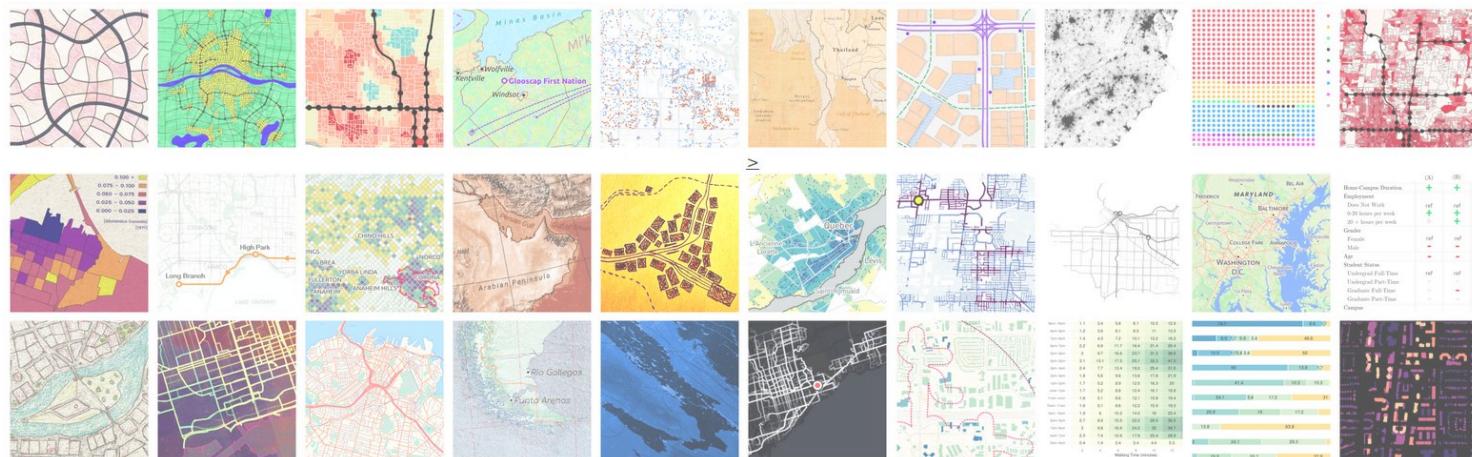


# Maps & Data Visualization

Jeff Allen, PhD - School of Cities, University of Toronto



## Why Visualize?

To explore your data

x	y
55.3846	97.1795
51.5385	96.0256
46.1538	94.4872
42.8205	91.4103
40.7692	88.3333
38.7179	84.8718
35.6410	79.8718
33.0769	77.5641
28.9744	74.4872
26.1538	71.4103
23.0769	66.4103
22.3077	61.7949
22.3077	57.1795
23.3333	52.9487
25.8974	51.0256
29.4872	51.0256
32.8205	51.0256
35.3846	51.4103
40.2564	51.4103
44.1026	52.9487
46.6667	54.1026
50.0000	55.2564
53.0769	55.6410



X Mean: 54.26

Y Mean: 47.83

X SD : 16.76

Y SD : 26.93

Corr. : -0.06

---

## Why Visualize?

Exploratory Data Analysis

e.g. The Datasaurus:

x	y
55.3846	97.1795
51.5385	96.0256
46.1538	94.4872
42.8205	91.4103
40.7692	88.3333
38.7179	84.8718
35.6410	79.8718
33.0769	77.5641
28.9744	74.4872
26.1538	71.4103
23.0769	66.4103
22.3077	61.7949
22.3077	57.1795
23.3333	52.9487
25.8974	51.0256
29.4872	51.0256
32.8205	51.0256
35.3846	51.4103
40.2564	51.4103
44.1026	52.9487
46.6667	54.1026
50.0000	55.2564
53.0769	55.6410



