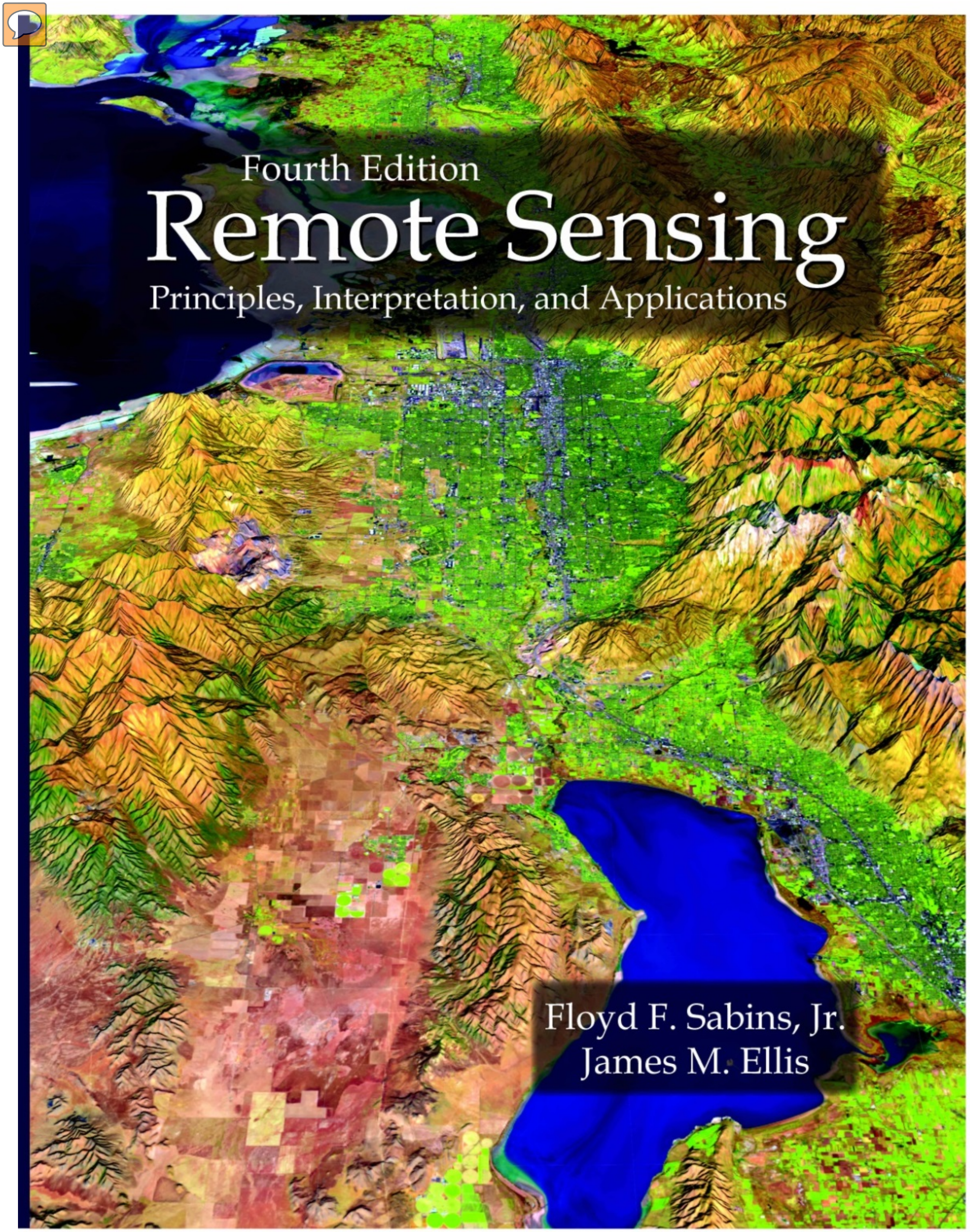

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Textbook

- Floyd Sabins' trademark clarity, insightful interpretations, and comprehensive coverage of different airborne and satellite systems made his 1st, 2nd, and 3rd editions classic and widely acclaimed, introductory remote sensing textbooks.

- Co-author James Ellis joined to update the technology and broaden the range of practical and research-oriented applications in the 4th edition.

- There is enough depth for both undergraduate and graduate students, and enough structure to support individuals outside of academics who are eager to learn how remote sensing can help them improve their scientific knowledge and impact in the workplace.

FLOYD F. SABINS, JR., PhD

(January 5, 1931–February 4, 2019)

Floyd was an American petroleum geologist, educator, and author. He was a pioneer in the development, application, and advocacy of the field of geological remote sensing. He had a BS from the University of Texas and a PhD in Geology from Yale University. Floyd was a research scientist for Chevron for 37 years and employed remote sensing to support the discovery of new oil fields in Saudi Arabia and Papua New Guinea. As a mineral explorationist he used remote sensing to enable copper and gold discoveries in Chile, boron and lithium discoveries in Bolivia, and most recently (2010–2013) target identification across Afghanistan.

Floyd was a Regent's Professor with the Earth and Space Sciences Department at UCLA and led many field trips under the auspices of the Geological Society of America, Environmental Research Institute of Michigan, NASA, and JPL. Floyd received a number of honors and professional awards—notably the William T. Pecora Award from NASA and the US Department of Interior in 1983 for "His outstanding contributions in education, science, and policy formulation to the field of remote sensing." His landmark text *Remote Sensing: Principles and Interpretation* was published in 1978 with the Third Edition published in 1997. Floyd was totally engaged in the process of clarifying principles, improving exploration examples, and creating new interpretation maps for the Fourth Edition when he passed.

JAMES M. ELLIS, PhD

James has implemented remote sensing and GIS for environmental and geological applications around the globe with Gulf Oil and Chevron (15 years), The MapFactory (5 years), and through his consulting firm Ellis GeoSpatial (18 years). Much of his work establishes environmental baselines for proposed and ongoing development, generates land use maps, and monitors change with satellite and airborne images. Recent projects include image processing, interpretation, and GIS database development in Afghanistan, Tanzania, Nigeria, Angola, China, Haiti, and Turkey. A multiyear project that analyzed modern carbonate environments resulted in many publications and educational DVD sets that include extensive GIS databases and visualizations. He conducted airborne radar surveys in Papua New Guinea, Colombia, and Congo and helped coordinate and process data from the first airborne hyperspectral surveys of Mongolia and Edwards Air Force Base. He realized the potential of remote sensing as a US Navy officer in the 1970s while tracking submarine movements with classified satellite images and ship- and seafloor-based sonar.

