Map Design and Statistical Visualisation

ENVS456 – week 2

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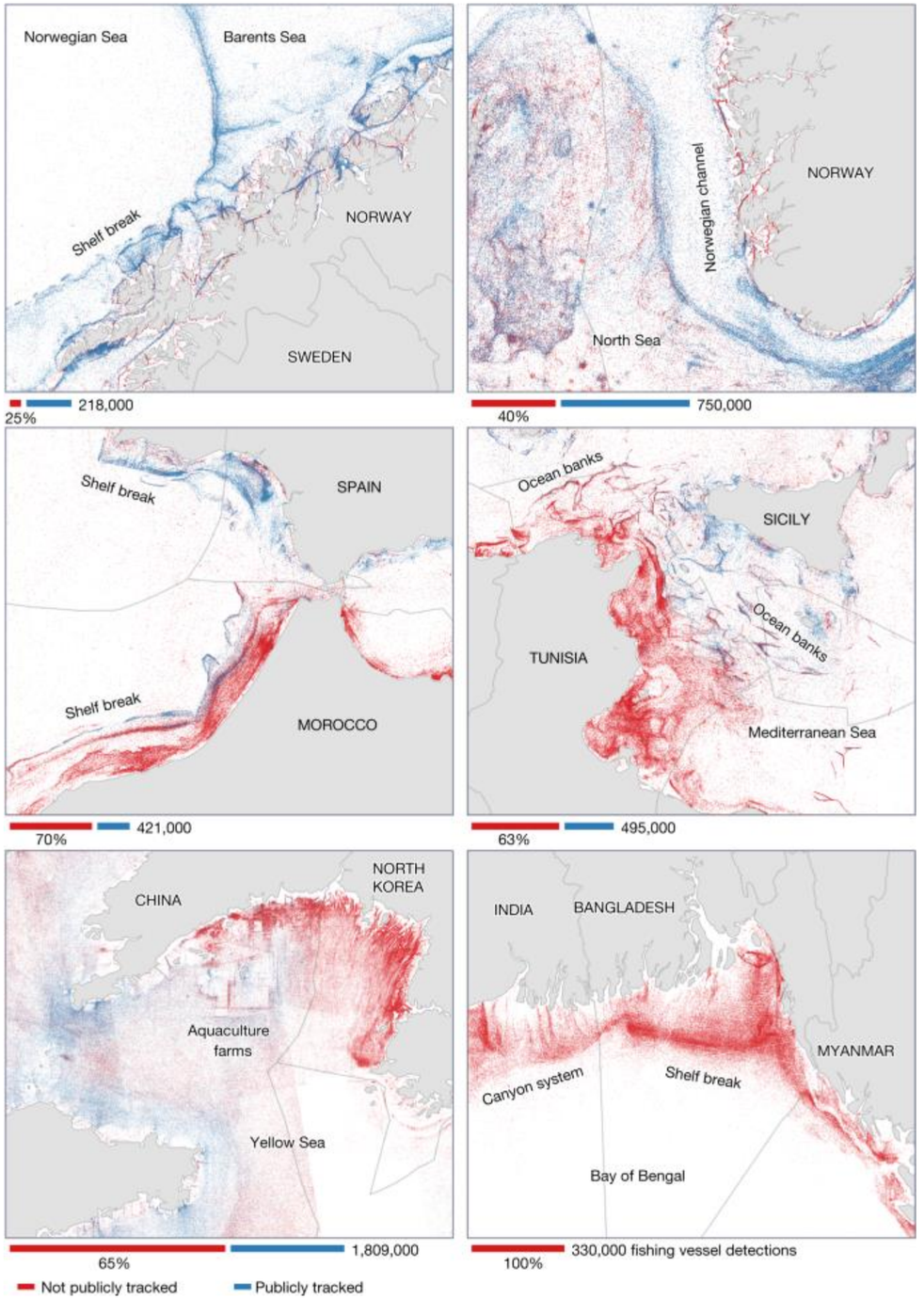


Source: https://www.nature.com/articles/s41586-023-06825-8

Agenda

- Visualisation
- Geovisualisation
- Symbols
- Choropleths
- Cartograms

Visualisation

What?

“Visual representations of datasets designed to help people carry out tasks more effectively”

Munzner (2014)

When?

- *Keep* the human in the loop
- *Augment* memory/internal representation
- *Ask* new questions rather than *answering* existing ones

Why?

- *Bridges* human and machine
- *Relies* on vision
- External representations work around limits of internal cognition/memory

How?

what-why-how

↓

data-task-idiom

Most ineffective designs are due to a poor match

Domain-specific → Abstract form

How?

- Visualisation is multi-use:
    - Exploring
    - Checking pre-conceived ideas
    - Long-term use in workflows/processes
    - Presentation

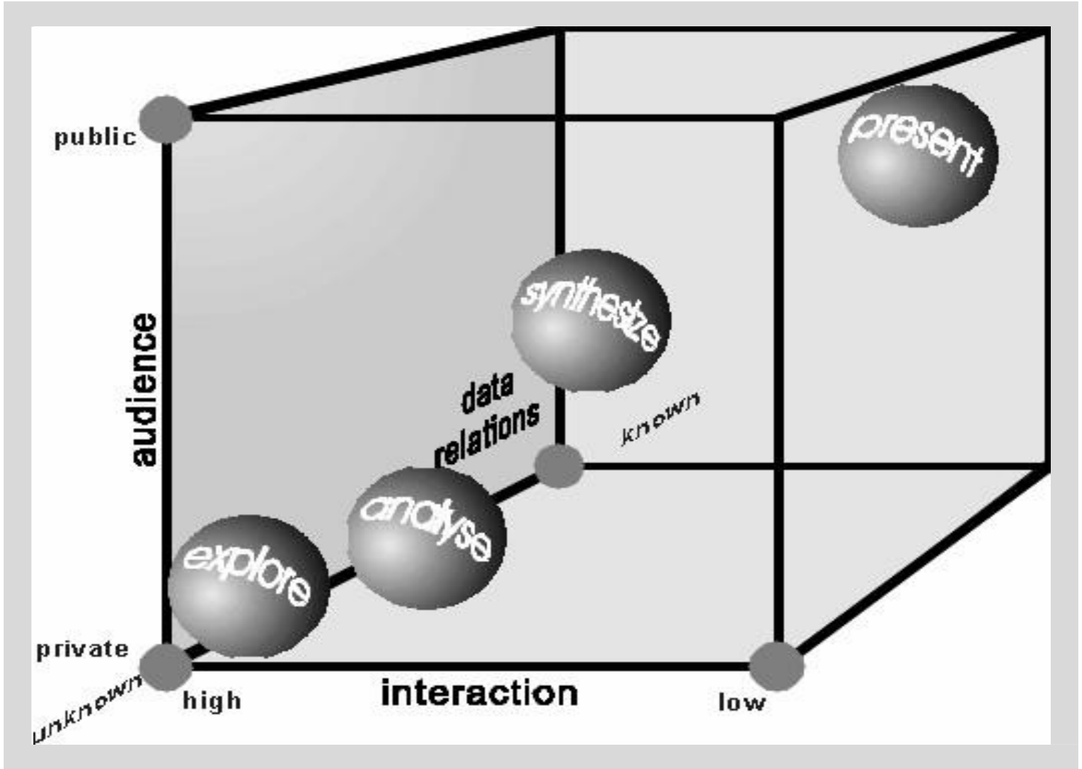
A tool that serves well for one task can be poorly suited for another

Geovisualisation

The most extensive data maps [...] place millions of bits of information on a single page before our eyes.
No other method for the display of statistical information is so powerful

Tufte (1983)

The Map Cube



http://cartography.tuwien.ac.at/wordpress/wp-content/uploads/2013/01/cartotalk-corne-van-elzakker.pdf

Designing Good Maps

- Knowledge of what is being plotted
- Target audience
- Degree of interactivity

MacEachren & Kraak (1997)

When to Use Mapping

- Capacity to communicate large quantities of information quickly and intuitively.
- Maps can be analytically powerful and aesthetically engaging.
- Spatial patterns and spatial variation are the priority
- When communicating place, space and location.

