

# **Bivariate Choropleth Maps: Overview and “How To” for ArcGIS**

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**ATSDR/GRASP**

GeoSWG Forum

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# What is a bivariate choropleth map?

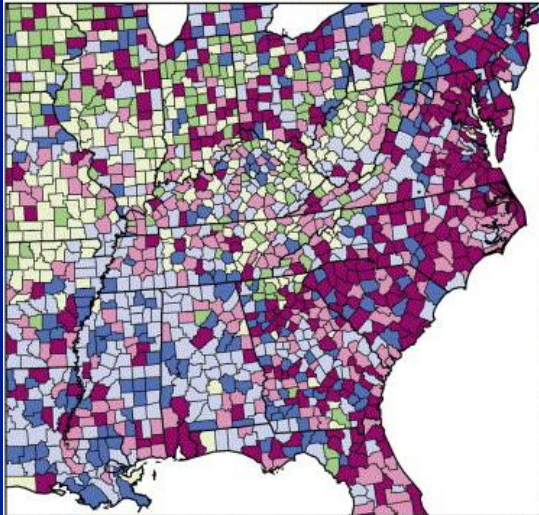
- ❑ Bivariate - two variables included in one map representation
- ❑ Choropleth – Areal enumeration units (states, census tracts, etc.) filled with colors symbolizing ranges in the data<sup>1</sup>
- ❑ A bivariate choropleth map is “a variation of the simple choropleth map that enables us to portray two separate phenomena simultaneously”<sup>2</sup>

<sup>1</sup>Brewer, CA. Basic Mapping Principles for Visualizing Cancer Data Using Geographic Information Systems (GIS). American Journal of Preventive Medicine, Volume 30, Issue 2, Supplement 1, February 2006, Pages S25-S36

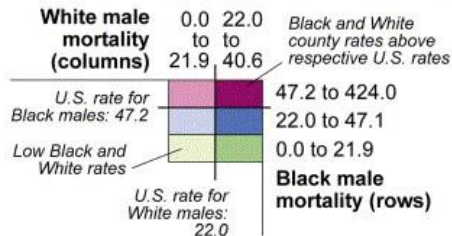
<sup>2</sup>Leonowicz, A. Research on Two-Variable Choropleth Maps as a Method for Portraying Geographical Relationships. Proceedings of the 21st International Cartographic Conference (ICC) Durban, South Africa, 10 -16 August. 2003.

# Examples

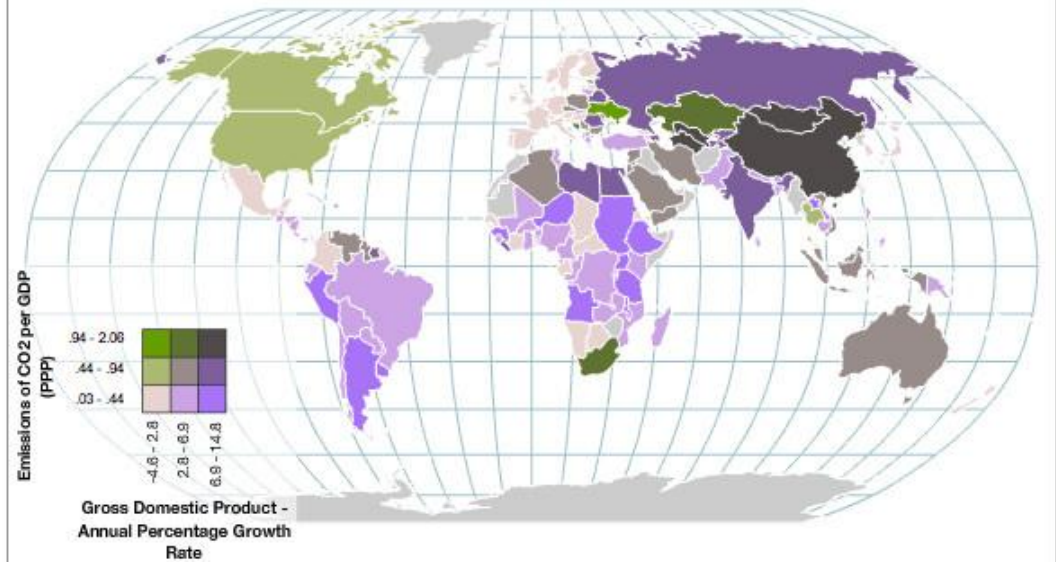
Prostate Cancer Race Comparison  
1970 to 1994



