

Advanced GIS

Raphaëlle ROFFO

Sciences Po - Urban School

Session 4

Cartograms & Isochrones

Today's plan

1. Bivariate choropleths tutorial: Feedback, Q&A
2. Coursework discussion
3. Isochrones
4. Cartograms



Session 3 Recap & Tutorial debrief

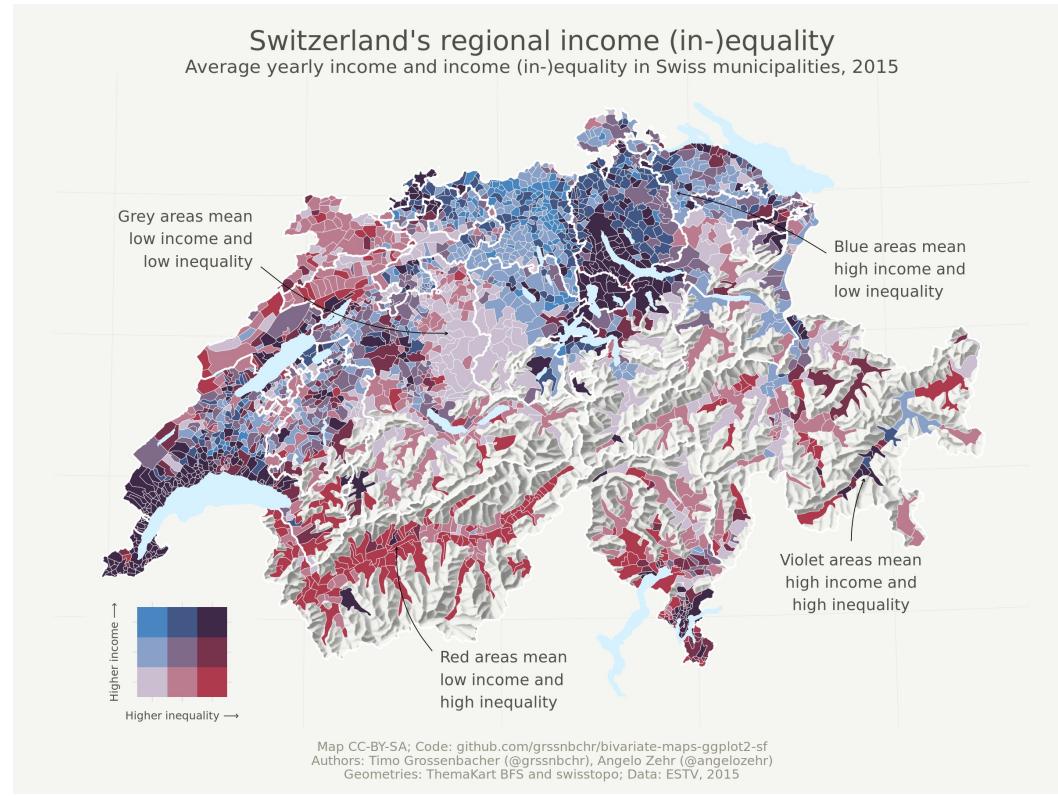


What is a bivariate choropleth map?

Bivariate: simultaneously represents two variables

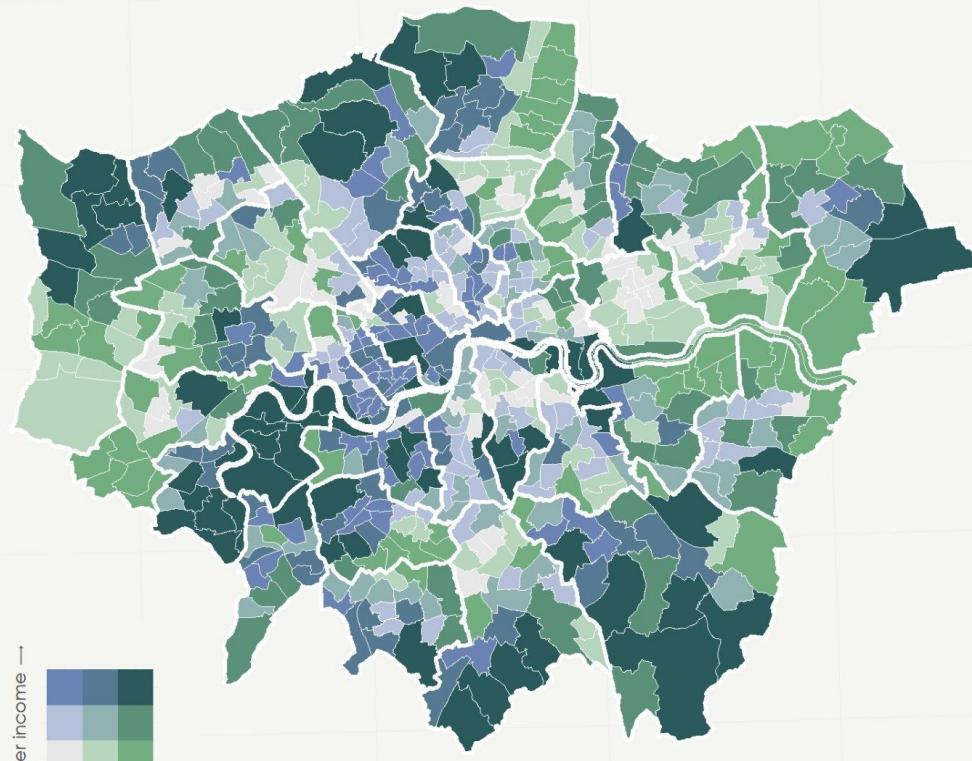
Choropleth: a type of thematic map (map that shows a phenomenon) that represents (colours) data as occurring within bounded areas.

Bivariate choropleth maps use a matrix of carefully chosen complementary colours to simultaneously represent two phenomena and how they relate to each other.

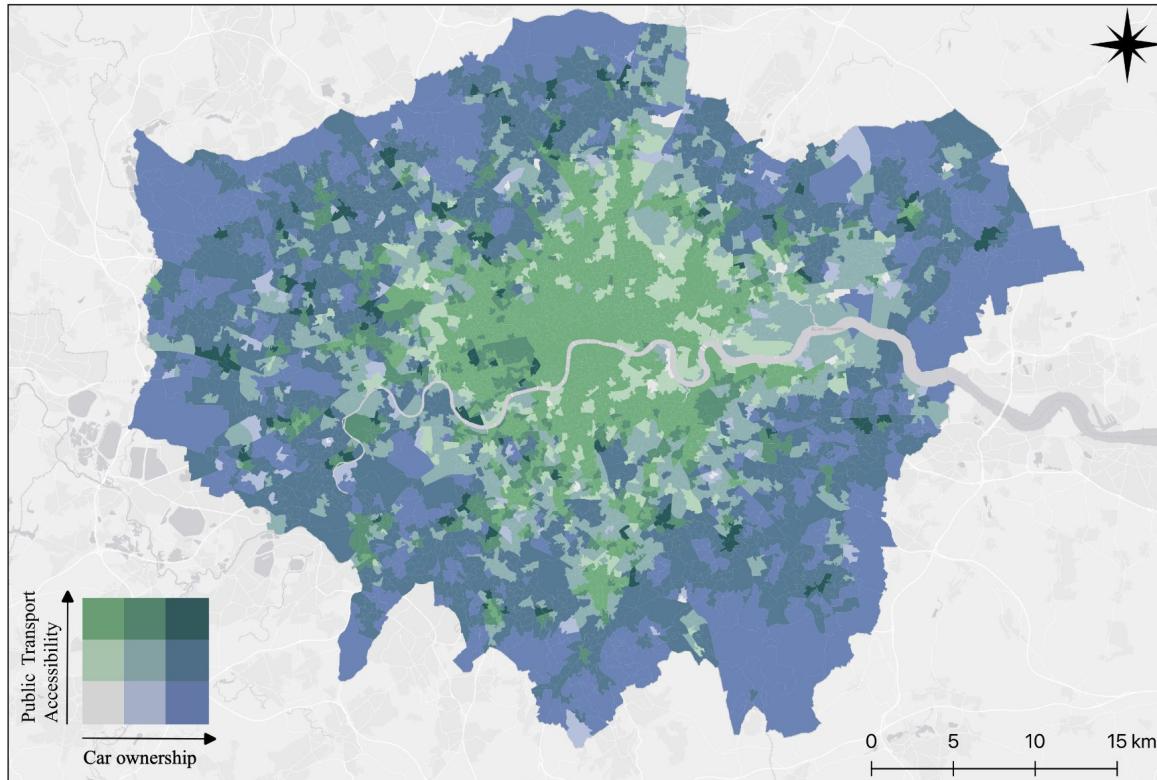


Example

London's vegetation-income distribution
Median household income and greenspace
cover % in Ldn wards, 2014



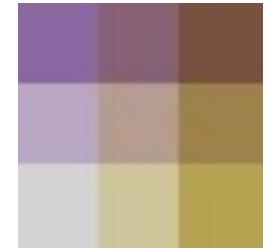
Car ownership and access to public transport in the Greater London Metropolitan Area: an unequal access to mobility



Data Sources: Office for National Statistics, 2011

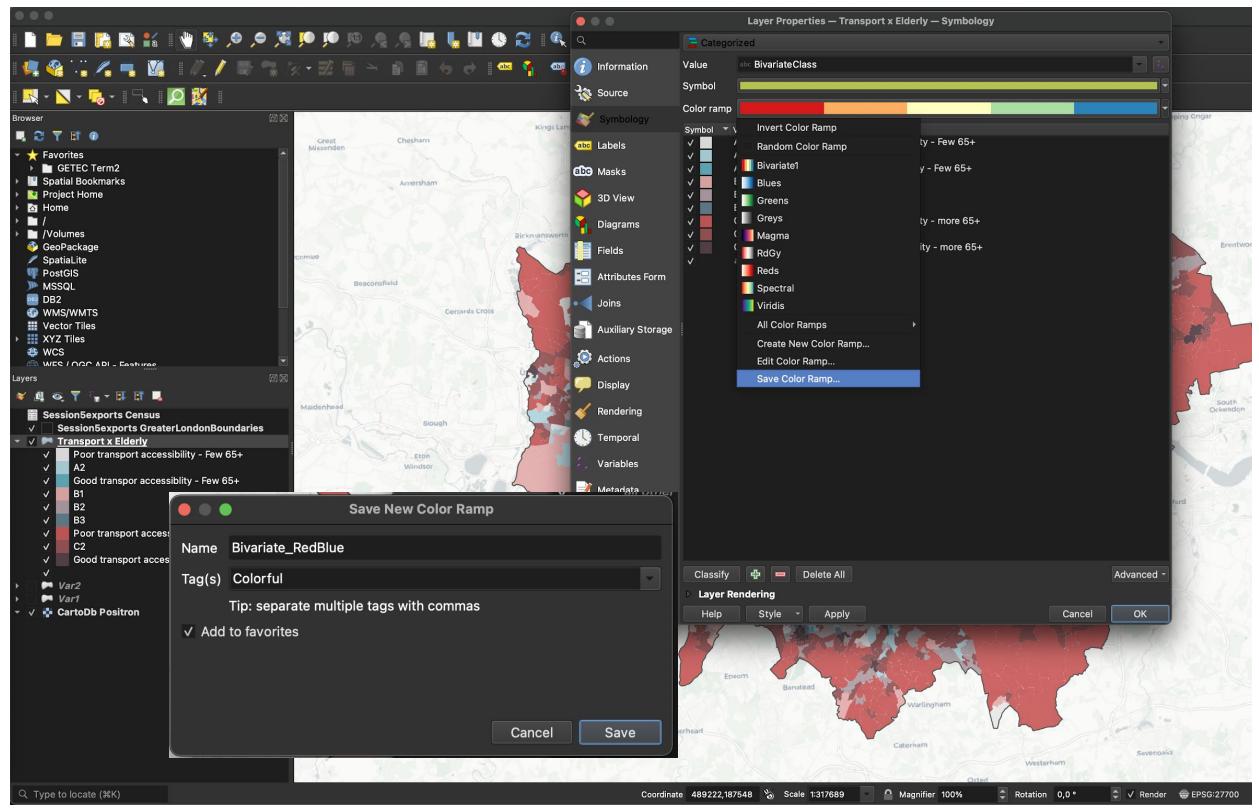
Creating a legend for a bivariate choropleth

You can save this images, created using the QGIS plugin **Bivariate Legend**.