Consider the Audience

- Research Audience: depth, insight and analytical capabilities.
- General Public: accessible and engaging.
- Promotional Context: used to promote a new project/dataset/paper. Eye-catching.
- Government & Policy Audience: support decision making

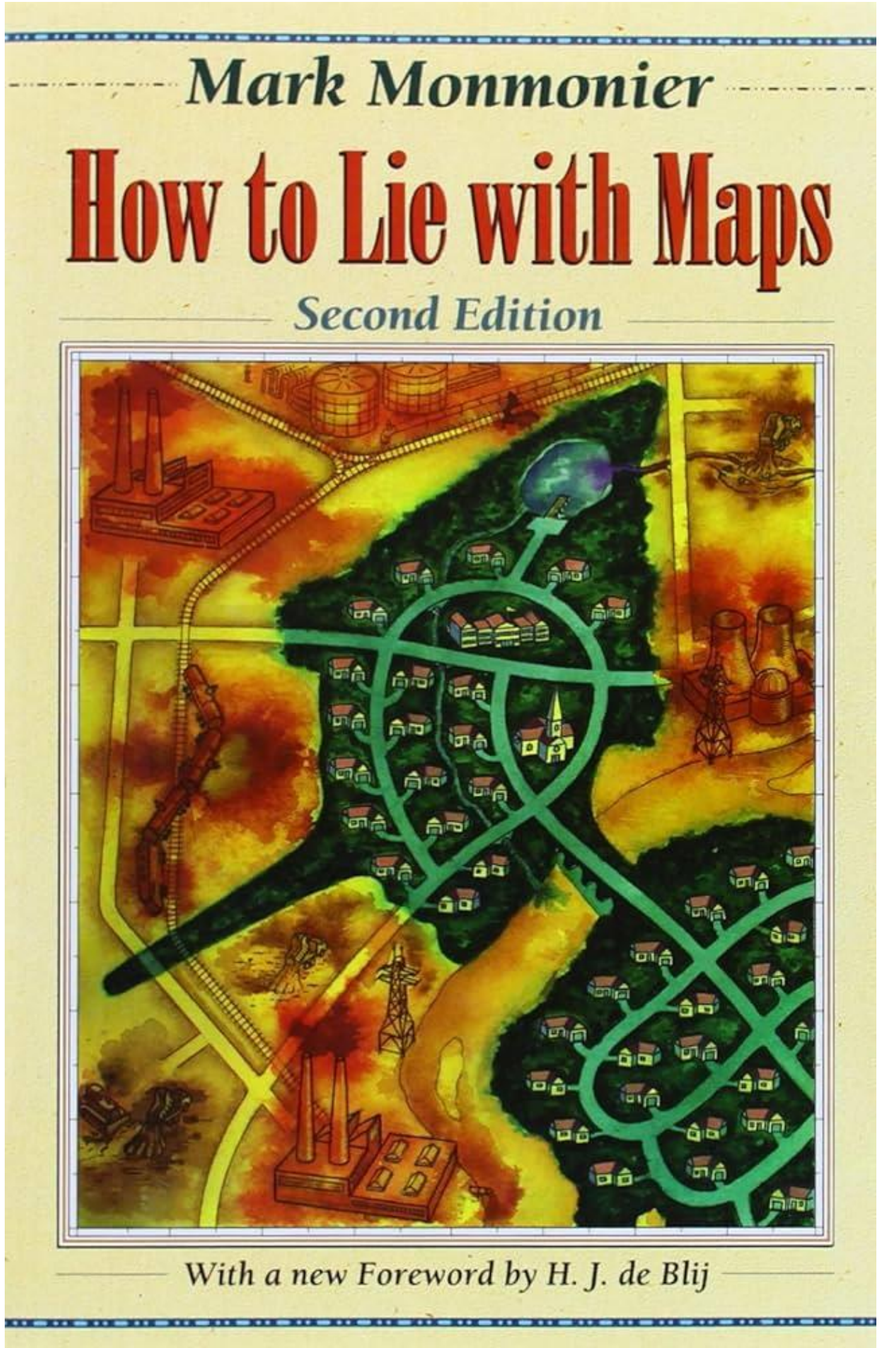
Design Principles

- Legibility: Maps should be clear and straightforward
- Accuracy: maps should be a consistent representation of reality.
- Aesthetic Appeal: visually engage the audience

Important: Sourcing

Map Critically

- Power of Mapping: Audience assume data is true
- From minor errors, to intentional misrepresentations (marketing and propaganda)
- Representation and Omission: Map authors have power over what is on and off the map



Symbols

Lines and Symbols

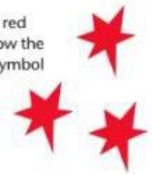
Ways to Think about Map Symbols

Everything on a map is a symbol. Map symbols, or signs, have two parts. The first is conceptual: an earthquake epicenter, a cold front, a sphere of influence. The second is a graphic mark. The mark is connected to the concept by a code or convention. For example, a cold front is often, though not always, shown as a blue line with regularly spaced triangles pointing in the direction of the front's movement:

Resemblance

Some map symbols look like particular data or concepts. A map showing the location of airports uses an airplane symbol. Airplanes make us think of airports.

Maps in a war atlas use red explosion symbols to show the location of battles. The symbol looks like an explosion, and we think of danger or conflict.



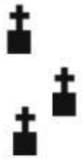
Relationship

Some map symbols intuitively suggest general kinds of data. A map showing the population of different cities uses circle sizes from small to large: sizes vary in amount, as do the data.

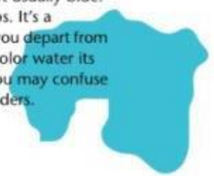
A map showing restaurants, antique stores, and museums in a town uses different shapes; shapes vary in kind, as do the data.

Convention

Of course, all map symbols are symbols by convention. But this is particularly clear when symbols reveal cultural bias or don't resemble what they symbolize. The U.S. Geological Survey uses a Christian cross to symbolize all places of worship – church, mosque, synagogue. Fail!

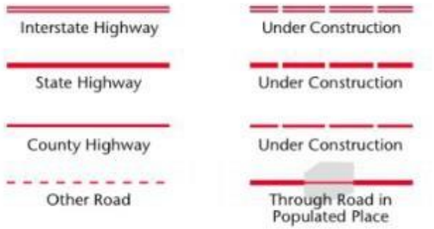


Most maps use blue for water. But water is not usually blue. Except on maps. It's a convention. If you depart from conventions (color water its actual color) you may confuse your map's readers.



Difference

All symbols work by being different from other symbols. But some symbols can be developed from others by using a process of visual differentiation.



Standardization

Isotype consists of a series of "universally communicable" symbols. Such standards aim to reduce ambiguity through a shared set of common map symbols.

