

2013 Esri International User Conference

July 8–12, 2013 | San Diego, California



Technical Workshop

Making Beautiful Maps

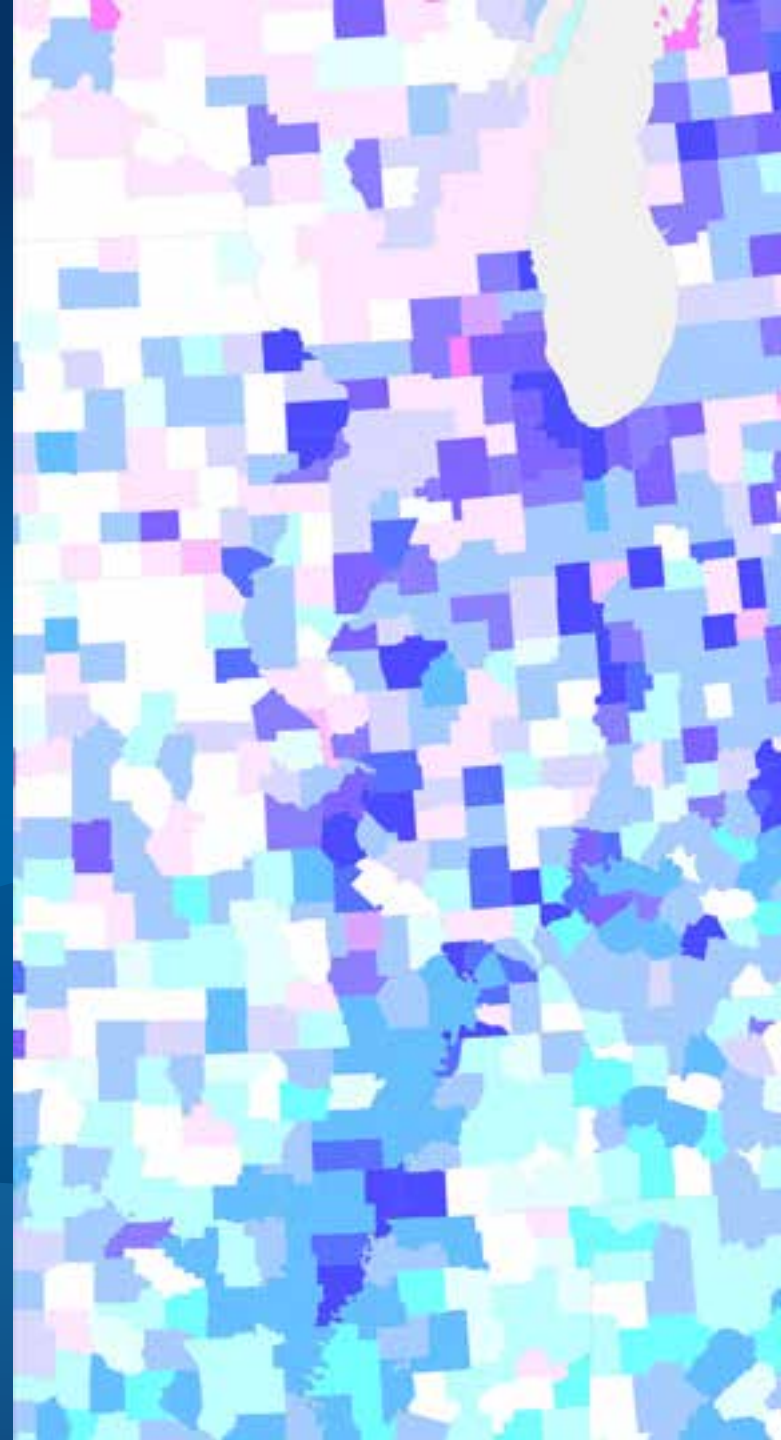
Aileen Buckley and Kenneth Field

Agenda

- Show you some maps we have made
- Explain some of the methods we used to make them
- Share some resources with you
- Aileen:
 - Bivariate choropleth maps
 - Temporal maps
- Ken:
 - Minard flow map of Napoleon's March on Moscow
 - Dasymetric mapping for the U.S. presidential election

