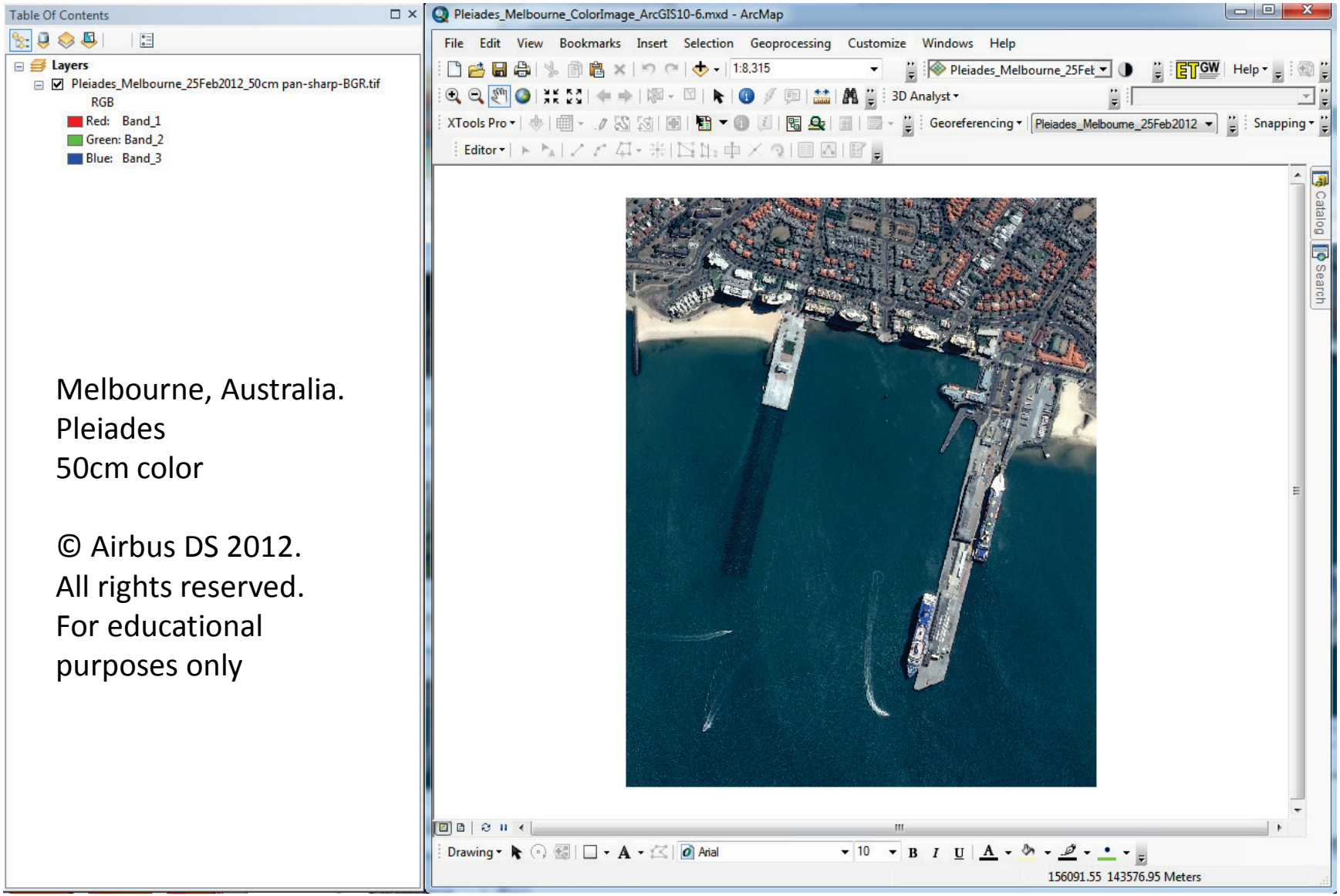
Landsat courtesy USGS



Thermopolis, Wyoming.
ASTER
VNIR-SWIR
reflectance

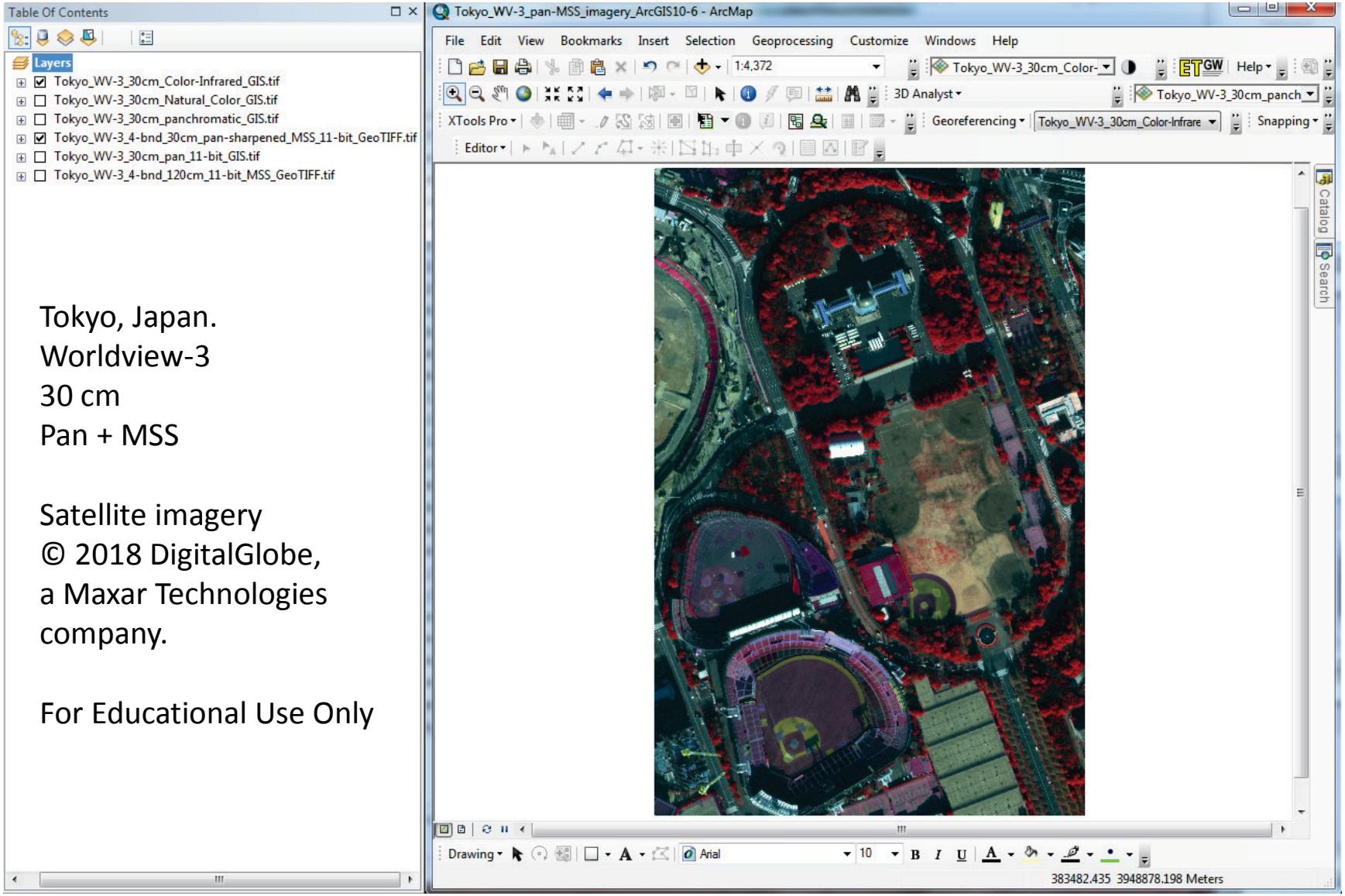
Data courtesy USGS

Compare to Ch 3 Thermopolis Landsat OLI data. Not referenced in text.



Melbourne, Australia.
Pleiades
50cm color

© Airbus DS 2012.
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For educational
purposes only



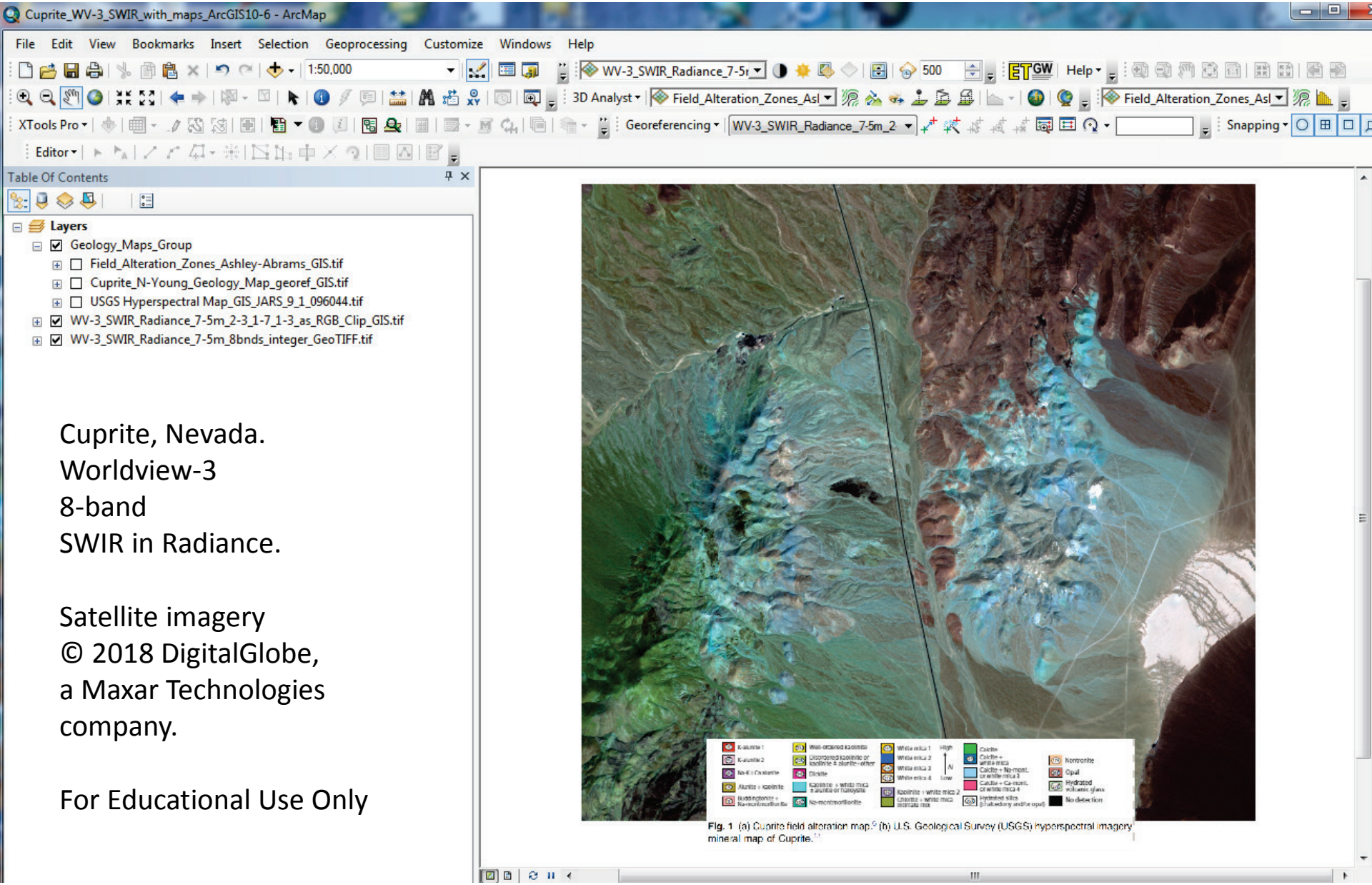
Tokyo, Japan.
Worldview-3
30 cm
Pan + MSS

Satellite imagery
© 2018 DigitalGlobe,
a Maxar Technologies
company.

