



The slide features a dark gray background with a large image of Earth from space on the left. The title "Digital Cartography" is in orange and "Graphics" is in green. A NASA image credit is at the bottom left. The footer contains the WV View logo and the AmericaView logo with the tagline "Empowering Earth Observation Education" and the website "AmericaView.org - Est. 2003".

Image from NASA:
https://commons.wikimedia.org/wiki/File:Earth_Western_Hemisphere_transparent_background.png#filelinks

WV VIEW

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In this module, we will explore topics relating to generating graphics from maps.



Module Topics



1. Map series creation
2. GeoPDFs
3. Map production considerations: color space, resolution, and viewing distance
4. Vector vs. raster graphics and considerations
5. Types of printers
6. Copyright and licensing considerations

2

These are the topics covered in this module.

Map Series



Map Series



- ❖ Collection of map pages or sheets built from a single layout that each represent a different geographic area
- ❖ Generate a set of output pages by using a layout and iterating over a set of map extents defined by an index layer
- ❖ Create consistent layout for all pages

4

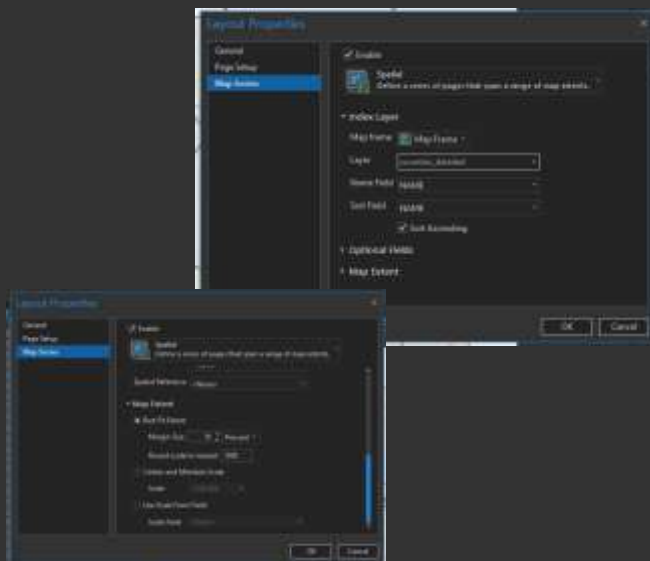
A map series in the ArcGIS environment indicates making multiple pages of maps representing different geographic extents using a common layout. The cartographer will define a layout and an index layer that defines what extent will be covered on each page. This process is designed to automate the tedious task of generating the same layout for different extents multiple times and can greatly speed up repetitive map design tasks.



Map Series in ArcGIS Pro



- ❖ Must activate Map Series under Page Setup
- ❖ Must specify an **Index Layer**
- ❖ Must specify a name field and a sort field
- ❖ Can incorporate margins and define the output scale based on scale rounding, a constant scale, or a scale field from the attribute table
- ❖ Can group based on additional fields
- ❖ Can use page numbering



5

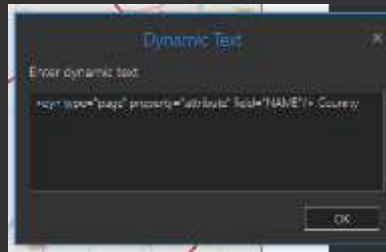
In order to generate a map series, you first need to activate the Map Series option using the Layout Properties. You can then specify an Index layer that defines the separate geographic extents to use for each separate map. For example, a layer of state boundaries could be defined so that a separate map layout will be generated for each state. Additional options include defining a field from the index file to use as a name and/or a field to sort on, which will determine the page order. You can also specify margins, apply scale rounding so that each map is produced at a simplified scale, or even make all maps have the same output scale. If you want to specify a scale for each index explicitly, you can use an attribute field. Lastly, you can also define page numbering.



Incorporating Dynamic Text



- ❖ Use **dynamic text** to update text between pages
- ❖ Title, page number, scale, index feature name, etc.