Deaths per 100,000 person years by county



Emissions per GDP by Growth Rate



<http://indiemapper.com/blog/2010/07/indiemapper-data-library/>

Brewer, CA. Basic Mapping Principles for Visualizing Cancer Data Using Geographic Information Systems (GIS). Am J Prev Med. 2006 Feb;30(2S)

# Things to Consider

## □ Data Classification Scheme

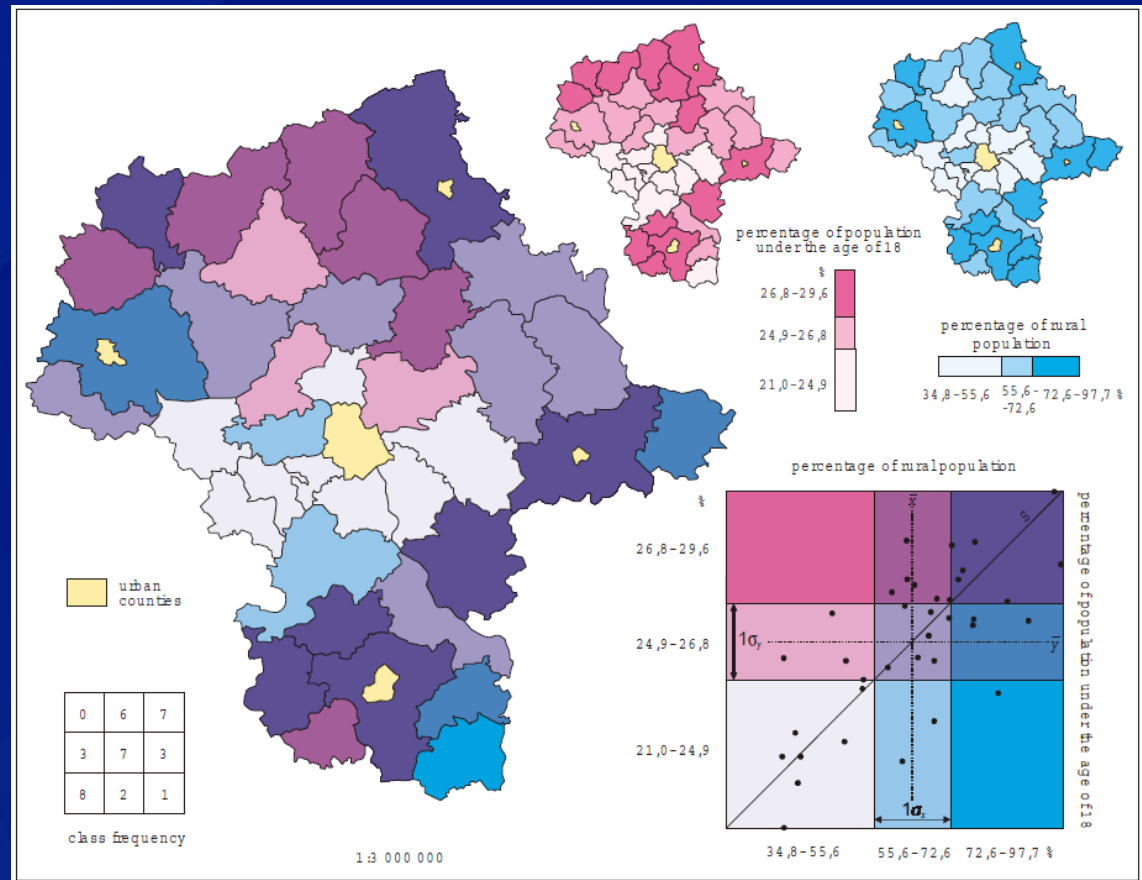
- Use classification methods that are appropriate for map comparison\*
  - Standard Deviations
  - Nested Means
  - Quantiles
  - Equal Areas

\* Slocum, Terry A. 1999. Thematic Cartography and Visualization. New Jersey: Prentice-Hall, Inc.

# Things to Consider

## Legend Design

- Colors must be logical and distinguishable
- 16 classes (4 x 4) or fewer

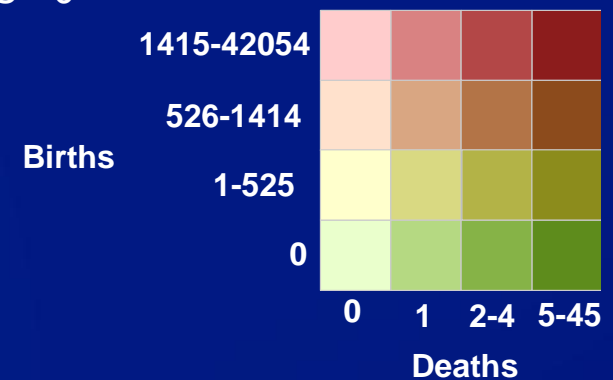


Leonowicz, A. Research on Two-Variable Choropleth Maps as a Method for Portraying Geographical Relationships. Proceedings of the 21st International Cartographic Conference (ICC) Durban, South Africa, 10 -16 August. 2003.