Unconvention

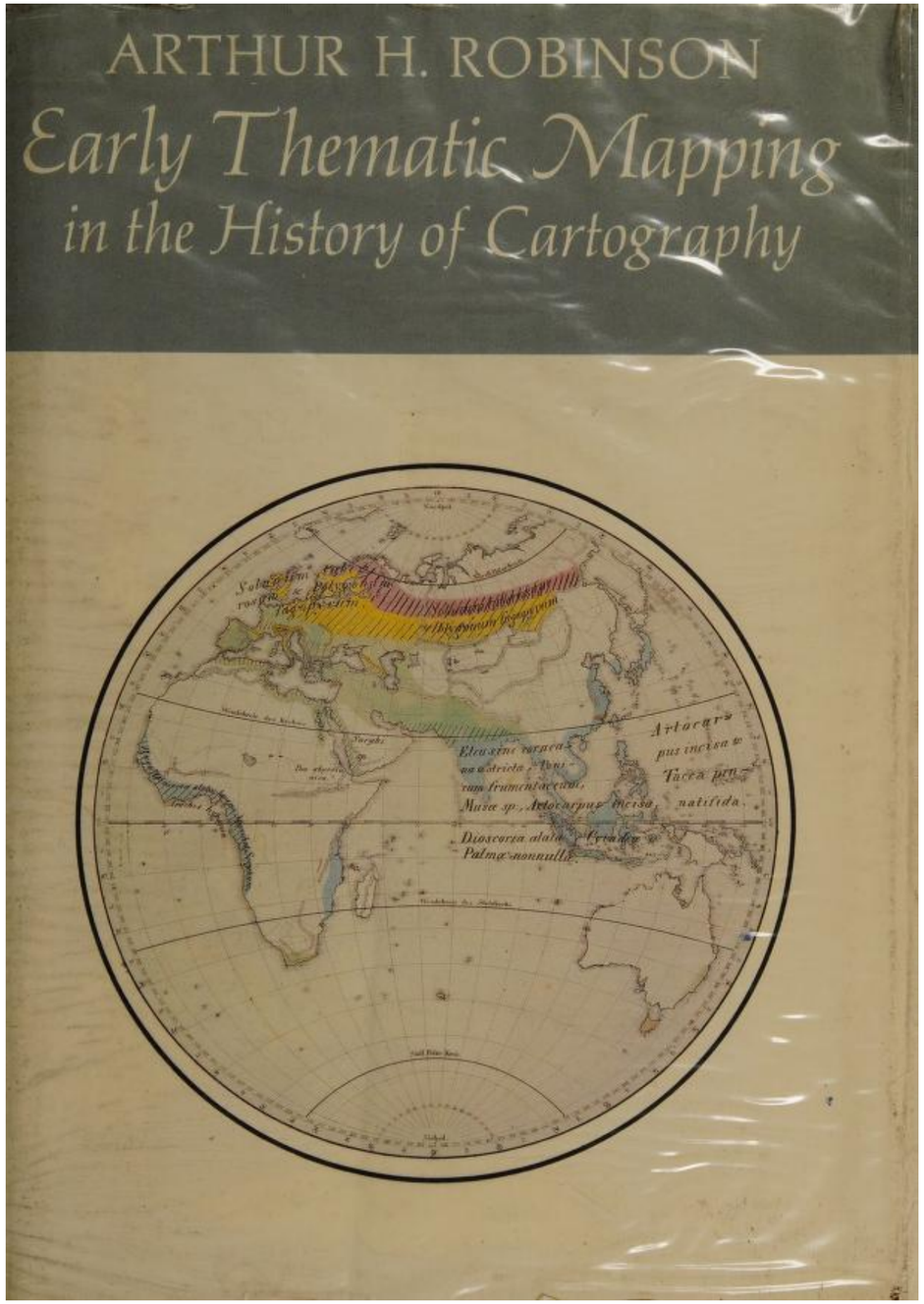
Old maps reveal startling, unconventional map symbols, often conventions of the past. This 17th-century Russian map contains very unconventional symbols for trees, rivers, and properties.

Source: Krygier and Wood 2011

Colour
Choropleths

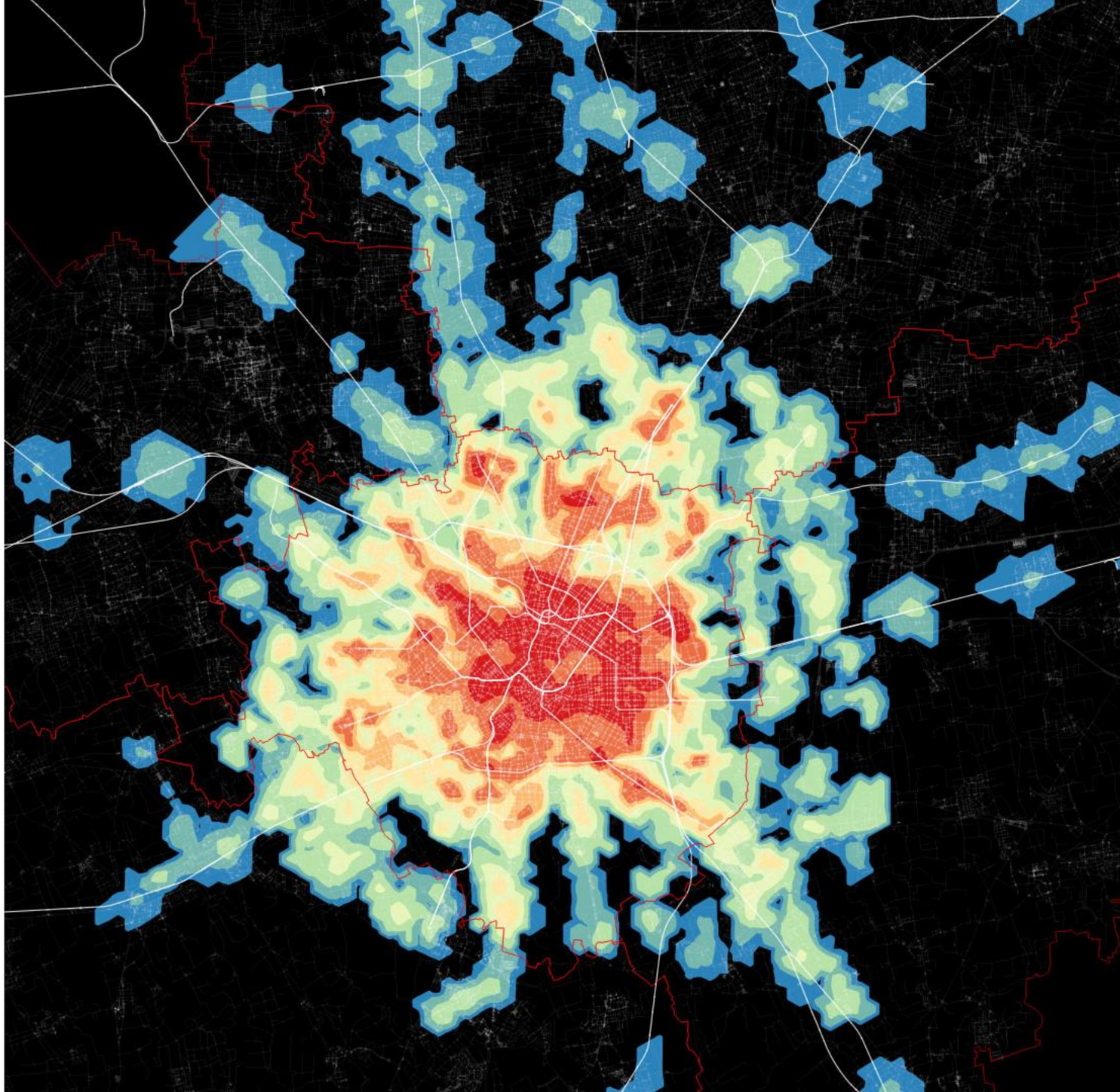
Choropleths

Thematic Maps in which values of a variable are encoded using a colour gradient



How?