6

Other than just the extent, you may want some text elements to be updated on each separate page, such as the title, scale, page number, index, name, etc. This can be accomplished by using dynamic text. Dynamic text can be defined using tags or by selecting from available options.



Navigating between pages



- ❖ Click on List Map Series Pages
- ❖ Can navigate to a specific page
- ❖ Can navigate using the arrows

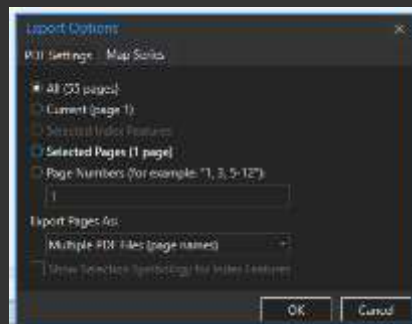
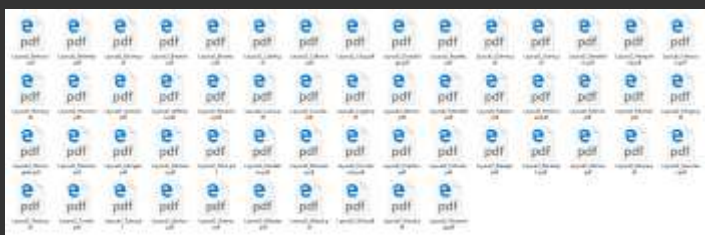
Once you generate a map series, you can view each separate layout using the List Map Series Pages setting in the Layout Contents Pane.



Exporting a Map Series



- ❖ Export one-by-one if using formats other than PDF
- ❖ Can export all at once using PDF
- ❖ Can export as multiple PDFs for a multipage PDF

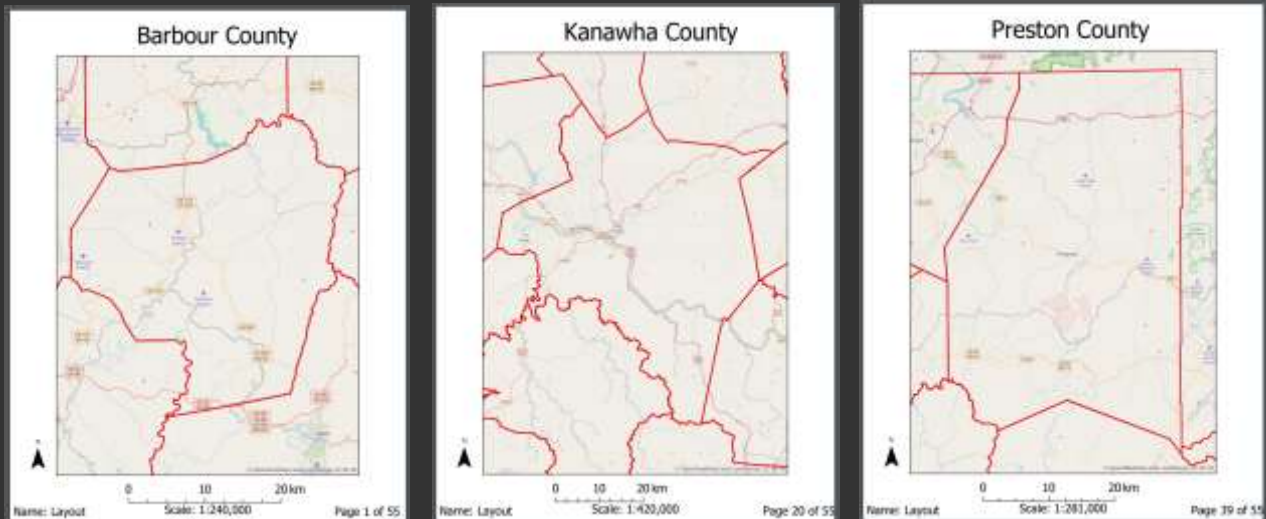


8

Once you are happy with your map series, it can be exported as separate files or as a single, multi-page file.