Bivariate choropleth maps

Aileen Buckley

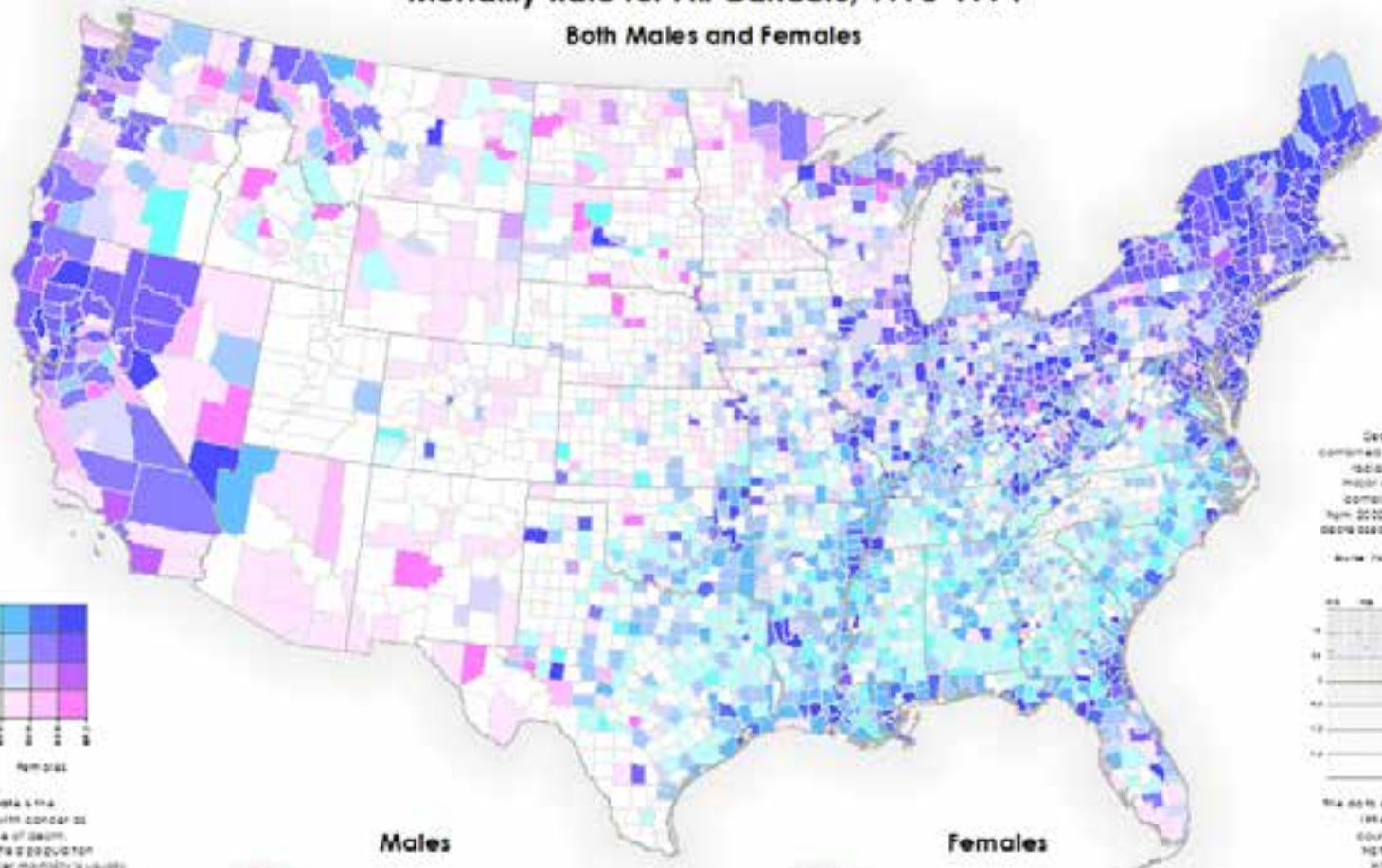


What are bivariate choropleth maps?

- Maps that simultaneously show two variables using the **choropleth** map method
 - Choropleth maps use polygon fills to represent quantitative values
 - Greek **χώρο** + **πλήθ[ος]**
 - “**choro**” (area/region) + “**pleth**” = quantity/increase

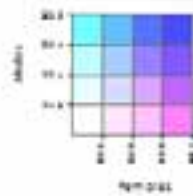
Mortality Rate for All Cancers, 1970-1994

Both Males and Females



Males

Females



A cancer mortality rate is the number of deaths with cancer as the underlying cause of death occurring in a specific population during a year. Cancer mortality usually is expressed as the number of deaths due to cancer per 100,000 population, that is,

$$\text{Mortality Rate} = \frac{\text{Cancer Deaths}}{\text{Population}} \times 100,000$$

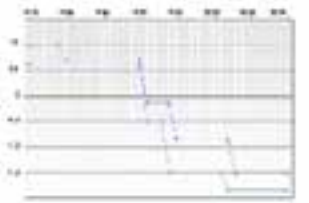
The numerator of the mortality rate is the number of deaths; the denominator is the size of the population. The population used depends on the rate to be calculated. For comparisons that occur in only one year, the respective population (e.g., females for cancer deaths) is used. The mortality rate can be compared for a given cancer site or for cancers combined.

The National Cancer Institute has a variety of published reports and research tools for tracking mortality statistics. Surveillance and Control of the National Cancer Institute, 1970-1994.

Source: National Cancer Institute, Surveillance and Control of the National Cancer Institute, 1970-1994.

Death rates decreased for all cancers combined for men and women of all major races and ethnic groups and for most major cancer sites. Rates for both sexes combined decreased by 1.2% per year from 2000 to 2001. Overall mortality rates decreased in men but increased in women.

Source: National Cancer Institute, Surveillance and Control of the National Cancer Institute, 1970-1994.



The data set for these maps contains 1970-1994 cancer mortality information for counties in the United States from the National Cancer Institute. Additional information may be obtained from www.nationalcancer.org.

The data used to create the cancer mortality maps in the National Cancer Institute's Surveillance and Control of the National Cancer Institute, 1970-1994 is the death rate occurring each calendar year for the National Cancer Institute. The rate is for all deaths per 100,000 population for males or females. The numbers are age-adjusted to the 1970 U.S. population.

An area was considered unstable if (a) the observed number of deaths was less than 6 or (b) the observed number of deaths was less than 12 and the rate was not significantly different statistically from the U.S. rate or (c) the expected number of deaths was less than 6 and the rate was not significantly different statistically from the U.S. rate.

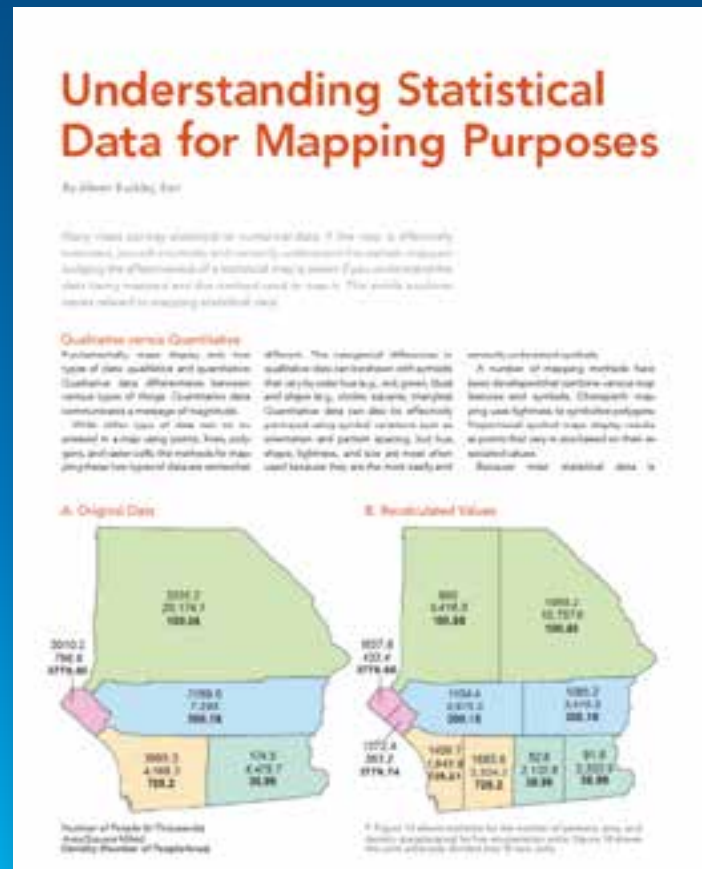
Source: National Cancer Institute, Surveillance and Control of the National Cancer Institute, 1970-1994.