James has a BA from the University of Rochester and a PhD in Geology from University at Buffalo. He was a National Science Foundation Postdoctoral Fellow and visiting Assistant Professor at Rice University. For 12 years he taught remote sensing and GIS cartography lecture/lab courses in Diablo Valley College's GIS/GPS certificate program. In 2017 he taught Environmental Remote Sensing at the Department of Geology, University at Buffalo. He is a State of California Professional Geologist (Certificate No. 7391). Links to publications are available at ellis-geospatial.com.

Textbook Chapters

Chapter	Topic
1	Introduction to Concepts and Systems
2	Aerial and Satellite Photographs
3	Landsat Images
4	Multispectral Satellites
5	Thermal Infrared Images
6	Radar Images
7	Digital Elevation Models and Lidar
8	Drones and Manned Aircraft Imaging
9	Digital Image Processing
10	Geographical Information Systems
11	Environment
12	Renewable Resources
13	Nonrenewable Resources
14	Land Use / Land Cover
15	Natural Hazards
16	Climate Change
17	Other Applications (humanitarian, infrastructure, archeology, public health)

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Textbook Style

Thermal Infrared Images

The thermal IR spectral domain is that portion of the electromagnetic spectrum ranging in wavelength from 0.7 to 1,000 µm. Remote sensing deals with the wavelengths from 0.7 to 14 µm that are subdivided as follows:

- Near IR (NIR) domain: 0.7 to 1.0 µm (reflected solar radiation).
- Shortwave IR (SWIR) domain: 1.0 to 3.0 µm (reflected solar radiation).
- Thermal IR (TIR) domain: 3.0 to 14 µm (radiated energy).

This chapter deals with the TIR domain, which is important because it records information about the internal composition of materials. Special detectors and optical-mechanical scanners detect and record images in the TIR spectral region. The ability to detect and record thermal radiation as images at night takes away the cover of darkness and has obvious reconnaissance applications. For these reasons, beginning in the 1950s government agencies funded the early development of TIR imaging technology. The developments were classified for security purposes. Military interpreters recognized that geologic and terrain features greatly influenced the signatures of the background against which strategic targets were displayed. Word of these benefits and their potential nonmilitary applications created interest in the civilian geologic community. In the mid-1960s some manufacturers received approval to acquire images for civilian clients using the classified systems. In 1968, the US government declassified systems that did not exceed certain standards for spatial resolution and temperature sensitivity. In 1978, the NASA Heat Capacity Mapping Mission (HCMM) acquired daytime and nighttime TIR images with a 600 m spatial resolution for geologic applications. Today, TIR scanner systems are available for unrestricted use.

TIR images record data within two wavelength ranges: 3 to 5 µm (*medium wavelength IR* [MWIR]) and 8.0 to 14.0 µm (*long wavelength IR* [LWIR]). Today many satellites, including Landsat 4 to 8, ASTER, AVHRR, MODIS, and GOES, acquire TIR imagery. TIR sensors are available for smartphones, drones, and handheld cameras due to miniaturization and sophisticated built-in, image processing algorithms. Drones currently acquire increasing amounts of the imagery that were formerly acquired by manned aircraft.

THERMAL PROCESSES

To interpret TIR images, one must understand the basic physical processes that control the interactions between thermal energy and matter, as well as the thermal properties of matter that determine the rate and intensity of the interactions.

Kinetic Heat, Temperature, and Radiant Flux

Kinetic heat is the energy of particles of matter moving in a random motion. The random motion causes particles to collide, resulting in changes of energy state and the emission of electromagnetic radiation from the surface of materials. The internal, or kinetic, heat energy of matter is thus converted into *radiant energy*. The amount of heat is measured in calories. A *calorie* is the amount of heat required to raise the temperature of 1 g of water by 1°C. *Temperature* is a measure of the concentration of heat. On the Celsius scale, 0°C and

F.F. Sabins & J.M. Ellis, 2020, Remote Sensing Principles, Interpretation, and Applications, 4th Ed.

Textbook Questions and References
at the end of each chapter

seen in the nighttime, east portion of the visible light disk. In Figure 4-28B, however, thermal energy emitted from the clouds, land, and ocean can be clearly seen, even on the nighttime, east side of the disk.

GOES full disk images are updated every three hours. GOES images, along with Meteosat and Himawari-8 images, are available at NOAA's Geostationary Satellite Server website (goes.noaa.gov/index.html).

Meteosat

The Meteosat program is operated by the EUMETSAT. The first generation Meteosat (1 to 7) collected images on the half-hour in three bands (visible, IR, and water vapor). Meteosat-7 transmitted the final first generation image on March 31, 2017.

The initial second generation Meteosat-8 was launched in 2004, followed by Meteosat-9 (2005), Meteosat-10 (2012), and Meteosat-11 (2015). Meteosat-8 is stationed at longitude 41.5°E over the Indian Ocean. Both Meteosat-9 and -10 are positioned over Africa. Meteosat-11 was placed into a storage orbit as a reserve. Table 4-9 shows the characteristics of second generation Meteosat satellites.

Himawari (Sunflower)

Himawari-8 is the eighth of the geostationary weather satellites operated by the Japan Meteorological Agency. Himawari-8 entered service in 2015 and succeeded Himawari-7, which was launched in 2006. Himawari-8 is positioned at longitude 140.7°E, over the Pacific Ocean north of the island of New Guinea. Himawari-9 was launched in 2016 and is in stand-by orbit until it replaces Himawari-8 in 2022. The main system on Himawari-8 is the Advanced Himawari Imager (AHI), which is a 16-band multispectral system that is summarized in Table 4-9.

Questions

1. Refer to Figure 4-26 and calculate how many Landsat images are required to cover one MODIS image.
2. Refer to Figure 4-26 and calculate how many Landsat pixels are required to cover
   a. One MODIS 250 m pixel.
   b. One AVHRR 1,100 m pixel.
3. If a WorldView-2 panchromatic (grayscale) pixel is 0.5 m and a Landsat-8 OLI panchromatic pixel is 15 m, how much more area is covered by one Landsat pixel compared to one WorldView-2 pixel?
4. SPOT 1 to 3 collected only nadir, left-looking or right-looking images while orbiting. What are the modes of acquisition for today's agile, high spatial resolution satellites?
5. Figure 4-7 is a Pleiades pan image of an urban scene. Plate 12 is a SPOT color image of a geologic scene. Describe the advantages and disadvantages of both pan and color images for interpreting urban and geologic scenes.
6. What is the spatial resolution of ASTER's VNIR bands?
7. What is the spatial resolution of ASTER's SWIR bands?
8. How does ASTER collect stereo images?
9. What's the difference between polar-orbiting and geostationary satellites?
10. How many bands does MODIS collect?
11. In what years were the two MODIS instruments launched aboard the Terra and Aqua satellites?
12. What is the temporal resolution of MODIS?
13. GOES means what?
14. GOES-R transitioned to GOES-16. What are the spatial resolutions of GOES-16?
15. GOES-16 has how many bands?
16. What is the GOES-16 swath (or geographic extent of the field of view)?