Map Series



Base map data from [OpenStreetMap](#)

9

This is an example map series for some simple base map data from OSM for three counties in West Virginia. In this example, a county boundary was used as the index file. I also used dynamic text to update the title, scale, and page number.

GeoPDF



- ❖ Multiple graphical layers stored on the same map
- ❖ Layers can be turned on and off



<https://nationalmap.gov/ustopo/>

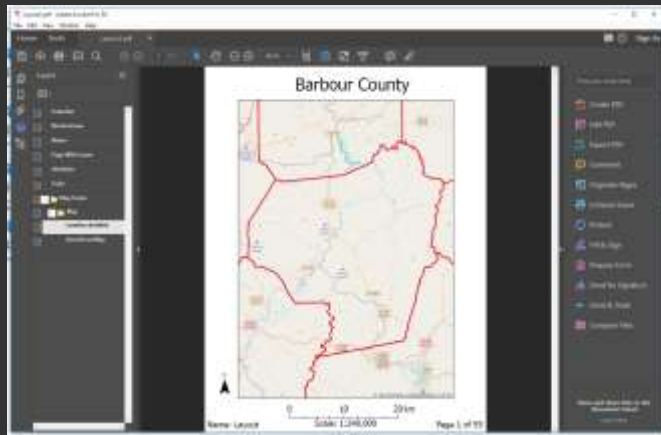
A GeoPDF allows for data to be stored in Portable Document Format (PDF) with associated spatial reference information. PDFs can generally be viewed on any device that has a PDF reader or a web browser, so they are a common output for published work. Also, it is possible to maintain layers so that certain features can be turned on-and-off. For example, recent topographic maps in the US commonly use this format, and it is possible to turn off some layers, such as the contour lines. This slide provides a link to these topographic products as an example.



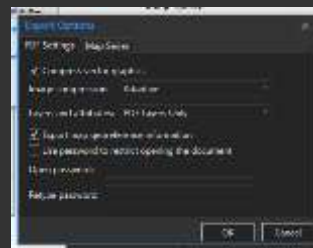
Again, GeoPDFs can be opened in web browsers and PDF reader or editing software, some of which are free. In this example, I have opened a GeoPDF topographic map in Adobe Acrobat. Notice that different map elements and data layers are stored in separate layers that are organized into a hierarchy, which again allows data layers to be turned on-and-off.



Make a GeoPDF in ArcGIS Pro



- ❖ Can apply **compression**
- ❖ Can export map **georeference information**
- ❖ Can export just the layers
- ❖ Can export layers and feature attributes



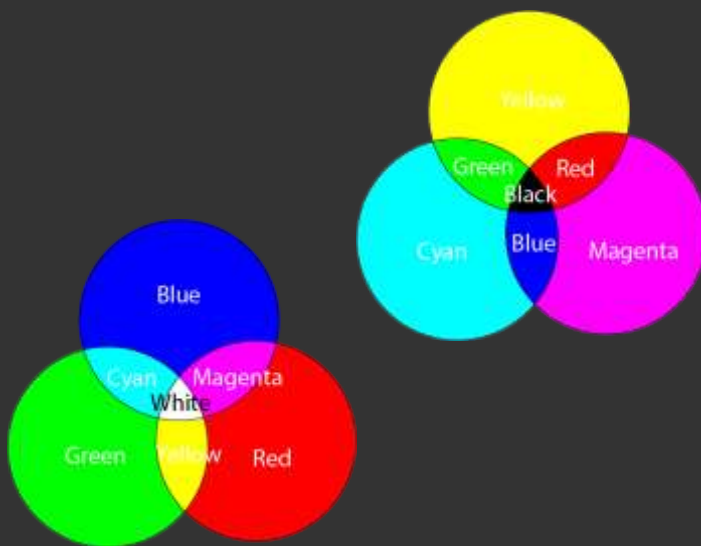
13

In ArcGIS Pro, GeoPDFs can be generated by exporting to PDF format and specifying that map georeferencing information be maintained. You can also choose whether to apply compression, whether to include attribute information with the vector data, and set a password for sensitive information.

