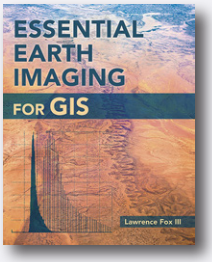
ESSENTIAL EARTH IMAGING FOR GIS



By Lawrence Fox III.

Esri Press, 2015.

128 pages, diagrams. $59.99, paperback.

ISBN: 9781589483453

Review by: Mark Denil

This is a great time for earth imaging. New sensors are being launched and are coming on line at a tremendous rate, and the variety of imagery available for use is really only limited by the depths of your pockets and the capacity of your system to consume the results. Choosing what images to obtain and how to reasonably employ them is, however, a job in itself, and it is pretty hard to make good decisions without a firm grasp of modern imaging technology basics. So, where is one to turn to learn these essentials?

To address this crying need, Esri Press has brought forth *Essential Earth Imaging for GIS* by Lawrence Fox III of Humboldt State University. It is a very slim, 128-page volume that, according to the back cover blurb, "discusses characteristics of images obtained from aircraft and spacecraft, and how to enhance, register, and visually interpret multispectral imagery and point clouds." Very ambitious, one might think, for such a small book; but it is all pulled off rather neatly and with admirable concision. There doesn't seem to be an ounce of fat anywhere in the text, nor is there any sales department boilerplate. Essential it is, indeed.

The book is made up of eight chapters plus a three-page introduction, a couple pages of references, and an index. The chapter titles are:

- Overview of imaging GIS
- The physical basis and general methods of remote sensing
- Effects of the atmosphere on image quality
- Creating two-dimensional images with sensors
- Displaying digital images with GIS software
- Generating three-dimensional data with photogrammetric measurements and active sensors
- Image processing
- Extracting information from images

Each seven to twenty page chapter contains between two and seven sub-sections.

Chapter 1 begins with a historical overview so very brief that it is over before the reader has quite noticed it has begun, and from there leaps directly into examining the structure of a digital image. We then briskly learn that there are various sorts of two-dimensional images and of three-dimensional data sets; and we are off and running.

Chapter 2 tells us about how images are formed by electromagnetic radiation sensors. Discussion touches upon the basic capabilities and limitations of the different sensing methods and how the characteristics of aerial and spaceborne platforms influence their output products: for example, how electromagnetic radiation wavelengths and reflectance patterns are important for passive sensors, how active sensors work, and why satellite orbits matter.

All earth imaging has to take place through the earth's atmosphere, and in Chapter 3 we learn about the interaction of radiation and air as it affects the quality of a remotely sensed image. Absorption, scattering, and big fluffy clouds are the main actors in this chapter.

The geometric and resolution characteristics of passive and active sensors fill two-thirds of Chapter 4. Simple geometric diagrams support texts explaining that the geometry of either sensor type is really a lot more complicated, but the explanations are hardly more than quick sketches themselves. As you read them you should keep that word, "essential," in mind. The discussion then turns to the four kinds of resolution (spatial, spectral, radiometric, and temporal), and these get a much fuller exposition.

The final third of Chapter 4 covers common sources for remote sensing imagery. It strikes one as an odd place in the book to put this; one would expect it in an appendix or at least an end chapter. As the kind of information that tends

to go out of date, plunking it in the midst of the sort of basics one could expect to remain pertinent for a long time mightn't seem obvious. The location does, however, group the sensors near their characteristics.

At twenty pages, the longest chapter in the book is Chapter 5: "Displaying digital images with GIS software," and it certainly has a lot of ground to cover. The chapter opens with a pretty good discussion of additive color. The author consistently refers to it as the *tristimulus* theory, which in my experience is a rather less common descriptor than "additive" or "trichromatic." The term tristimulus (and tristimulus value) is more usually associated with the CIE color spaces, and one would guess that it is likely to be in more frequent use amongst folks building image software than people using GIS applications. Still, the author is correct and consistent in his usage and clear in his meaning, and that is what matters.

The author is also quite clear in his explanations of the various options in assigning colors to spectral bands. His detailed and well-explained discussion, for example, of natural-color, standard false-color, and false-color with IR composites, and how to use them, is excellent, as are the sections on contrast, brightness, and histogram stretching.

Chapter 6 tackles generating three-dimensional data. Starting with measurements on a single photo, it moves on to stereo pairs and to surface models and orthophotos, automated photogrammetry, and finally to lidar and interferometric radar. It's all there; readable, short, and sweet and stuffed into just fourteen pages.

Image processing, divided into restoration, rectification, and enhancement, with an emphasis on automated execution of routines with little human input is covered in Chapter 7. The topic is expanded to include converting brightness values to radiance and atmospheric correction of brightness values. Here are another fourteen pages packed as full as a nut.

Chapter 8 is titled "Extracting information from images," and covers manual image interpretation as well as the advantages and disadvantages of automated classification, plus how to evaluate automated outputs. Here, *Essential Earth Imaging for GIS* only professes to touch on the rudiments of automated classification, and, as in other places in the text, it is not shy of telling the reader they have to look to the references for anything beyond the basics supplied.