For Educational Use Only

 Tennis courts in Figure 4-9 just outside the southeast corner of this subscene)

Chapter 4: Multispectral Satellites

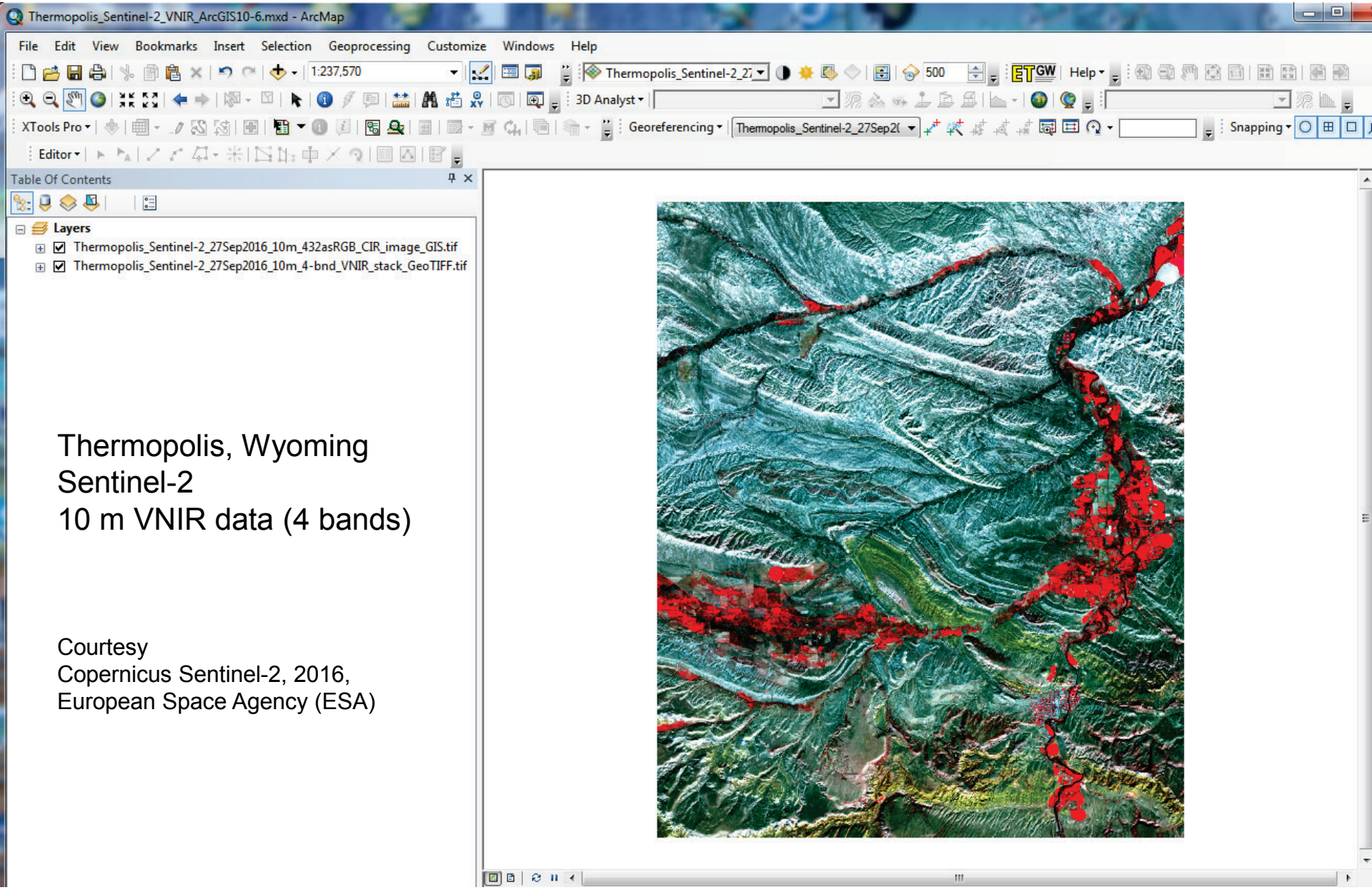


Cuprite, Nevada.
Worldview-3
8-band
SWIR in Radiance.

Satellite imagery
© 2018 DigitalGlobe,
a Maxar Technologies
company.

For Educational Use Only

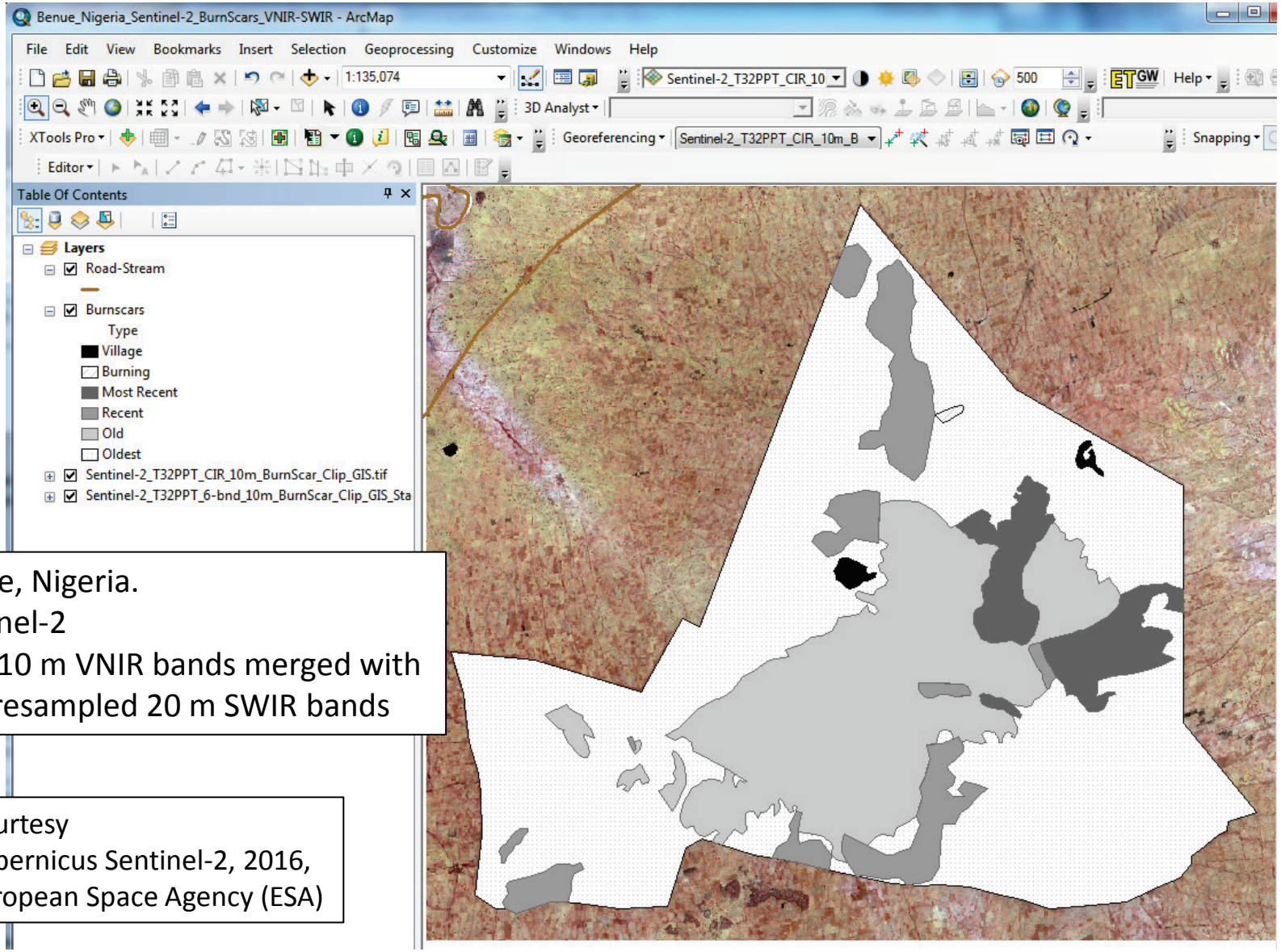
Chapter 4: Multispectral Satellites



Thermopolis, Wyoming
Sentinel-2
10 m VNIR data (4 bands)

Courtesy
Copernicus Sentinel-2, 2016,
European Space Agency (ESA)

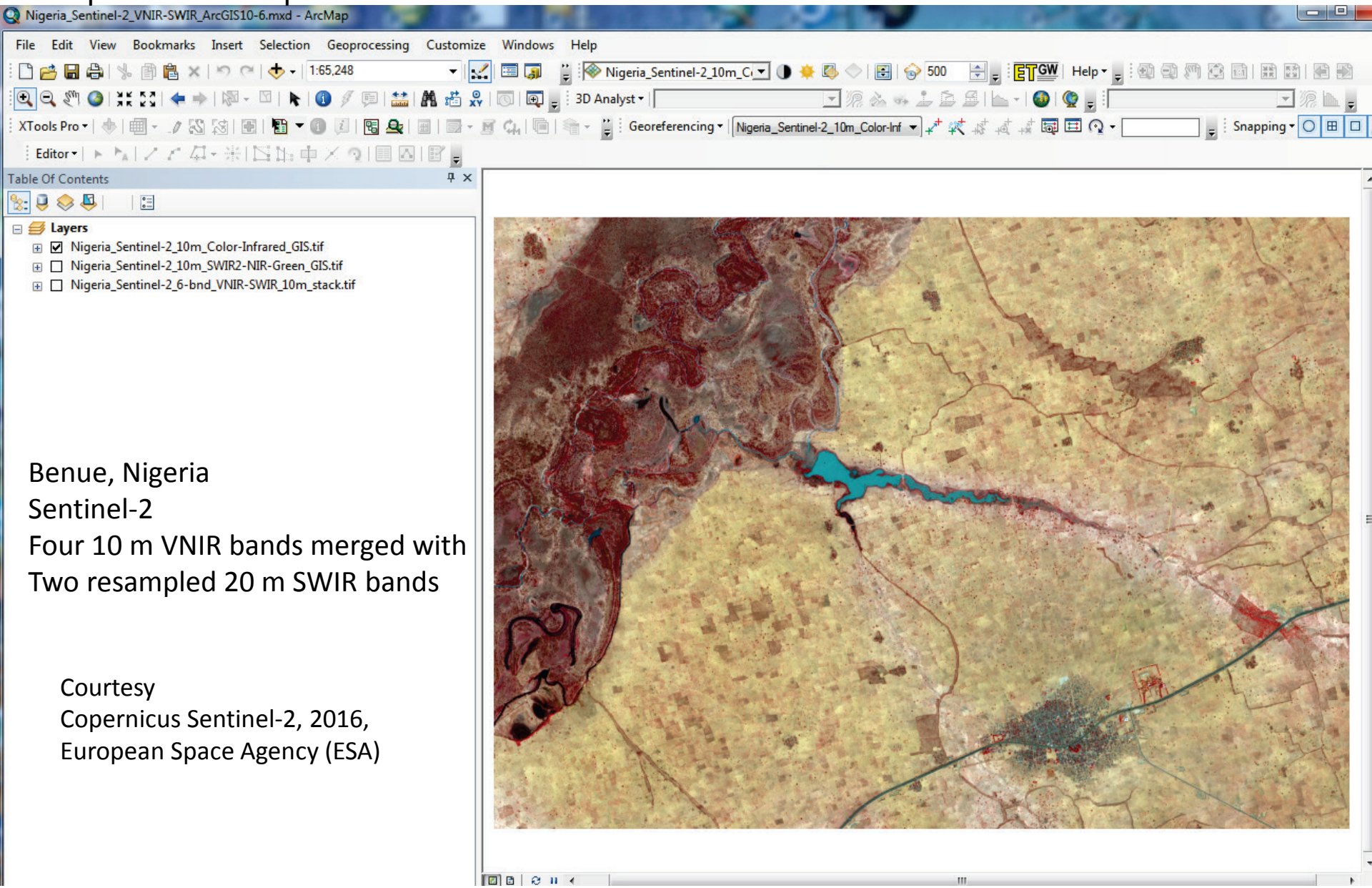
Chapter 4: Multispectral Satellites



Benue, Nigeria.
Sentinel-2
Four 10 m VNIR bands merged with
Two resampled 20 m SWIR bands