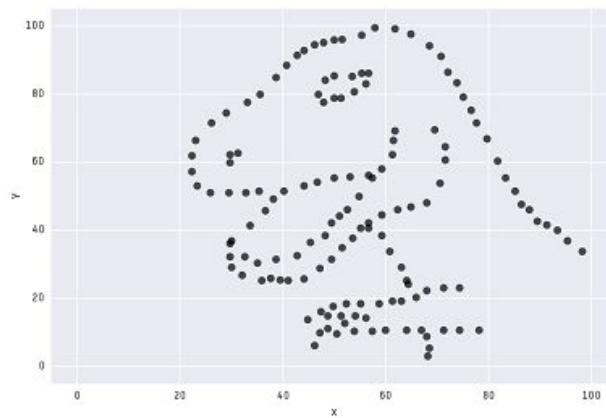
X Mean: 54.26

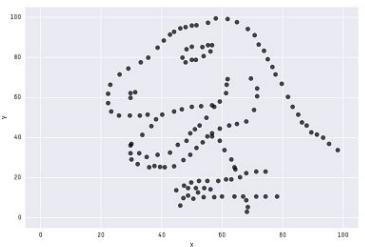
Y Mean: 47.83

X SD : 16.76

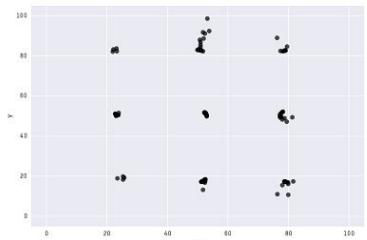
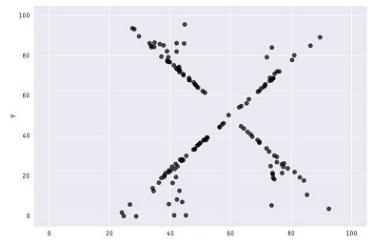
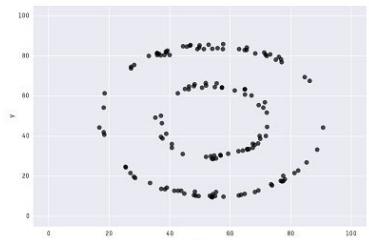
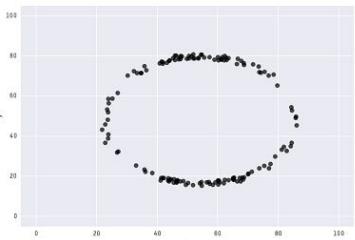
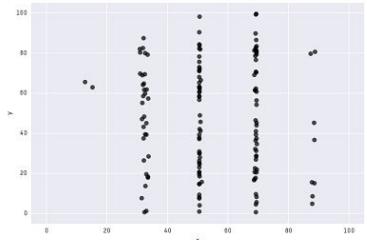
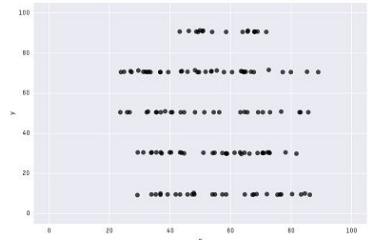
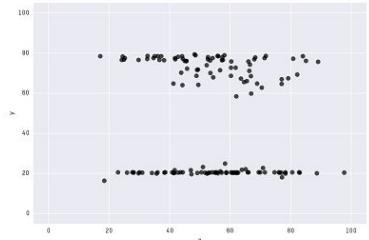
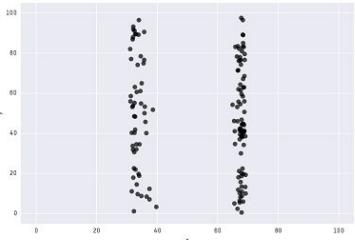
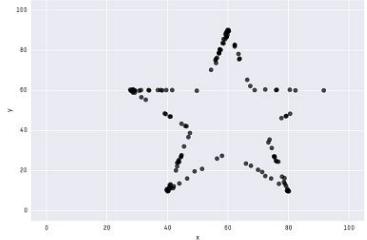
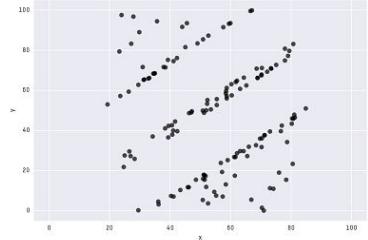
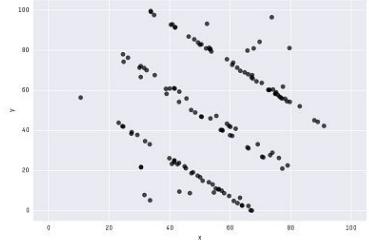
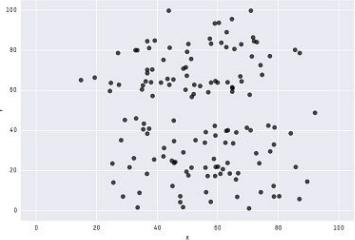
Y SD : 26.93

