GARP 0544 Cookbook: 18 March 2013

Lying with Maps!

Overview

1. What is Lying with Maps?
2. Lying with Maps: Projections!
3. Maps = One Version of Reality!
4. How to Avoid Lying with Maps!
5. Better Maps: The Map as a Canvas
7. Better Maps: Legends
8. ArcGIS Online Basemaps
9. ArcGIS to Google Earth
10. The Lying with Maps Project

What have we learned so far?

Basic GIS is about making meaningful and intelligent maps – we know how to do that. Now all we need are some GIS data, some analysis tools, and we are ready for more advanced GIS mapping and GIS analysis.

Aka: we now know how to drive – let’s go places!
1) What is Lying with Maps?

After Monmonier (2005)

Maps (typically) serve a dual role: they need to inform and impress your audience. That’s (typically…) not a problem unless form is put ahead of function.

- Maps always contain ‘white lies’ (scale issue, generalization, symbols, classifications, break-points, etc.)

= Every map is only one version of reality!

But that necessary abstraction in map making is enormously beneficial for analysis and communication.

2) Lying with Maps: Projections!

A Map...

1. Is a 2-D (i.e. flat) representation of the 3-D (i.e. spherical) Earth (= distortion).
2. Is always smaller than the Earth (= reduction / scale).
3. Is always simpler than the Earth (= generalization)
4. A map shows where stuff is located (= where?)
5. A shows us spatial relationships (= why?)

➤ A great tool for us!
Problem for Map Making:
How do we take a complex 3-D object, such as the Earth, and make it flat (i.e. 2-D)?
This is further complicated by: The Earth being a sphere, but not a perfect one!

Solution: Map Projection!
= a set of complicated mathematical equations whereby the round surface of the Earth is transformed into
the flat surface of the map.

The Problem of Distortion
No matter what type of map projection you use, you will always end up with some geographic distortions
in your map. It is simply impossible to create a 100 percent perfect map because the Earth’s surface is
curved in a weird way.

Something will be wrong with:
• The shapes (of the continents)
• The relative size (of the continents)
• The distances between points on the map
• The directions on the map

This is especially a problem when making maps that cover a large area of the Earth (such as entire
continents). This is less of a problem when making maps that cover only a small section of the Earth – at
that level, the surface of the Earth is more-or-less flat (e.g. town map).

The size and shape of the USA depends on which map projection is being used to create your map!
Compare the Mercator and the Mollweide Projection!
3) Maps = One Version of Reality!

Generalization in Maps

- **Omission and Smoothing of details to increase readability**
  A map is always smaller than the Earth, hence it is impossible to include every minor
detail in the map – omission and smoothing of (unimportant?) detail.

- **Deliberate Enlargement of important features**
  Important features are often printed “too large” on maps, relative to other features. This
highlights the most important information on the map.

- **Use of Symbols**
  Symbols are often used to indicate the (general) location of a feature, rather than showing
the exact shape of the feature.

Plus, the Earth always changes…so you map is always outdated!

*The only correct reality is what is outside – everything else is incorrect – at least to some extent.*

4) How to Avoid Lying with Maps

The key to making good maps is to know how to make bad maps!

Hand-outs/Readings

- Monmonier (2005): Lying with Maps
- Jerry’s Crime Mapping Tips
- Making a Meaningful Map – A Checklist (ArcUser, Fall 2011)
- Make Maps People Want to Look At (ArcUser, Winter 2012)

Available at [http://www.westfield.ma.edu/cbraun/resources/gis-resources/](http://www.westfield.ma.edu/cbraun/resources/gis-resources/)

Understand your data: Look at the histogram!

1. Explore the histogram = how are the data distributed?
2. Are there any meaningful break-points for the map user?
3. How do you handle outliers?

How to select your classification and break-points

- Select the appropriate classification method (Equal Interval, Quantile, Natural Breaks,
  Custom, etc.)
- Select the appropriate number of classes (1 to ???)
- Select appropriate break-points
- Select appropriate color ramp (monochromatic, panchromatic)
- Select sorting (normal or reversed)

<table>
<thead>
<tr>
<th>Document your decision-making process:</th>
<th>What did I do?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explain your decision-making process:</td>
<td>Why did I do it?</td>
</tr>
</tbody>
</table>
Demographic data are usually not evenly-spread, but rather highly-skewed. For example:
- Many states/counties/cities with a small number of Hispanics.
- Few states/counties/cities with a large number of Hispanics.

Understand your data: Choose your break-points!
- Choose even/round break-points.
- Zero can be a useful break-point as it separates gains from losses.
- The national (state) average can be a useful break-point when showing state (local) data.