What are the considerations when you use choropleth maps?

- Choropleth maps give the impression of
 - Uniformity in data within the data collection units
 - Abrupt breaks that occur at the unit boundaries
- Use quantitative values that are **spatially intensive** (do not depend on the size of the unit area)

Learn more!

- *ArcUser*, Winter 2013



The purpose of multivariate mapping

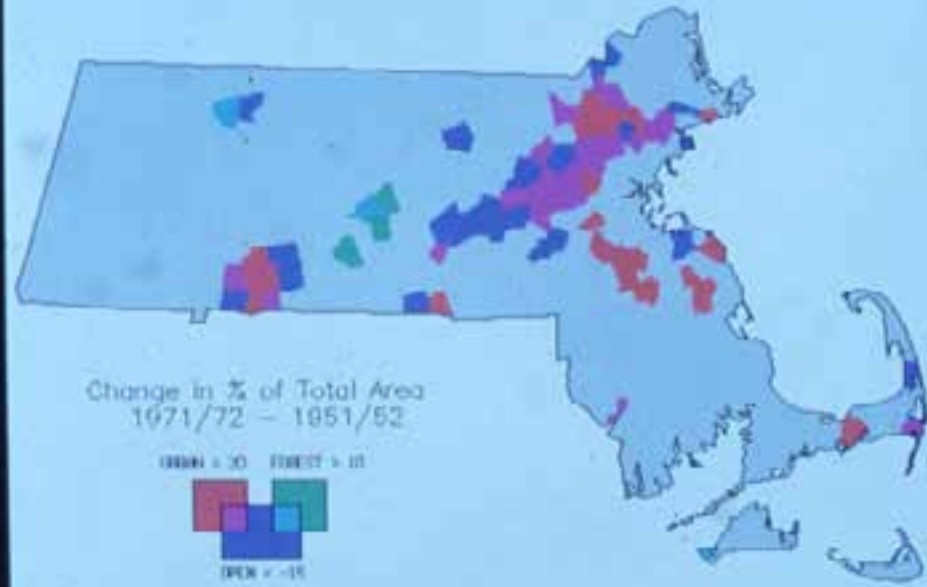
- To display more than one variable simultaneously
- To allow for estimation of the degree or spatial pattern of cross-correlation between variables
- Effectiveness of a method is related to readability and accurate representation of the data

Cross-variable mapping

- Simultaneously depict magnitude of variables within homogeneous area for multiple map themes
 - **Bivariate mapping**
 - **Trivariate mapping**

Early examples

LAND COVER CHANGE MASSACHUSETTS TOWNS OF CONSIDERABLE CHANGE



Data from the MacConnell Project

Denis White
Harvard University

FUEL SOURCE FOR ELECTRICITY GENERATION : 1978



DATA FROM U.S. DOE
via Book of the States

DENIS WHITE
HARVARD UNIVERSITY

DEGREE OF
DEPENDENCE

FUEL

100- 80- 60- 40-
100 80 60

Hydro

Oil

Gas

Coal

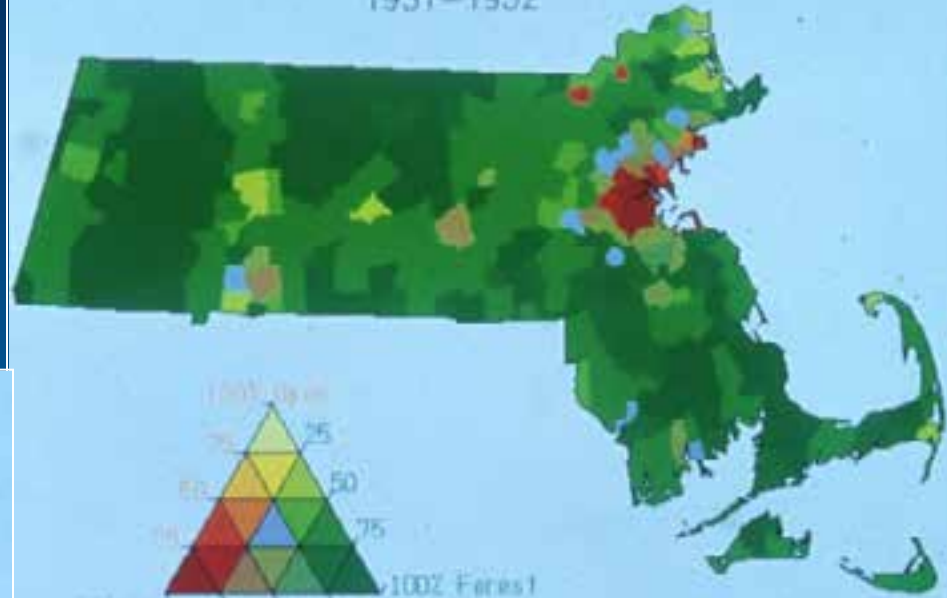
Nuclear

No Dependence

Making Beautiful Maps

Early examples

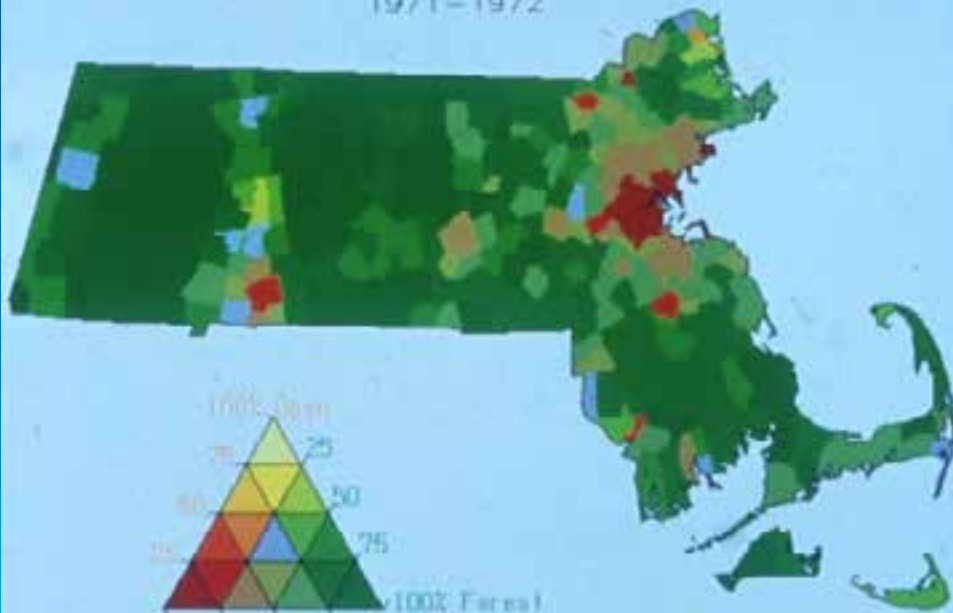
LAND COVER CHARACTERISTICS
MASSACHUSETTS' CITIES AND TOWNS
1951-1952