- Encode value using the colour channel
- Values are classified into groups (bins)
- Information loss as a trade off for simplicity



Classification choices

N. of bins:

- Trade-off: detail *vs* cognitive load
- Exact number depends on purposes
- Usually not more than 12

- How to bin?
- Colours

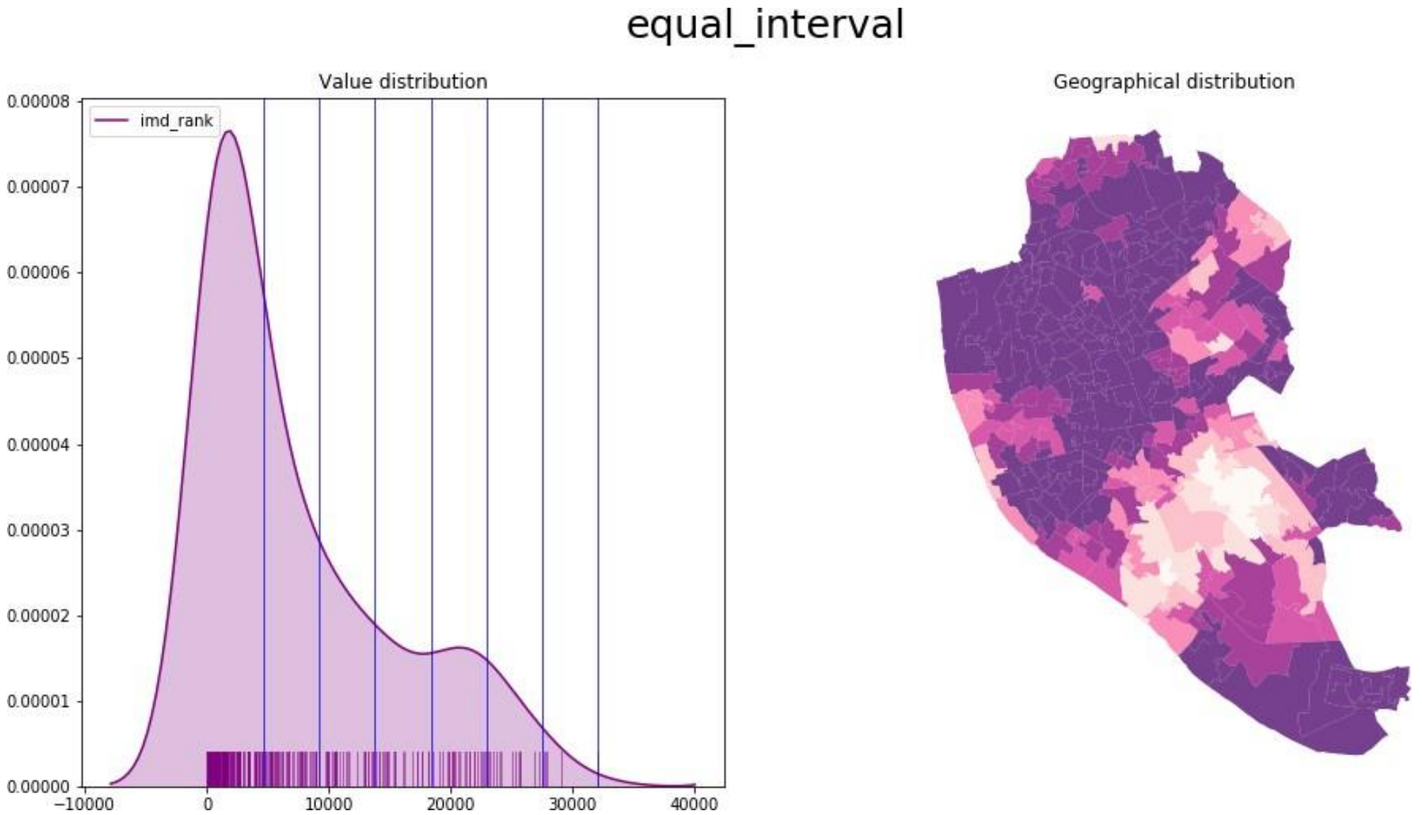
Unique values

- Categorical data
- No gradient
- Examples: Religion, country of origin…

Equal Intervals

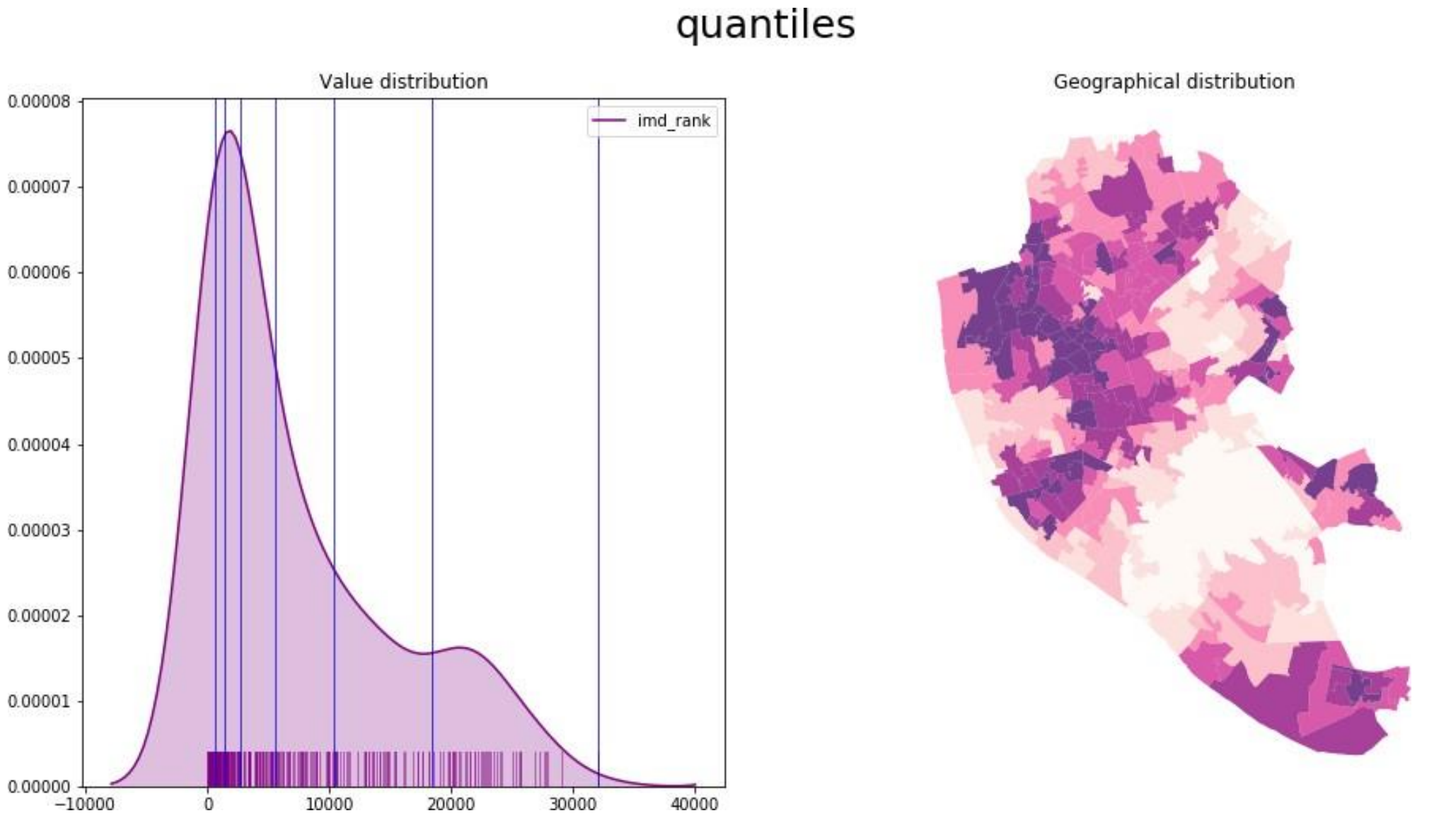
- Take the value span of the data to represent and split it equally
- Splitting happens based on the numerical value