References

Abrams, M., H. Tsu, G. Hulley, K. Iwao, D. Pieri, T. Cudahy, and J. Kargel. 2015. The Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) after fifteen years: Review of global products. *International Journal of Applied Earth Observation and Geoinformation*, 38, 292–301. doi: http://dx.doi.org/10.1016/j.jag.2015.01.013

Astrium. 2012. Pleiades Imagery: Users' Guide (USRPHR-DT-125-SPOT-2.0). Astrium Services. http://www.intelligence-airbusds.com/en/65-satellite-imagery (accessed December 2017).

Beck, R. 2003. EO-1 User Guide (v. 2.3). Sioux Falls, SD: USGS Earth Resources Observation Systems Data Center, Satellite Systems Branch.

Darwin, C. R. 1842. *The Structure and Distribution of Coral Reefs*. London: Steward and Murray.

De Selding, P. B. 2014, December 4. Airbus sells in-orbit SPOT 7 imaging satellite to Azerbaijan. SpaceNews. http://spacenews.com/42840airbus-sells-in-orbit-spot-7-imaging-satellite-to-azerbaijan (accessed December 2017).

DigitalGlobe. 2013. The Benefits of the Eight Spectral Bands of WorldView-2 (WP-8SPEC Rev 01/13). http://www.digitalglobe.com (accessed December 2017).

DigitalGlobe. 2015. Exploring the Benefits of SWIR Satellite Imagery (WP-RAD 03/15). http://www.digitalglobe.com (accessed December 2017).

DigitalGlobe. 2016a, February 22. Helping Facebook Connect the World with Deep Learning. Blog. http://blog.digitalglobe.com/news/helping-facebook-connect-the-world-with-deep-learning (accessed December 2017).

DigitalGlobe. 2016b. WorldView-2 Data Sheet (DS-WV2-rev2 02/16). http://www.digitalglobe.com (accessed December 2017).

European Space Agency. 2015. Sentinel-2 User Handbook. ESA Standard Document, Issue 1, Rev. 2. Paris: European Space Agency.

Hall, R. C. 2001. A History of the Military Polar Orbiting Meteorological Satellite Program. National Reconnaissance Office, Center for the Study of National Reconnaissance.

Hirano, A., R. Welch, and H. Lang. 2003. Mapping from ASTER stereo image data: DEM validation and accuracy assessment. *Journal of Photogrammetry and Remote Sensing*, 57(5–6), 356–370.

Jensen, J. R. 2007. *Remote Sensing of the Environment: An Earth Resource Perspective* (2nd ed.). Upper Saddle River, NJ: Pearson.

Kruse, F. A., W. M. Baugh, and S. L. Perry. 2015. Validation of DigitalGlobe WorldView-3 Earth imaging satellite shortwave infrared bands for mineral mapping. *Journal of Applied Remote Sensing*, 9, 096044. http://remotesensing.spiedigitallibrary.org/journal.aspx (accessed December 2017).

Lencioni, D. E., D. R. Hearn, C. J. Digenis, J. A. Mendenhall, and W. E. Bicknell. 2005. The EO-1 Advanced Land Imager: An overview. *Lincoln Laboratory Journal*, 15(2).

U.S.A. Images discussed in the Textbook

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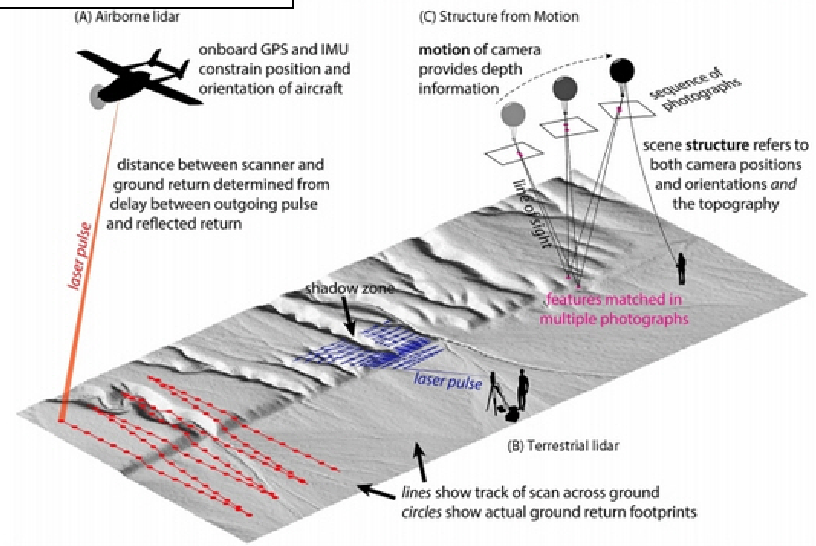

FIGURE 7-9 Three methods of producing high resolution digital topography. From Johnson and others (2014, Figure 1).

United States. *Point of Beginning* is an informative website and magazine that is focused on surveying technologies, business, and education (pobonline.com).

LIDAR

Lidar has been used in surveying and mapping since the mid-1990s (Maune and Nayegandhi, 2018). In the last two decades, development of key enabling technologies, such as satellite navigation systems (GNSS), airborne INS and IMU technologies, lasers, and optical detectors, has made lidar the most accurate and highest resolution geodetic imaging and mapping method available (Diaz, 2011).

The lidar sensor transmits laser light to illuminate a target and then records the reflections of that light with a receiver. Lidar operates at the speed of light, measuring the traveling time from the transmitter to the target and back to the receiver. The range measurement process results in a collection of elevation data points (mass points or a cloud) with an *x*, *y*, and *z* location for each point. Lidar sensors can collect 3-D models of features from different platforms, including airborne (aircraft and drones), mobile (vehicles), and terrestrial (tripods). Lidar is acquired by different technologies, including cross-track line scanners, multiwavelength, Geiger-mode, and Flash (Romano, 2015). IceSAT-2 is a satellite-based, laser altimetry system launched in September 2018 to measure the heights of the Earth's ice, vegetation, land surface, water, and clouds (reviewed in Chapters 11 and 16).