Tips / Remarks

Here is how to save your colour ramp, so that next time you don't have to do it from scratch



Questions?

Final Coursework

Final coursework: Policy brief (100%)

Deadline: Tuesday 2nd May, 23.59 Paris time.

If late: -1 point penalty for each day past the deadline.

- Groups of 2-3 students or individual report
- 3 pages minimum, 5 pages **maximum**
- **Policy brief** aimed at the Mayor of the large metropolis you're studying (//!
writing style !)
- You may - and are encouraged to - build upon your first term report and push the methodology further. You can also pick a completely different topic and/or study area
- You **must** use at least one of the advanced techniques learnt in the Advanced module, while ensuring it's well suited to answer your research question.

Final coursework: Policy brief (100%)

Proposed outline

- Executive summary (maximum ½ page, bullet points are fine)
- Introduction / Problem / Context
- Data sources in a table
- High-level methodology. Keep it short but use precise terminology
- 2 to 4 maps. Careful, you only have 5 pages maximum in this report so these maps must be very relevant to answering your policy question (*i.e. for a suitability analysis, I don't need every step in your weighted overlay, just the final potential sites you've identified, which you can pair with a map of some key variables in your analysis*)
- Analysis of the findings
- Policy recommendations to decision makers

In this exercise, concision and precision are key! Your analysis must lead to actionable results.

Final Coursework: Marking Criteria

The marking criteria reflect the learning outcomes expected at the end of this module. Students should be able to:

- Formulate a research question suitable for GIS analysis
- Source relevant data and assess their relevance based on the metadata provided
- Be comfortable working with vector and raster datasets
- Design complex GIS workflows to combine multiple datasets, using at least one technique covered in the Advanced course (bivariate choropleths, raster processing, cartograms, digitization, isochrones, weighted overlays)
- Produce clean map exports that respect cartographic design principles, are colour-blind safe, and are complete with all key cartographic elements (title, legend, north arrow etc.)
- Justify all key methodology choices, focusing on key decisions (choice of datasets, geoprocessing steps, raster processing steps, class breaks chosen for a choropleth, etc.)
- Draw policy insights from their maps and translate those into applicable policy recommendations **or** future research outlooks. Please be very explicit!

Final Coursework: Marking Criteria

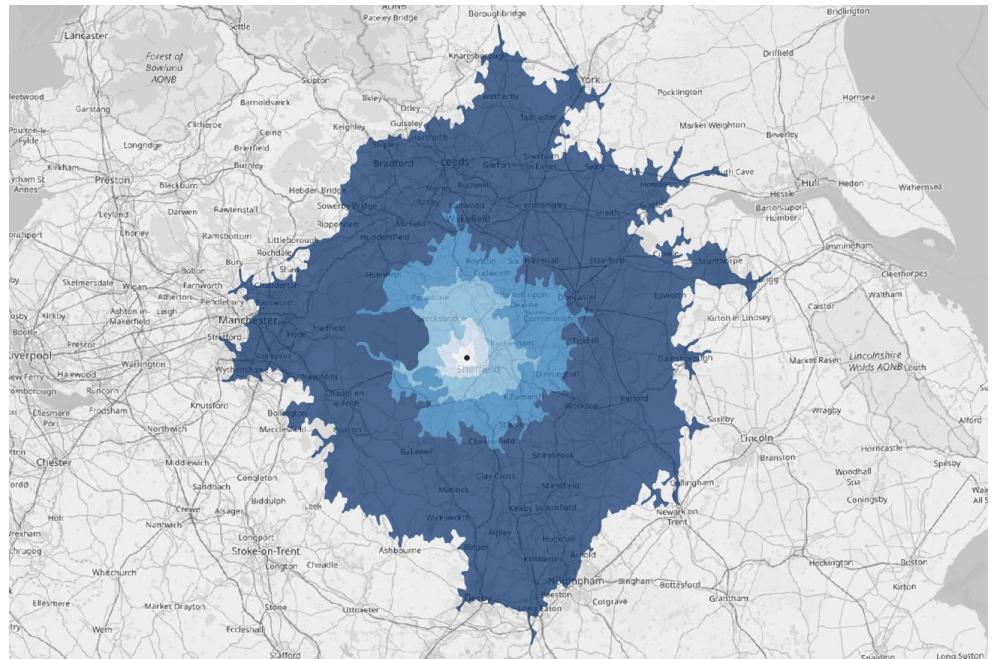
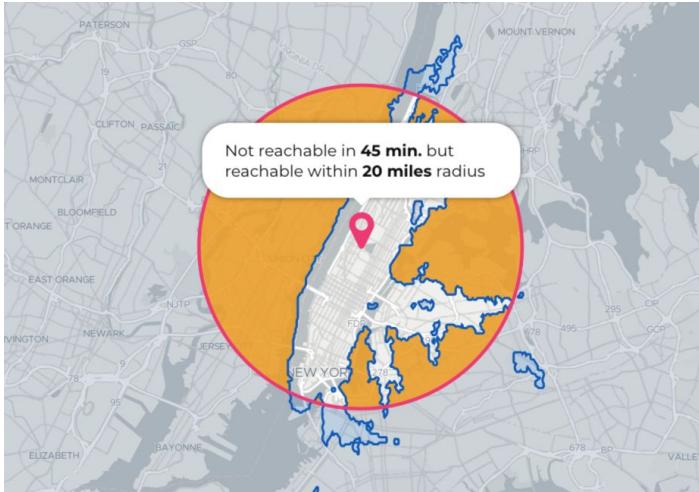
Criteria:

- Research question and whether your methodology adequately addresses it (10%)
- Methodology, choice of relevant datasets and design of your workflow (35%)
- Quality of the map outputs (35%)
- Quality of the writing, structure and visual clarity of the report (10%)
- Relevance of the recommendations / insights (10%)

Isochrones

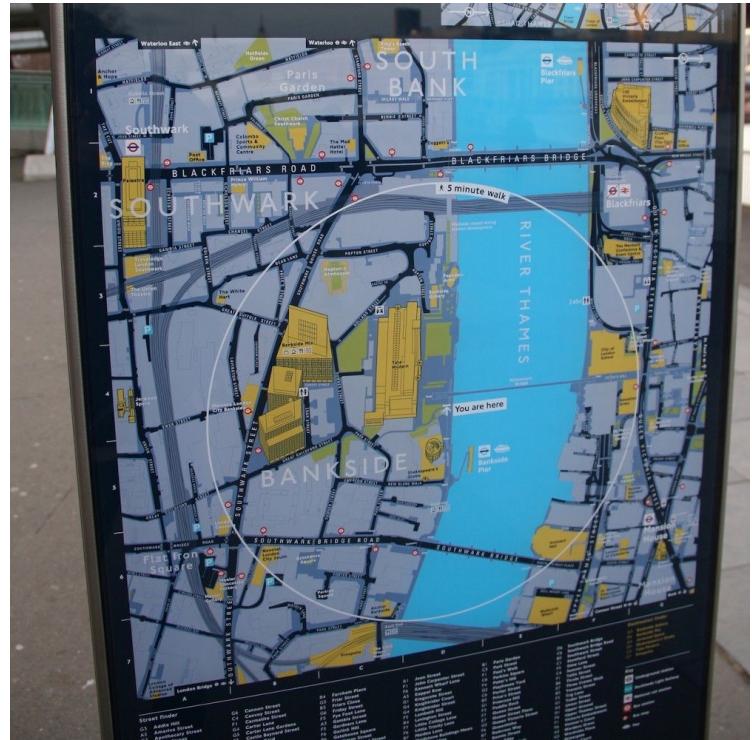
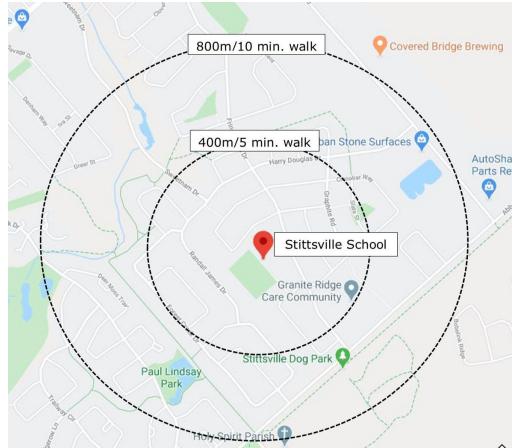
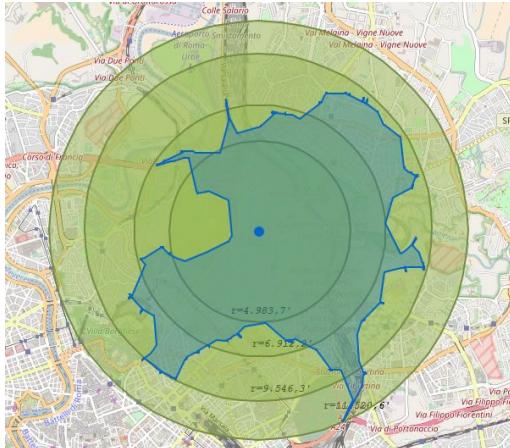
What are isochrones?

Isochrones are lines that connect points at which something occurs/arrives at the same time.