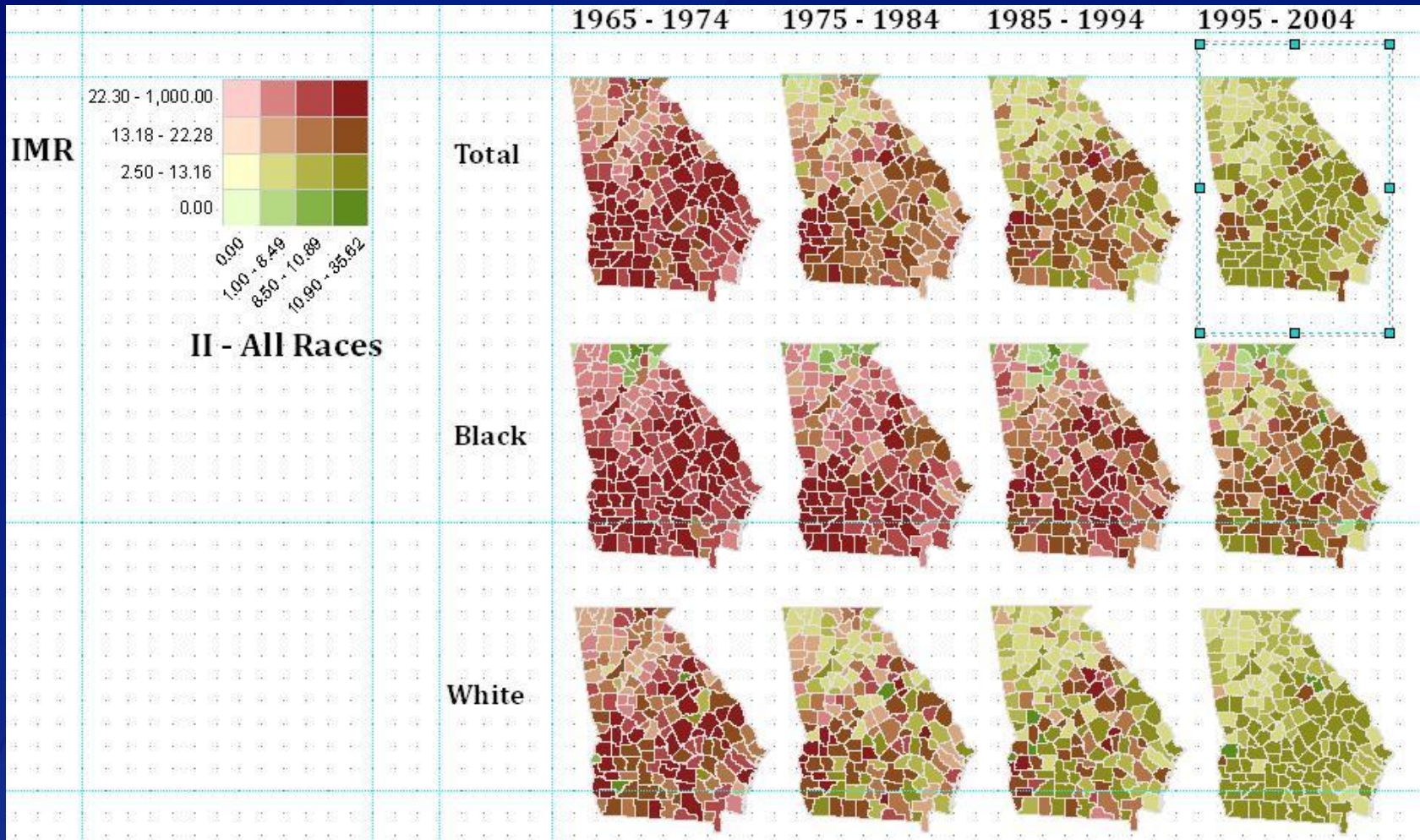
# “How to”

## ❑ Manual Method

- Start with a single feature class containing the two variables to be mapped
- Determine class data ranges for each of the two variables
- Create a new field and perform queries to populate the new field with all the class combinations
  - e.g. for the 16 classes in the example on this page  
BIRTHS = 0 AND DEATHS= 0  
BIRTHS> 0 AND BIRTHS <= 525 AND DEATHS= 0  
and so on
- Color the mapped enumeration units