Choose colors wisely!
Additional Information

- Colours in Culture explained: http://www.informationisbeautiful.net/visualizations/colours-in-cultures/
- Interactive color advice for cartography at http://colorbrewer2.org/

5) Better Maps: The Map Sheet as a Canvas

Basic GIS, to me, is all about making meaningful and intelligent maps – we know how to do that. Now all we need are some GIS data, some analysis tools, and we are ready for more advanced GIS mapping and GIS analysis.

To me, the map sheet starts as an empty canvas (or poster board) on which you display the results of your GIS analysis. You can present these results in a variety of complementary ways, including maps (i.e. data frames), graphs, tables, text, and photographs. An intelligent map combines all of the above so that the GIS analysis is presented professionally, accurately, comprehensively, and visually-pleasing.

Map Sheet
That’s the actual piece of paper that the map is printed on. The size of the map obviously impacts the size and number of your data frames, graphs, tables, text, etc. Common sheet paper sizes are: 8.5 by 11 inches, 18 by 24 inches, and 24 by 36 inches. In addition, larger color printers print using rolls of paper, typically 3 feet wide.

Data Frames
Your map sheet will typically show a series of data frames – each showing a map consisting of a series of map layers containing your GIS analysis. One data frame may be show an overview/location map, whereas other data frames show the actual data analysis.

Graphs
Often, it is easier and better to illustrate the relationship between variables as graphs, for example line graphs, scatter plots, bar graphs, pie charts, etc. It is usually best to create these graphs in MS Excel and copy them into your map. This is especially useful if you are showing and quantifying the correlation between two variables.

Tables
Often, it is useful to summarize your data or results as a table (= data arranged as rows and columns). It is usually best to create the table in MS Excel and copy it into your map. In some cases you may include the actual data mapped in the data frames as a table.

Text
Don’t forget to use text to convey information. An intelligent map typically includes a few sentences or paragraphs of text to explain your GIS analysis.

Photographs
Photographs can be very useful to illustrate an important aspect of your GIS analysis.

All these items can be arranged on your map sheet (using the guidelines) to create a final map that presents your GIS analysis professionally, accurately, comprehensively, and visually-pleasing. We will practice this approach in the two remaining projects this semester (MassGIS Project and Zoning Project).
Example: 2003 Residential Energy Consumption of the U.S.

This map (shown below) contains four data frames showing choropleth maps. The table in the center of the map sheet lists the underlying data for each state and the graph compares energy consumption with CO2 emissions (per state). The text describes the overall GIS analysis, the methodology, and the results.

- Note: This map is not 'perfect' (no map ever is) – but illustrates how you can combine the various techniques to convey information in an intelligent map.

Example: 2003 Residential Energy Consumption of the U.S.
6) Better Maps: Base Layers and Analysis Layers

A data frame often contains one (or more) analysis layers shown on top of one (or more) base layers.

Analysis Layers(s)
- ‘Active’ data layers that show your GIS analysis, for example your choropleth map.

Base Layer(s)
- Static background data that provides spatial context without distracting from the GIS analysis shown in the analysis layers.
- Here we are often using satellite images, aerial photographs, roads, town lines, etc.

In other words: Your analysis layers show your creativity and intelligence in GIS analysis, whereas the base layers are only supposed to look good and show where the analysis layers are located in space.

Example 1: Stanley Park Trail Map

The map sheet in 18 by 24 inches and contains just one data frame. This is a simple trail map, so we did not include any graphs or tables. Text is included to provide some information about Stanley Park and the trail network. We also did not include photographs to give us as much room as possible on the map sheet for the data frame.

- The main analysis layer is the colored lines showing the trails that we mapped using GPS. This is essentially a choropleth map where the color of each line represents a trail characteristic, here its name. There is also a second analysis point layer showing important points.

- The base layer is an aerial photograph from 2005 – without it we would just see a bunch of colored lines printed on white paper. But, the aerial photograph is ‘static’ – I just downloaded it from a website – I did not perform any GIS analysis with it.

This map is intelligent and meaningful because it combines analysis layers with base layers.
Example 2: Pittsburgh Schools

Here you had one analysis layer in each data frame: the schools shown as circles, with the size of the circles as a function of student enrollment. That analysis layer was shown superimposed on a base layer showing the neighborhoods in Pittsburgh. That neighborhood layer did not show any GIS analysis – it just provided the spatial context for the analysis layer (see example below) – without it all you would have seen is a bunch of colored circles printed on white space.

The base layer was static: the neighborhood lines in Pittsburgh do not really change. The analysis layer was dynamic: here you conveyed meaningful information as a choropleth map.

This is an example of the Pittsburgh school map – a classic point choropleth map where the size of the symbols (here: circles) is a function of the characteristic of the feature.