Courtesy
Copernicus Sentinel-2, 2016,
European Space Agency (ESA)

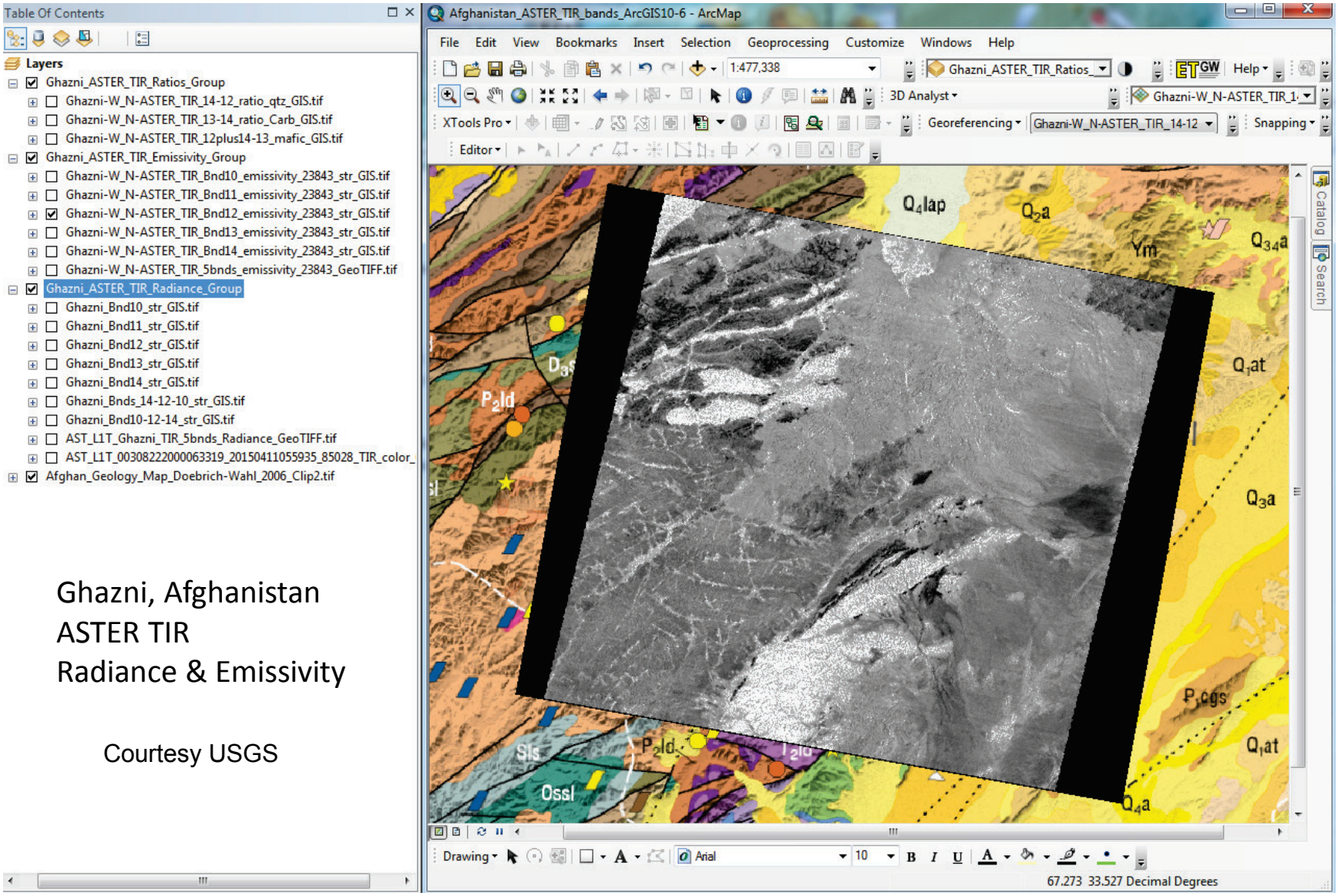
Chapter 4: Multispectral Satellites



Benue, Nigeria
Sentinel-2
Four 10 m VNIR bands merged with
Two resampled 20 m SWIR bands

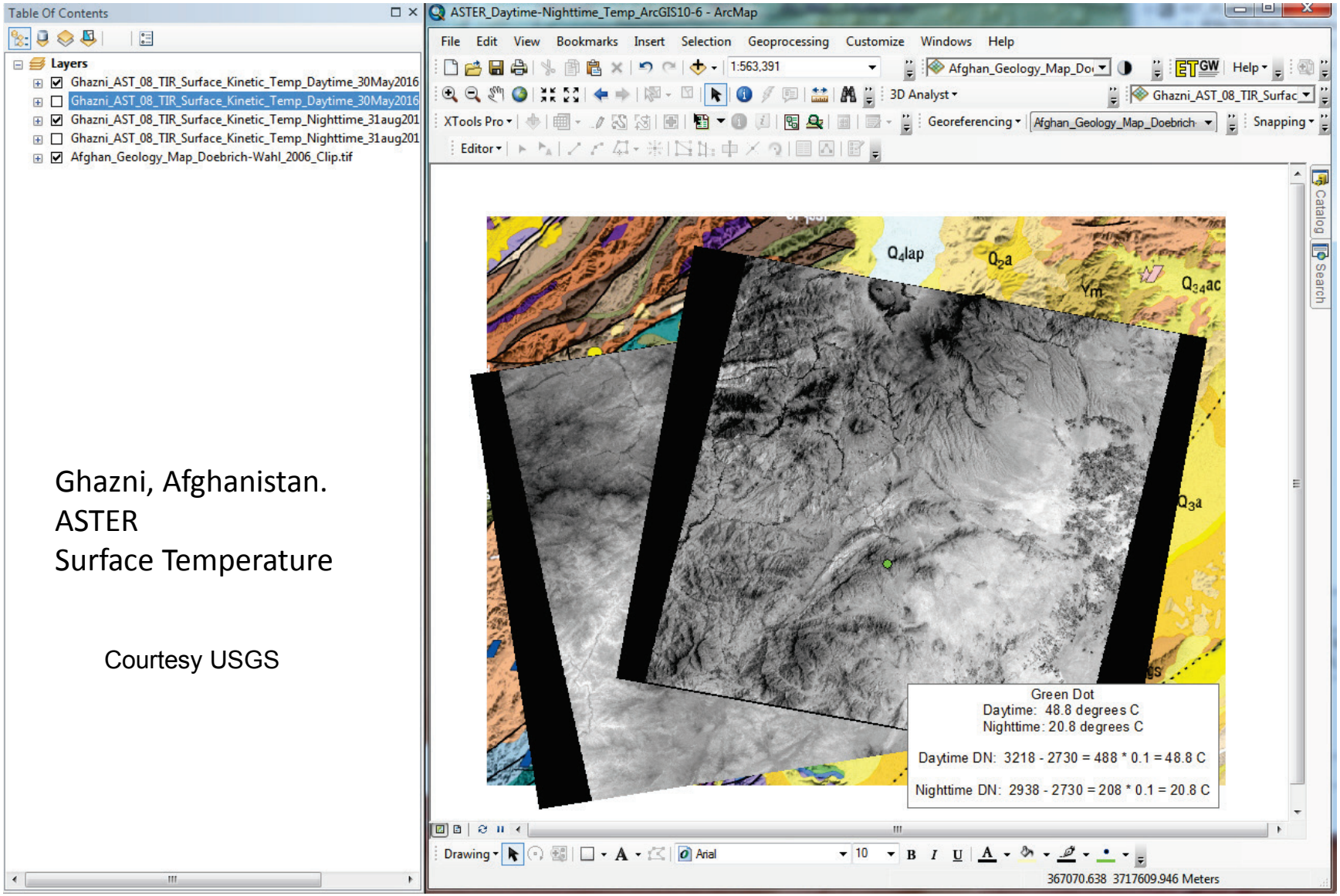
Courtesy
Copernicus Sentinel-2, 2016,
European Space Agency (ESA)