Data from the MacConnell Project

Denis White
Harvard University

LAND COVER CHARACTERISTICS
MASSACHUSETTS' CITIES AND TOWNS
1971-1972



Data from the MacConnell Project
Making Beautiful Maps

Denis White
Harvard University



Percent Change, 1990 to 2000 and Population Density, 1990

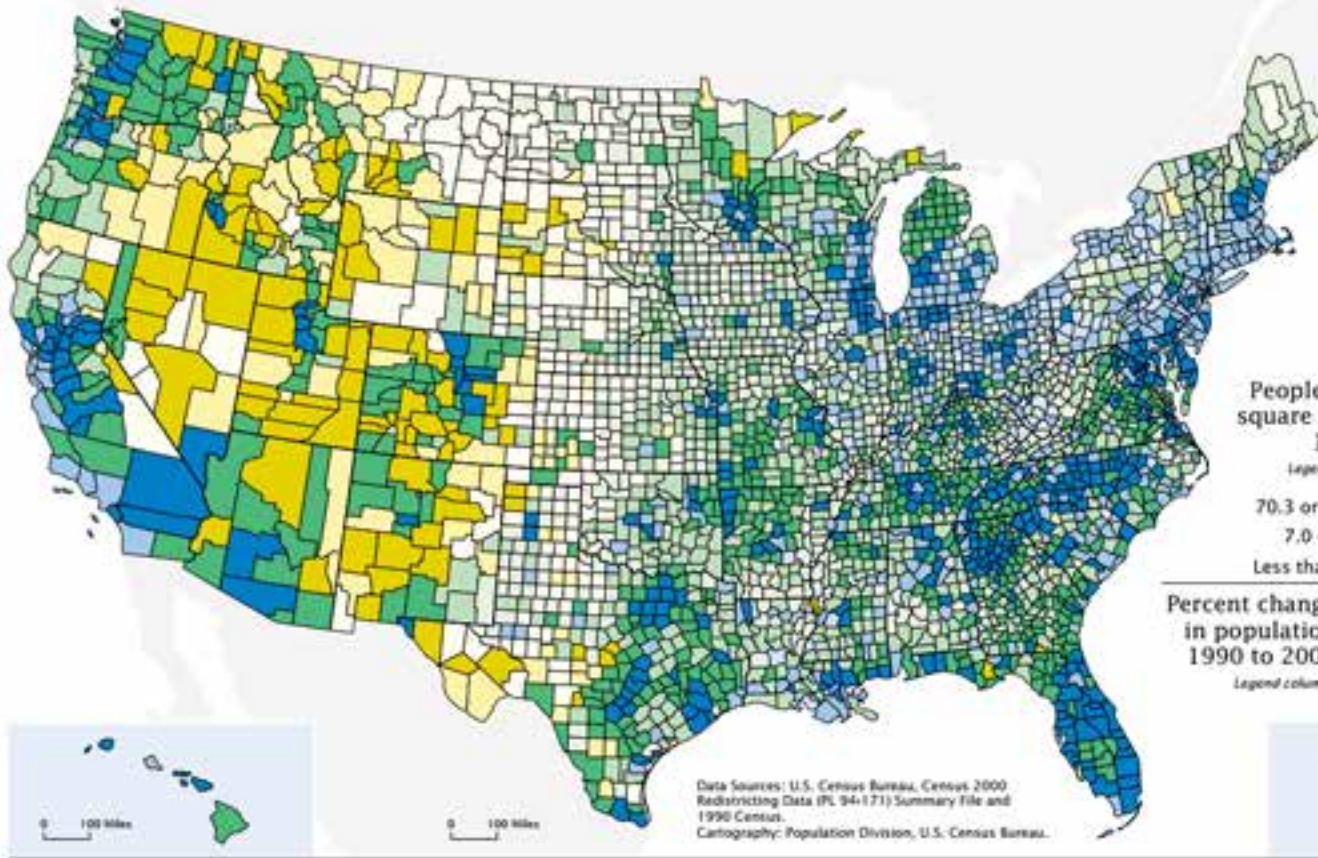


Large population increase
Equal to or more than U.S.
increase of 13.2 percent and:

- Equal to or more than 1990 U.S. density of 70.3
- Less than U.S. density

Loss or small increase
Less than U.S. increase of 13.2
percent and:

- Equal to or more than 1990 U.S. density of 70.3
- Less than U.S. density



County colors:
Color hue represents 1990
population density;
yellow counties had the
lowest densities, less than
7 people per square mile
bottom row in the legend;
green counties were
less than 70.3, the U.S.
density in 1990;
blue counties had the
highest densities.
Color lightness represents
population change from
1990 to 2000:
light counties lost
population (left column
in the legend);
dark counties grew the
most, with gains equal to
or more than the U.S.
change of 13.2 percent.

People per
square mile
1990

Legend rows

70.3 or more	7.0 - 70.2	Less than 7.0
--------------	------------	---------------

Percent change
in population
1990 to 2000

Legend columns

Loss	0.0 to 13.1	13.2 or more
------	-------------	--------------

Data Sources: U.S. Census Bureau, Census 2000
Redistricting Data (PL 94-171) Summary File and
1990 Census.
Cartography: Population Division, U.S. Census Bureau.