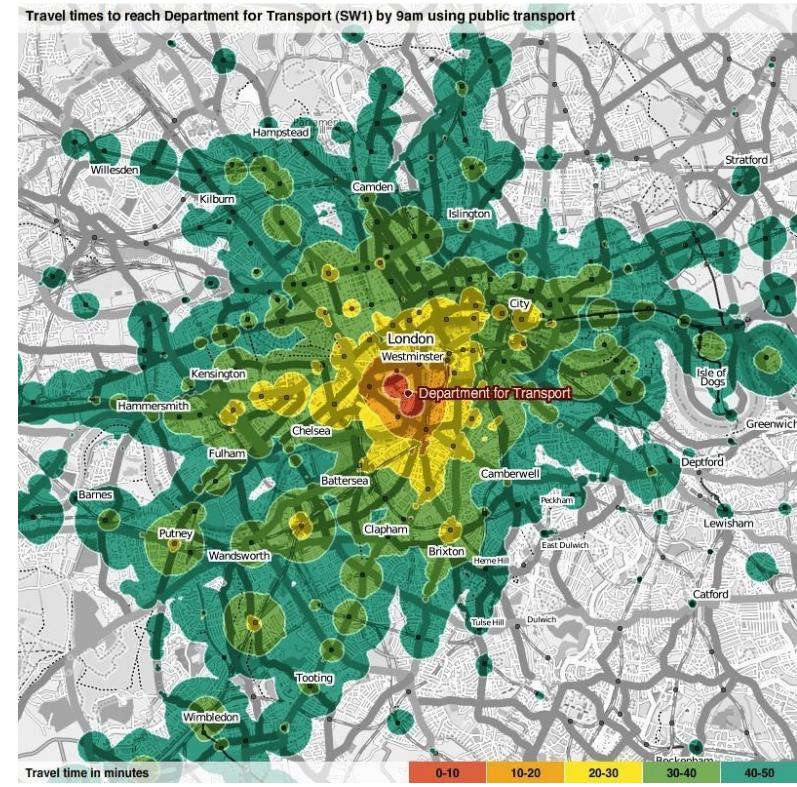
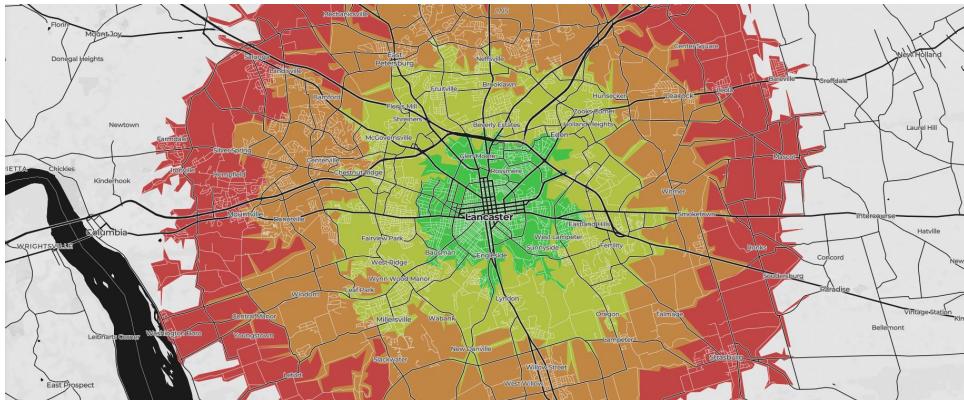
Isochrones & Transport planning

In transport planning, isochrone maps are very useful to define boundaries for areas of equal travel time (areas that can be reached within a given time of walking / driving / cycling / public transport). A rough approach to isochrones can consist in looking at distance as an indicator for walking time.



Isochrones & Transport planning

More sophisticated approaches actually take into account the road network. This is for instance the case with the TravelTime plugin in QGIS, which uses OpenStreetMap to compute the isochrones. Other plugins are available (OpenTripPlanner, QNEAT3, ORS Tools, etc)



Isochrones & Service Area

Isochrones can also be used to assess accessibility of public services such as medical facilities, and what it means in terms of public health inequities.



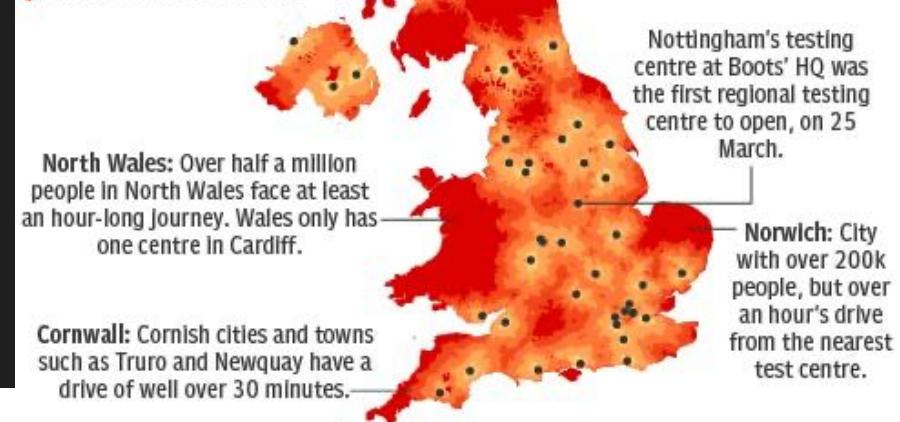
Source: <https://pudding.cool/2017/09/clinics/>

Testing centres

- Regional testing centre

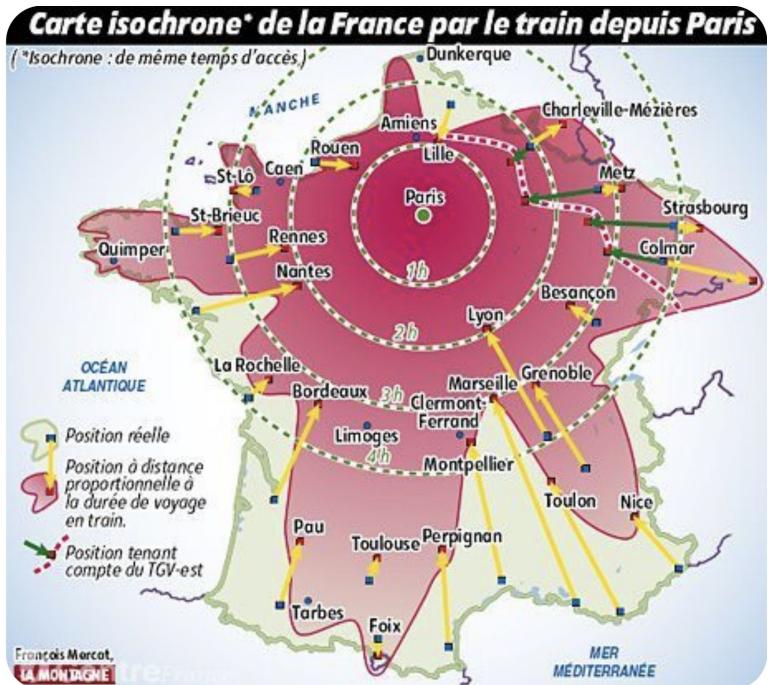
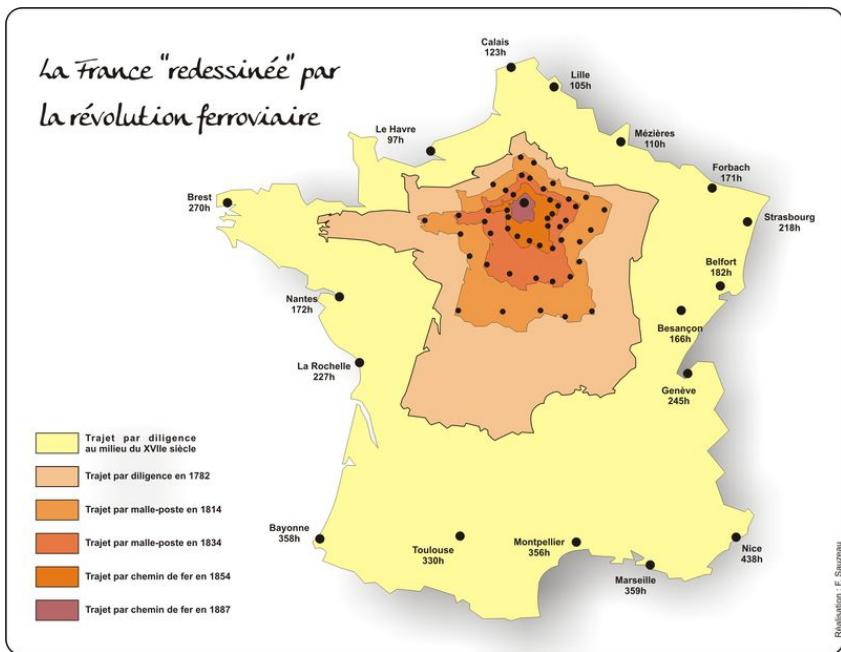
Driving time from testing centre (off-peak times)

- Within 15-minute drive
- Within 30-minute drive
- Within 45-minute drive
- Within 60-minute drive
- Over 60-minute drive away



Source: <https://traveltime.com/case-study/telegraph-traveltime>

Isochronic cartograms



Source: <https://cartonumerique.blogspot.com/2018/12/cartes-isochrones.html>

TravelTime plugin (tutorial)

Spatialite PostGIS MSSQL DB2 WMS/WMTS XYZ Tiles OpenStreetMap TravelTime - Dark Matter TravelTime - Klokantech-Basic TravelTime - OSM Bright TravelTime - Positron WCS WFS