In addition to the printed text, your $60 gets you access to an online Esri Press resource page with exercises and a free 180-day ArcGIS trial. There are five exercises that come with instructions and sample data:

- Exploring brightness values of pixels in a simple image
- Assigning colors in multiband images
- Global brightness and contrast manipulation with histograms
- Color-coding a single-band image and a vegetation index image
- Extracting information from a multispectral image by digitizing polygons on screen

As already mentioned, this book sets out by promising to deliver the essential, baseline things that anyone using earth imaging products in a GIS must know. In the end, it delivers on that promise and it does so with seemingly effortless panache.

This book is, nonetheless, not without fault. The text is sprinkled with awkwardly constructed passages that are unnecessarily confusing. The individual sentences are fine, but they are in places assembled into paragraphs with odd switches of perspective. For example:

> Atmospheric scattering can also be reduced by avoiding early morning or late afternoon hours. Solar radiation must travel through a greater thickness of atmosphere when the sun is low in the sky because of the angled path. Not only is the haze effect reduced, but the intensity of the solar radiation is greater near solar noon. (27)

The first two sentences discuss low angle light, and the following one, mid day lighting. However, the reader doesn't realize that the light has changed until the end of that third sentence where the key words "near solar noon" are buried. The reader gets well into the sentence wondering why the haze is suddenly spoken of as *reduced*, and the radiation as *intensified*, with, as they assume, the sun still low in the sky. This sort of unnecessarily clunky construct crops up time and again and is cussedly annoying.

Then too, the author is given to sudden insertions of some quite startling assertions, equally unequivocal and factually questionable. "Contour lines are being replaced by three-dimensional perspective views…." (67), is one such, but the bald statement that "…images are only a map (an orthographic projection of the Earth's surface having a constant scale) if the image is perfectly vertical and the terrain is absolutely flat" (69) is a real corker. Where can that have sprung from? First off, there is that flatly absurd definition of a map (as demonstrated by Jacob [2006] and Denil [2011]), and, second, the author (if anyone) should know that no actual photograph is orthographic (although photos can be ortho-corrected). There are other examples of quirkiness lurking between the covers, but the point needn't be belabored.

You may think that these objections are pretty minor, but they mar and diminish the smooth and placid finish on what is otherwise an admirable production.

Despite these shortcomings, *Essential Earth Imaging for GIS* is well worth having. It is not a bible of remote sensing, like Avery and Berlin's *Fundamentals of Remote Sensing and Airphoto Interpretation* (1992) was, back in the day; it is not full of formulas, detailed explanations, and stereoscope-ready image pairs, but it is a good, basic introduction to the remote sensing essentials that matter for GIS. The complexities of modern earth imaging can be bewildering, even for experienced hands, and good, basic, essential texts are hard to find. The concise explanations found within this book can help clarify critical points, both for oneself and when one is looking to explain things to others. I know I am happy to have a copy on my shelf, and, not infrequently, in my hand.

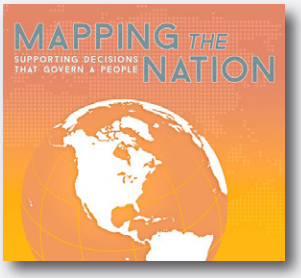
REFERENCES

Avery, Thomas Eugene, and Graydon Lennis Berlin 1992. *Fundamentals of Remote Sensing and Airphoto Interpretation*. New York: Macmillan.

Denil, Mark. 2011. "The Search for a Radical Cartography." *Cartographic Perspectives* 68: 7–28. doi: 10.14714/CP68.6.

Jacob, Christian. 2006. *The Sovereign Map*. Translated by Tom Conley. Edited by Edward Dahl. Chicago: The University of Chicago Press.

MAPPING THE NATION (SERIES)

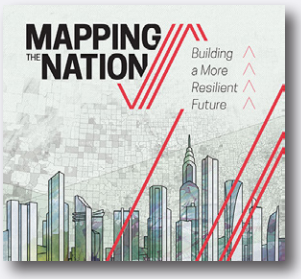


Mapping the Nation: Supporting Decisions that Govern a People

Esri Press, 2014.

144 pages, maps, credits. $19.95, softcover.

ISBN: 9781589483477



Mapping the Nation: Building a More Resilient Future.

Esri Press, 2015.

108 pages, maps, credits. $19.99, softcover.

ISBN: 9781589483910

Review by: Russell S. Kirby, University of South Florida

Since 2011, Esri Press has been publishing a series of books featuring maps generated by federal government agencies using GIS software. These books, published in large format, softcover editions, are attractively produced with high-resolution graphics. The two volumes reviewed here are respectively the fourth and fifth books in the series. Each has the same structure, beginning with a foreword by Jack Dangermond, President of Esri, Inc., and a brief introduction, then continuing through a series of chapters focusing on US government departments and a final chapter on independent government agencies, followed by a brief conclusion and some information concerning the sources of the maps included in each chapter.

For someone unfamiliar with GIS and its many potential applications, these books—printed on high-gloss paper with strikingly colorful maps, plus photographs and quotations from leading government agency officials— reveal both the wealth of spatial data managed by federal agencies and creative ways to display that information and, in some cases, enable the public to examine it interactively. And, perhaps, the inquisitive reader may also take the time to learn more about Esri, Inc., the producer both of