# Example of Automated Method Output



# Example "How to"

## Manual Algorithm Automated

- Geoprocessing tool created using Python scripting

**Bivariate Choropleth Script**

Input Feature Layer: \\Cdc\project\ATS\_GIS\_Store4\Projects\prj03595\_Spirit\_Lu

Output Feature Class: \\Cdc\project\ATS\_GIS\_Store4\Projects\prj03595\_Spirit\_Lu

**First Variable**

First Variable Field: IMRA95\_04

First Input Field MAX value: 18.036072

Maximum Class Values for First Variable:

0	+
13.16	x
18.036072	↑
	↓

**Second Variable**

Second Variable Field: IIAI2000

Second Input Field MAX Value: 27.295503

Maximum Class Values for Second Variable:

0	+
8.49	x
10.89	↑
27.295503	↓

**First Variable Field**

Field 1 of 2 used in the Bivariate script method. Valid fields may be of type:

- SHORT
- LONG
- FLOAT
- DOUBLE

The color scheme for each of the classes specified for the first variable will be as shown on the vertical, or y-axis

**First Variable Classes**

Highest Class

4-1	4-2	4-3	4-4
3-1	3-2	3-3	3-4
2-1	2-2	2-3	2-4
1-1	1-2	1-3	1-4

Lowest Class

**Second Variable Classes**

Lowest Class

Highest Class

OK Cancel Environments... << Hide Help Tool Help



# Example

## Manual Algorithm Automated

- Two new fields are added to the output shapefile

4-1	4-2	4-3	4-4
3-1	3-2	3-3	3-4
2-1	2-2	2-3	2-4
1-1	1-2	1-3	1-4

Attributes of BVC\_OUTPUT\_Polygon\_102610\_11:18:45AM

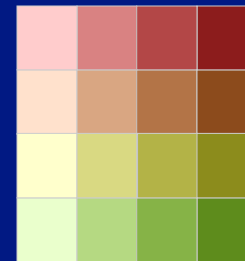
PB2000	BVC_CLASS	BVC_EXPR
0.043981	2-3	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 8.49 AND IIAI2000 <=10.89
0.019956	2-2	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 0 AND IIAI2000 <=8.49
0.009177	2-2	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 0 AND IIAI2000 <=8.49
0.037809	2-3	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 8.49 AND IIAI2000 <=10.89
0.01402	2-2	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 0 AND IIAI2000 <=8.49
0.038131	2-2	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 0 AND IIAI2000 <=8.49
0.004817	2-2	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 0 AND IIAI2000 <=8.49
0.010166	2-3	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 8.49 AND IIAI2000 <=10.89
0.000858	2-3	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 8.49 AND IIAI2000 <=10.89
0.001791	2-2	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 0 AND IIAI2000 <=8.49
0.000505	2-3	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 8.49 AND IIAI2000 <=10.89
0.006709	2-3	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 8.49 AND IIAI2000 <=10.89
0.011943	2-3	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 8.49 AND IIAI2000 <=10.89
0.566837	2-4	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 10.89 AND IIAI2000 <=27.295503
0.516927	2-4	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 10.89 AND IIAI2000 <=27.295503
0.531451	2-4	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 10.89 AND IIAI2000 <=27.295503
0.486077	2-4	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 10.89 AND IIAI2000 <=27.295503
0.495827	2-4	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 10.89 AND IIAI2000 <=27.295503
0.480904	2-4	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 10.89 AND IIAI2000 <=27.295503
0.399804	2-3	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 8.49 AND IIAI2000 <=10.89
0.266587	2-3	IMRA95_04 > 0 AND IMRA95_04 <= 13.16 AND IIAI2000 > 8.49 AND IIAI2000 <=10.89

Record: 1 Show: All Selected Records (0 out of 159 Selected) Options

# Example

## ❑ Manual Algorithm Automated

- For the script as currently written, legend colors are limited to the palette shown below.
- The script uses a layer file, so you can create a new palette layer and modify the script to call for your layer. Or, you can symbolize the map and legend grid using your own layer file once the script has run.
- The legend grid is available as a shapefile to make it easy to modify the palette.
- We plan to develop additional palettes and make them available as part of the bivariate choropleth geoprocessing tool.



# Thank you

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**For more information please contact Agency for Toxic Substances and Disease Registry**

4770 Buford Hwy. NE, Chamblee, GA 30341

Telephone: 1-800-CDC-INFO (232-4636)/TTY: 1-888-232-6348

E-mail: [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov) Web: [www.atsdr.cdc.gov](http://www.atsdr.cdc.gov)

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.



U.S. Department of Health and Human Services  
Agency for Toxic Substances and Disease Registry