Chapter 5: Thermal IR



Ghazni, Afghanistan
ASTER TIR
Radiance & Emissivity

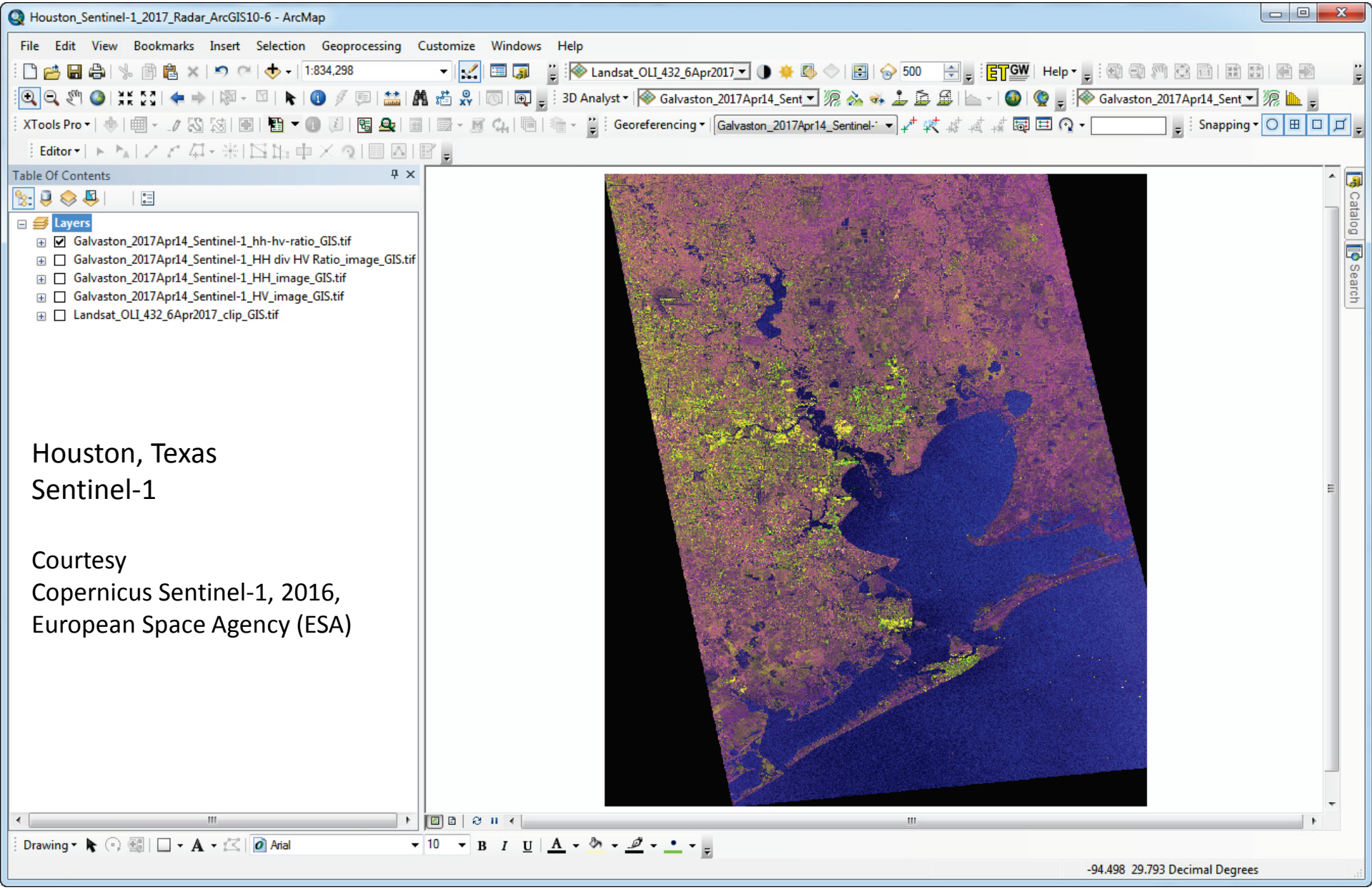
Courtesy USGS



Ghazni, Afghanistan.
ASTER
Surface Temperature

Courtesy USGS

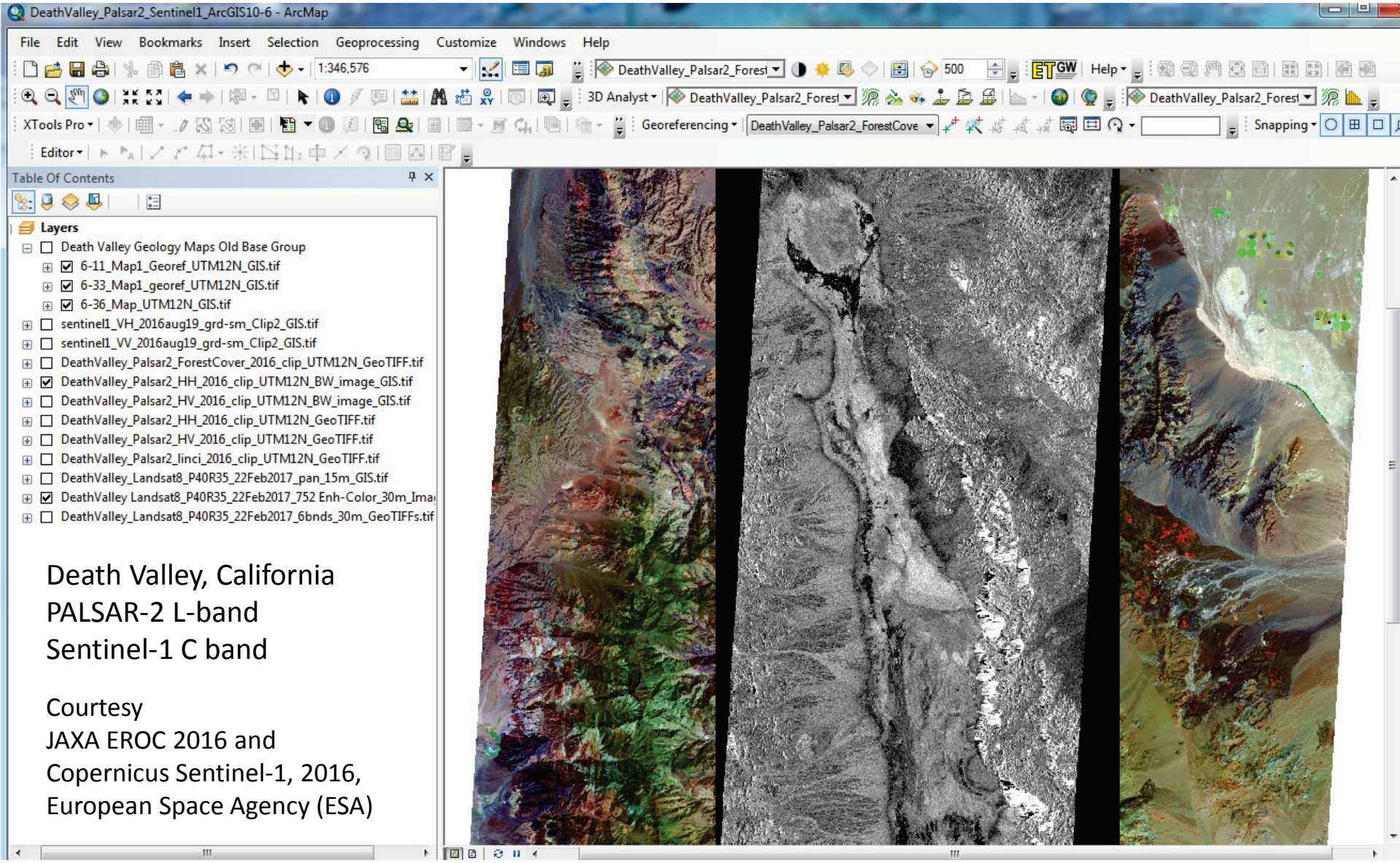
Chapter 6: Radar Imagery



Houston, Texas
Sentinel-1

Courtesy
Copernicus Sentinel-1, 2016,
European Space Agency (ESA)

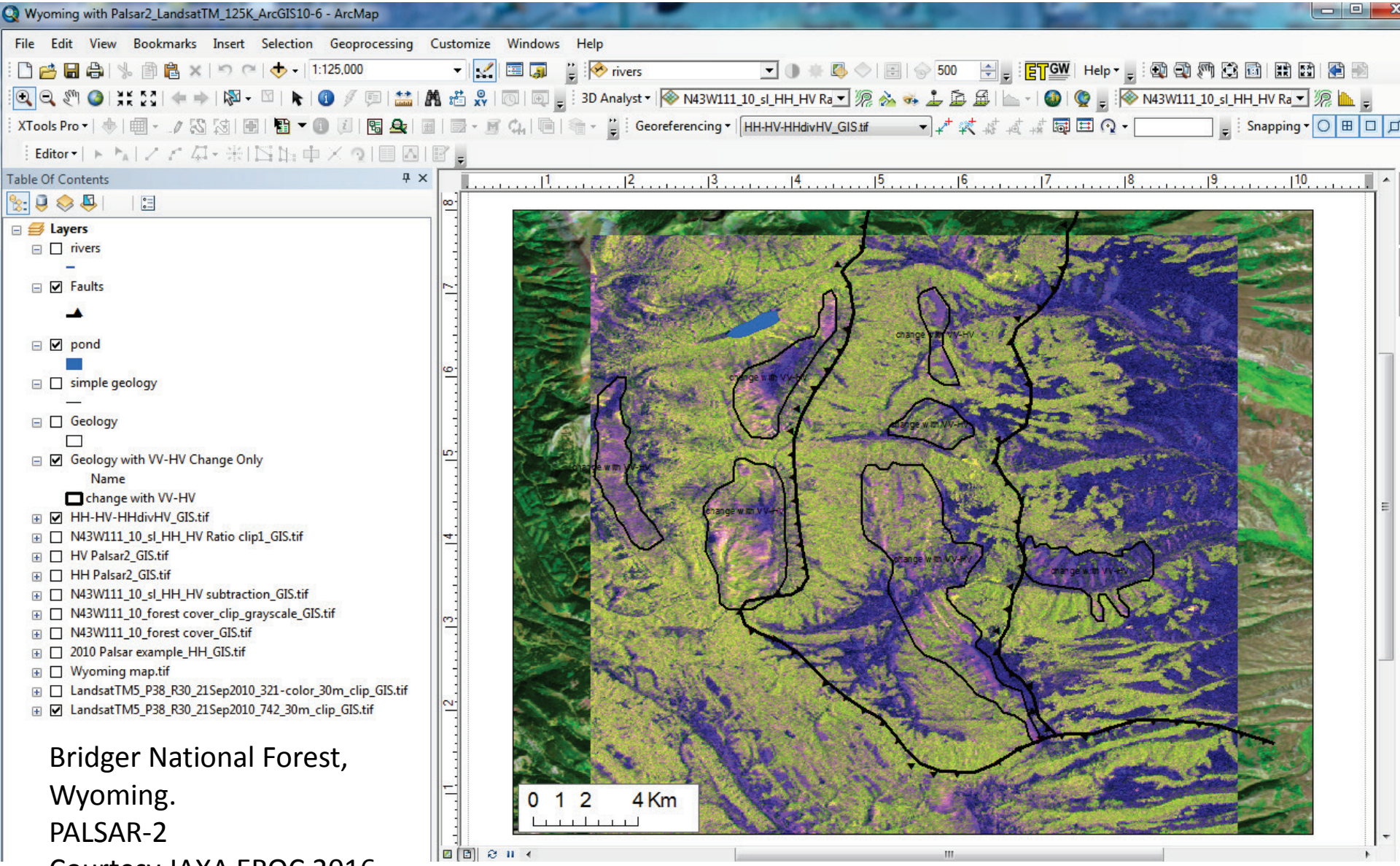
Chapter 6: Radar Imagery



Death Valley, California
PALSAR-2 L-band
Sentinel-1 C band

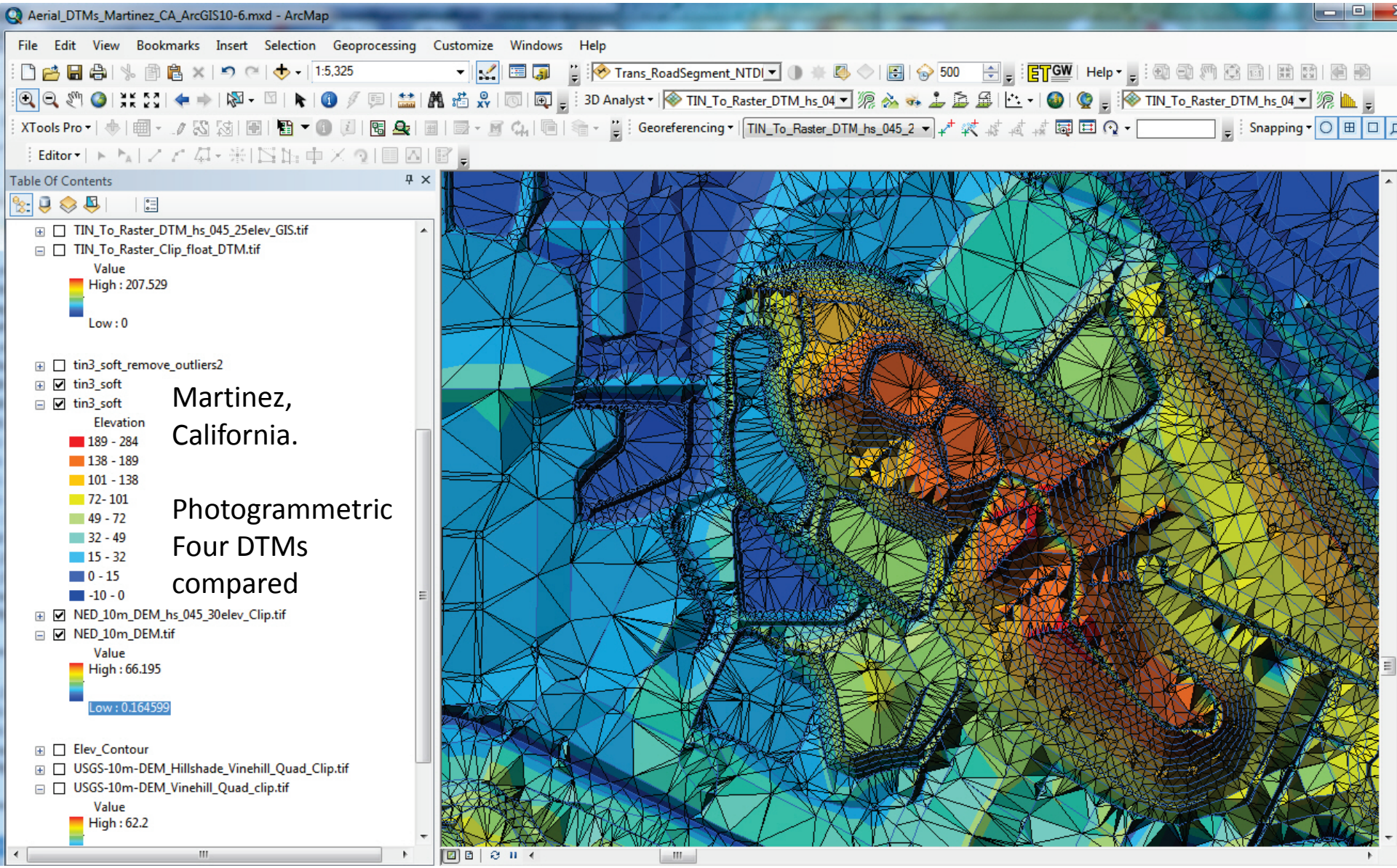
Courtesy
JAXA EROC 2016 and
Copernicus Sentinel-1, 2016,
European Space Agency (ESA)