Output Output Output TravelTime - Positron

KING'S CROSS PENTONVILLE HOXTON HAGGERSTON BETHNAL GREEN OLD FORD BOW BROMLEY-BY-BOW

FINSBURY CLERKENWELL SHOREDITCH SPITALFIELDS WHITECHAPEL STEPNEY LIMEHOUSE POPLAR

LOOMSBURY ST GILES CITY OF LONDON ST. GEORGE IN THE EAST SHADWELL WAPPING ROTHERHITHE ISLE OF DOGS

TEMPLE SOUTH BANK BOROUGH BUTLER'S WHARF ELEPHANT AND CASTLE SURREY QUAYS MILLWALL CUBIT

LAMBETH VAUXHALL KENNINGTON

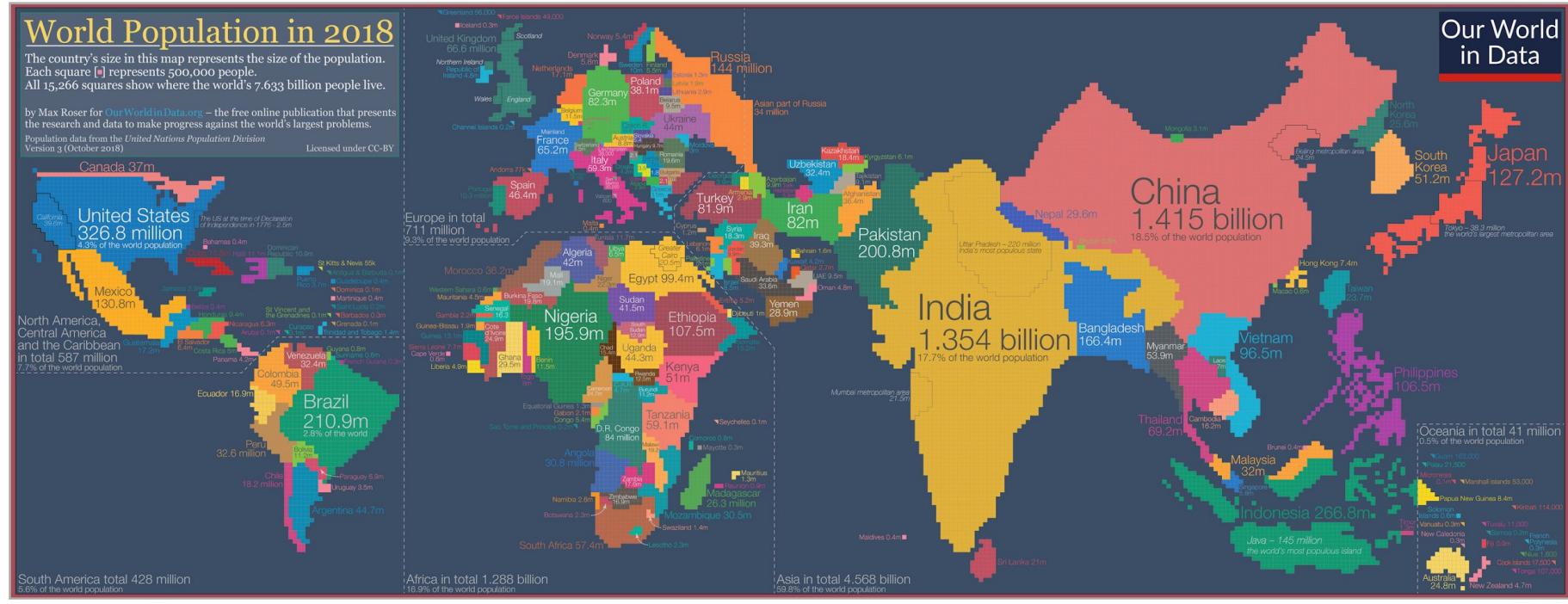
Processing Toolbox

- TravelTime platform
 - Advanced
 - Routes
 - Time Filter
 - Time Map
 - Simplified
 - Routes - Simple
 - Time Filter - Simple
 - Time Map - Simple
 - Utilities
 - Geocoding
 - Reverse Geocoding

Cartograms

What is a cartogram?

You may also see them referred to as "value-area maps" or "anamorphic maps"



What is a cartogram?

US Presidential Election 2020

Results mapped at county level showing the candidate with the largest vote share in each area

Preliminary results*

Biden

78,790,121 votes (50.9%)

306 electoral votes

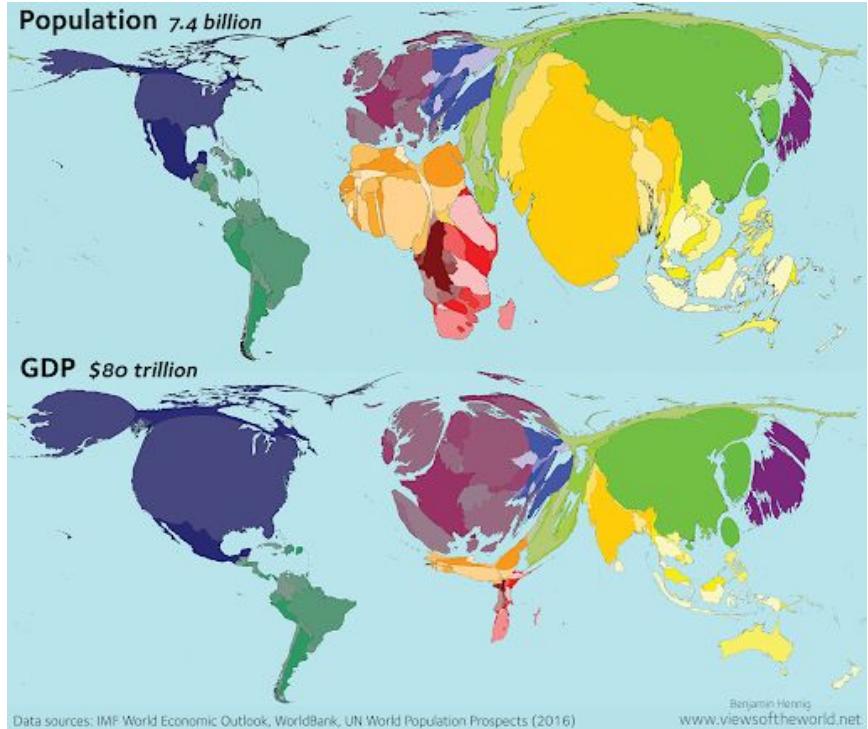
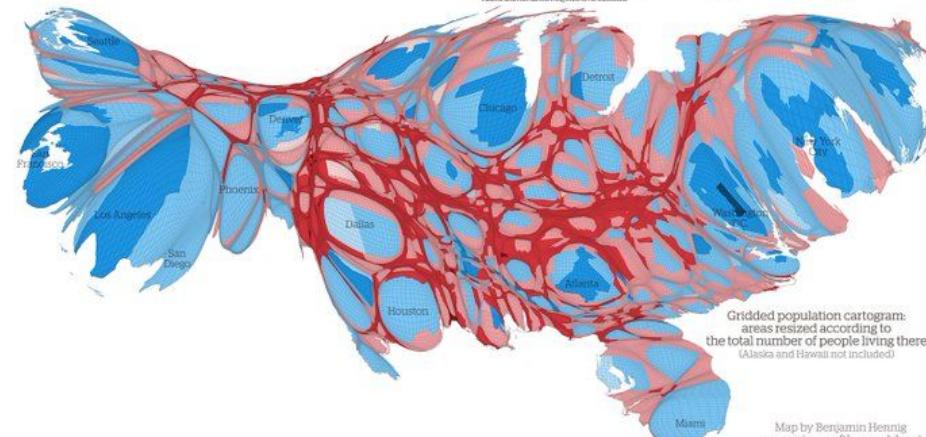
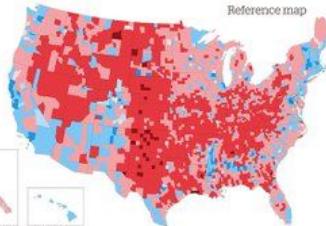
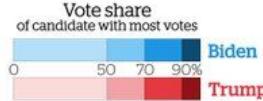
Trump

73,163,140 votes (47.3%)

232 electoral votes

* not confirmed final result, last updated 16 Nov 2020

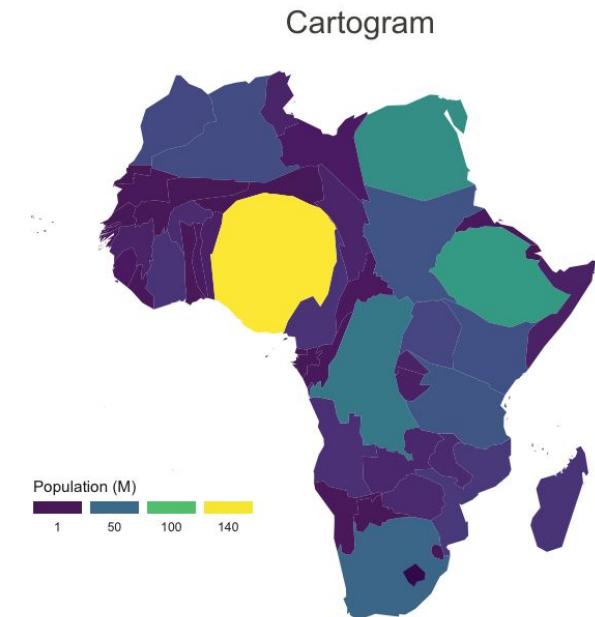
Source: <https://projects.fivethirtyeight.com/2020-election-nyt/>



What is a cartogram?

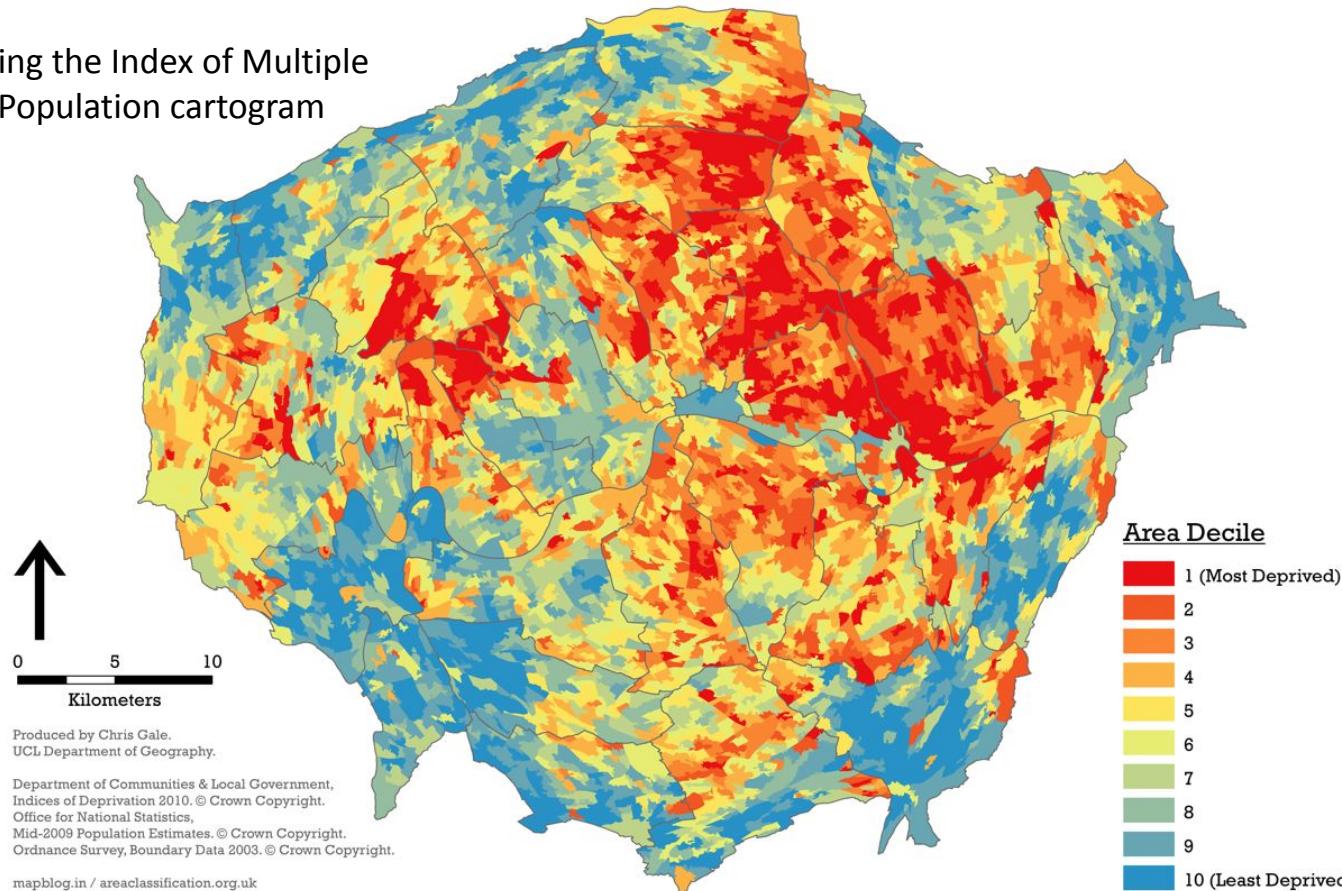
A cartogram is a map in which the geometry of regions is distorted in order to represent an additional variable. The region area will be inflated or deflated according to its value.