LIDAR PRINCIPLES

A lidar instrument emits a pulse of laser light energy with a typical duration of a few nanoseconds and a *pulse repetition frequency* (PRF) that ranges from 10,000 to > 150,000 pulses per second (10 to > 150 kHz). *Scan frequency* is another term used to specify the number of pulses emitted in 1 second. At the same time, the lidar instrument is receiving reflections from these pulses (Figure 7-10). These laser pulses travel at the speed of light (c) (3×10^8 m · s^{-1}).

The lidar instrument calculates the distance (or *range*) to a target by measuring the travel time (t) of the laser pulse from the transmitter to the target and back to the receiver.

$$\text{range} = \tfrac{1}{2}\, tc \qquad (7\text{-}2)$$

Lidar instruments emit near-infrared laser light for topographic mapping and blue-green light for bathymetric applications. The cross-track, line scanner pulses of lidar light are moved along the flight line by the forward motion of the aircraft or drone and from side to side (perpendicular to the flight line) by a scanning mechanism in the lidar instrument

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Aerial Mapping 235

Planar Divergent Convergent

Figure 8-13 Do not acquire photos in a planar or divergent fashion. Acquire photos in a convergent manner. From Shervais (2016, Figure 11).

Figure 8-14 Acquire photos converging on a feature, at multiple distances and angles. From Shervais (2016, Figure 12).

lap between images during airborne acquisition, works with consumer-level cameras, and is inexpensive and relatively accurate (see discussion in Chapter 7).

Camera Orientation

James and Robson (2014) have shown photos from sUAS should be pointed at the terrain or object of interest in a convergent manner as divergent or planar orientations distort the SfM model (see also Raugust and Olsen, 2013; Shervais, 2016). For example, Figures 8-13 and 8-14 show a topographic profile of terrain with flat land to the left and elevated land in the center-right. The camera is shown in many positions and pointing in different directions as it is flown across the terrain, illustrating three methods for photo acquisition: planar, divergent, or convergent.

In the left portion of Figure 8-13, the camera is looking straight down (planar orientation) at the terrain. In the center of the profile, the camera is in a stationary position and pointed in diverging directions. In Figure 8-14, the camera is pointed off nadir but in converging directions, increasing overlap between images, and the camera is flown at two altitudes. Also, the camera-viewing direction converges on the topographic feature with higher elevation in the center-right, minimizing distortion in the model. Views of the same feature from multiple angles and different elevations ensure a more reliable SfM model.

Image Overlap

The amount of overlap/sidelap between individual images is another key factor for building a good SfM model, an accurate orthoimage mosaic, and a DEM. Shervais (2016) notes less than 70% overlap will affect the interpreted scene while more than 90% may significantly increase processing time. Miller (2016) imaged 2.5 acres of an abandoned quarry with 80% forward lap and 40% sidelap while Mapir (2017) covered 18.7 acres of a vineyard with 70% forward lap and 70% sidelap.

Mission Planning

Collecting sUAS imagery in the field that can support accurate aerial mapping requires an unmanned aerial vehicle, a ground control station with a communications data link (operator's remote control), flight planning interface, battery recharger, and onboard GPS/IMU (Figure 8-15). A GPS base station will increase the x, y, z accuracy of the

Figure 8-15 Components for operating a sUAS. Courtesy Black Swift Technologies.

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Remote Sensing Digital Database

Three Image-Processing Lab Manuals

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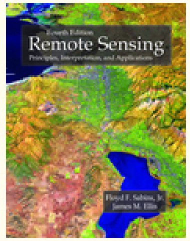

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Remote Sensing

Principles, Interpretation, and Applications
Fourth Edition

Floyd F. Sabins, Jr., James M. Ellis

Remote sensing has undergone profound changes over the past two decades as GPS, GIS, and sensor advances have significantly expanded the user community and availability of images. New tools, such as automation, cloud-based services, drones, and artificial intelligence, continue to expand and enhance the discipline. Along with comprehensive coverage and clarity, Sabins and Ellis establish a solid foundation for the insightful use of remote sensing with an emphasis on principles and a focus on sensor technology and image acquisition.

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- **Support Materials**, including **an introduction video**, describe and guide users on ways to access and utilize the Remote Sensing Digital Database and the Digital Image Processing Lab Manuals (ENVI, ArcGIS Pro, and ArcGIS Desktop).

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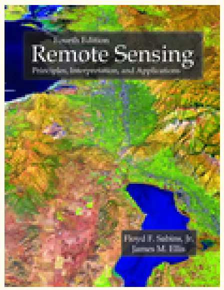