Gives more weight to outliers if the distribution is skewed



Quantiles

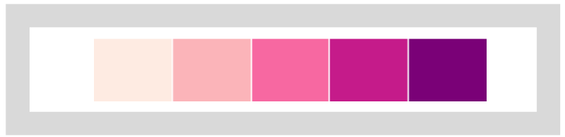
- Regardless of numerical values, split the distribution keeping the same number of values in each bin
- Splitting based on the rank of the value
- If distribution is skewed, it can put very different values in the same bin



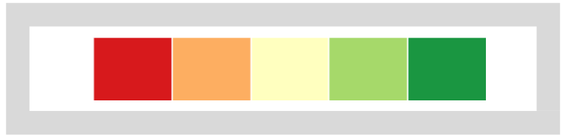
Color schemes

Categories, non-ordered

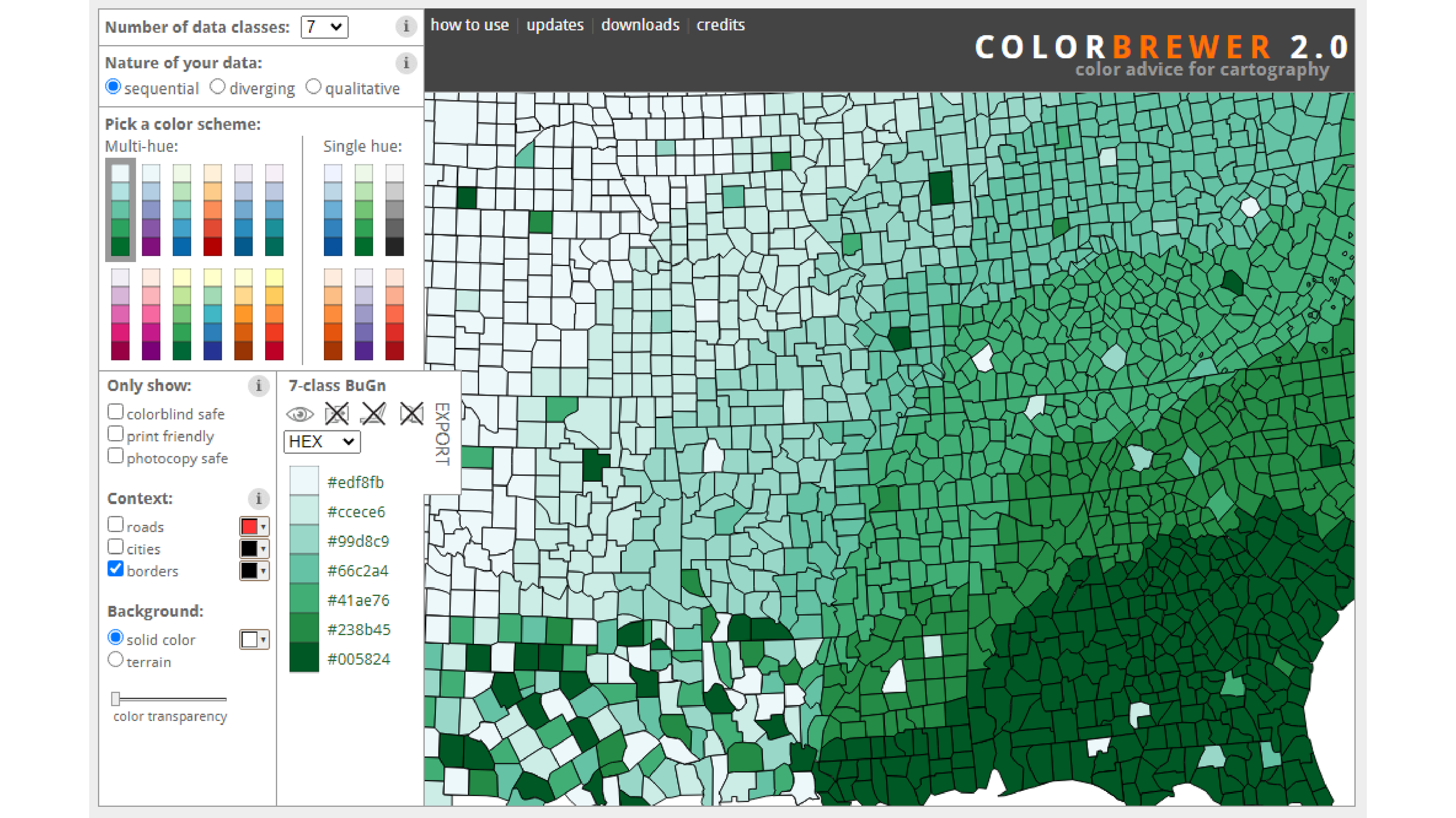
Graduated, sequential



Graduated, divergent