U.S. Census Bureau

Cross-variable mapping

- **Limitations**

- Because the number of classes the human eye can distinguish is limited, cross-variable mapping is generally restricted to combinations of either two or three variables
- Appropriate symbol (color) selection is important for map readability

- **Advantages**

- This technique is useful for simultaneously displaying a few variables (two or three)

- **Recommendations**

- It is often useful to also provide separate maps of each of the variables shown on the bi- or trivariate map

Two ways to do this in ArcMap

- Bivariate renderer

- Use this to render the data on-the-fly
- Use this to create a live legend (linked to the renderer)

- Bivariate script tool

- Use this to calculate the quantile classes in the feature class
- Use the Match to Symbols in a Style renderer
- Use the LegendMaker.mxd to make the legend

Two ways to do this in ArcMap

Exploration

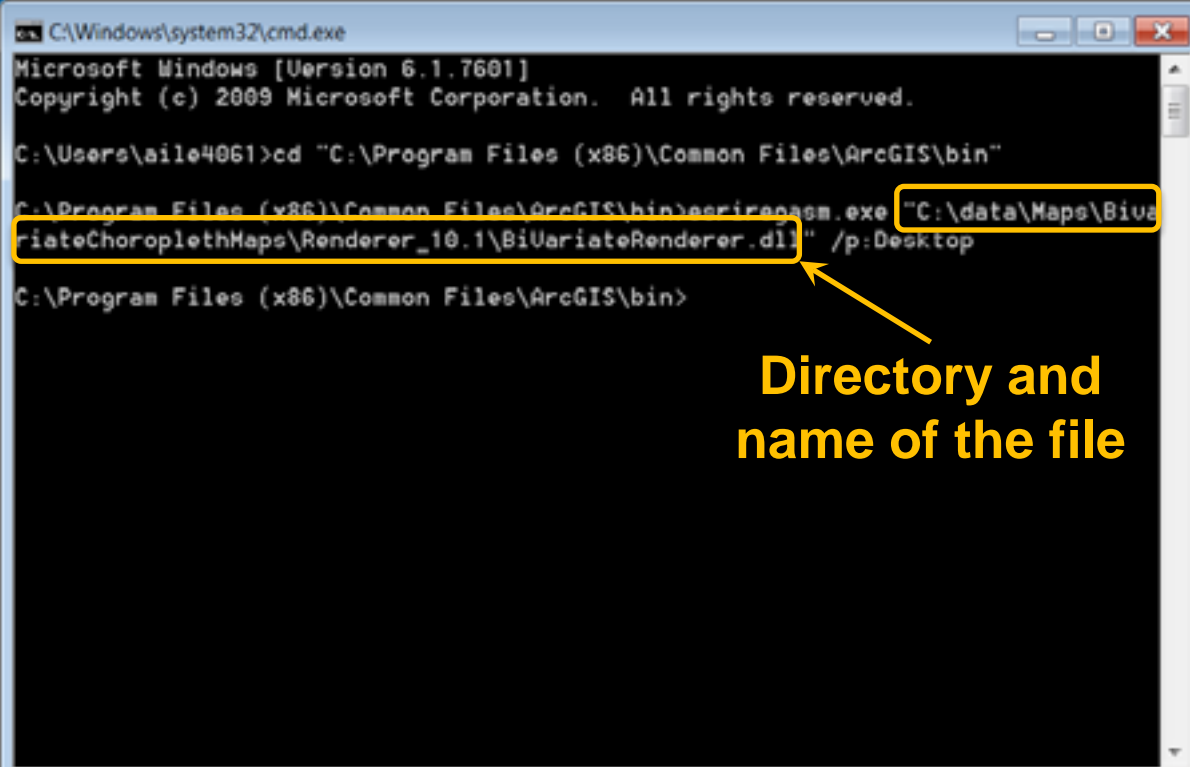
- Bivariate renderer
 - Use this to render the data on-the-fly
 - Use this to create a live legend (linked to the renderer)

Presentation

- Bivariate script tool
 - Use this to calculate the quantile classes in the feature class
 - Use the Match to Symbols in a Style renderer
 - Use the LegendMaker.mxd to make the legend