Chapter 6: Radar Imagery



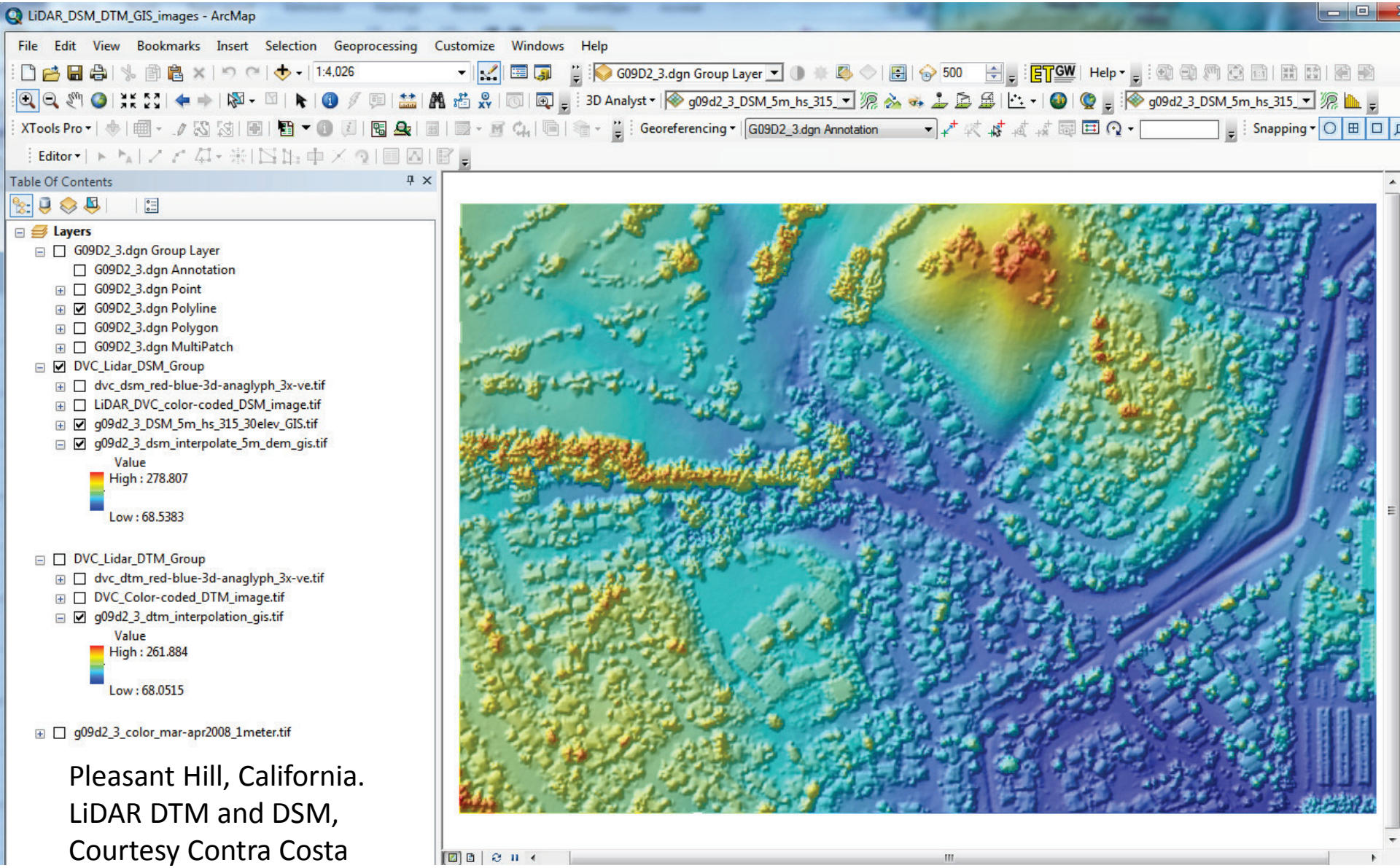
Bridger National Forest, Wyoming.
PALSAR-2
Courtesy JAXA EROC 2016

Chapter 7: DEMs



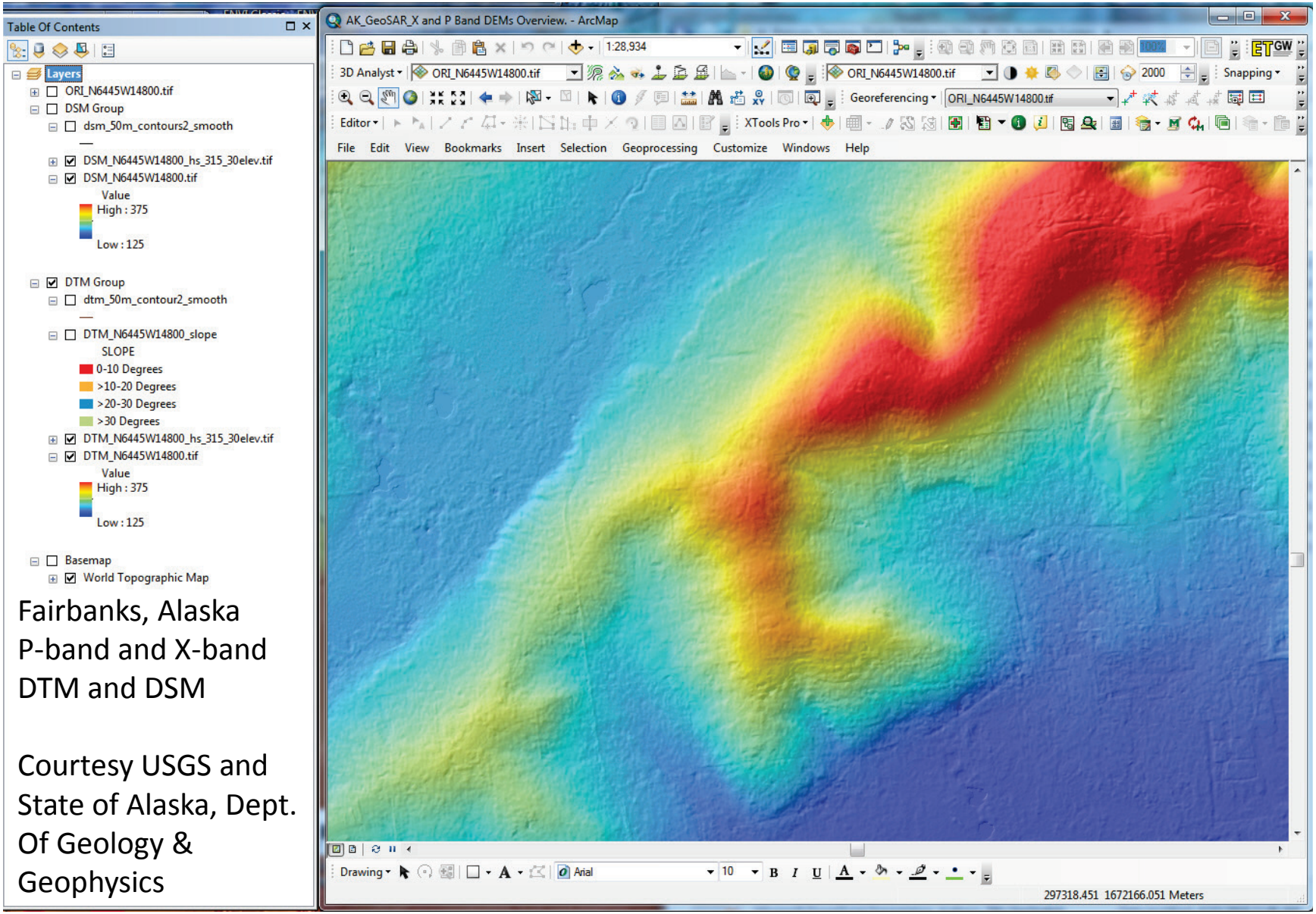
Courtesy USGS; P, Ashley, TetraTech

Chapter 7: DEMs



Pleasant Hill, California. LiDAR DTM and DSM, Courtesy Contra Costa County.