Oftentimes, cartograms are **also simultaneously a choropleth map**. Regions are colored according to a numeric variable, which may or may not necessarily be the one you used to build the cartogram. Here: you have the population in African countries, represented by both the size and the colour of each country.



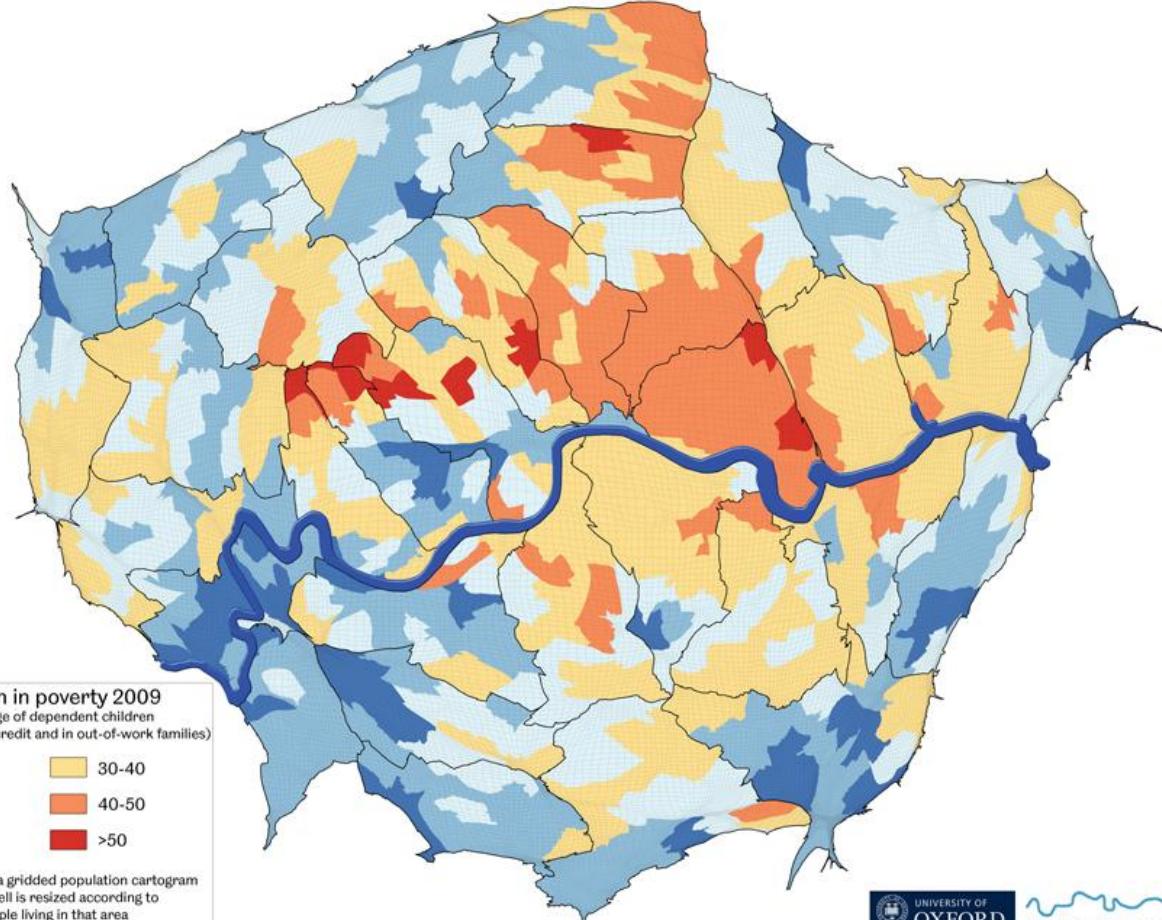
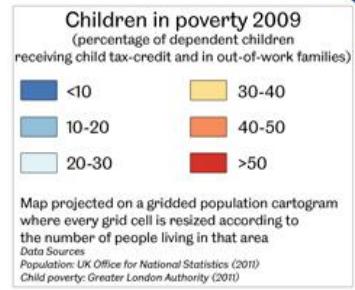
Overall Index of Multiple Deprivation for London in 2010 Cartogram

Choropleth using the Index of Multiple
Deprivation + Population cartogram



Choropleth using children in poverty + population cartogram

In your own time, have a read at this [cartogram-based exploration](#) of inequalities in London. Note how each of the map leads to a next question, linked to the overall theme of inequality.



Source: <http://london.worldmapper.org/analysis/inequality-in-london/>

Why build a cartogram?

Combining choropleth and cartogram techniques is a great way to correct for population size or sample size.

Imagine you display average unemployment rate per region on your choropleth map. A large rural area with 100 inhabitants but 10 unemployed people will look like it has the same unemployment situation than a smaller urban area with 1 million inhabitants but 100,000 job-seekers. This induces a strong bias, because the **two areas are actually very different**. The cartogram aims to reduce this bias by shrinking the size of the rural area and increasing the size of the urban area, to reflect absolute numbers of unemployed people.

Area A - Rural

Population = 100

Unemployed = 10

Unemployment rate = 10%

Area = 100km²

Area B - Urban

Population = 1,000,000

Unemployed = 100,000

Unemployment rate = 10%

Area = 100km²

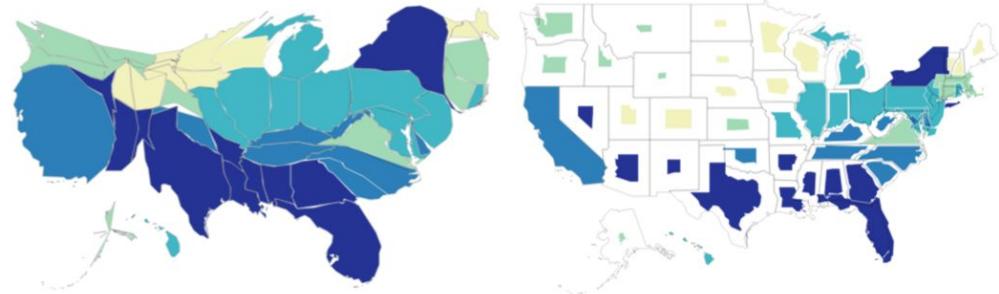
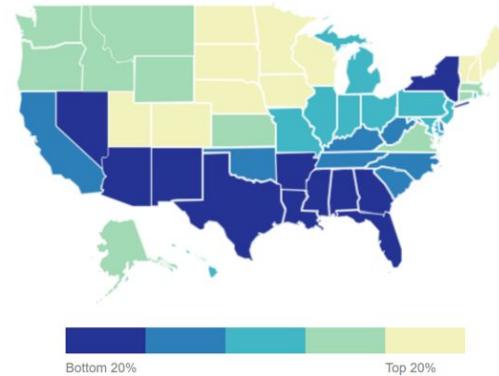
Why build a cartogram?

Combining choropleth and cartogram techniques is a great way to correct for population size or sample size.

In this example:

The social capital index rankings take a whole different meaning when you adjust each US state for the size of its population!

Social Capital Index Rankings

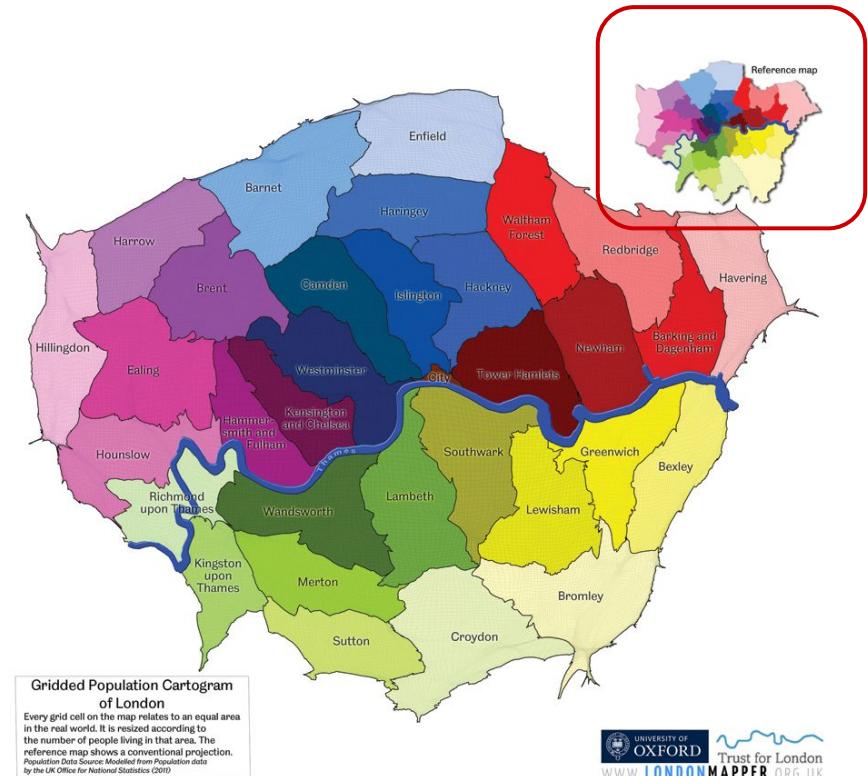


Tips

If you're working at city-level:

- It's a good idea to include a reference map, since not everyone is familiar with the exact boundaries of each of these administrative units.
- Do not use areas that are too small like IRIS or LSOA; instead, use slightly larger areas (boroughs, arrondissement, districts...); you want to be able to pinpoint what is happening within each identifiable area.