Bivariate renderer

- Download the .zip file and unzip it
- Register the .dll

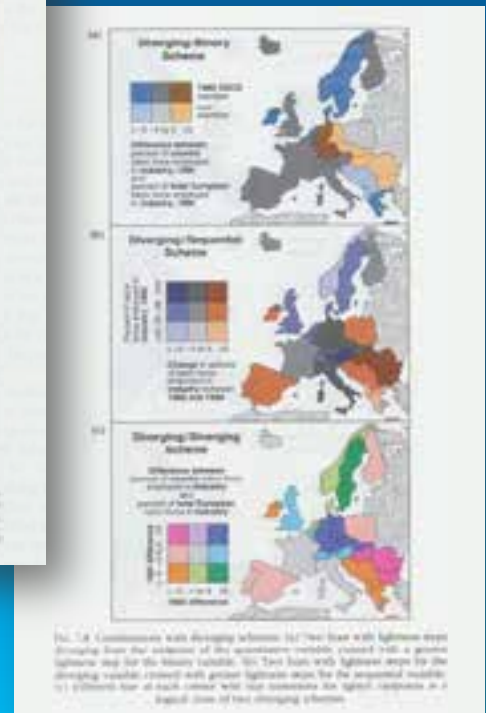
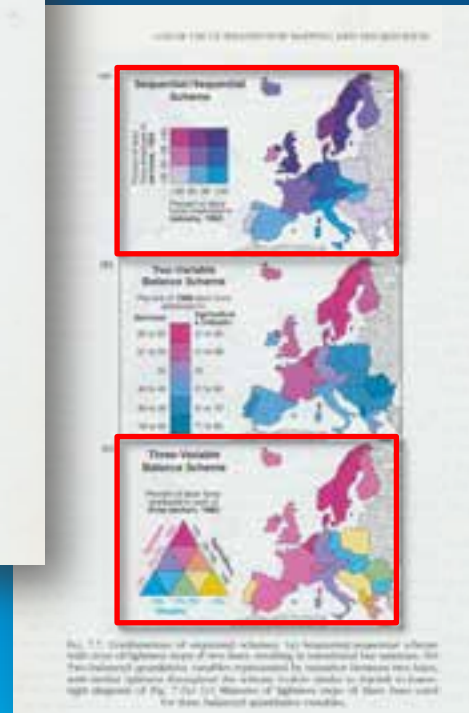
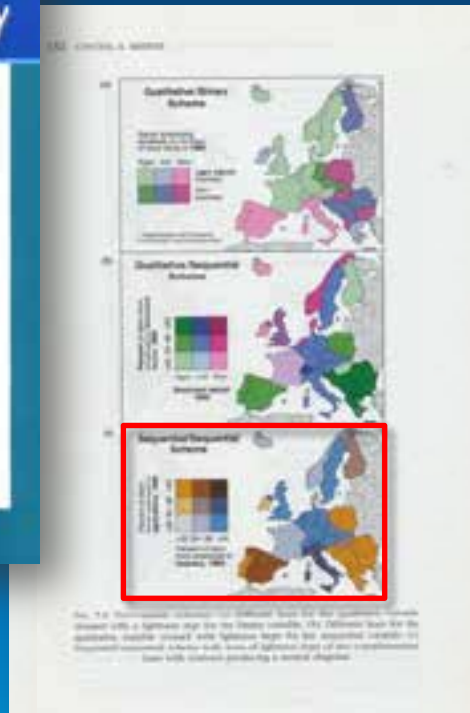
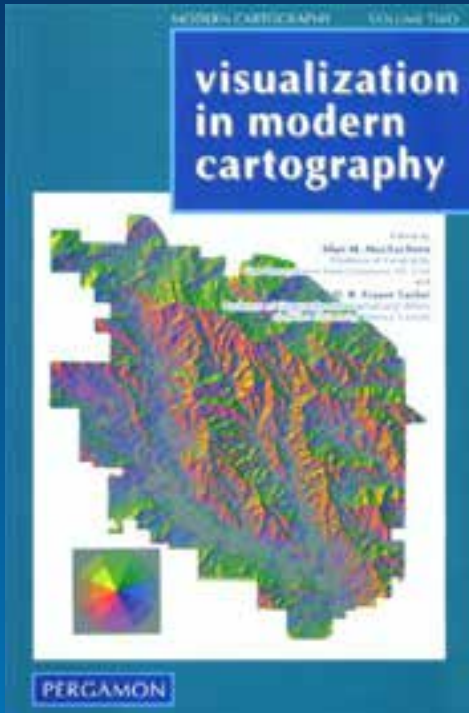


```
C:\Windows\system32\cmd.exe
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\aille4061>cd "C:\Program Files (x86)\Common Files\ArcGIS\bin"
C:\Program Files (x86)\Common Files\ArcGIS\bin>asriregasm.exe "C:\data\Maps\BivariateChoroplethMaps\Renderer_10.1\BiVariateRenderer.dll" /p:Desktop
C:\Program Files (x86)\Common Files\ArcGIS\bin>
```

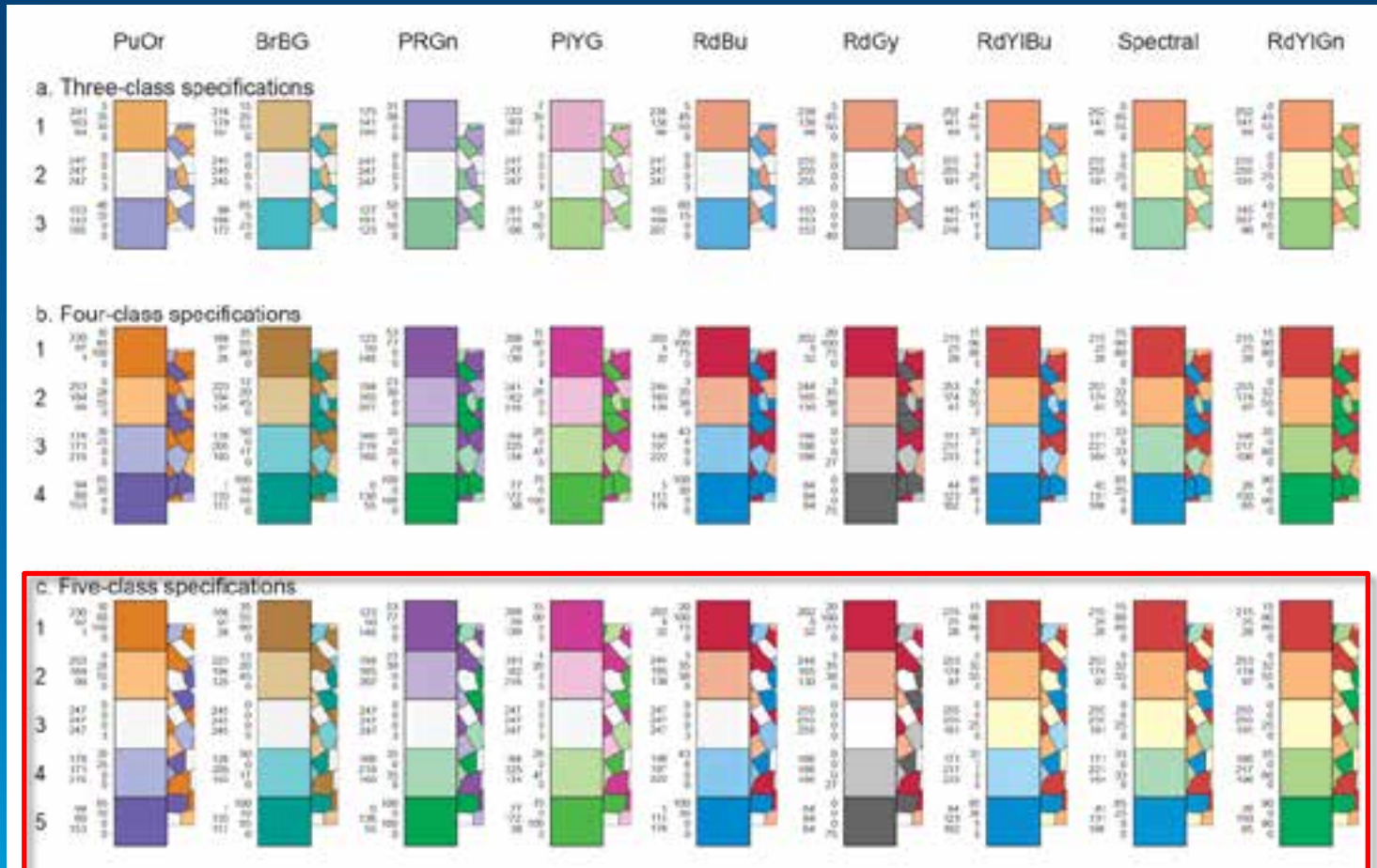
Directory and name of the file

Styles – based on Brewer's color research



Brewer's Color Schemes

- Diverging color schemes



Brewer, Cynthia. 2005. *Designing Better Maps, with permission from CaGIS and Esri Press*