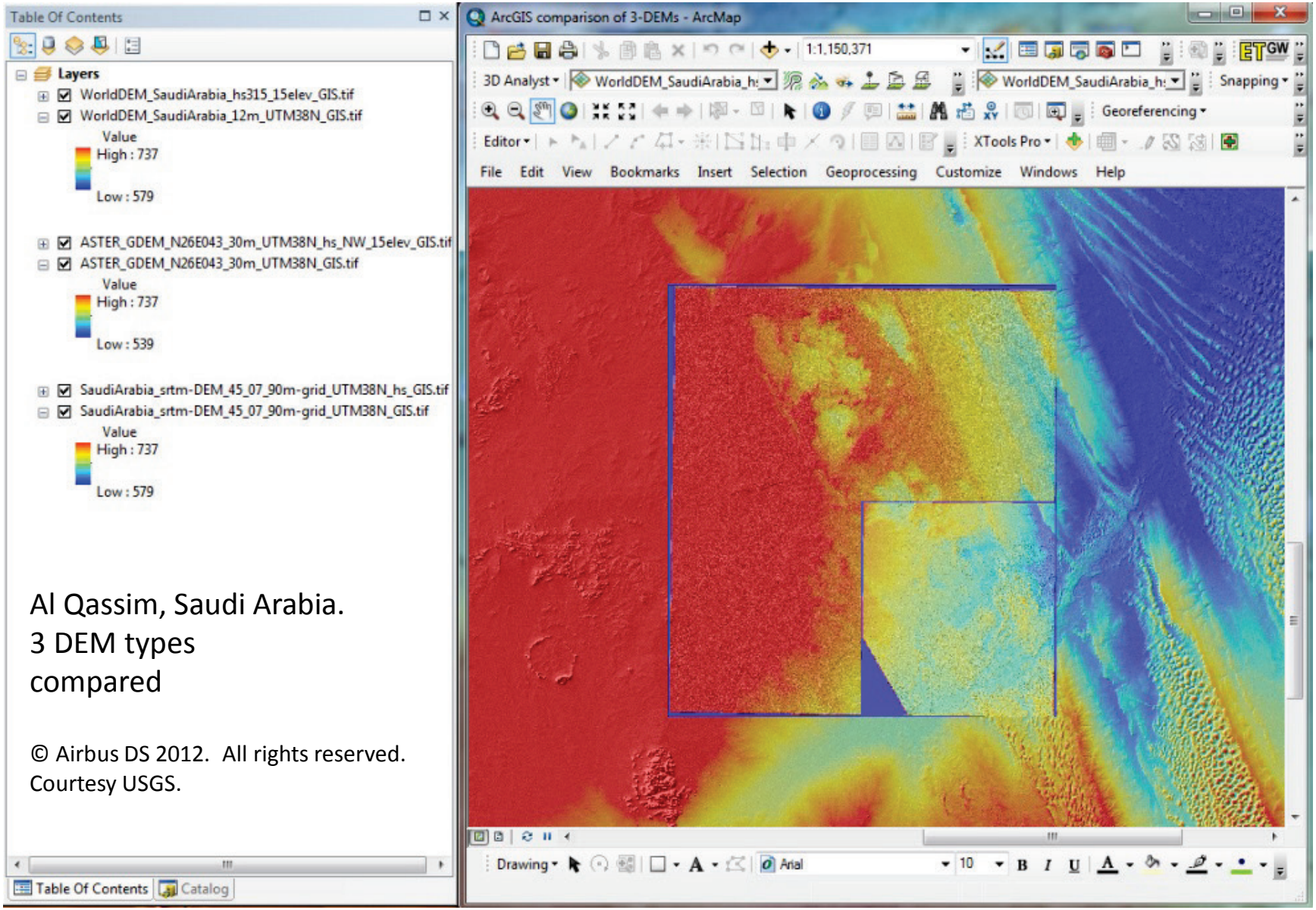
Chapter 7: DEMs



Fairbanks, Alaska
P-band and X-band
DTM and DSM

Courtesy USGS and State of Alaska, Dept. Of Geology & Geophysics

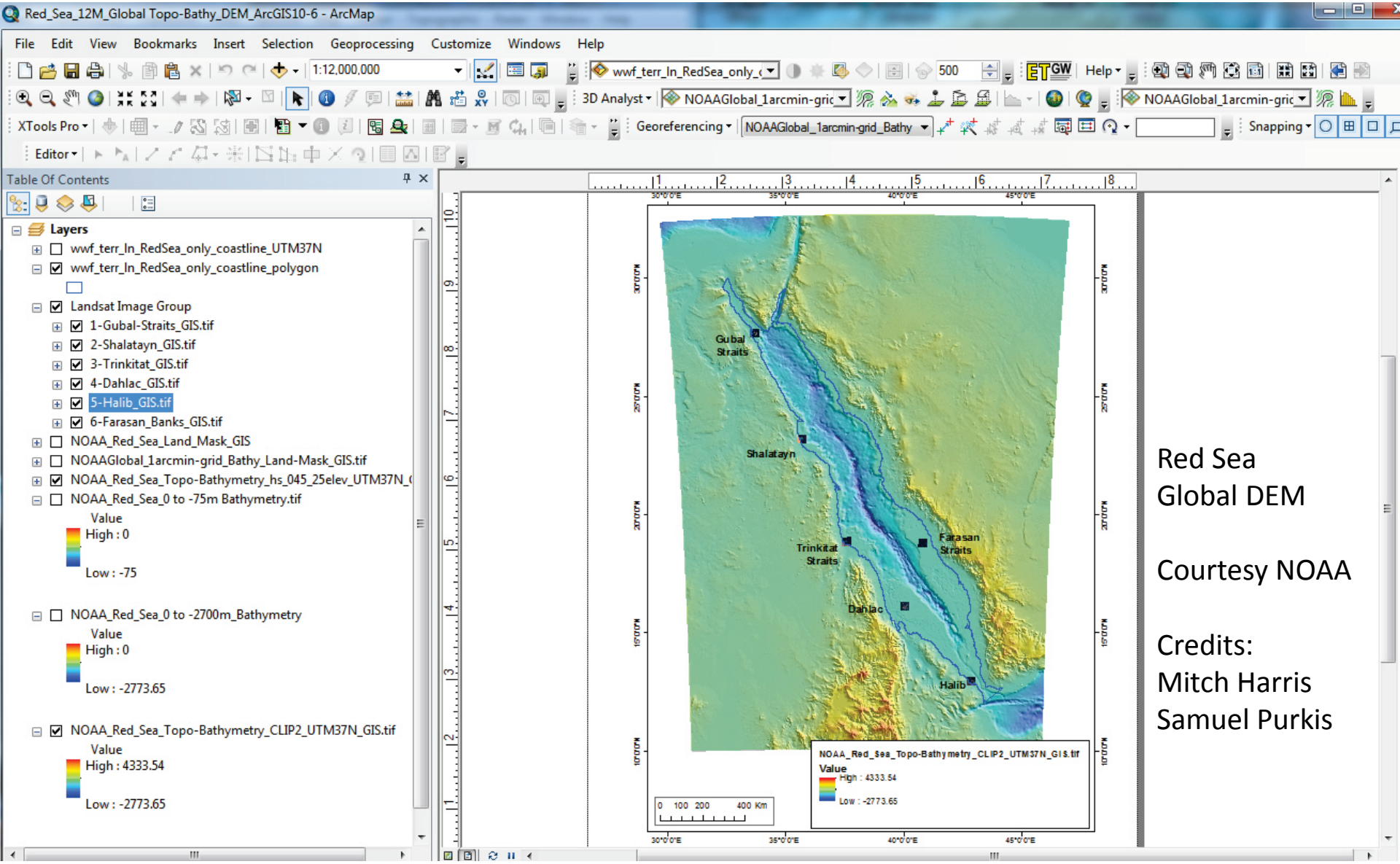
Chapter 7: DEMs



Al Qassim, Saudi Arabia.
3 DEM types
compared

© Airbus DS 2012. All rights reserved.
Courtesy USGS.

Chapter 7: DEMs

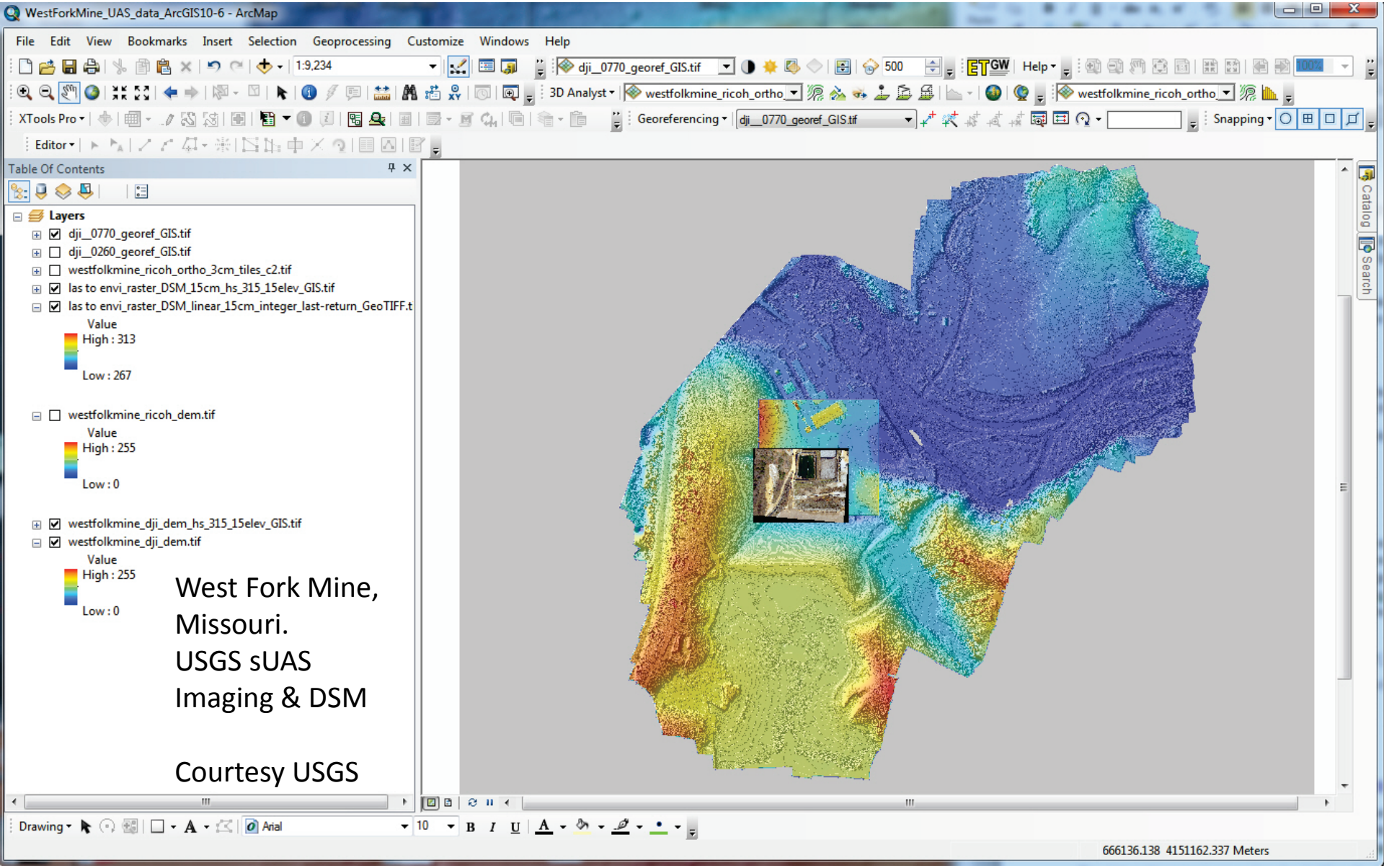


Red Sea
Global DEM

Courtesy NOAA

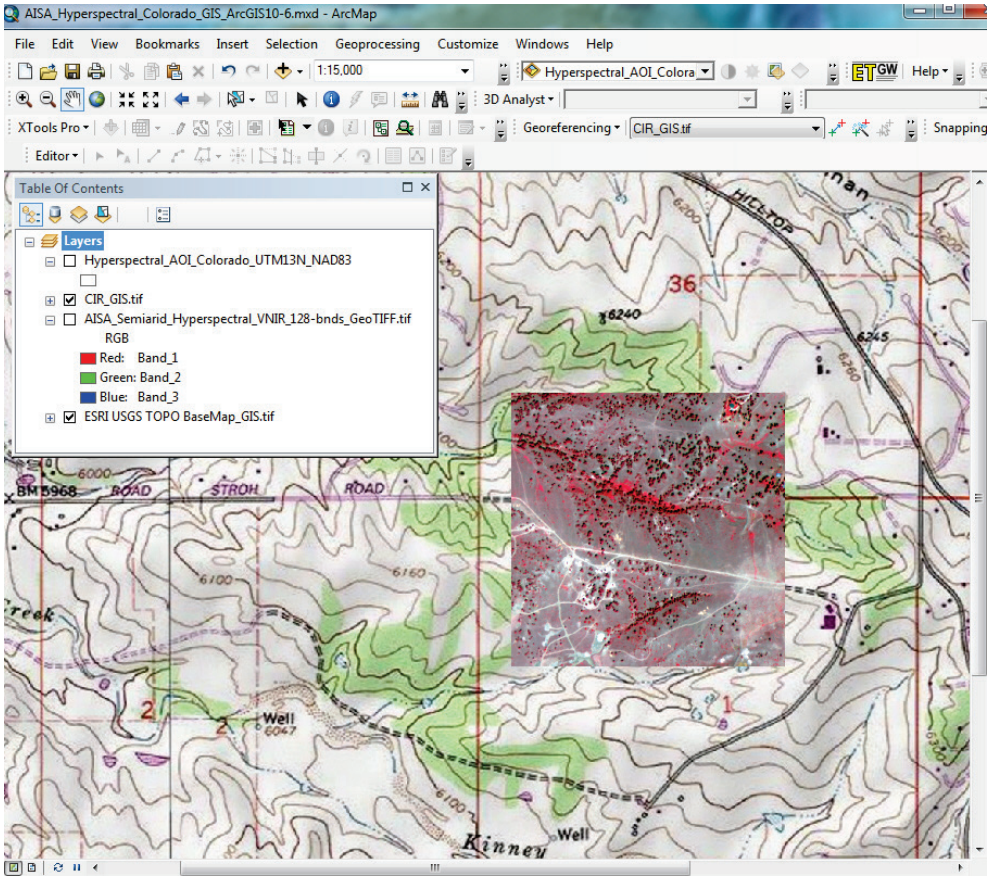
Credits:
Mitch Harris
Samuel Purkis

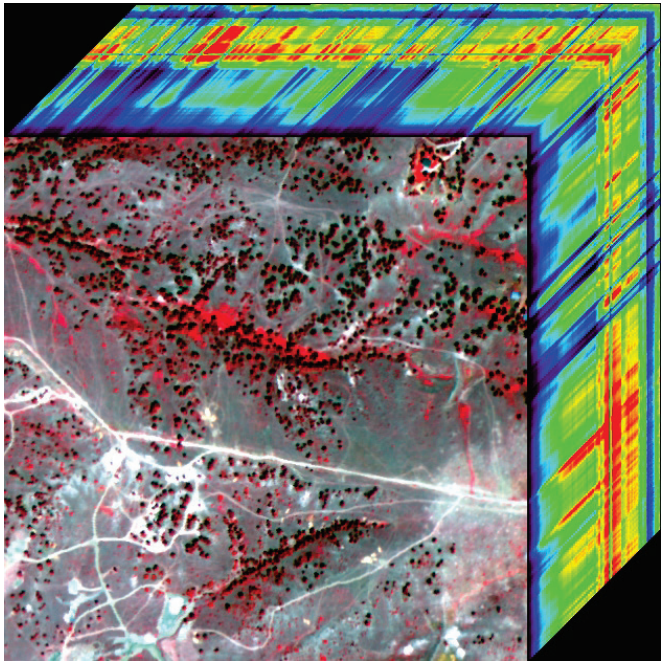
Chapter 8: sUAS/drones



Chapter 9: Image Processing

Douglas County, Colorado.
AISA VNIR 128-band
Hyperspectral Data
2 m pixels
Available as ENVI datacube with wavelengths
Also available as GeoTIFF stack without wavelengths (refer to table in database)