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    - Plate_2_1959_Aerial_Anaglyph_Pix
    - Plate_3_NAIP_Aerial_Multispectral
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  - Ch_4_METADATA_Only_Commercial-Sentinel2
  - Ch_4_Other_MSS_Satellites
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      - Worldview-3_SWIR_8-bands_Radiance_Nevada
    - Sentinel-2
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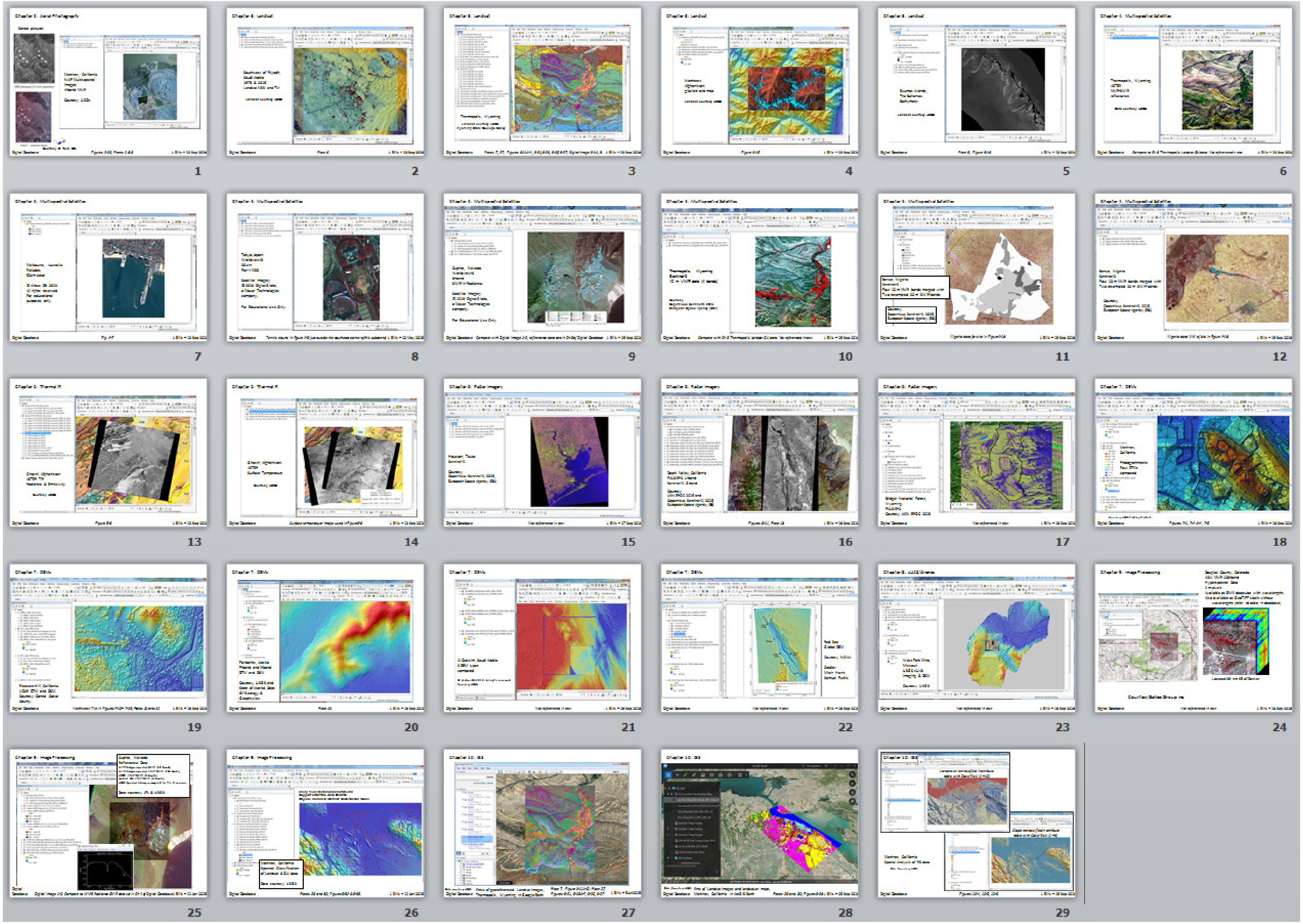

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  - AISA_VNIR_Hyperspectral
  - Dig_Img_1-2_Hyp-Multi_Cuprite-NV
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- Ch_10_GIS
  - Fig_10-10 SpatialAnalysis
  - Plates_8_27_Thermopolis_kmzs
  - Plates_29_30_Landsat_Classification_kmzs

F.F. Sabins & J.M. Ellis, 2020, Remote Sensing Principles, Interpretation, and Applications, 4th Ed., Waveland Press, Inc.

J. Ellis – 27Jan2020

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

Remote Sensing Digital Database Image Formats

Ch_3_Landsat

Fig_3-15_Landsat7_Glaciers

Unzipped files

DEM	1/26/2020 9:32 AM	File folder	
glacier map	1/26/2020 9:32 AM	File folder	
Afghanistan_Cirque_Glaciers_Landsat7_ArcGIS10-2.mxd	1/24/2019 9:05 AM	ArcGIS ArcMap Doc...	586 KB
Afghanistan_Cirque_Glaciers_Landsat7_ArcGIS10-6.mxd	9/13/2018 12:03 PM	ArcGIS ArcMap Doc...	321 KB
Badakhshan_Landsat7_30Jul2000_CLIP_6-bnd_ice_ENVI	10/1/2013 6:40 PM	File	2,561 KB
Badakhshan_Landsat7_30Jul2000_CLIP_6-bnd_ice_ENVI.hdr	10/1/2013 6:40 PM	HDR File	2 KB
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Badakhshan_Landsat7_30Jul2000_CLIP_6-bnd_ice_stack_GeoTIFF.aux	11/19/2017 10:08 AM	AUX File	8 KB
Badakhshan_Landsat7_30Jul2000_CLIP_6-bnd_ice_stack_GeoTIFF.tfw	11/18/2017 12:42 PM	TFW File	1 KB
Badakhshan_Landsat7_30Jul2000_CLIP_6-bnd_ice_stack_GeoTIFF.tif	11/19/2017 10:13 AM	TIFF Image	2,611 KB
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L71152034_03420000730_MTL.txt	6/5/2010 10:15 AM	Text Document	65 KB
README.GTF	6/5/2010 10:17 AM	GTF File	9 KB
SRTM DEM_UTM42N_Hillshade_330_30elev_clip_geotiff.tif.lyr	11/19/2017 10:13 AM	ArcGIS Layer	14 KB

Digital Image Processing Lab Manuals

- The Lab Manuals use data in the Remote Sensing Digital Database. Images and DEMs in the lab exercises are discussed and shown in the textbook.

- Each exercise provides step-by-step guidance using:
  - L3Harris ENVI image-processing software,
  - ESRI ArcGIS Pro,
  - ArcGIS Desktop.

- Each lab exercise averages ~15 pages (ENVI) and ~18 pages (ArcGIS). Data is included with each lab.

- Available for download from the Publisher's website.

Lab Manual Exercises for ENVI

The Digital Image Processing Lab Manual contains twelve 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

Lab Manual – Self-Taught Students

- Self-taught students have the opportunity for a 30-day, free ENVI license (contingent upon U.S. laws and regulations) to complete the exercises and process other imagery in the database.

- Contact James Ellis via email jellis@ellis-geospatial.com to facilitate coordination with the L3Harris Academic & NGO Account Manager.

- Prior to launching the 30-day ENVI license, self-taught students should read Chapters 1-10 of the textbook to become familiar with remote sensing principles and technology and to learn about the many examples that are discussed in the textbook and used in the lab manual.