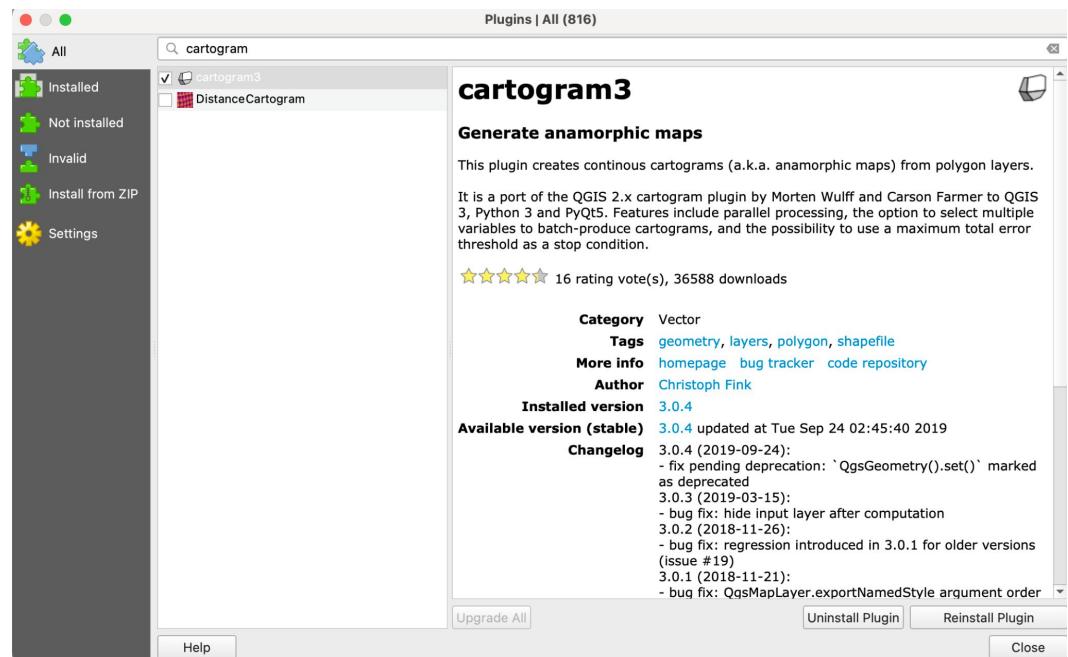
Note: On this map they used a grid and distorted each cell, then superimposed the borough boundaries. The plugin we use in QGIS [works differently](#); it distorts each individual polygon boundary based on the variable you want to use as weight. Therefore, you really need to pay attention to the administrative level you pick for your analysis!



Cartograms in QGIS

To produce cartograms in QGIS, you can install the plugin [cartogram3](#).

The slides in annex walk you through the steps required to build a cartogram using this plugin, with an example using the population in China. This could easily be replicated by looking at population by Boroughs in London or by Arrondissements in Paris, for instance.

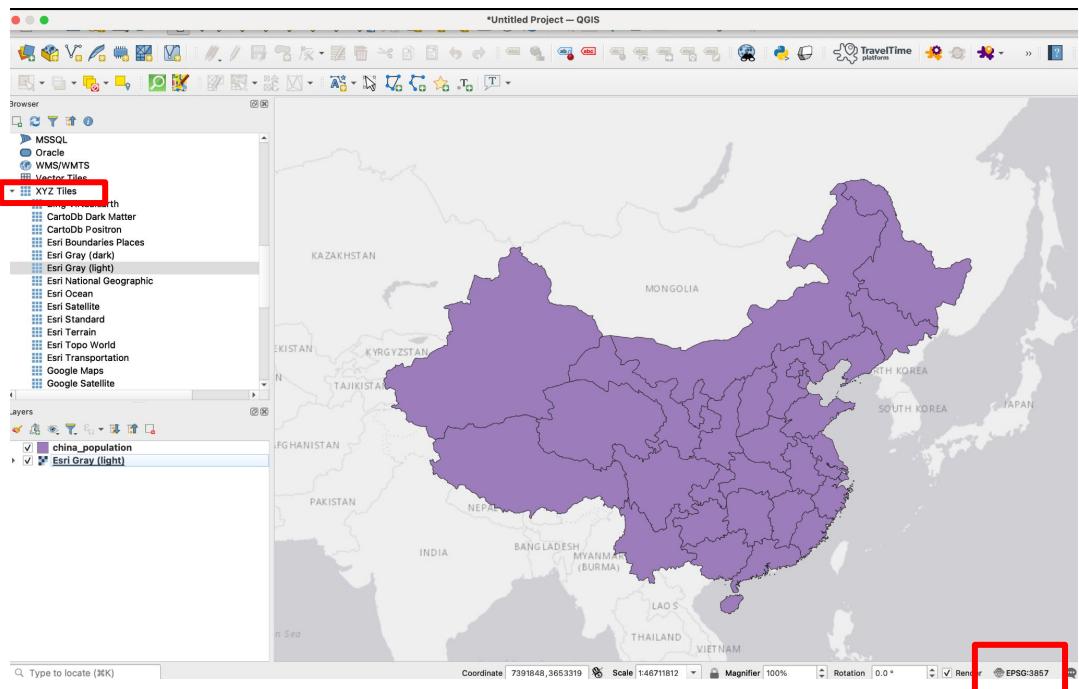


Cartogram Tutorial

Data

Please download this [Cartogram.gpkg geopackage](#). In it you'll find a layer called *china_population*, which contains polygons of Chinese province boundaries, their population and their population density (pop/km²).

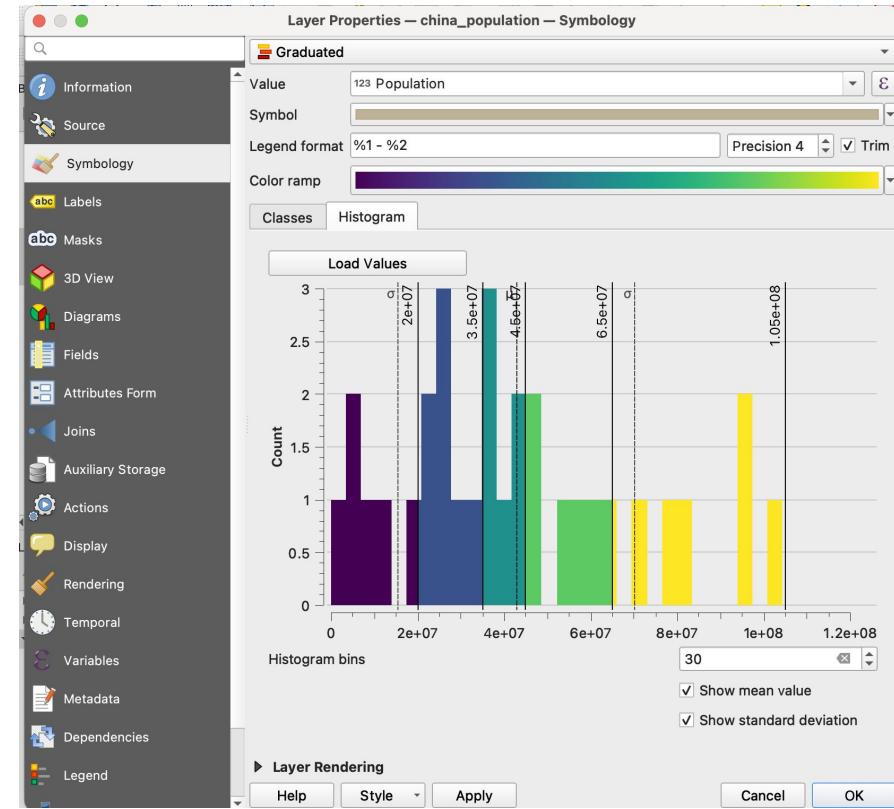
Set your map canvas to CRS:3857 (pseudo Web Mercator) and drag that layer onto it. Then, add a basemap, for instance the Esri Gray (light) layer from your XYZ Tile.



Making a choropleth

Double click your *china_population* layer and navigate to the Symbology tab. Use the Graduated style, select the Population field, a colour ramp (I picked Viridis) and click classify. Then, check the Histogram tab.

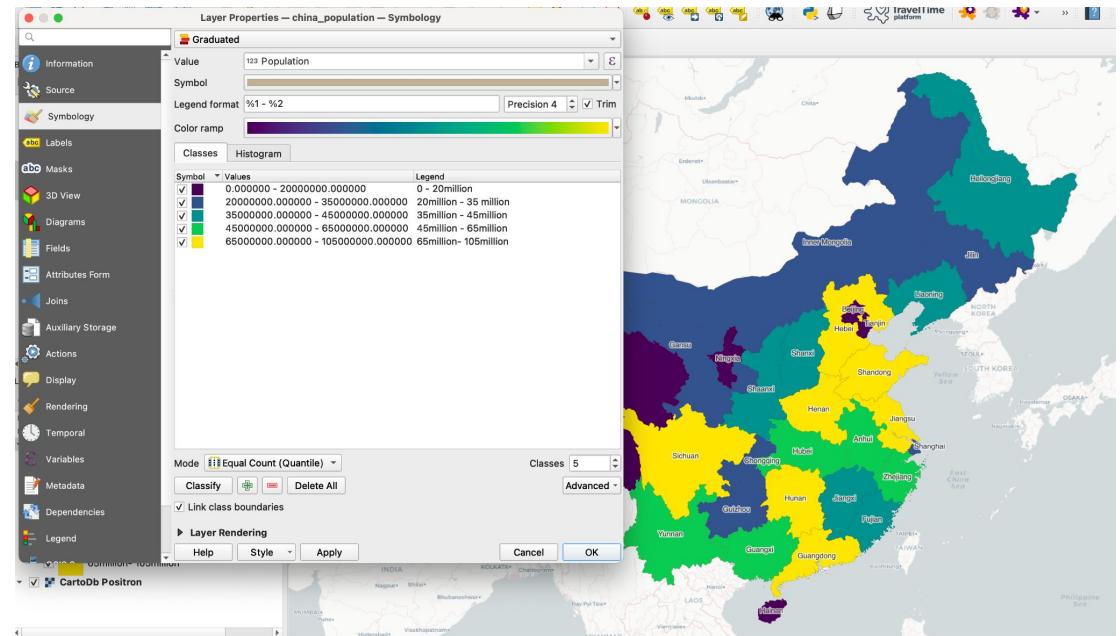
When inspecting the histogram, we can see that the data is relatively evenly distributed. We are interested in spotting areas that are most or least populated, so we'll use quantiles as our classification method, with 5 classes.