1 map sheet (size 8.5 by 11 inches) with 3 data frames.

1 analysis layer = the point layer showing the schools as a function of student enrollment.

1 base layer = the neighborhood lines.

Without the base layer…the analysis layer would just be a bunch of points floating in space.

Without the analysis layer…the base layer is just a boring wire frame map without any real content.

Together: they make an intelligent and meaningful map.

7) Better Maps: Legends!

Good legends are the key to a good map…In other words: Bad legend = bad map.

A few general comments

1. In ArcGIS the legends are dynamically-linked to the map. What does that mean? It means that your legend changes automatically when you change your map. In the example above, if you were to change the circle color from yellow to red, or change the classification – those changes would automatically change the legend.
2. The Legend Wizard in ArcGIS does a reasonable job creating useful legends, but you should always fine-tune your legends afterwards. Things to consider:

   Layout: vertical or horizontal layout, title, border, background, etc.
   Content: all layers? selected layers? units? labels?

3. If you use physical data in your map (for example elevation, temperature, etc.) then you legend has to include the units of measurement (feet, meters, °F, etc.).

8) ArcGIS Online: Base Layers and Web Mapping

ArcGIS Online is a service provided by ESRI. ArcGIS Online is not ‘free’ – rather included in the purchase price for ArcGIS 10.1.

ArcGIS Online has essentially two parts

1. ArcGIS Online is a web mapping application where anyone can create and share maps (requires a free account).

2. ArcGIS Online provides great base layer data that that you can embed into your own maps via the Internet. In this case you do not download a huge file to your computer. Instead, the base layer data resides on a GIS server and is linked to your map. This requires you to have (and use) ArcGIS 10.1.

Adding a Base Layer from ArcGIS Online

Adding a base layer from ArcGIS Online is very easy, but requires a live and fast Internet connection!

1. Create an empty map.

2. Select File – Add Data or click on the small downward pointing triangle next to the Add Data button on main toolbar.
3. Select Add Basemap…

4. You have the choice between 12 different basemaps

   Bing Maps Aerial and Hybrid are high-quality satellite images.
   Bing Maps Road, OpenStreetMap, and Streets show transportation features.
   Terrain, Topographic, and USA Topo Maps are great for showing topography.
   Light Gray Canvas and Physical and Ocean are useful as non-distracting base layers.
   National Geographic is useful for general information maps.

5. Select the Basemap you want (for example Bing Maps Hybrid) and click Add.

6. Zoom into your area of interest, add your analysis layers, and create a choropleth map, for example cities in Massachusetts shown as different colored circles depending on population.

7. Switch to Layout view, add your map elements, make your map perfect, and done!

Caution 1:
These are very high-quality data, so try zooming into Westfield State University. The data are transferred to your computer live via the Internet, so you need to be patient at times. Do not open more than a few base layers at a time!

Caution 2:
The Bing images are great, but often too distracting to serve as a good base layer – try the Light Gray Canvas instead!
9) ArcGIS to Google Earth

You can easily create KML files from your map layers and maps by running one of the KML export geoprocessing tools available from the Conversion toolset in the Toolbox window. These tools allow export of a single layer to KML or the export of an entire map to KML.

A KML file created from ArcGIS Desktop will be a snapshot of the current GIS data. If the GIS data is updated regularly, then the KML file will also need to be updated accordingly.

When KML files contain image data—either native raster data or vector data displayed as raster—then a downsampld image is exported for inclusion in the KMZ (zipped KML) file. As this image is contained within the KMZ, it will not crisp up into a higher-resolution image as the user zooms in on the content.

General Information (ArcGIS 10.1)

- Overview of KML tools
- What is KML?
  http://resources.arcgis.com/en/help/main/10.1/index.html#/00s20000000m000000/
- Why use KML to share GIS data?
- Create KML in ArcGIS Desktop
- Layer to KML
- Map to KML
- Preparing you Maps for KML conversion
  http://help.arcgis.com/en/arcgisdesktop/10.0/help/index.html#/Preparing_your_map_documents_in_ArcGIS_for_KML_publishing/00s20000000n0000000/
- KML to Layer

You can easily convert features classes to KML (including the attribute data).
You can also export a map with multiple layers to KML.
You can also convert a KML file into a feature class.
10) The Lying with Maps Project

In this project, you practice your ‘lying with maps’ skills – using demographic data for the 48 contiguous US states (and Washington D.C.). The best way to learn how to make a meaningful map is to practice just the opposite: making a bad map that deliberately distorts the data and creates false impressions.