Firefox


Color Blender

meyerweb.com/eric/tools/color-blend/

Most Visited Getting Started Suggested Sites Web Slice Gallery

Color Blender

Format	Hex	RGB	RGBA
Color 1		rgb (129, 74, 105)	
Color 2		rgb (255, 255, 191)	
Midpoints		7	
		<input type="button" value="blend"/>	<input type="button" value="clear"/>
Palette		rgb (129, 74, 105)	
		rgb (145, 97, 116)	
		rgb (161, 119, 127)	
		rgb (176, 142, 137)	
		rgb (192, 165, 148)	
		rgb (208, 187, 159)	
		rgb (224, 210, 170)	
		rgb (239, 232, 180)	
		rgb (255, 255, 191)	



- Pick a color value format, input two **valid** CSS color values in the format you chose, and pick the number of midpoints you'd like to see. The palette will show the colors you input as well as the requested number of midpoint colors, and the values of those colors.
- All numbers are rounded to the nearest integer.
- Clicking on a square in the "waterfall" display will fill in the appropriate value for whichever input is highlighted.
- Switching between value formats will translate whatever values are in place.
- "Clear" removes all values and colors, but does not change the current value format.
- If you'd like to have the Color Blender for offline use, just view source and save to your hard drive.

Used to find intermediate colors

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Firefox

Color Blender

meyerweb.com/eric/tools/color-blend/

Most Visited Getting Started Suggested Sites Web Slice Gallery

Bookmarks

Color Blender

Format: Hex RGB RGB%

Color 1: rgb (129, 74, 105)

Color 2: rgb (255, 255, 191)

Midpoints: 7

Palette

rgb (129, 74, 105)	
rgb (145, 97, 116)	
rgb (161, 119, 127)	
rgb (176, 142, 137)	
rgb (192, 165, 148)	
rgb (208, 187, 159)	
rgb (224, 210, 170)	
rgb (239, 232, 180)	
rgb (255, 255, 191)	



rgb (129, 74, 105)	
rgb (145, 97, 116)	
rgb (161, 119, 127)	
rgb (176, 142, 137)	
rgb (192, 165, 148)	
rgb (208, 187, 159)	
rgb (224, 210, 170)	
rgb (239, 232, 180)	
rgb (255, 255, 191)	