Corr. : -0.06



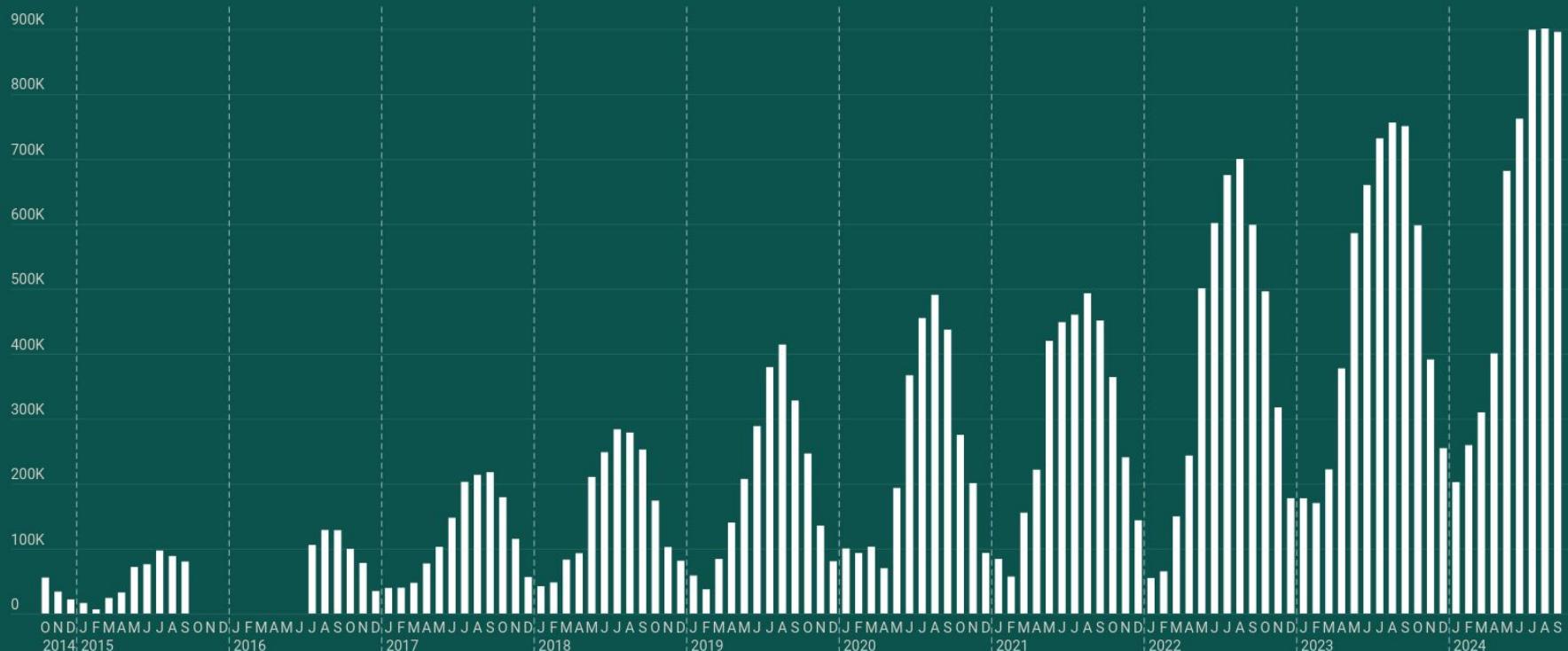


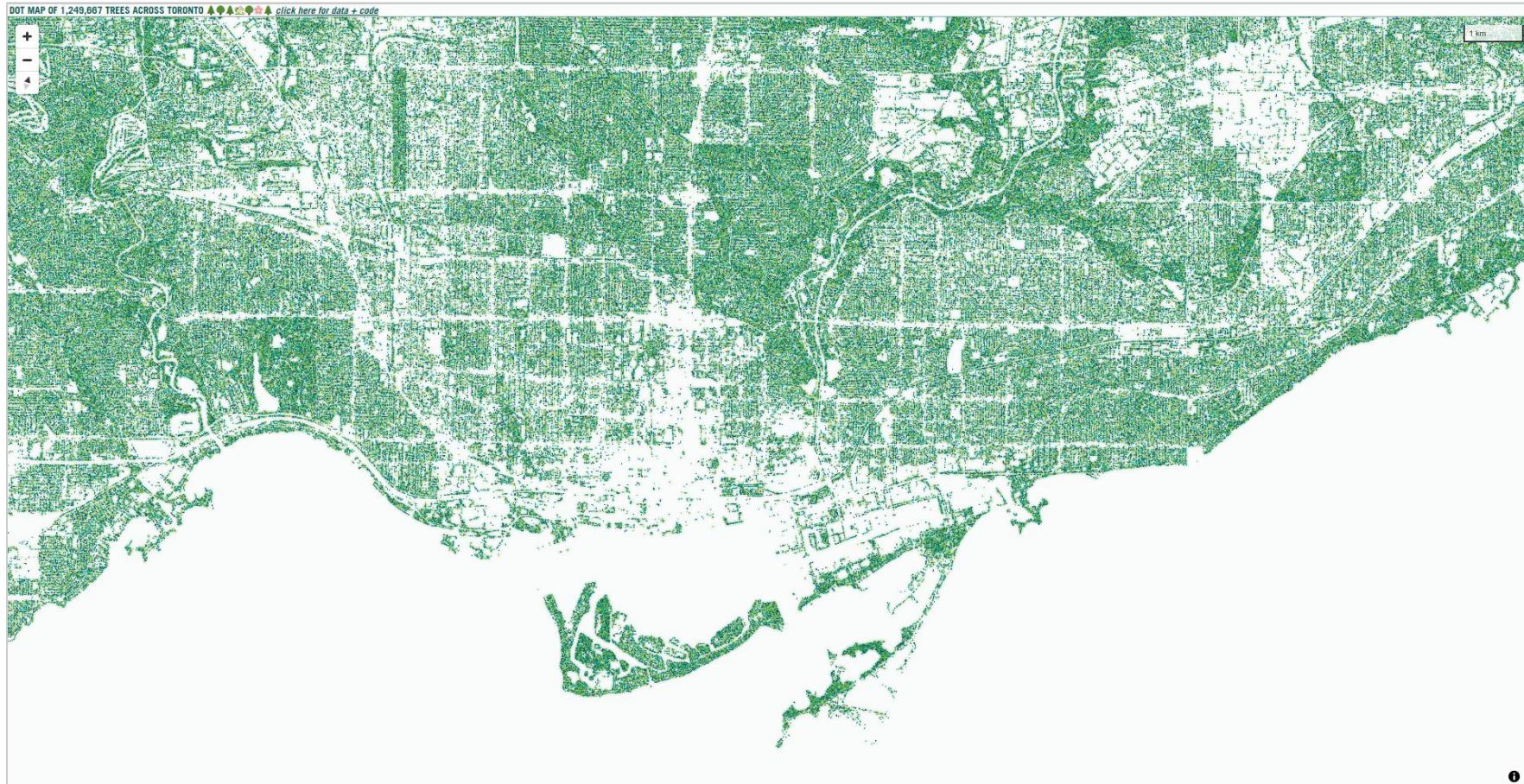
X Mean: 54.26  
Y Mean: 47.83  
X SD : 16.76  
Y SD : 26.93  
Corr. : -0.06