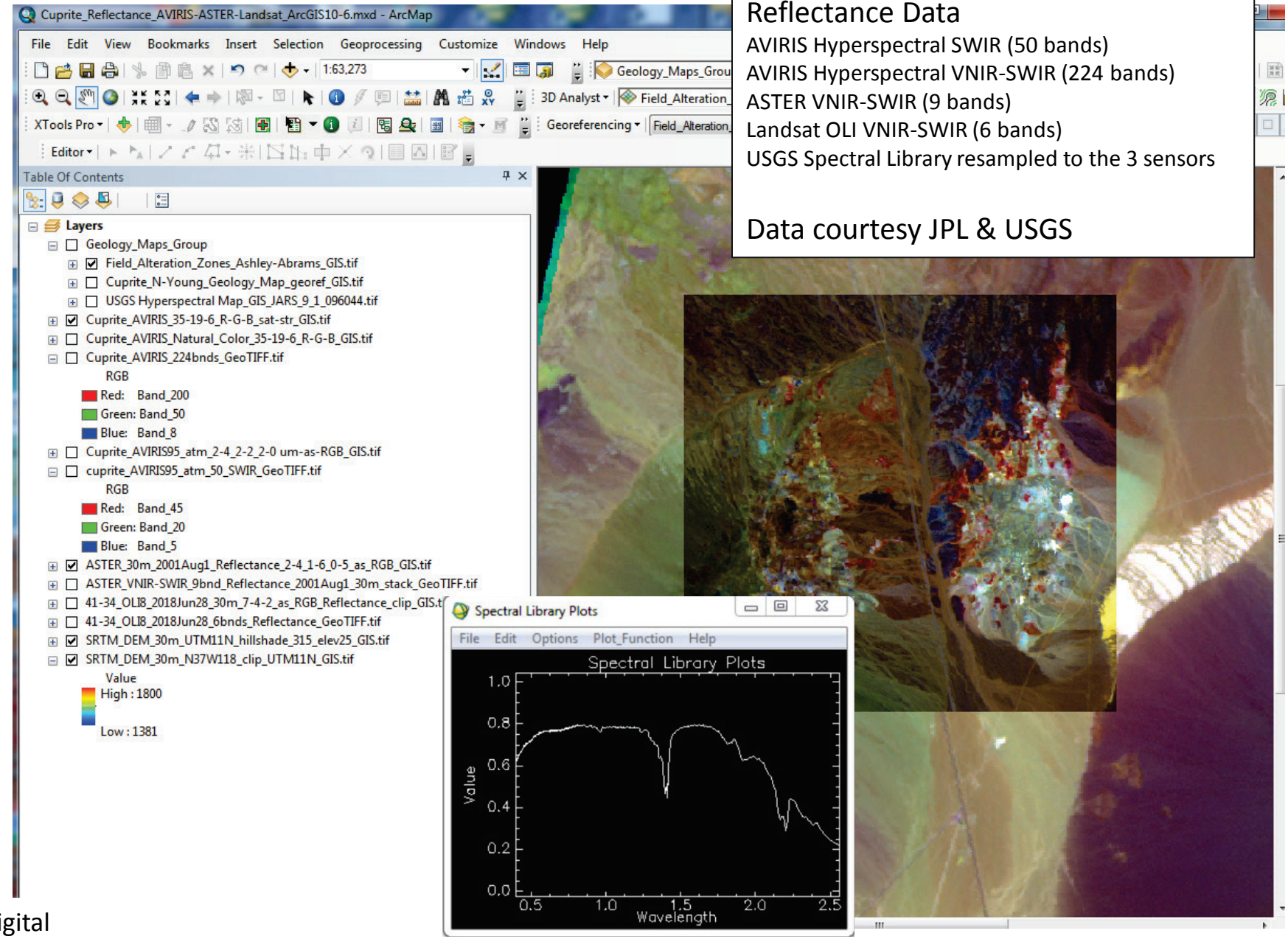
Located 39 km SE of Denver

Courtesy Galileo Group Inc.

Chapter 9: Image Processing

Cuprite, Nevada.
Reflectance Data
AVIRIS Hyperspectral SWIR (50 bands)
AVIRIS Hyperspectral VNIR-SWIR (224 bands)
ASTER VNIR-SWIR (9 bands)
Landsat OLI VNIR-SWIR (6 bands)
USGS Spectral Library resampled to the 3 sensors

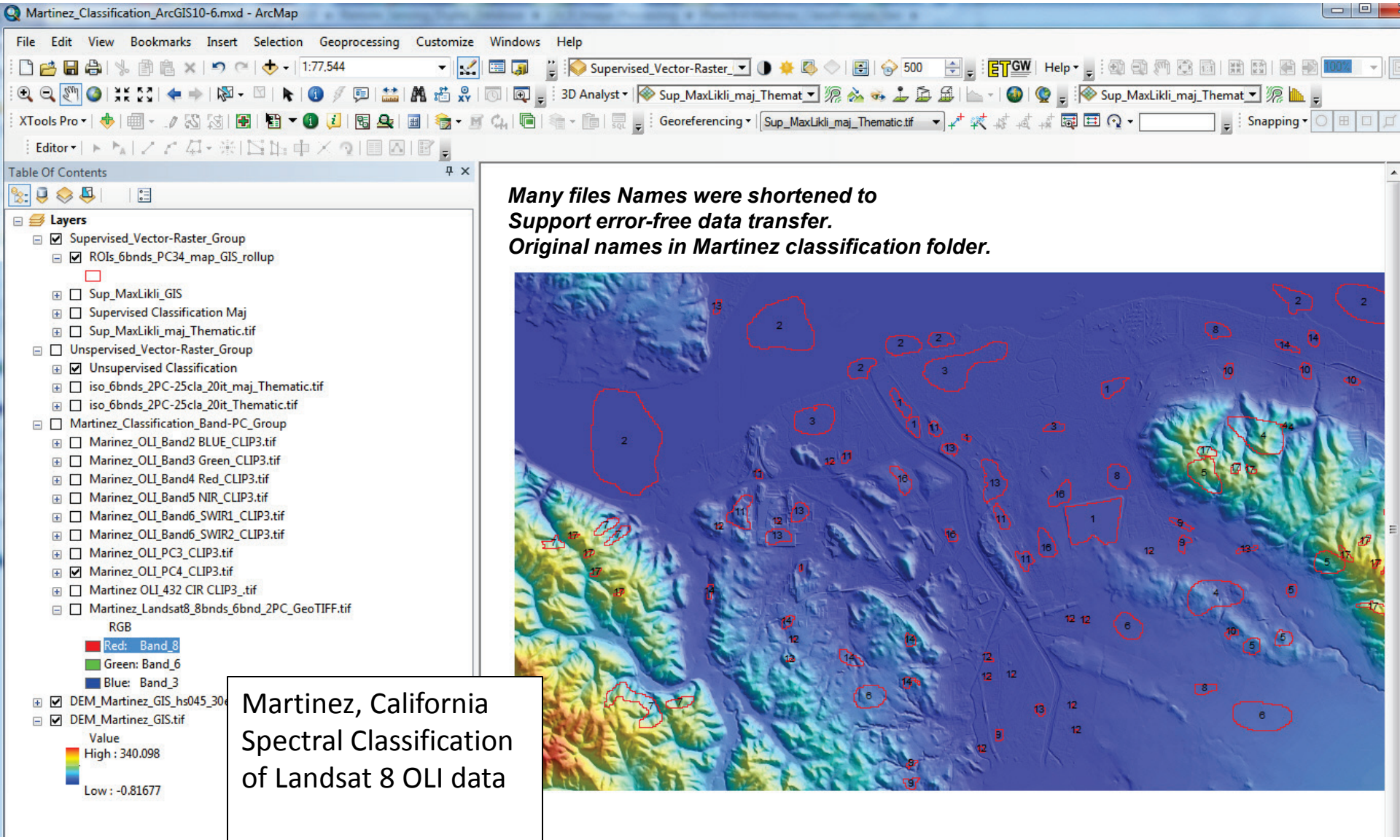
Data courtesy JPL & USGS



Digital Database

Digital Image 1-2; Compare to WV-3 Radiance SWIR data set in Ch 4 of Digital Database J. Ellis – 11 Jan 2019

Chapter 9: Image Processing

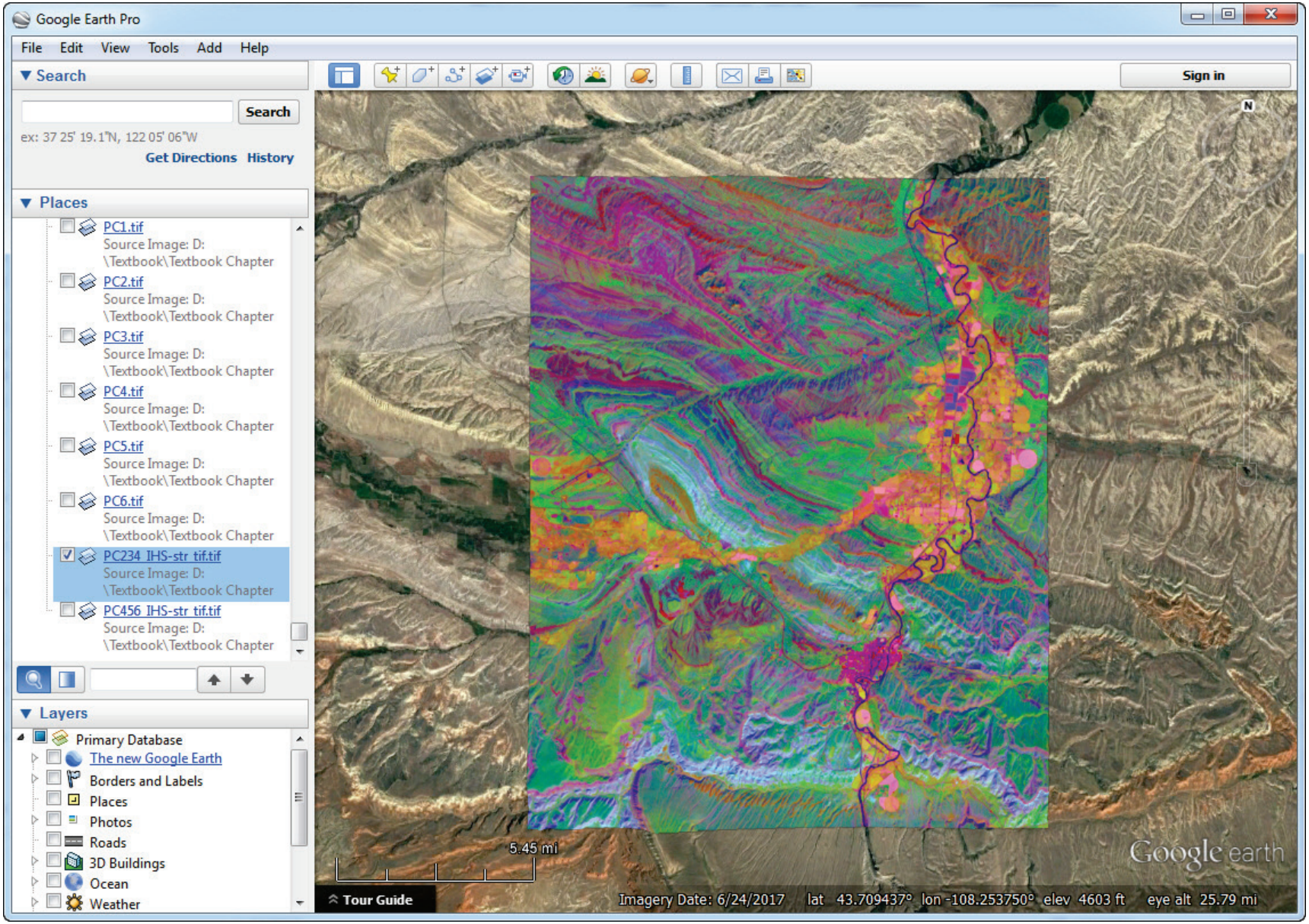


Many files Names were shortened to Support error-free data transfer. Original names in Martinez classification folder.