This project includes four complementary parts:

- A literature review to learn more about the topic
- A GIS mapping task where you practice good (and bad!) map making skills
- An interpretation task where you analyze and explain your maps
- A project report to formalize and document your project

This mimics the standard scientific project sequence: you investigate an issue (= background research/literature review), you conduct the analysis, you interpret and explain your analysis, and you discuss/publish your findings. Plus: you document your study.

Part 1: Literature Review

Monmonier (2005)
Read the Monmonier (2005) paper and write a 1 to 2 page synopsis of the paper, covering the following points:

1. What are the author’s main points? List at least 3 main points, with examples, and explain and discuss.
2. Why are these points important? Explain the authors reasoning, with examples.
3. How do the authors arguments relate to your experience with GIS? Explain and discuss at least two specific examples of ‘lying with maps’ that you have encountered so far.

Jerry’s Crime Mapping Tips
Read Jerry’s top ten crime mapping tips and think about the following:

1. Sort Jerry’s ten tips from most important to least important and explain your reasoning for your sorting.
2. Ten is obviously an arbitrary number. Add your own two tips and explain why you think these two tips should be included in a top-twelve list.

ESRI Map Checklist
Read the ESRI Map Checklist and decide/explain the following:

1. Which three of these ten tips do you think are most important?
2. Summarize your top-three tips and explain your reasoning.
**Part 2: GIS Mapping Task**

Create two choropleth map of the USA (in 8.5 by 11 inch), with 2 data frames each, showing one of the following two attributes (your choice) of United States demographics:

BLACK or HISPANIC

**Map 1**
Map 1 shows the absolute values of the attribute.
- In the left data frame: create an objective choropleth map choosing a classification system and map design that shows the spatial patterns as objective as possible.
- In the right data frame you do the opposite (using the same data) by choosing a classification system and map design that deliberately ‘lies’ to the map reader.

**Map 2**
Map 2 is essentially the same as Map 1, expect you show normalized values of the attribute = as percentage of population in 2007.

**Tips and Hints**
- Each data frame includes a legend, a title, and the other standard map elements.
- Remember: Your classification system includes the classification method, the number of classes, the break points, the color bar, the sorting, etc.
  Be sure to consider all these options when creating your classification systems.
- Refer back to Monmonier (2005) and Jerry’s Tips for ideas and information on how to make a good or a bad map.

One thing to consider: There are simple and blatant ways to lie with a map. For example: you can change the underlying data or ‘forget’ to include a legend.

But that’s too obvious, so try more subtle ways of lying, such as inappropriate break points, bad color ramps, sorting, large/small classes, etc.

**Data Source:** C:\GIStutorial\UnitedStates\States.shp
  - C:\ESRIPress\GIST1\Data\UnitedStates.gdb\USStates feature class.

**Part 3: Analysis and Interpretation Task**

1. What classification system did you choose for your objective data frames (method, break-points, sorting, etc.)? Why? Explain and discuss your reasoning – what alternatives did you consider?

2. What classification system did you choose for your lying data frames (method, break-points, sorting, etc.)? Why? Explain and discuss your reasoning – what alternatives did you consider?

3. You created two maps showing (a) the attributes as absolute values and (b) the attributes normalized as percentage of population. Are there any differences in the spatial pattern? Why? Explain and interpret! Which map is more meaningful?
Part 4: Deliverables

Please submit professional, well-written report using proper English language and professional formatting and layout. Think in terms of using this report as a sample of your work for a job interview. Include:

- Monmonier (2005) synopsis (1 to 2 pages)
- Jerry’s Tips (1 page)
- ESRI Map Checklist (1 page)
- A step-by-step documentation of your mapping and analysis procedure Think in terms of writing a cook book recipe that a similarly-trained GIS user can follow along to repeat your mapping and analysis. I need to be able to understand your methods to assess your work. Use a numbered list to organize your recipe (2 pages)
- The answers to the analysis questions (2 pages)
- Your two printed maps as the last 2 pages of your report.
- Due Date: next class.

As always, include a cover page and page numbers in the page footer. Your overall project report will therefore include 10 to 11 pages (including the cover page). The number of pages is merely suggestions, but based on experience with this project. Some of you will write more, others will be able to condense your answers, explanations, and interpretations into less text.

Please note: the maps, the analysis questions, the documentation, the literature review, professionalism, effort, and attention to detail are all equally important in terms of your project grade.

➔ Contact me for help or clarification of this assignment or my expectations as needed.

“Too commonly, though, the naïve or noncritical user accepts this arbitrary display [= the defaults] as the standard solution, not merely as a starting point, and ignores the invitation of the program’s pull-down menus to explore other approaches to data classification.

A single choropleth map only presents one of many possible views of a geographic variable.”

(Monmonier, 1996)