## Bike Share Ridership by Month

(we are missing monthly data from Oct 2015 to June 2016)





<https://schoolofcities.github.io/trees-toronto/dot-map>



# TORONTO

*Where do the snow plows go?*

Density of ~21 million GPS locations of snow plows in Toronto queried every 10 seconds from January 15 at 7pm to January 17 at 7pm (2026)

Fewer snow plows

More snow plows

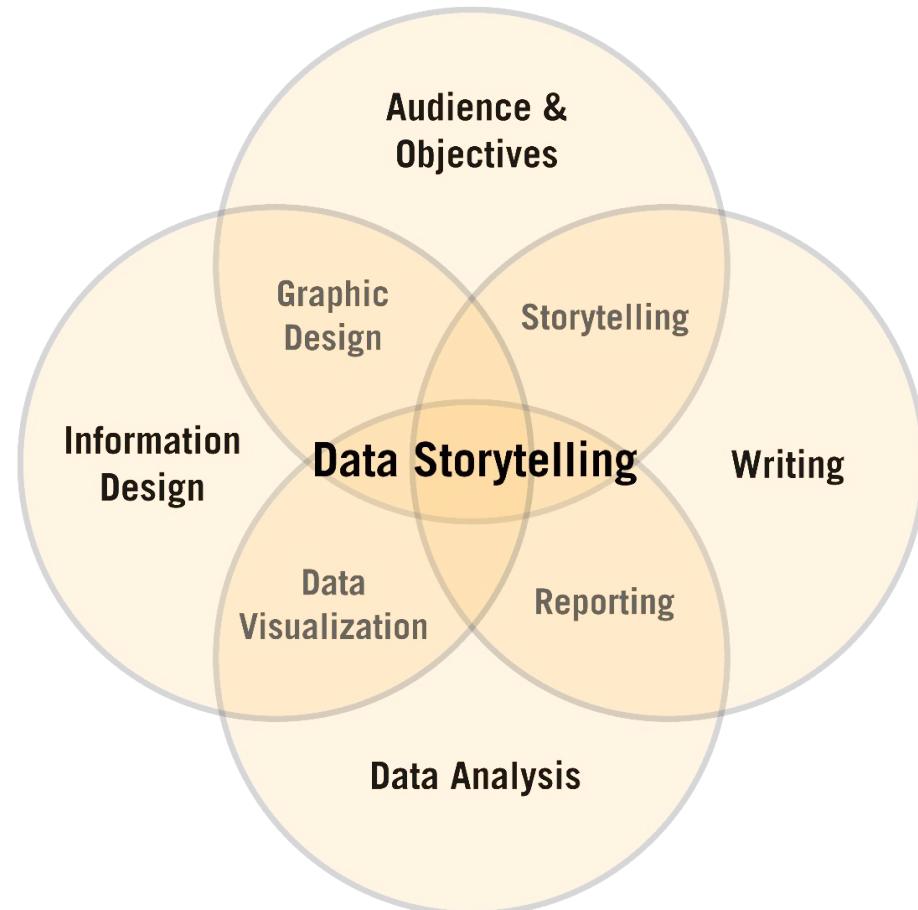
Map: Jeff Allen

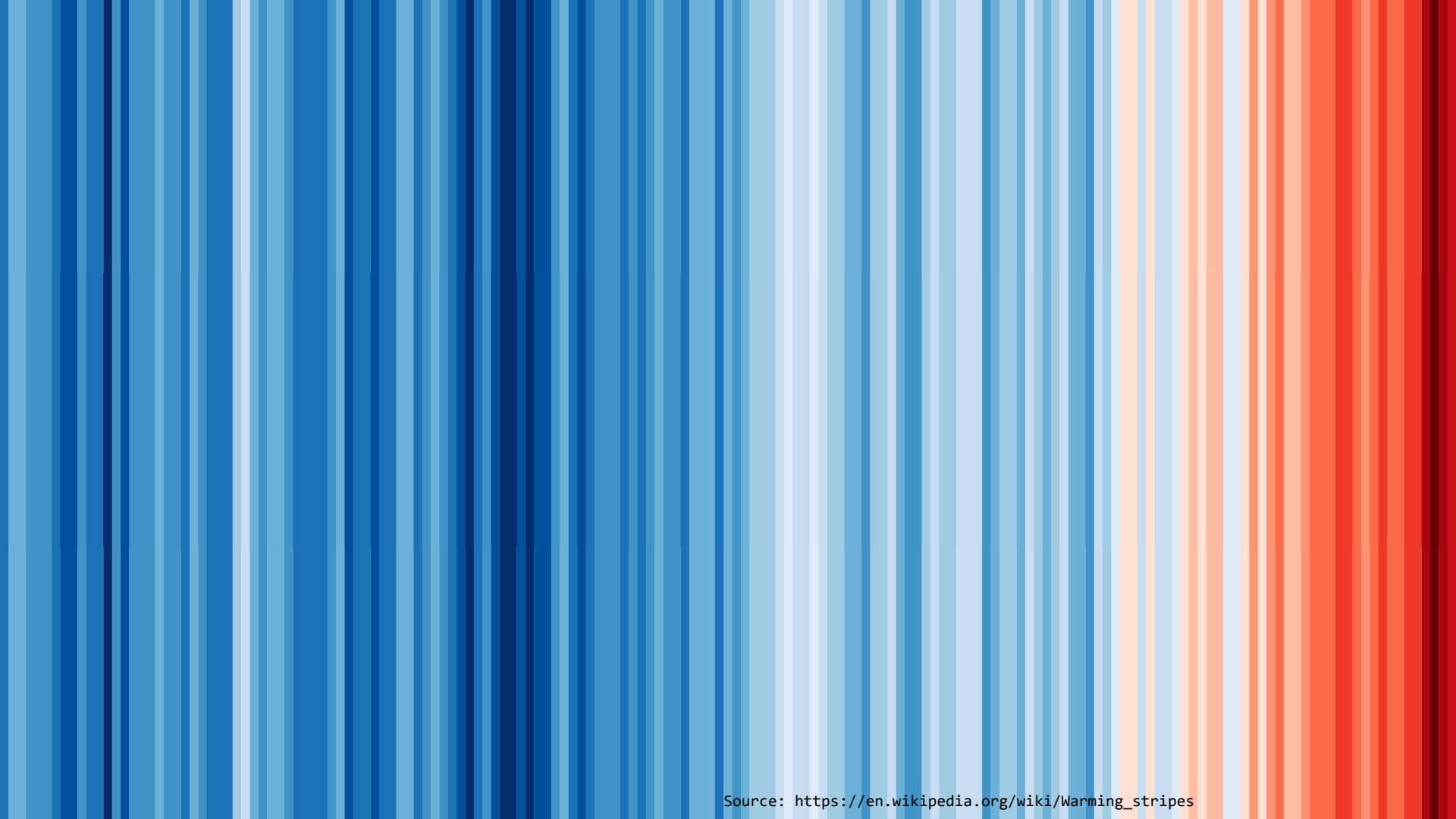
Date: City of Toronto

Tools: Python, QGIS, GIMP, Inkscape

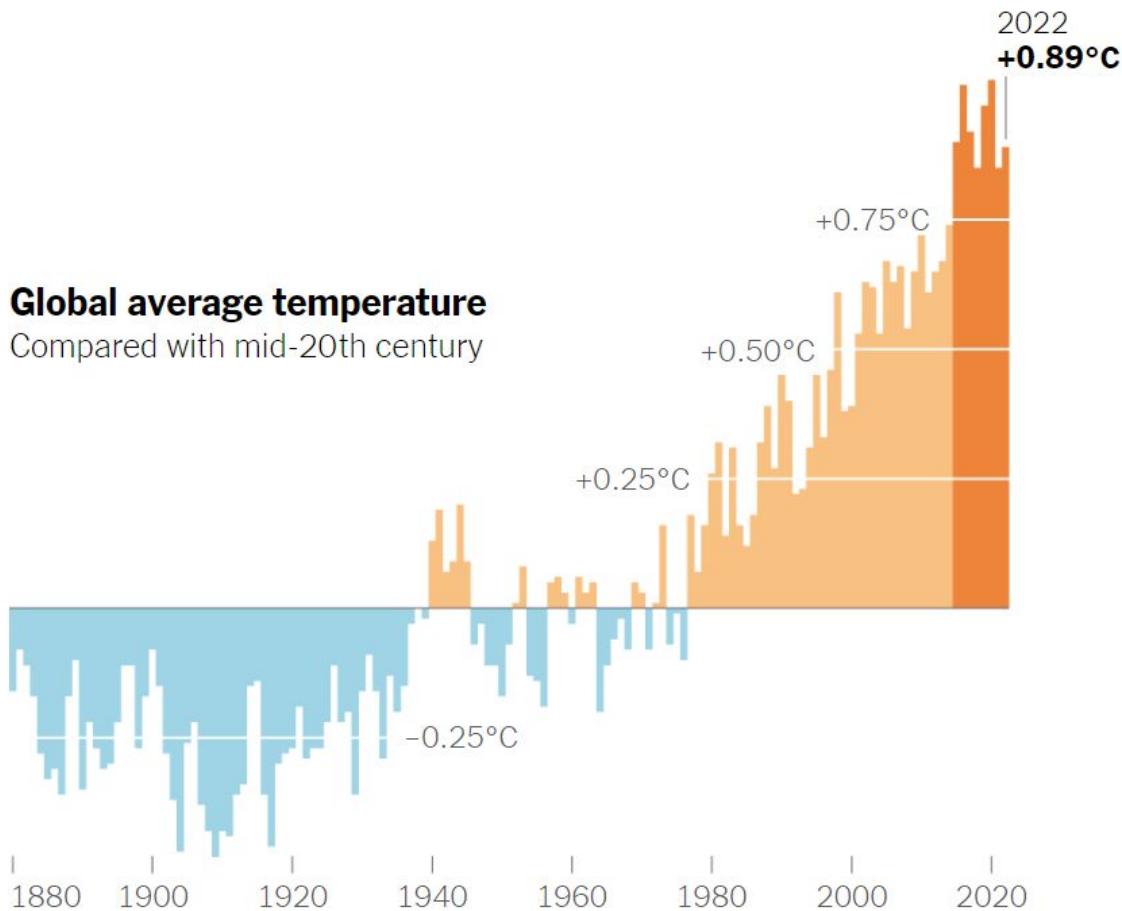
## Why Visualize Your Data?

- *Exploratory Data Analysis*
- Communicate
- Tell Stories
- Make a Case





Source: [https://en.wikipedia.org/wiki/Warming\\_stripes](https://en.wikipedia.org/wiki/Warming_stripes)