Lab Manual Exercises for ArcGIS Pro and Desktop

Lab 1A	Interpretation of Remote Sensing Images
Lab 1B	ArcGIS *Pro* and *Desktop* Overview
Lab 2	Image Enhancement and Plotting
Lab 3	Landsat Multispectral Images
Lab 4	Vegetation Maps, Density Slice, and Masks
Lab 5	Heads-up Interpretation
Lab 6	Principal Components, Mosaicking, and Pan-Sharpening
Lab 7	Georeferencing
Lab 8	DEMs
Lab 9	Unsupervised Classification
Lab 10	Supervised Classification
Lab 11	Change Detection
Lab 12	National Land Cover Database (NLCD) Overview

Remote Sensing Digital Database

ENVI Lab Manual

Digital Image Processing Lab Manual

- Compilation of Lab Manual Exercises 1 to 12
- Lab_1_Introduction to ENVI Software_
- Lab_2_Landsat_Multispectral_Processing_
- Lab_3_Image Processing 1_
- Lab_4_Image_Processing_2_
- Lab_5_Band_Ratios and PCs_
- 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_
- READ ME Digital Image Processing Lab_Manual

Zipped files

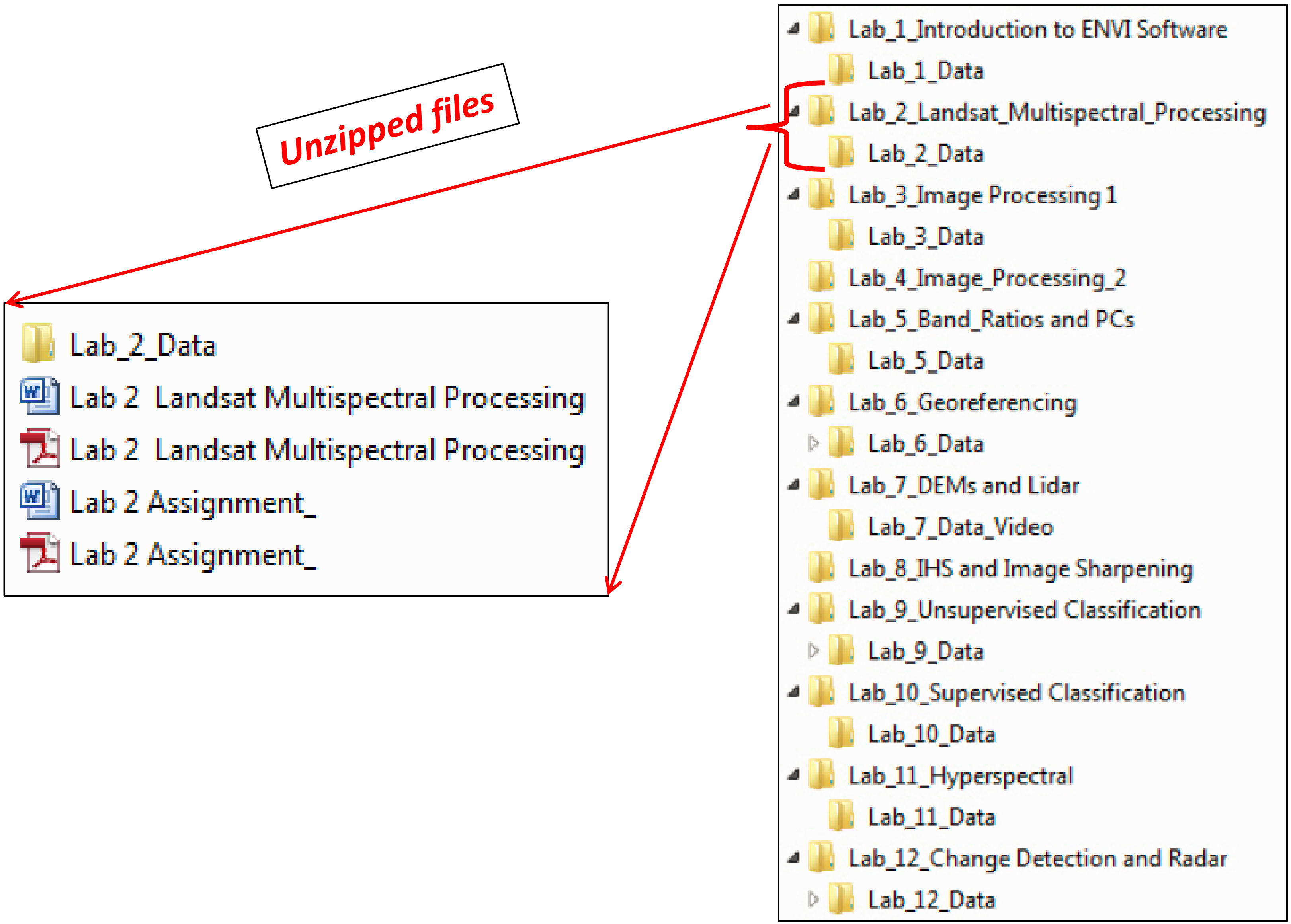
235 MB

Downloadable

Digital Images

Digital Image 1-1

Lab Manual File Structure for ENVI



Lab Manual File Structure for ArcGIS

- ImageProcessing_LabManual_with ArcGIS_Pro_and_Desktop
  - Lab 1A Interpretation_of_Remote_Sensing_Images
  - Lab 1B ArcGIS Desktop-Pro Overview
  - Lab_2_Image_Enhancement
  - Lab_3_Landsat_Multispectral
    - Lab_3_Data
      - State_Geology_Map
  - Lab_4_Vegetation Maps_Density Slice_Masks
  - Lab_5_Heads-Up_Interpretation
  - Lab_6_PCs_Mosaicking_Pan-sharpening
  - Lab_7_Georeferencing
  - Lab_8_DEMs
  - Lab_9_Unsupervised_Classification
  - Lab_10_Supervised_Classification
  - Lab_11_Change_Detection
  - Lab_12_NLCD_Land_Cover

Name

- Lab_3_Data
- Lab 3 Assignment_v1.pdf
- Lab 3 Landsat Multispectral_Desktop_pdf_v1.pdf
- Lab 3 Landsat Multispectral_Pro_pdf_v1.pdf

321 MB

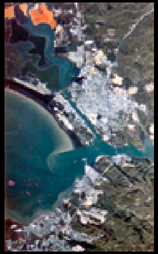
View downloadable pdf that displays the 12 lab manual exercises

Digital Image 1-1

Digital Images

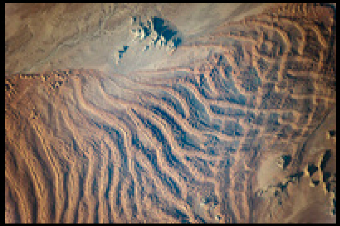
Digital Images for Sabins-Ellis, Remote Sensing, 4/E

Parent Directory **http://waveland.com/Sabins-Ellis/**



Digital Image 1-1 Color image from multispectral data of San Pablo Bay, California. Area covered is the same as in Figures 1-23 and 1-24. Courtesy NASA Ames Research Center.