Making a choropleth

To go further in the styling of your layer:

- 1) You can click on Symbol to change the opacity of the layer (I made it 80%) and make the stroke colour lighter or transparent.
- 2) You can manually adjust the values of quantiles so that they fall on round values, and edit what the legend will display
- 3) In the Labels tab, you can add a label of the provinces names, with a light white buffer

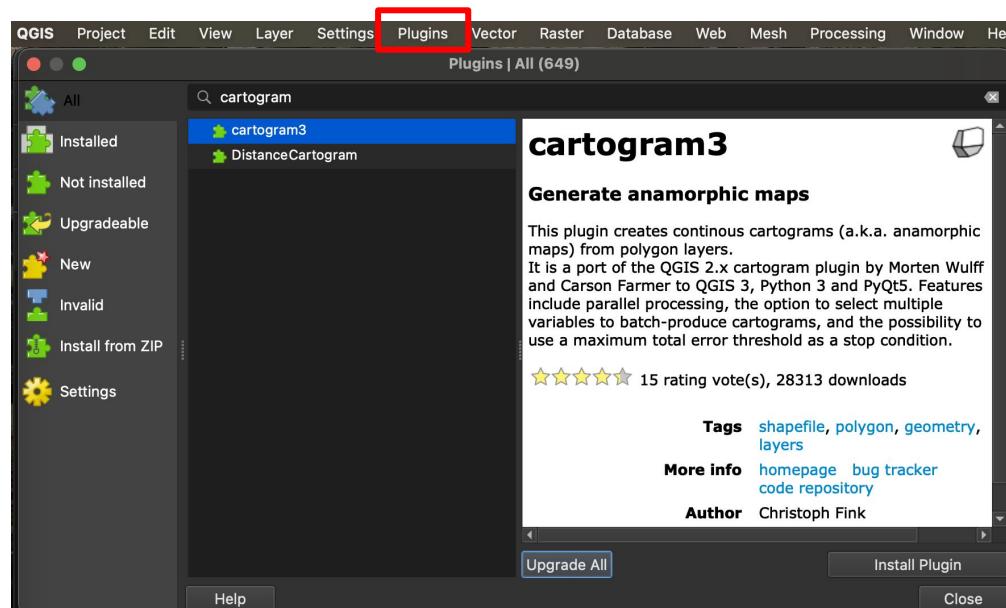


Download the plugin

Now, let's move on to the cartogram!

Install the `cartogram3` plugin. Click the top menu *Plugins > Manage and install plugins...*, then search for `cartogram3`.

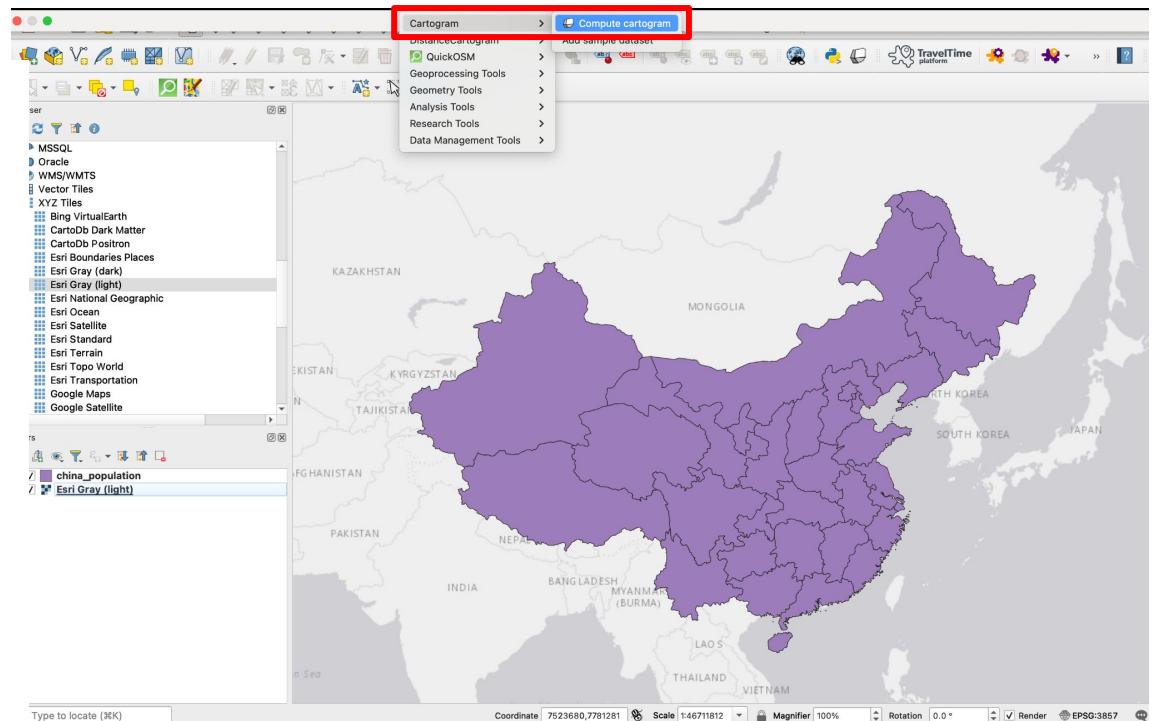
Here is the [GitHub repository](#) of the plugin (the Python code that built this plugin). Please read the README for some context on what the tool does and what kind of data you can feed it. You can also relay any feedback to the developer over there!



Open the tool

The tool is now available under your Vector menu.

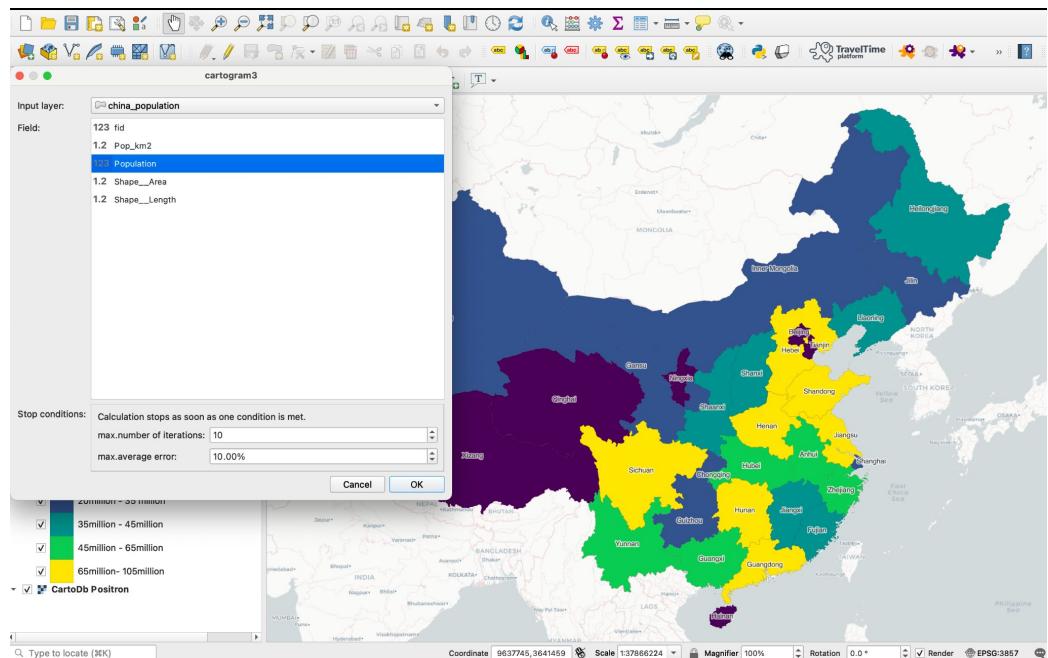
Vector > Cartogram > Compute Cartogram



Run the tool

It's really simple!

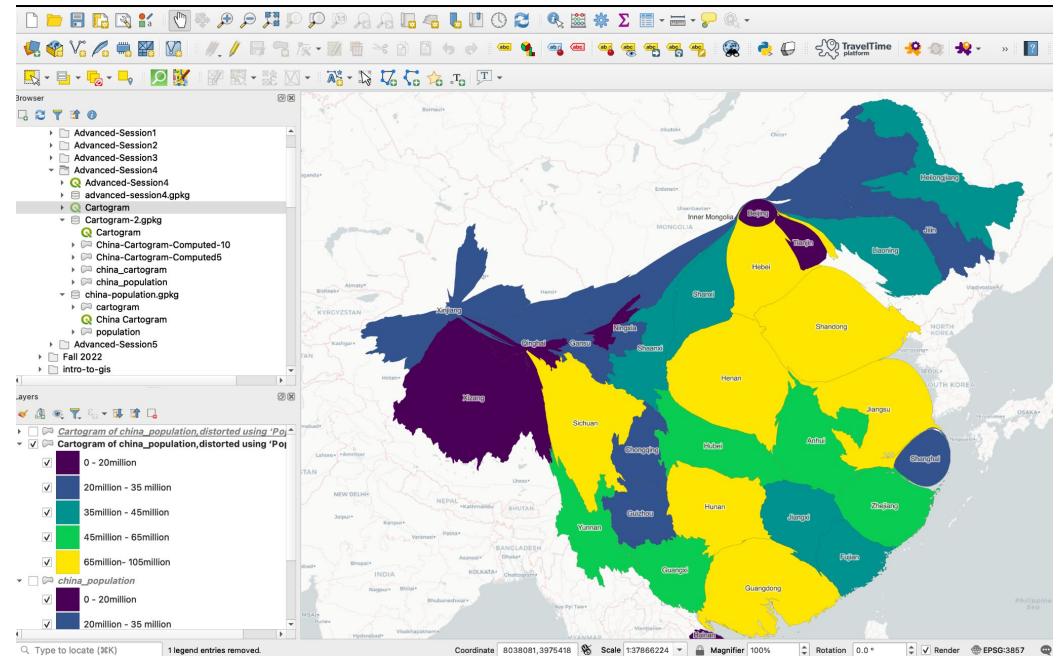
- Select your layer (china_population)
- Select the numeric field you'd like to use to distort your map; here we will use **Population**.
- Leave the number of iterations as is. Leave the max average error to 10%
- Press OK
- A progress bar will appear. It may take a couple minutes to run, leave it to it and wait for the algorithm to complete.



The population density cartogram

Congratulation, You have produced your first cartogram! By default your layer should use the same Population choropleth symbology as your initial layer If it's not the case, you can always:

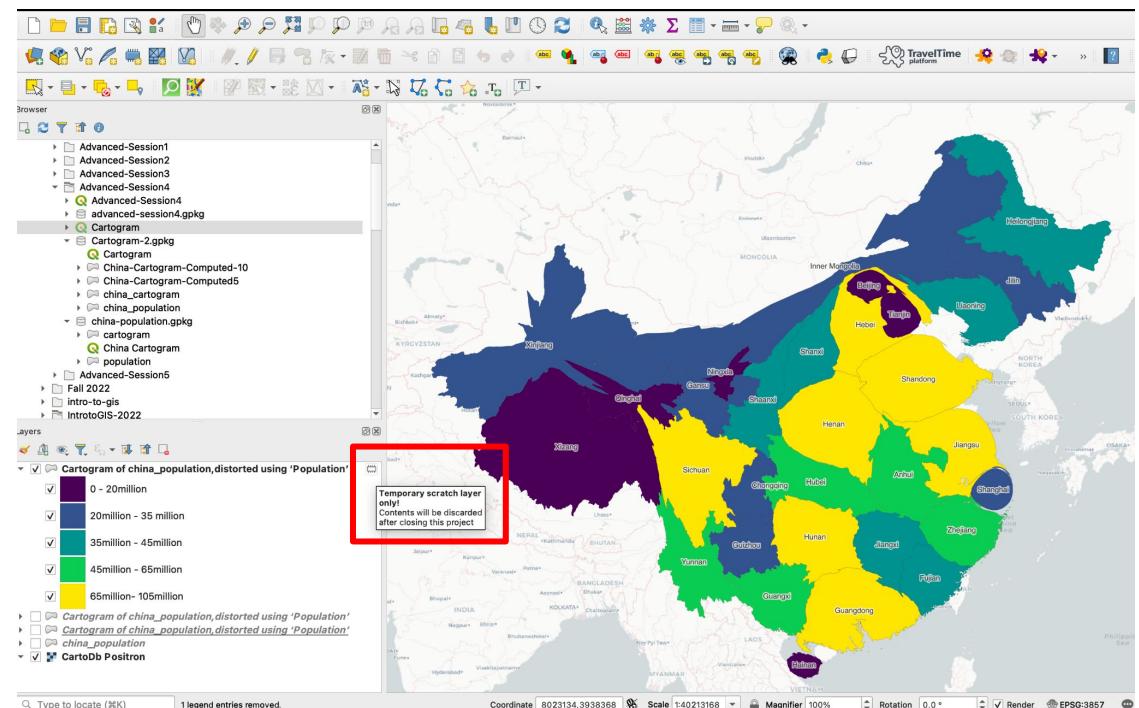
- right-click your `china_population` layer, Styles > Copy Style > All Style Categories.
- right-click your new layer, Styles > Paste Style > All Style Categories.