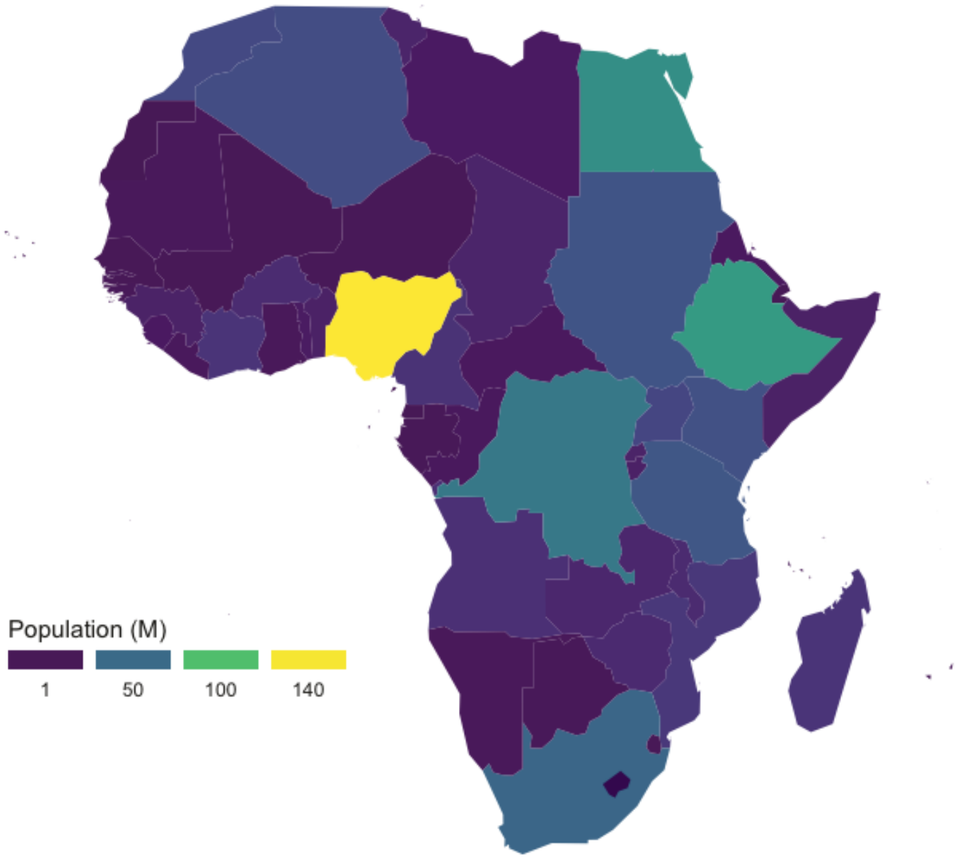


Check ColorBrewer for guidance

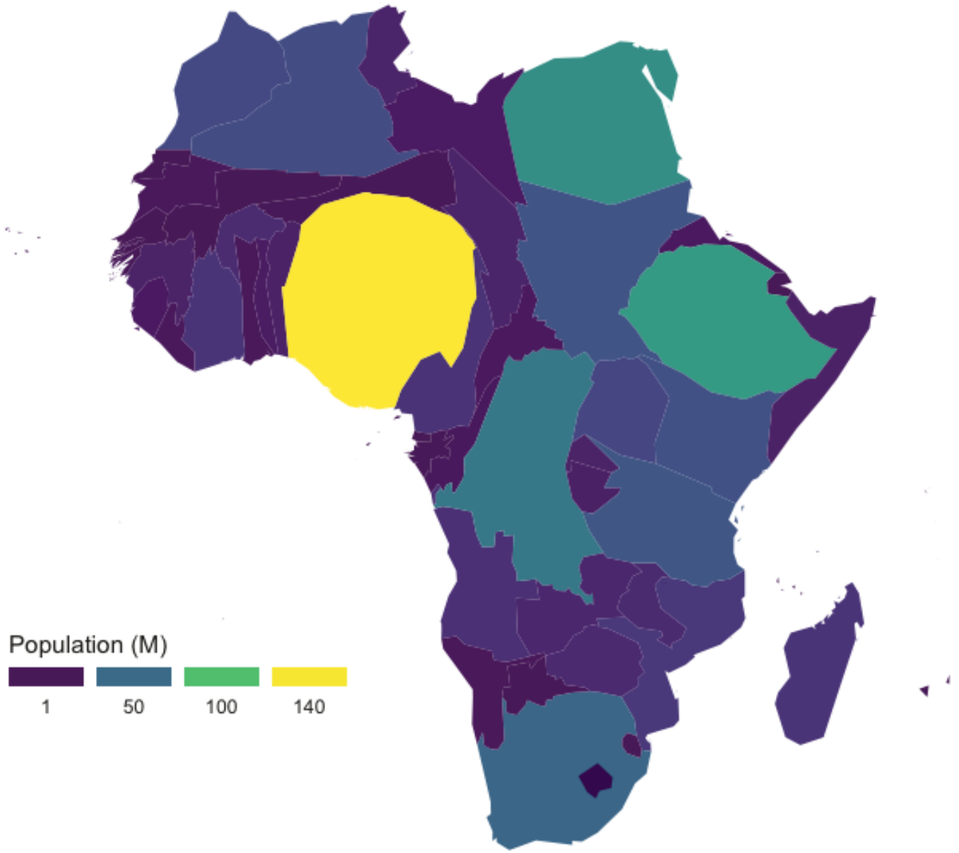

how to use | updates | downloads | credits
COLORBREWER 2.0
color advice for cartography
Number of data classes: 7
Nature of your data:
sequential diverging qualitative
Pick a color scheme:
Multi-hue:
Single hue:
Only show:
colorblind safe
print friendly
photocopy safe
Context:
roads
cities
borders
Background:
solid color
terrain
color transparency
7-class BuGn
EXPORT
HEX
#edf8fb
#ccece6
#99d8c9
#66c2a4
#41ae76
#238b45
#005824