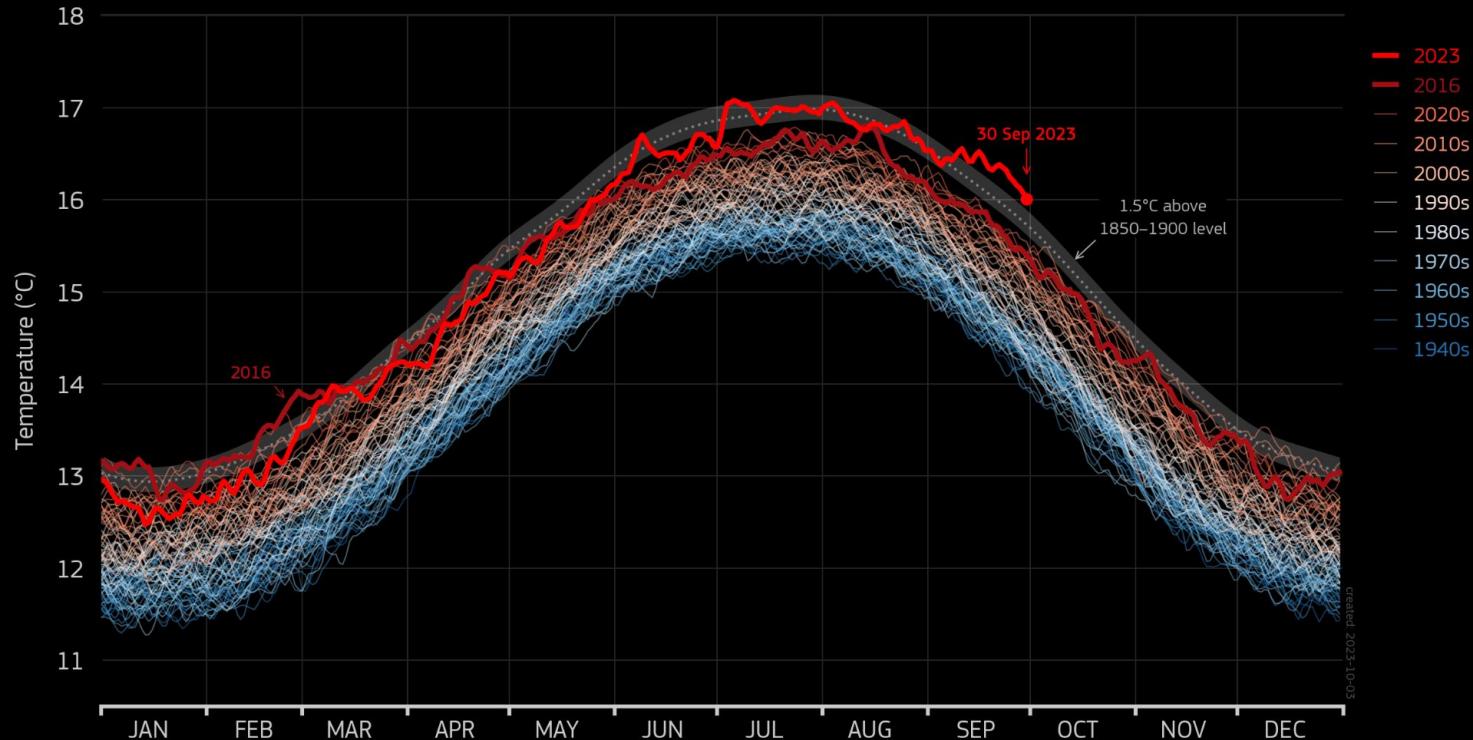


Source: NASA Goddard Institute for Space Studies

Source: <https://www.nytimes.com/2023/01/26/learning/whats-going-on-in-this-graph-feb-1-2023.html>