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ArcMap styles



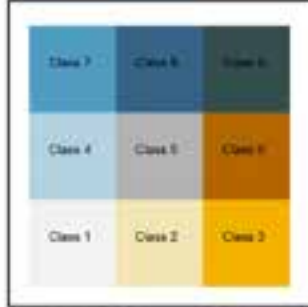
Bivariate_9Classes_BrBG



Bivariate_9Classes_BrBu_Dk



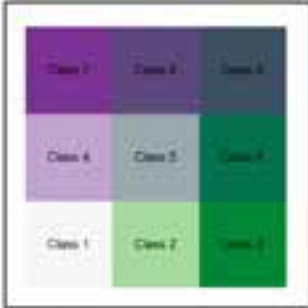
Bivariate_9Classes_BrBu_Lt



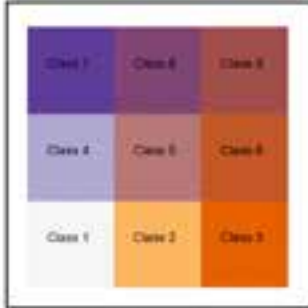
Bivariate_9Classes_BuOr



Bivariate_9Classes_PiGn



Bivariate_9Classes_PuGn



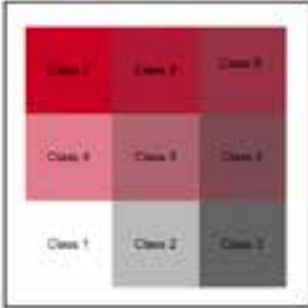
Bivariate_9Classes_PuOr



Bivariate_9Classes_RdBu



Bivariate_9Classes_PiBu



Bivariate_9Classes_RdGy

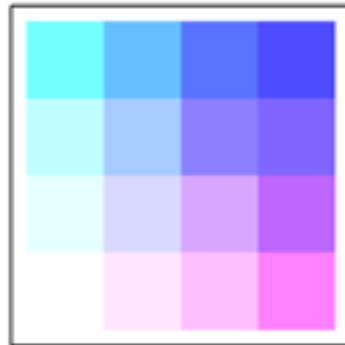


Bivariate_9Classes_RdYiBu



Bivariate_9Classes_RdYiGn

ArcMap styles



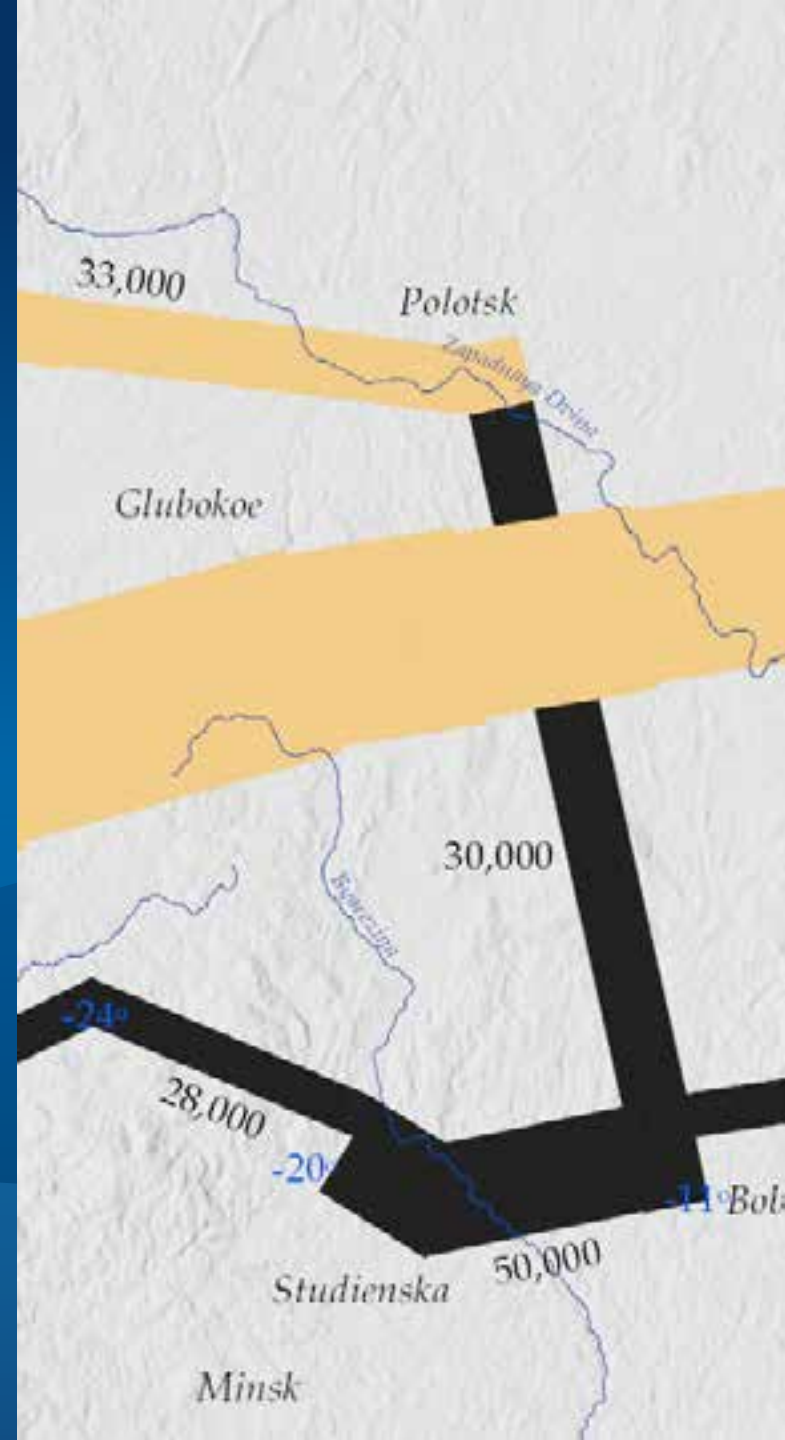
Bivariate_16Classes_BuPi



Trivariate_9Classes_RdBuYI

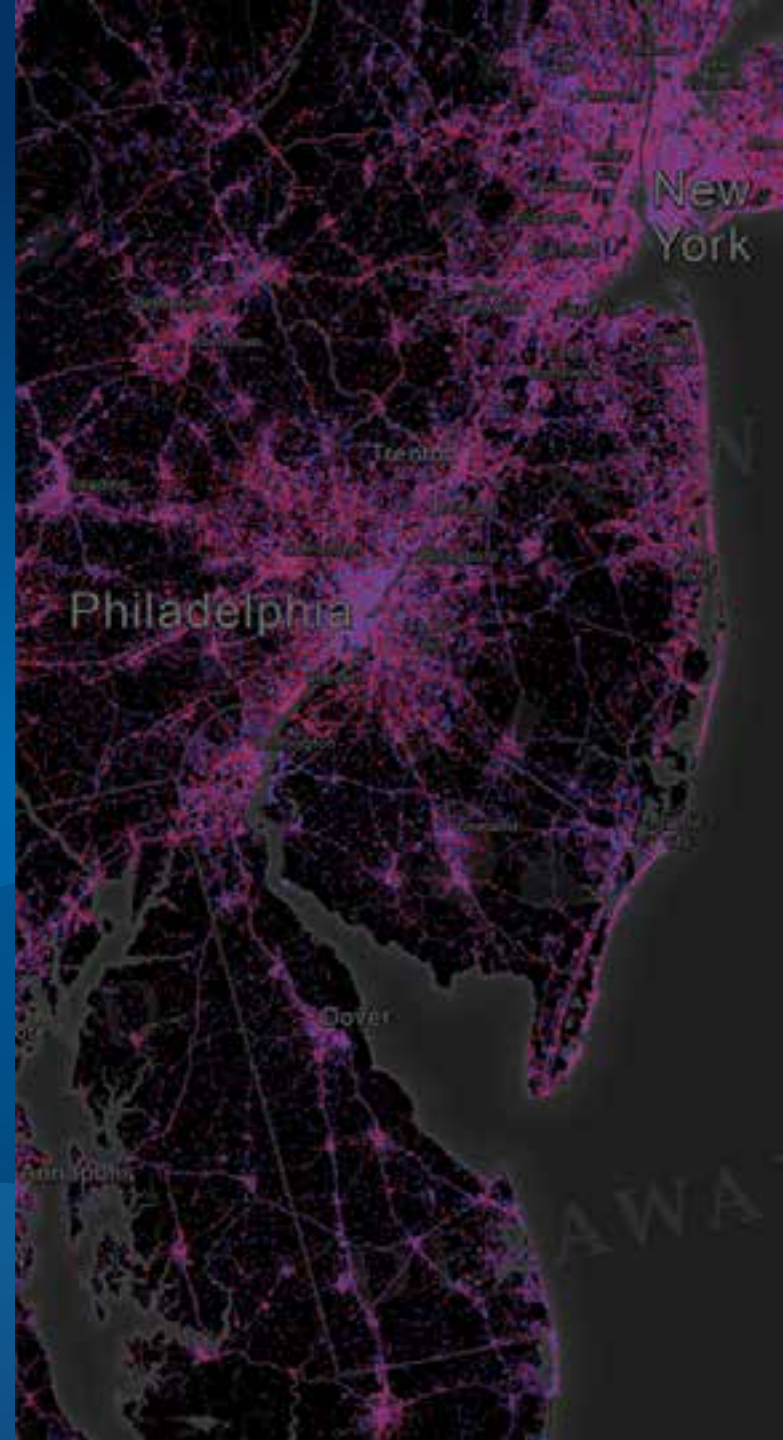
Napoleon's March on Moscow

Kenneth Field



Dasymetric mapping

Kenneth Field



Thank you...



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Understanding our world.