Size
Cartograms

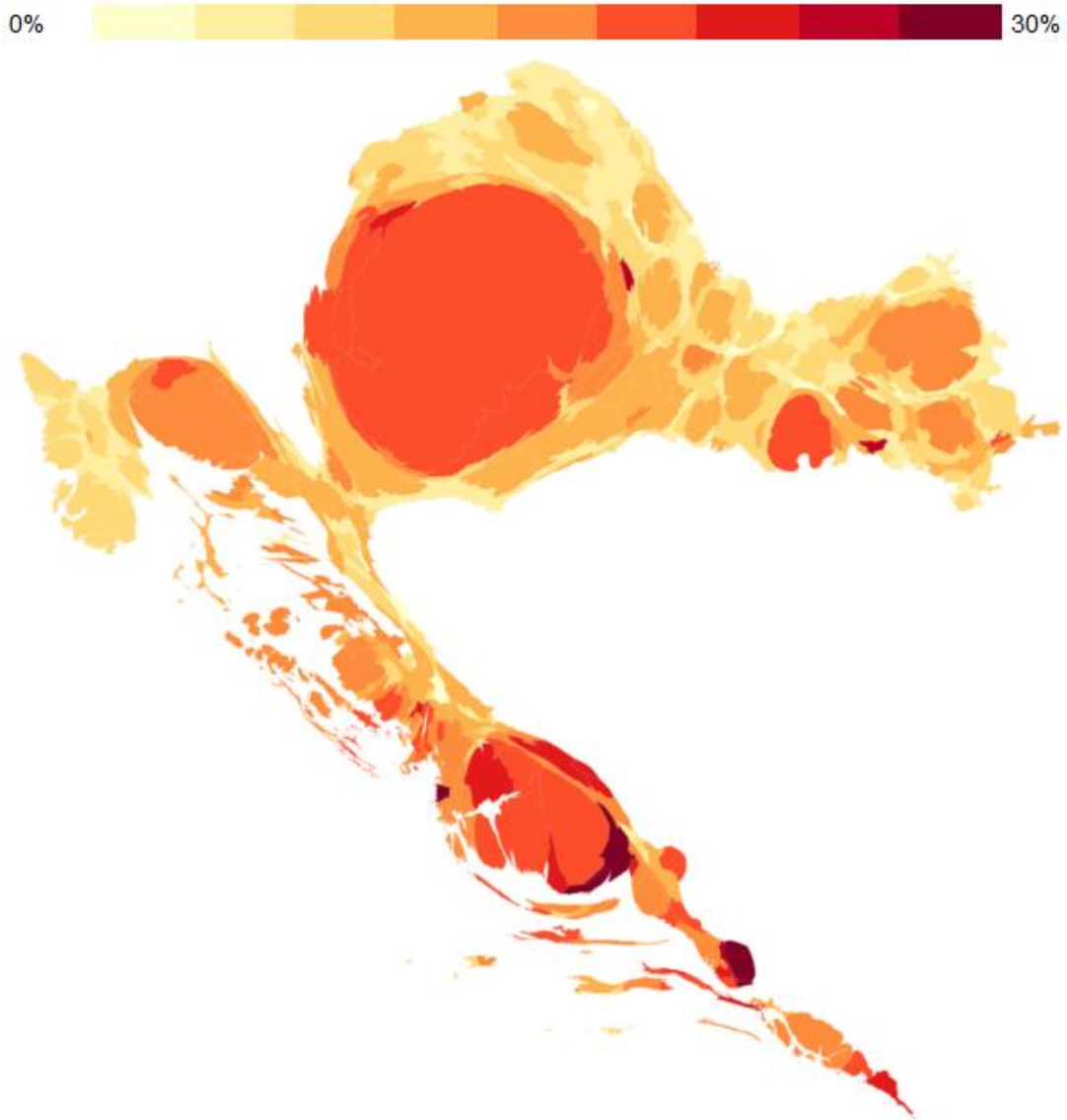
Real boundaries



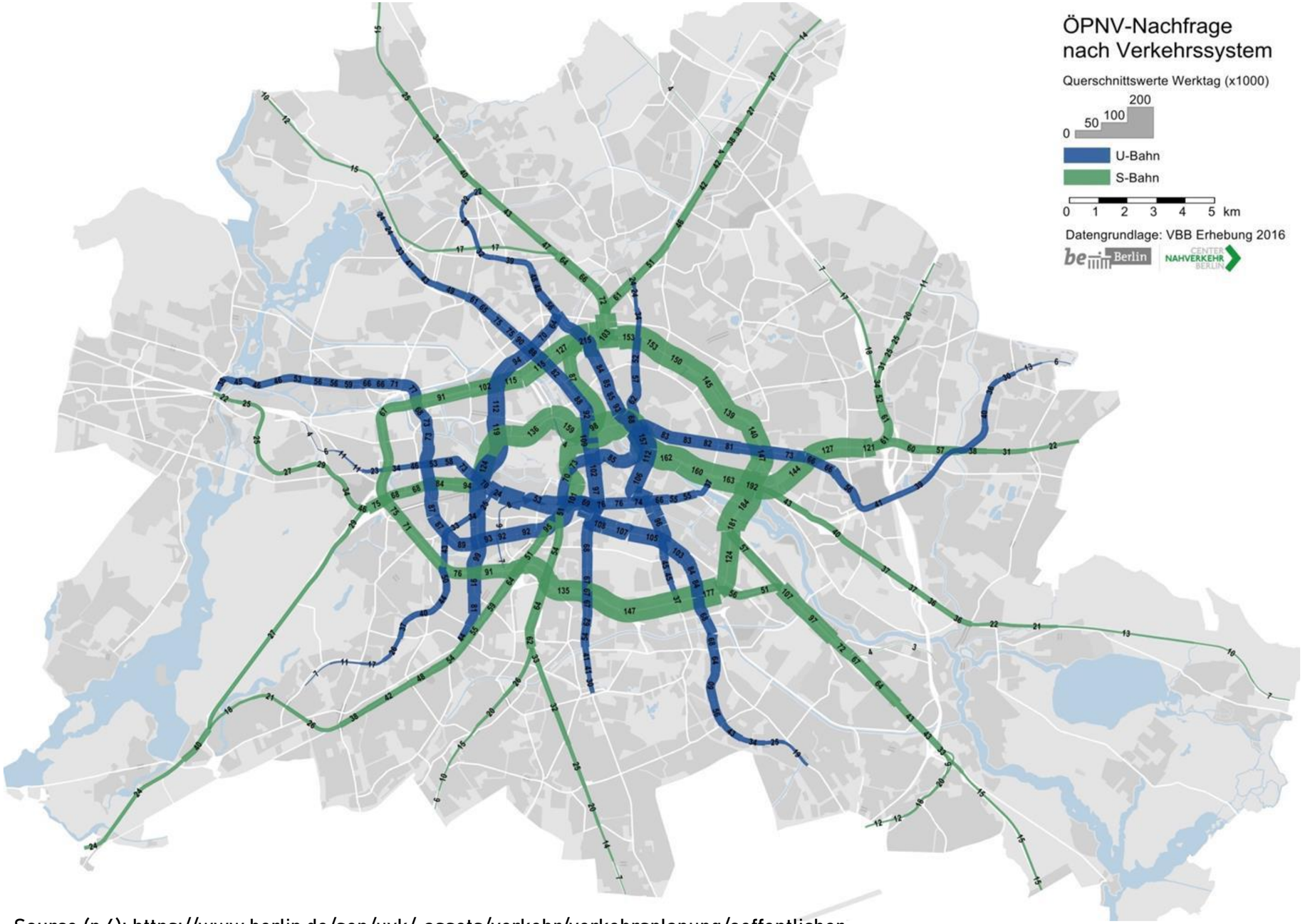
Cartogram



https://www.data-to-viz.com/graph/cartogram.html



Source:
Dejan Vinkovic: work at http://oraclum.eu/cartograms-of-election-results/



Source (p.6): https://www.berlin.de/sen/uvk/_assets/verkehr/verkehrsplanung/oeffentlicher-personennahverkehr/nahverkehrsplan/broschure_nvp_2019_anlage_2.pdf

Comparison of different cartogram types. The more filled bubbles they are, the better.

	Contiguous cartograms	Grid/Tile cartograms	Dorling cartograms	Geographical map
Easy recognition by **position**?	●●○	●○○	○○○	●●●
Easy recognition by **size**?	○○○	○○○	○○○	●●●
Easy recognition by **shape**?	●○○	●○○	○○○	●●●
Easy to compare the shape sizes?	●○○	●●○	●●●	
Accurate?	●●○	●●○	●●●	