Digital Image 1-2 AVIRIS hyperspectral image, Cuprite mining district, Nevada. S. J. Hook, C. D. Elvidge, M. Rast, and H. Watanabe. 1991. An evaluation of short-wavelength-infrared (SWIR) data from the AVIRIS and GEOSCAN instruments for mineralogic mapping at Cuprite, Nevada. Geophysics, 56, 1,432–1,440. Courtesy S. J. Hook, JPL.

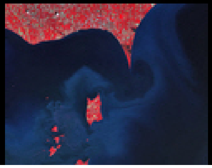


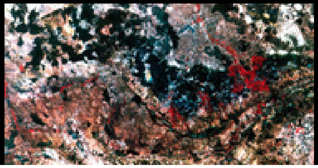
Digital Image 2-1 Handheld photograph taken by an astronaut onboard the International Space Station. Photo by M. J. Wilkinson. NASA Earth Observatory. 2016, November 21. Linear Dunes, Namib Sand Sea. NASA Earth Observatory. http://earthobservatory.nasa.gov/IOTD/view.php?id=89136 (accessed December 2017).

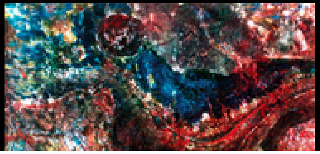
Digital Image 3-1A Landsat images showing change detection in Cambodia. Landsat 7 ETM+ natural color image acquired in 2000 (bands 1-2-3 in B-G-R). Courtesy NASA Earth Observatory and USGS.

Digital Image 3-1B Landsat images showing change detection in Cambodia. Landsat 8 OLI natural color image acquired in 2016 (bands 2-3-4 in B-G-R). Courtesy NASA Earth Observatory and USGS.

Digital Image 3-2A Lake Erie. Landsat OLI images acquired July 28, 2015 during a major algae bloom. Landsat OLI color image (bands 2-3-4 as B-G-R). Courtesy NASA Earth Observatory and USGS.







Digital Images

Digital Image 1-1 Color image from multispectral data of San Pablo Bay, California. Area covered is the same as in Figures 1-23 and 1-24. Courtesy NASA Ames Research Center.

Digital Image 1-1

http://waveland.com/Sabins-Ellis/

4) Instructor’s Resource Materials (password-protected)

- Answers to Textbook Questions.
- Answers to Lab Manual Questions.
- Examples of student-processed uploads for
  Lab Manual exercises
  (jpgs, geotiffs (.tif with .tfw), pdf, shapefiles).
- Access to digital figures, color plates, and color digital images.

Instructor's Resource Materials

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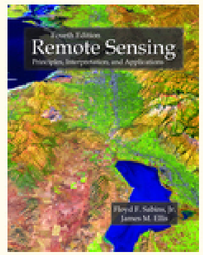

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ISBN 13: 978-1-4786-3710-3

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Remote Sensing

Principles, Interpretation, and Applications

Fourth Edition

Floyd F. Sabins, Jr., James M. Ellis

Remote sensing has undergone profound changes over the past two decades as GPS, GIS, and sensor advances have significantly expanded the user community and availability of images. New tools, such as automation, cloud-based services, drones, and artificial intelligence, continue to expand and enhance the discipline. Along with comprehensive coverage and clarity, Sabins and Ellis establish a solid foundation for the insightful use of remote sensing with an emphasis on principles and a focus on sensor technology and image acquisition.

The Fourth Edition presents a valuable discussion of the growing and permeating use of technologies such as drones and manned aircraft imaging, DEMs, and lidar. The authors explain the scientific and societal impacts of remote sensing, review digital image processing and GIS, provide case histories from areas around the globe, and describe practical applications of remote sensing to the environment, renewable and nonrenewable resources, land use/land cover, natural hazards, and climate change.

- **Remote Sensing Digital Database** includes 27 examples of satellite and airborne imagery that can be used to jumpstart labs and class projects. The database includes descriptions, georeferenced images, DEMs, maps, and metadata. Users can display, process, and interpret images with open-source and commercial image processing and GIS software.

- Flexible, revealing, and instructive, the **Digital Image Processing Lab Manual** provides 12 step-by-step exercises on the following topics: an introduction to ENVI, Landsat multispectral processing, image processing, band ratios and principal components, georeferencing, DEMs and lidar, IHS and image sharpening, unsupervised classification, supervised classification, hyperspectral, and change detection and radar.

- **An introduction video** describes and guides users on ways to access and utilize the Remote Sensing Digital Database and the Digital Image Processing Lab Manual.

- To encourage further interpretation and discussion of the apllications of remote sensing and digital image processing, **Digital Images** are highlighted throughout the text.

Table of Contents

Instructor's Resource Materials – Answers to Textbook Questions

Chapter 1 Questions

1. Use Equation 1-1 to calculate the wavelength in cm of radar energy at a frequency of 10 GHz. What is the frequency in GHz of radar energy at a wavelength of 25 cm?

   GHz = 10^7 Hz (Table 1-3)   10 GHz = 10^{12} Hz

   $\lambda = c / \upsilon = 3 \times 10^8$ m • sec^{-1} / 10 x 10^{10} cycles• sec^{-1} = 0.07 m = **7 cm**

   $\upsilon = c / \lambda = 3 \times 10^8$ m • sec^{-1} / 0.35 m = 1,700,000,000 Hz = **1.7 GHz**

2. What is the temperature of boiling water at sea level in °K?

   0°C = 293°K, 100°C = **193°K**

3. Distinguish between the earth's radiant energy peak and the reflected energy peak.

   Reflected energy peak of 0.5 µm (green light) corresponds to xxxxxx emitted by the very xxxxxx. Radiant energy peak of 9.7 µm is wavelength of xxxxxxxx emitted by the xxxxxx.

4. The atmosphere is essential for life on earth, but it causes problems for remote sensing. Describe these problems.

   a) See Fig xxx with xxxxxx ranges due to different xxxxxxx in the atmosphere. xxxxxxxx in xxxxxxxxx.

   b) xxxxxxx from xxxxxx impact image quality.

Instructor's Resource Materials – Answers to Lab Questions

Lab 5 Band Ratios and Principal Component Name: KEY

Upload the following files to the instructor:

(1) "Your Name_Iron_Sites" geotiff

(2) "Your Name_Clay_Sites" geotiff

(3) "YourName_color-coded_NDVI" jpg

Question 1: Put your cursor on the brightest pixel in the Chainman Shale (Red Rose Anticline (see textbook Figure 3-11H if you don't remember where that is).