The population density cartogram

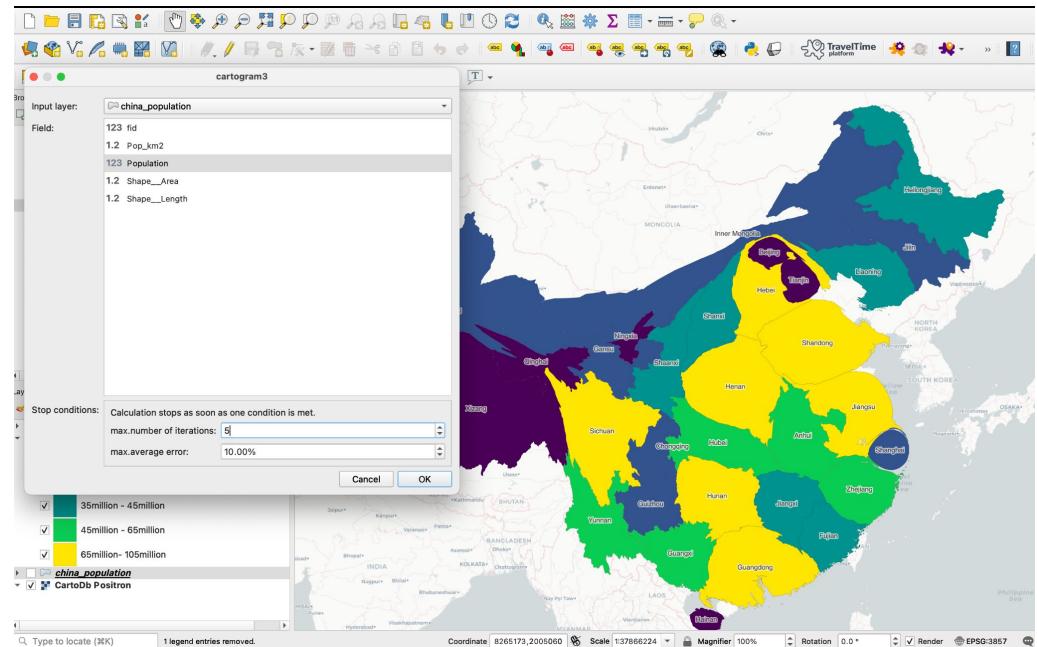
Remember that this cartogram layer is a scratch layer. Right click to save the layer (either using **Make Permanent**, or **Export**) or it will be lost next time you open QGIS!

Save your project.



The population density cartogram

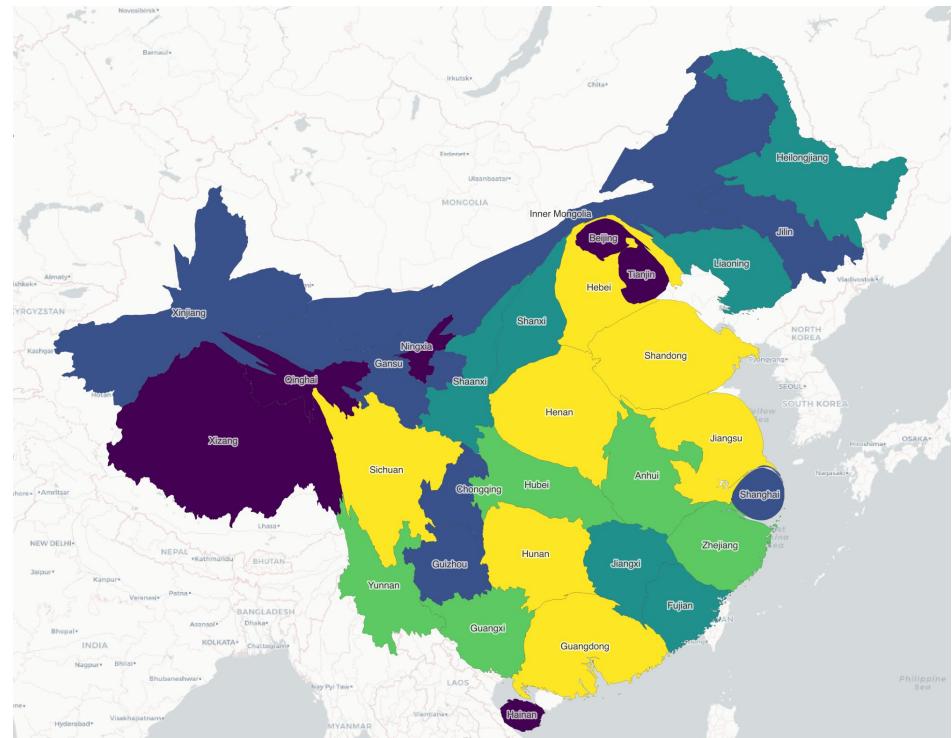
Feel free to repeat the previous steps to run the cartogram with only 5 iterations. You will notice that the distortions produced are less extreme. Each iteration incrementally exaggerates the distortions, so you can run the tool a few times to find out which number of iterations is ideal to you.



The population density cartogram

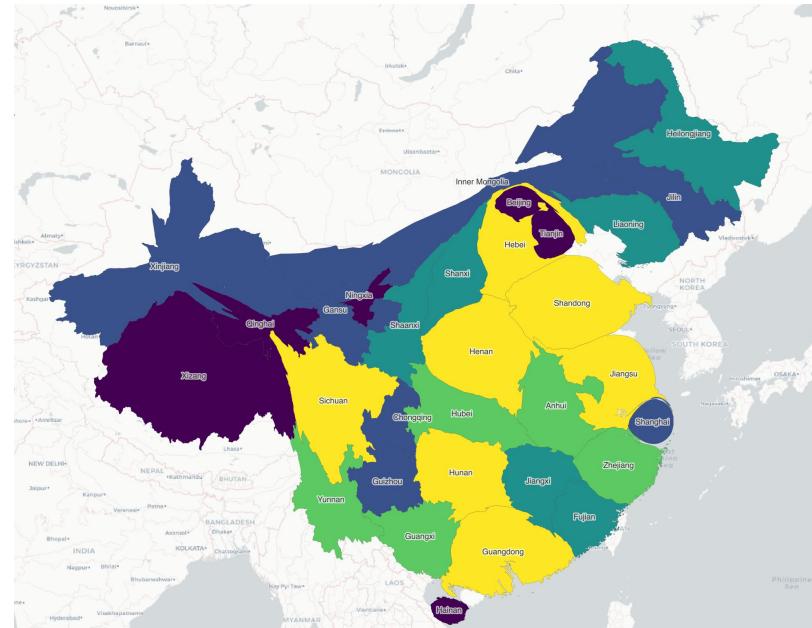
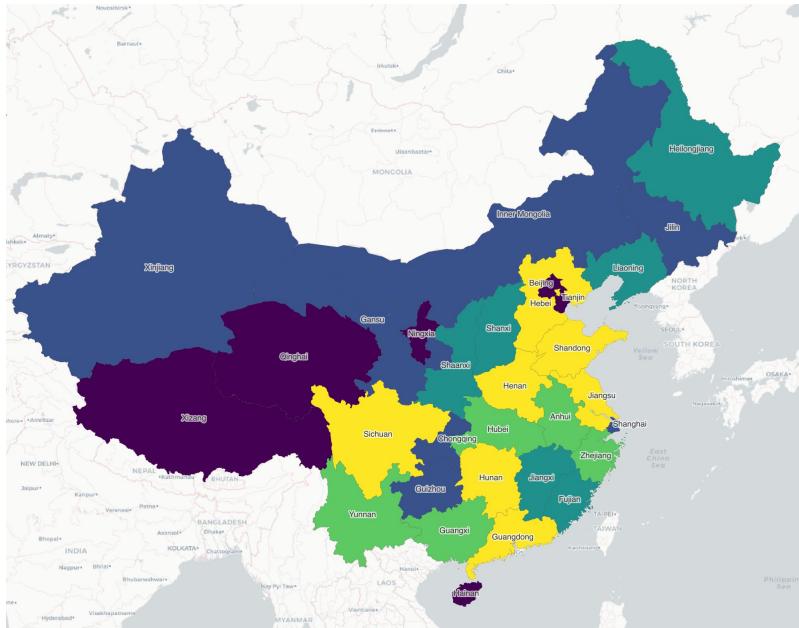
Notice how some provinces in the West and North shrink entirely while coastal cities and most Eastern provinces expand! (look at Shanghai, Beijing, Tianking, Hainan, Guangdong!)

Note that because of the distortions induced, basemaps can look a bit weird. The choice of keeping a basemap is up to you. Here, you can argue that our basemap is useful to see how much provinces such as Xinjiang and Heilongjiang shrank compared to the actual borders of those provinces.



The population density cartogram

When you're happy with your map, use the Print Layout composer to add cartographic elements (legend, north arrow etc). Consider inserting both maps next to each other to allow your audience to examine the distortions easily. Export it as usual.



Final remarks

- The cartogram3 tool is slow and probably will take a long time to run if you are using very detailed polygons or a large number of polygons. Bear in mind that there isn't much value in doing cartogram on very small geographical units anyway, it is much more powerful used identifiable areas (countries / provinces / regions / boroughs) for your map to be interpretable.
- The plugin can also be a little bit unstable, so be sure to save your project frequently!
- Try it out on other datasets! You just need a polygon layer that does not contain too many features, and a numeric variable to play with.

Homework

(Next session in person!)

Homework

1. Do the [QGIS tutorial](#) on isochrones
2. Use Slack if you have questions (#help).
3. Make sure you start working on your final coursework, we can spend time in person going through some of the challenges you might be facing.