Map Production



- ❖ **CYMK** for print
- ❖ **RGB** for screens, projectors, and the web
- ❖ Need to assess output in the final medium



15

When generating maps for on screen viewing or publication on the web, we commonly use additive color space. Additive color space is used when images are generated by projected light, such as monitors, televisions, and projections. For printing, we tend to use subtractive color space since this approximates how dyes are used to generate color on a medium. The additive primaries (red, green, and blue) sum to white and each pair combine to one of the subtractive primaries. The subtractive primaries (yellow, cyan, and magenta) sum to black and pairs combine to one of the additive primaries. Additive colors are called additive because these colors when combined on a white surface yield a variety of colors. In contrast, inks and dyes subtract from the white page to generate a color.

The important point here is that the color space used should match the desired medium. If you are generating a map to be displayed on a webpage, you would use additive color space. If you are generating a map to be printed in a text, you would use subtractive color space. If you want to use a map in multiple environments, you may want to generate different versions using the appropriate color spaces.



Resolution

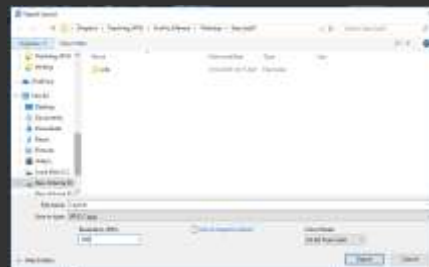


❖ **ppi** = pixels per inch

❖ **dpi** = dots per inch

❖ **Varies based on device**

- Computer screen ~ 96 ppi
- HDTV ~ 33 ppi
- Mobile phone ~ 300 ppi
- Laser printer ~ 600 dpi
- Offset press ~ 12,000 dpi



❖ Should take into account screen resolution when selecting dpi/ppi

- If you are using a monitor with a 96 ppi resolution, and you export your 360-by-360 pixel image at 96 ppi, the image's final dimensions will be as you designed it: 360 x 360
- Image will appear smaller on devices that have a higher display resolution or pixel density because those pixels can fit into a smaller visible area
- If you want your 360 by 360 image to appear at the same visible size and equal sharpness on a phone with 383 ppi as it does on a computer with 96 ppi, you need to increase the pixel dimensions of your image by 4 times, to 1440 by 1440 pixels
- An image set at a higher ppi than the display can support will simply appear at the maximum resolution of the display.

❖ Generally, should use as least 300 dpi/ppi

16

Practically, resolution relates to how pixelated or blurry a graphic looks. This is generally measured in dpi (dots per square inch). This comes from printing techniques and relates to the number of dots of ink that can be placed in an area on the page. For monitors and digital devices, we tend to use the term ppi, which relates to the number of pixels in a square inch of screen space.

Different devices will have different resolution requirements. For example, an offset press generally can produce much higher resolution renderings than a laser printer. This slide provides some notes relating to how screen resolution can impact image resolution. Images will appear smaller on devices that have a higher display resolution or pixel density because those pixels can fit into a smaller visible area. In contrast, an image set at a higher ppi than the display on which it is being viewed will simply appear at the maximum resolution of the display, since it is not capable of rendering graphics at a higher resolution.

When deciding on an appropriate resolution at which to export a map, you should check the requirements for where it will be published. For example, if you are creating a map to include in a paper or trade article that will appear in a journal, the journal will provide resolution requirements.

As a general rule of thumb, I generally export graphics at 300 dpi/ppi or higher.



Viewing Distance



- ❖ Features may need to be enlarged to be viewable from a distance
- ❖ Resolution may need to be increased
- ❖ Lettering and labels may need to be increased in size
- ❖ Line width may need to be increased
- ❖ May need to enhance contrast/difference between colors

17

Viewing distance is also important to consider when designing a map layout. If a map or image will be viewed at a distance, then features may need to be enlarged and resolution may need to be increased. Lettering, labels, and line widths may need to be increased in size or thickness. You may also need to choose colors that offer more contrast. So, if you are designing a map that will be displayed on a wall vs. a map that will be embedded in a webpage, you may need to make changes to enhance readability and contrast at a larger viewing distance. It is generally a good idea to print out drafts at the correct size and view the product at the anticipated viewing distances to get a sense of what may need to be enlarged or enhanced.