# DAILY SURFACE AIR TEMPERATURE

Data: ERA5 1940–2023 • Credit: C3S/ECMWF



PROGRAMME OF  
THE EUROPEAN UNION



IMPLEMENTED BY  
**ECMWF**

# There Are Many Types Of Charts ...

Often several good choices to visualize your data

Distribution



Violin



Density



Histogram



Boxplot



Ridgeline

Flow



Chord diagram



Network



Sankey



Arc diagram



Edge bundling

Correlation



Scatter



Heatmap



Correlogram



Bubble



Connected scatter

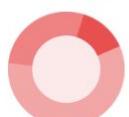


Density 2d

Part of a whole



Treemap



Doughnut



Pie chart



Dendrogram



Circular packing

Ranking



Barplot



Spider / Radar



Wordcloud



Parallel



Lollipop



Circular Barplot

Evolution



Line plot



Area



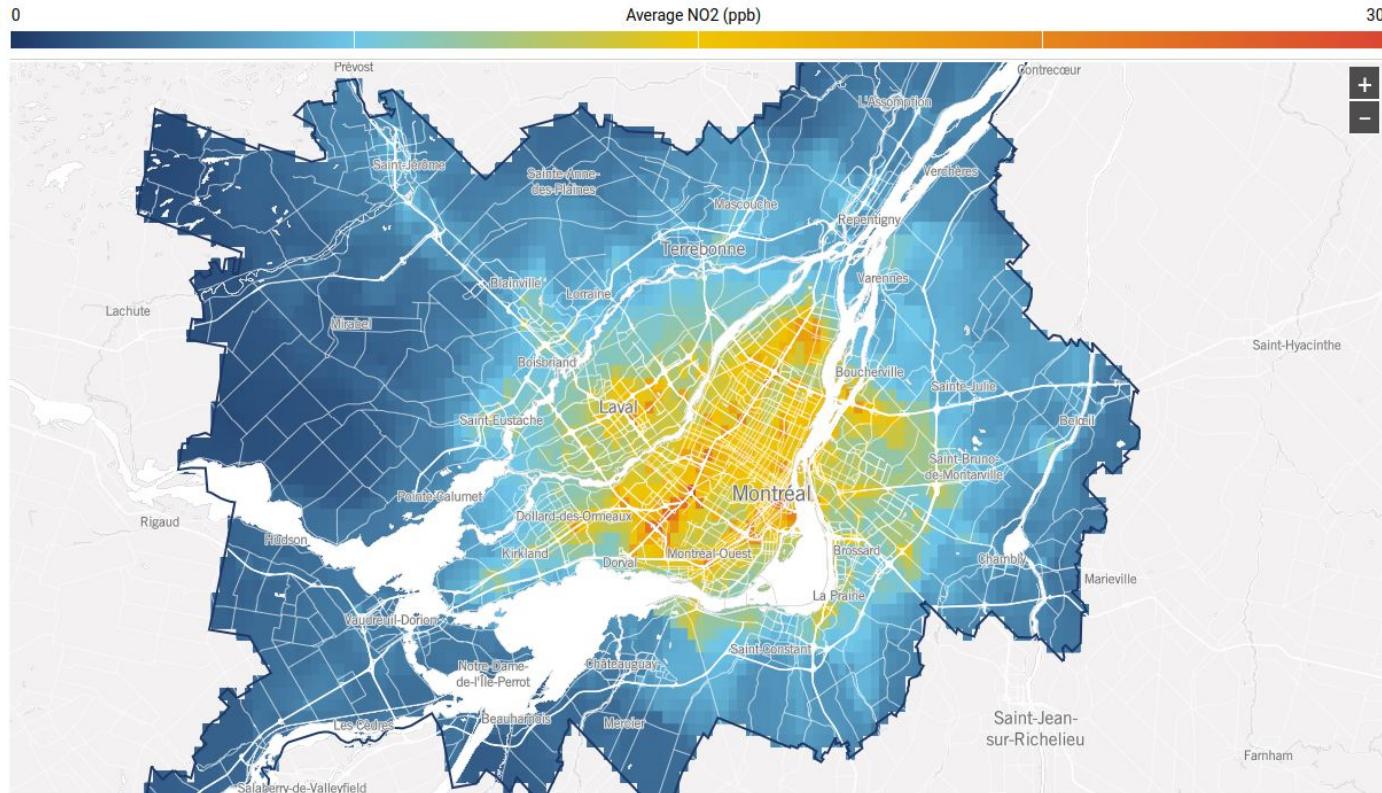
Stacked area



Streamchart

## Why Visualize?

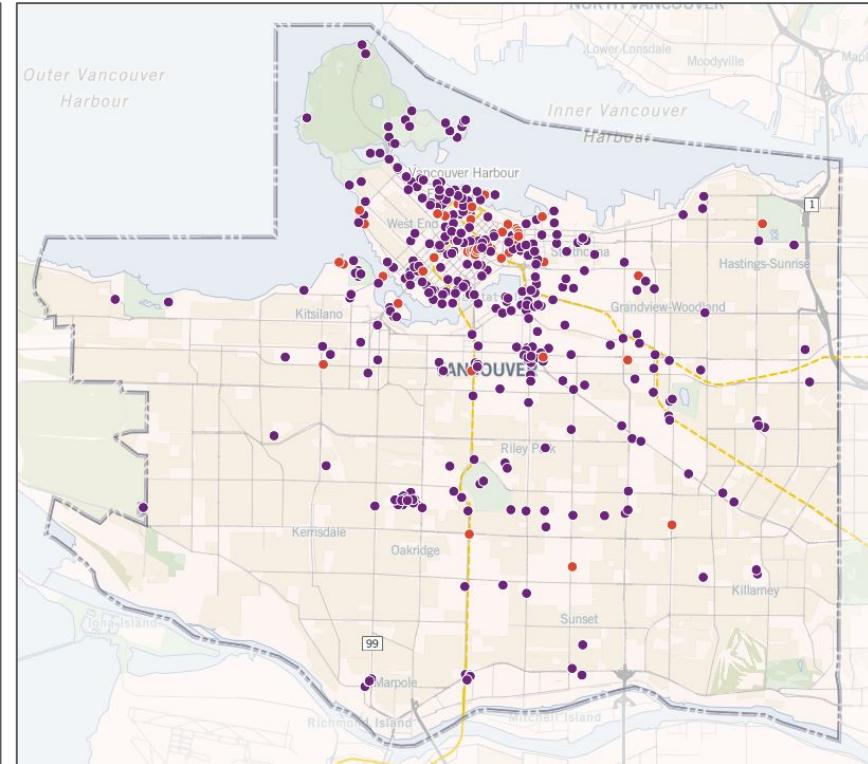
- Communicate
  - Tell Stories
  - Advocacy



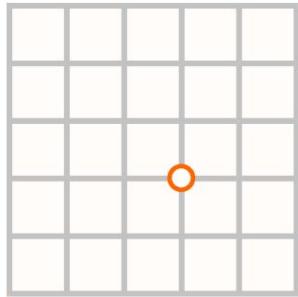
# Spatial Data

e.g. locations of public art in Vancouver