A. What is the Data value (DN) for the bright pixel on the iron ratio image: 4.30

B. What is the Data value (DN) for the same pixel on the clay ratio image: 2.18

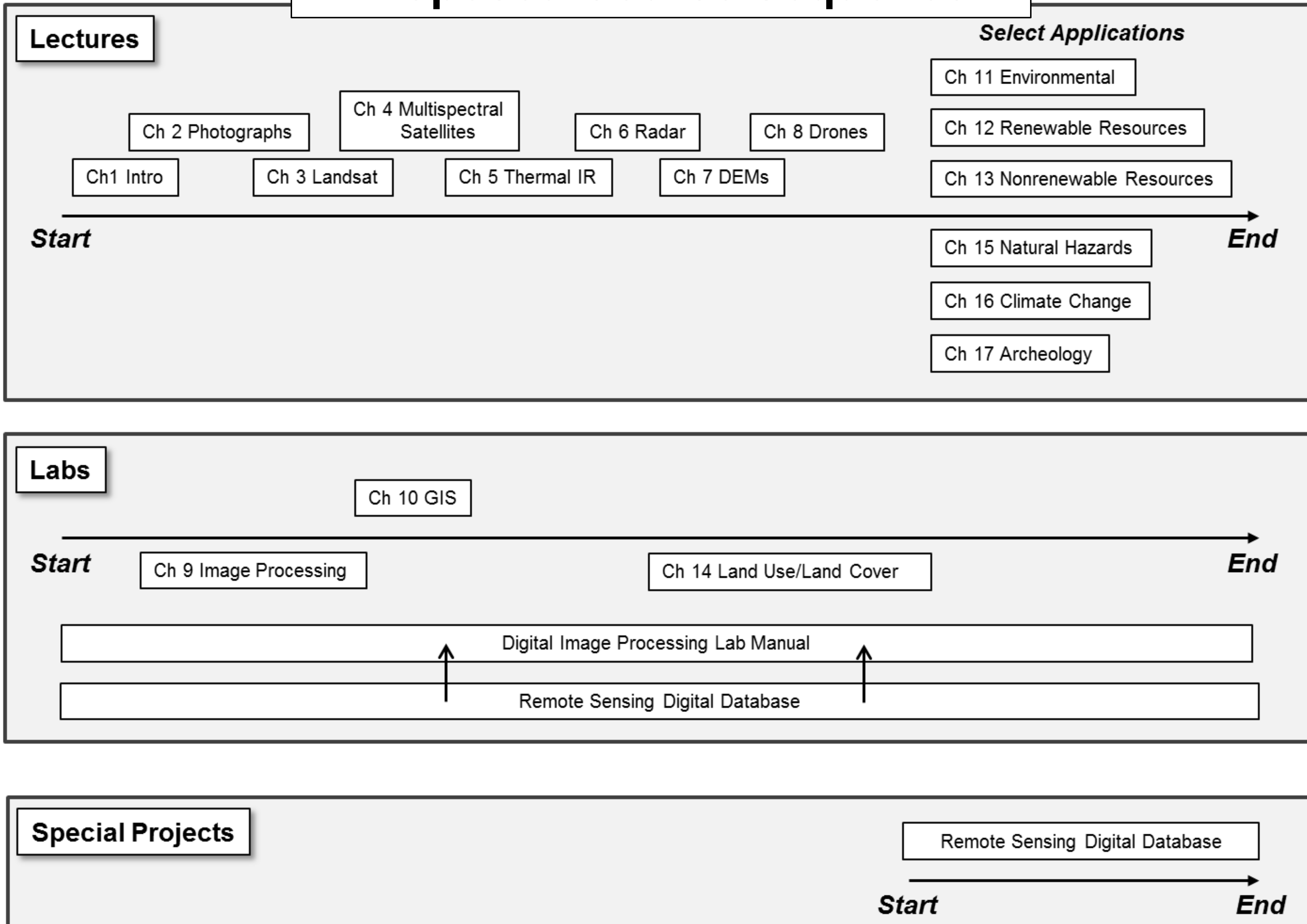
Question 2: Put your cursor on the brightest pixel in a Wind River agricultural field (see textbook Figure 3-11H if you don't remember where the river is).

A. What is the Data value (DN) for the bright pixel on the clay ratio image: 2.90

B. What is the Data value (DN) for the same pixel on the iron ratio image: 1.82

Question 3: A. Why do you think the clay ratio image in View 3 is so similar to the NDVI image (vegetation greenness or vigor) image in View 4? The clay ratio image is similar because xxxxxx. Also the NDVI index highlights xxxxxxx that is associated with xxxx in the ratio image.

Proposed Course Sequence



F.F. Sabins & J.M. Ellis, 2020, Remote Sensing Principles, Interpretation, and Applications, 4th Ed. J. Ellis – 27 Jan 2020

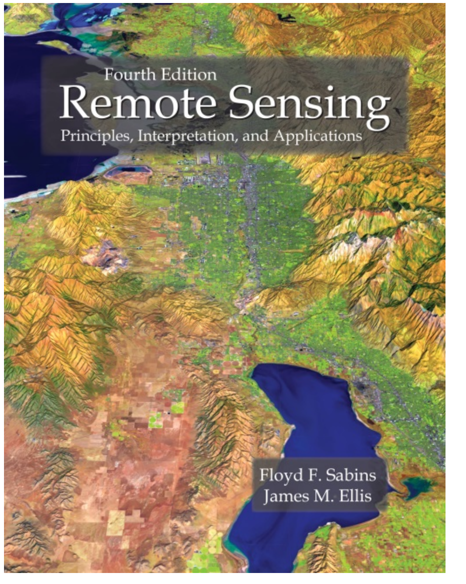
Remote Sensing
Principles, Interpretation, and Applications
4th edition, 2020, Waveland Press

Floyd F. Sabins and James M. Ellis

1) **Printed Textbook ($89.95 list)**

2) **eBook (rent starting at $15.69)**

3) **Open Access, Online Supplemental Material**
   - *Remote Sensing Digital Database*
   - *Image Processing Lab Manual for ENVI*
   - *Image Processing Lab Manual for ArcGIS*
   - *Digital Images*



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4) **Instructor's Resource Material**

Comments and Questions?
Contact: James Ellis
jellis@ellis-geospatial.com