❖ JPEG (Joint Photographic Experts Group)

- .jpg
- Lossy compression
- Small file size
- Used for web publishing
- Does not support transparency
- Will see compression artifacts if image is enlarged
- Can specify the amount of compression

It is common to export to a raster graphic format if you do not intend to do any additional editing or if the map is considered finalized. Here, we will discuss some common raster graphic formats where data are stored as pixels to create an RGB image.

The Joint Photographic Experts Group (JPEG) format is a common format for storing compressed images. This is a lossy compression format, meaning that some data are lost in the compression process and cannot be retrieved.

Websites generally require that images be provided in a compressed format, such as JPEG or PNG, to decrease file size and increase the rendering speed of the website. JPEG allows for different levels of quality/compression; however, this format does not support transparency.

JPEG2000 offers an update of this format that allows for less data loss with compression and also a higher dynamic range.



❖ PNG (Portable Network Graphics)

- .png
- Lossless compression
- Used for web publishing
- Supports transparency
- Will not see compression artifacts

Portable Network Graphics (PNGs) use lossless compression, which means that original data values can be retrieved from the compressed version. Similar to JPEG, this format is commonly used for images that will be rendered on webpages. In contrast to JPEG, PNG supports transparency. So, a logo stored as a PNG file can have a transparent background so that the logo could be overlaid on other graphics without a solid color square containing it. This is not an option for JPEG.



❖ TIFF (Tagged Image File Format)

- .tif
- No compression or lossless compression (LZW)
- Not commonly used on the web
- Used for print
- Supports transparency
- Will not see compression artifacts

TIFF, or Tagged Image File Format, offers both uncompressed and lossless compression options. This format is commonly used in printing and supports transparency. It is not commonly used for images that will be displayed on websites. In fact, browsers won't render TIFF files.

TIFF files are a very commonly used raster file format. In the geospatial sciences, this format can be used to store our raster geospatial data. A GeoTIFF is a TIFF with associated georeference information.



Vector Graphics



- ❖ Allow you to edit your map in a vector graphics software such as Adobe Illustrator or Inkscape
- ❖ Use when you want to further edit your map in graphics software
- ❖ AI, EPS, or SVG formats are a good choice
- ❖ Vector graphics editing software:
 - **Adobe Illustrator:**
<https://www.adobe.com>
 - **Inkscape:**
<https://inkscape.org/en/>



21

If you would like to edit your map outside of your map design or GIS software, raster graphics are limiting since the layout is rendered to pixels and no text or layers are maintained. However, vector graphic files do allow for maintaining text, colors, layers, and geometric shapes. So, if you export to a vector graphic format, you can do additional editing in a program capable of manipulating these files. Adobe Illustrator and Inkscape are two options.



Vector Export Options



❖ AI (Adobe Illustrator)

- .ai
- For editing in Adobe Illustrator

❖ PDF (Portable Document Format)

- .pdf
- Not as editable as AI files
- Has the same layers, groups, and clipping paths as AI files

❖ EPS (Encapsulated PostScript format)

- .eps
- Not used as often
- Largely replaced by PDF

❖ SVG (Scalable Vector Graphics)

- .svg
- Open-source

22

There are a variety of vector graphic file formats available. AI files are proprietary and designed for use in Adobe software, such as Illustrator. Currently, ArcGIS Pro cannot export to AI files. Other options include Encapsulated PostScript (EPS) and Scalable Vector Graphics (SVG). AI and SVG are the most commonly used formats currently.

PDF files have characteristics of both vector and raster graphics. If you export a map as a PDF and maintain the layers, you can edit the output in a vector graphic editor and/or convert it to other vector graphic formats.