Martinez, California
Spectral Classification
of Landsat 8 OLI data

Data courtesy USGS

Chapter 10: GIS

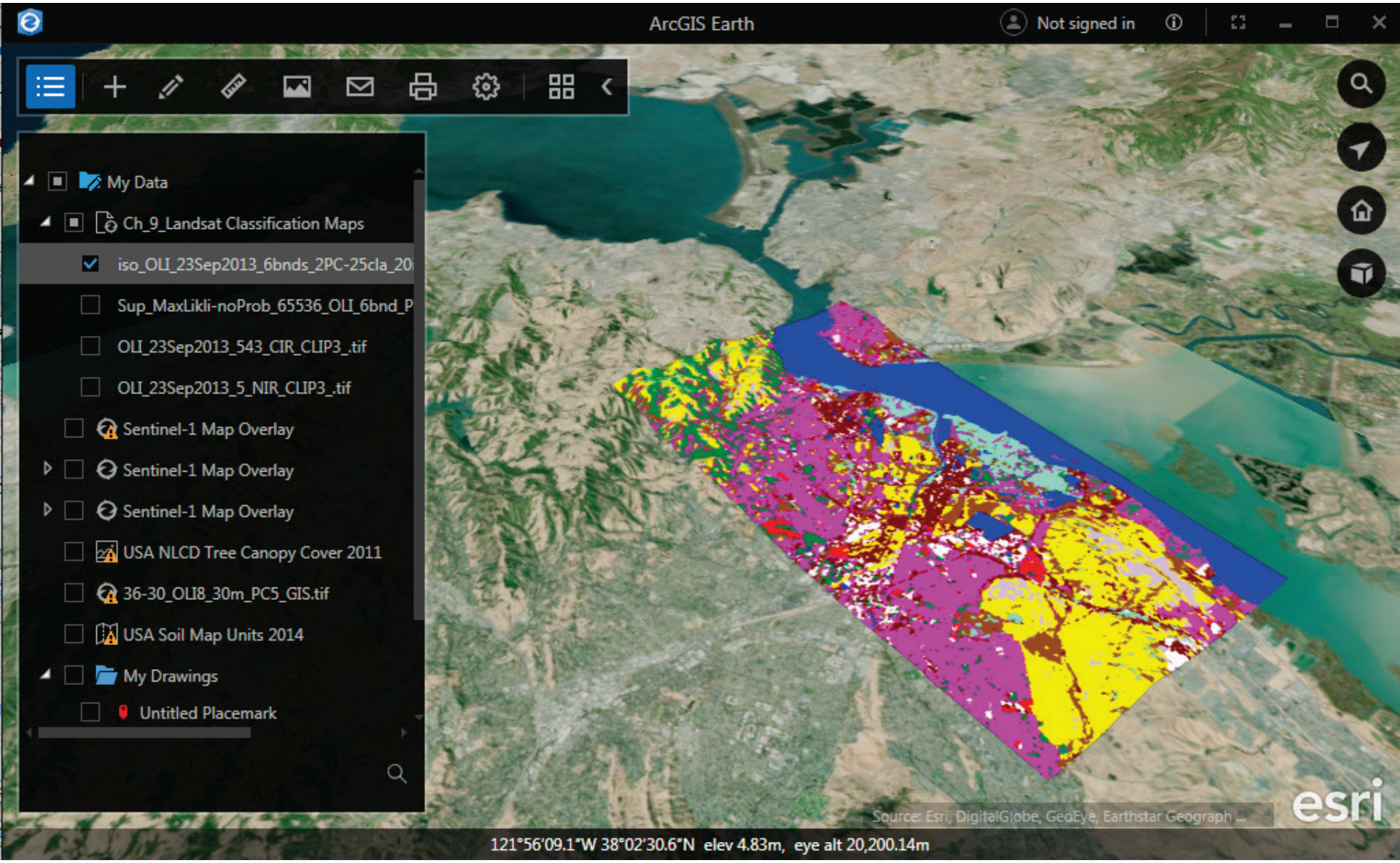


Data courtesy USGS Digital Database

Kmzs of georeferenced Landsat images, Thermopolis, Wyoming in Google Earth

Plate 7 ; Figure 3-11A-G; Plate 27, Figures 9-21, 9-23A-F, 9-25, 9-27

J. Ellis – 5Jun2019



Data Courtesy USGS

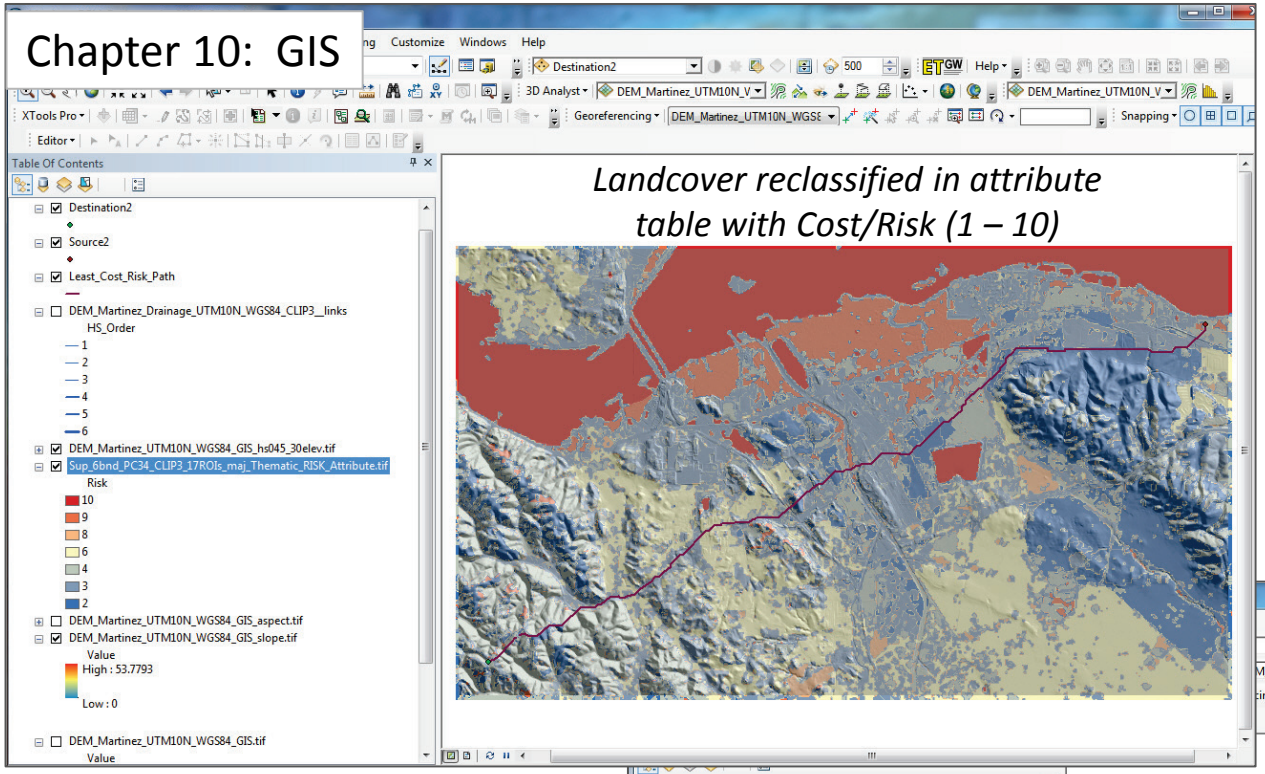
Digital Database

Kmz of Landsat images and landcover maps, Martinez, California in ArcGIS Earth

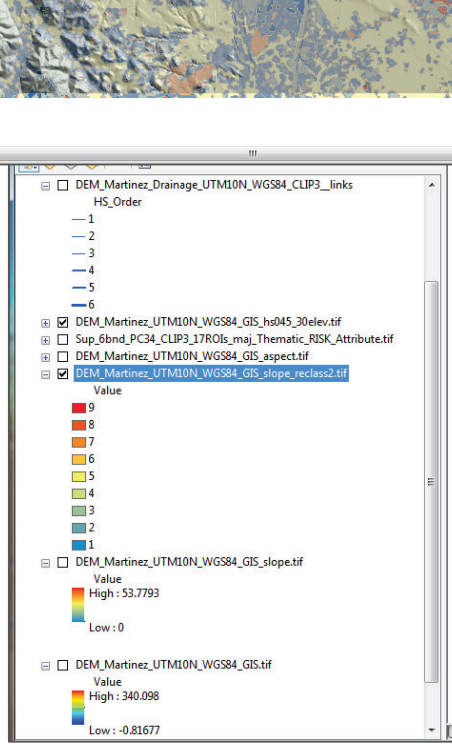
Plates 29 and 30; Figures 9-28

J. Ellis – 26 Sep 2018

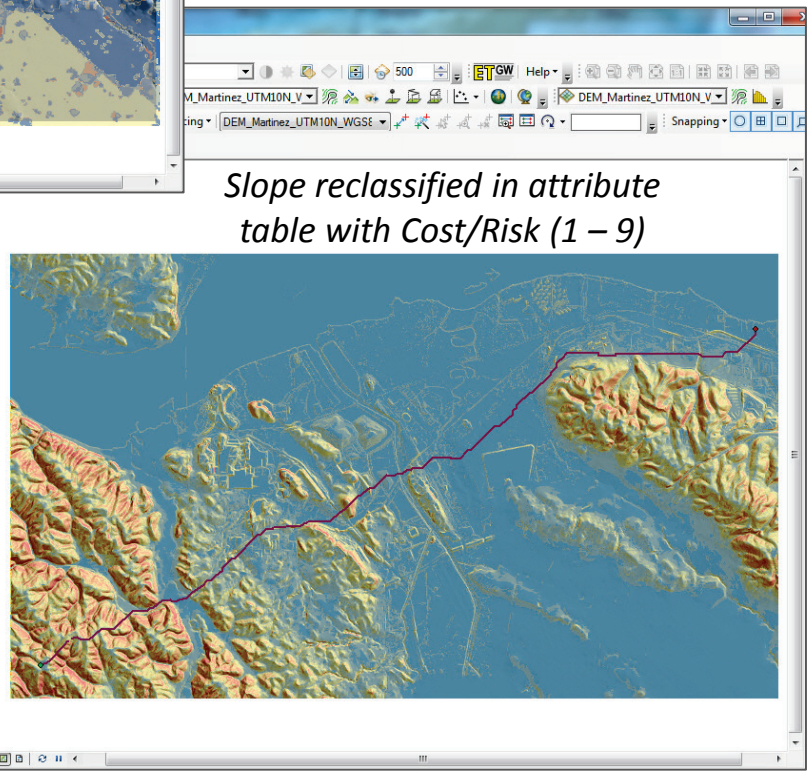
Chapter 10: GIS



Landcover reclassified in attribute table with Cost/Risk (1 – 10)



Slope reclassified in attribute table with Cost/Risk (1 – 9)



Martinez, California
Spatial Analysis of RS data

Data Courtesy USGS