Source:
Lisa Charlotte Muth: https://blog.datawrapper.de/cartograms/

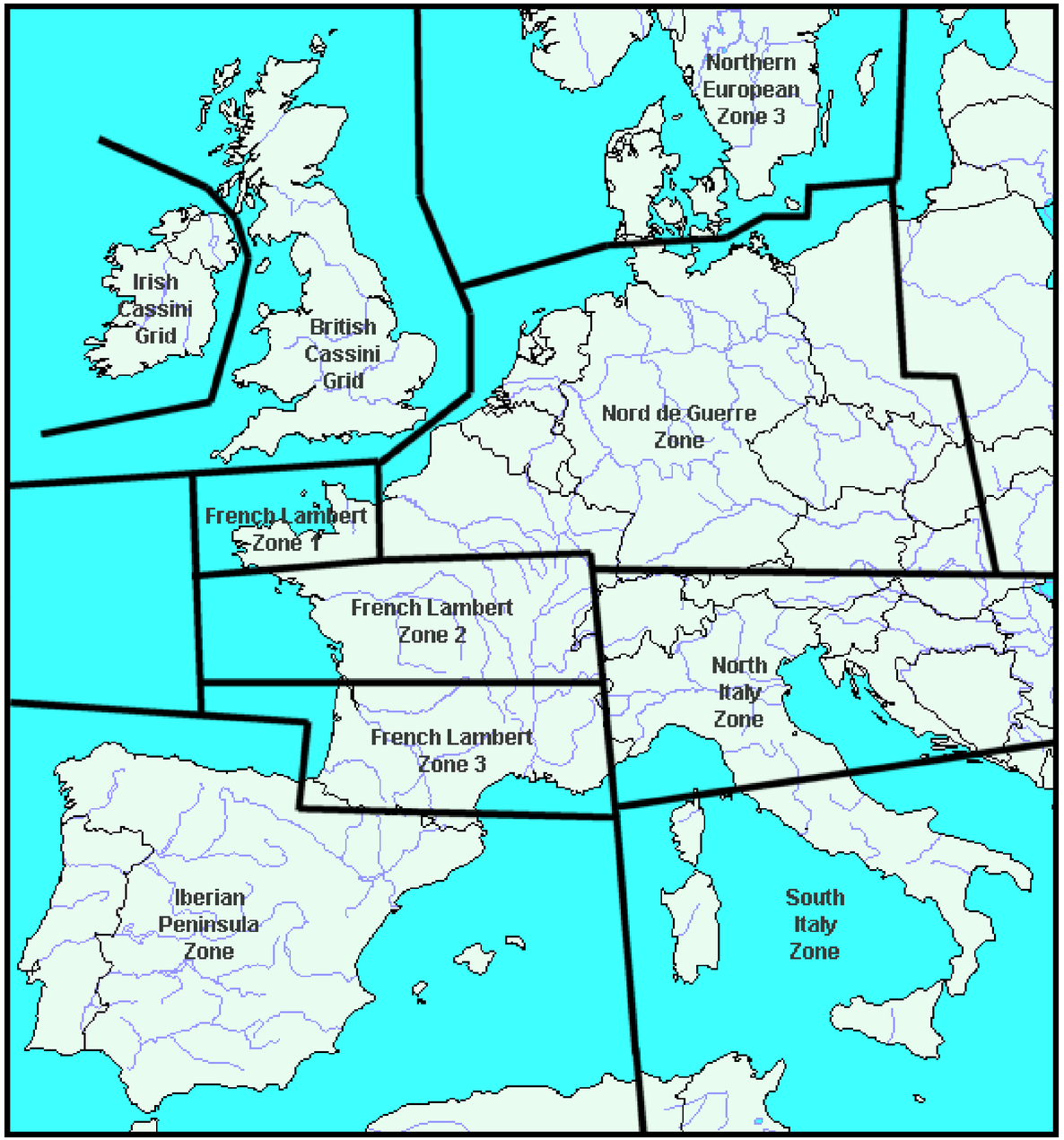
Final Remarks

Global Projections

- Different projections cause large distortions in sizes and shapes.
- Consequences on aesthetics of and political perceptions.
- Standard *Mercator* projection used by Google shrinks countries at the equator.

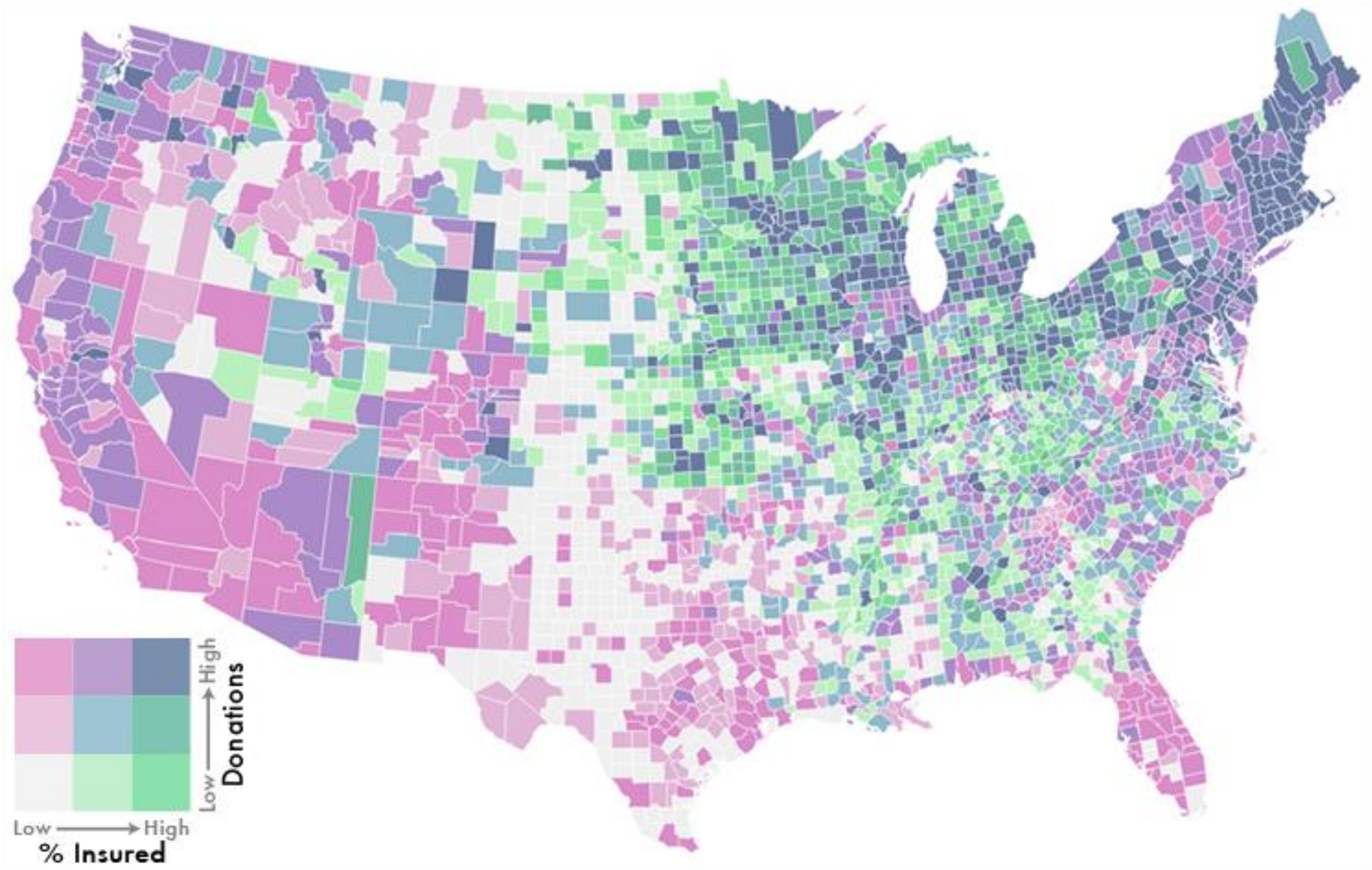
Local Projections

- Most countries release data using national coordinate system and projection (e.g. British National Grid).
- In larger countries there can be more than one projections
- Standardisation minimises issues for analysis at the country level.



Source: https://www.echodelta.net/mbs/eng-overview.php

Bivariate Maps



Source: https://www.echodelta.net/mbs/eng-overview.php

Tips

- Think about the purpose of the map
- Determine the best visualisation by trying different classification alternatives
- Combine (Geo)visualisation with other statistical devices

Less is better

References

- Tamara, Munzner. *Visualization Analysis and Design*. CRC Press, 2014
- Tufte, Edward R. *The visual display of quantitative information*. Graphic Press, 1983
- Krygier, John and Wood, Deni. *Making maps: A visual guide to map design for GIS (2nd edition).* The Guilford Press, 2011.
- MacEachren, Alan M., and Menno-Jan Kraak. *Exploratory cartographic visualization: advancing the agenda*. Computers & geosciences 23, no. 4 (1997): 335-343.