Vector Export Options



❖ AIX (Adobe Illustrator Exchange)



<https://doc.arcgis.com/en/maps-for-adobe/install/using-aix-files.htm>

Currently, ArcGIS Pro allows for export to AIX (Adobe Illustrator Exchange) files. This allows you to store your maps in an Adobe Creative Cloud account and open them in Adobe Illustrator for editing. We will not make use of this option in this course since an Adobe Creative Cloud account is required.



❖ Ink Jet Printers

- Most common in consumer market
- Applies ink to paper
- Cyan, yellow, magenta, and black (K) ink
- Often used for photographic printing

❖ Laser Printers

- Toner-based
- Uses a laser to produce an image on a drum, which then electronically attracts powdered toner to the paper to form an image
- Can be black-and-white or color
- Often higher dpi than ink jet, especially for black-and-white printing

<https://www.techwalla.com/articles/3-types-of-printers>

24

There are also different types of printers that each have pros and cons and varying use cases. Most consumer or household printers are ink jet printers. These type of printers contain separate ink reservoirs for each of the subtractive primaries and black, which need to be replenished. Ink Jet printers tend to work well for photographic printing. Laser printers use a laser and toner. The laser is used to produce an image on a drum, which then electronically attracts powdered toner to the paper to form an image. These types of printers are very commonly used in office settings.



❖ Dot Matrix Printers

- Rugged and low cost
- Images are applied to paper by a print head that strikes the paper through a ribbon embedded with ink, like a typewriter
- Noisy and slow

<https://www.techwalla.com/articles/3-types-of-printers>

25

Dot matrix printers are now out-of-date. They use a print head that strikes the print medium through a ribbon embedded in ink, similar to a typewriter. These types of printers are generally noisy and slow.



Offset Printing



- ❖ Inked image is transferred (“offset”) from a plate to a rubber blanket, then to the printing surface
- ❖ CMYK are separated and printed individually
- ❖ Generally good for **large-volume printing** and production
- ❖ Fast and excellent quality



https://commons.wikimedia.org/wiki/File:Offset_press.jpg

<https://www.youtube.com/watch?v=5LMU-zB8Sro>

https://en.wikipedia.org/wiki/Offset_printing

26

Offset printing is the current industrial standard for large-scale, large volume printing and publishing. It allows for fast production and excellent quality. An inked image is transferred from a plate to a rubber blanket and then to the printing surface. Each subtractive primary and black are printed separately and then combined. The YouTube video linked on this slide provides a great explanation of this printing method and process.



Dealing with Copyrights



- ❖ You have copyright protection for your maps
- ❖ Other cartographers have copyright protection for their work
- ❖ A map cannot be under copyright until that mapmaker puts an “appreciable” amount of creative work into the product
- ❖ If you produce a map as part of your job, your employers may own the copyright as opposed to you (“work for hire”)
- ❖ Original work is assumed to be the copyright of the creator with all rights to reproduce or publish reserved to the creator of the work
- ❖ Licensing allows the creator to share some or all rights to the work with a license

27

When using content generated by others or when wanting to exercise control over how others can use your content, it is important to understand copyrights. When you produce maps, you may be able to apply a copyright to protect this intellectual property. However, if you produce a map as part of your job, your employers or client may own the copyright as opposed to you. Generally, original work is assumed to be the copyright of the creator with all rights to reproduce or publish reserved to the creator of the work. Licensing allows the creator to share some or all rights to the work via a license.

The next set of slides explain some licensing options defined by the Creative Commons.



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<https://creativecommons.org/licenses/>

28

The next few slides describe common licensing options for data and graphics. CCo, or Creative Commons Zero, is the least restrictive license in which the data or products are placed fully in the public domain and the author(s) waive all rights.

Read through the next few slides, which provide descriptions of Creative Commons licensing options that are increasingly more restrictive.

Note that these licensing options can apply to data and graphics, such as generated maps.



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This is the end of this lecture module.

Please return to the West Virginia View
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Thanks! Hope you found this useful.