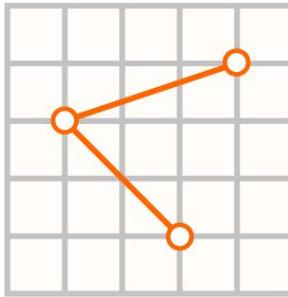
	A	B	C
1	title_of_work	X	Y
2	Follow 4 Follow?	-123.101430	49.261857
3	Failure To Communicate	-123.101441	49.263244
4	Untitled	-123.113936	49.261316
5	A Modest Veil	-123.120461	49.282879
6	Listening. On. Waking Terrain.	-123.099640	49.272845
7	Colour Seekers, The Colour Collector's Way	-123.123566	49.261523
8	All My Favourite People Are Animals	-123.088927	49.281065
9	Pattern Reflection	-123.114618	49.260162
10	Pick-up Sticks	-123.150744	49.262801
11	Excavations	-123.114234	49.279663
12	Should I Be Worried?	-123.113823	49.271123
13	Salvage	-123.123947	49.285762
14	Shigeru Ban	-123.123827	49.285591
15	Life Transformations	-123.119083	49.281865
16	Waft	-123.115822	49.285797
17	Wheel of Everyday Life	-123.130059	49.278095
18	Eyes on the Street	-123.103057	49.270886
19	Building A - Livestock Building	-123.114234	49.279663
20	Vancity Skyline	-123.113948	49.279993
21	Sinulhka: Story of the Double Headed Serpent	-123.152699	49.264120



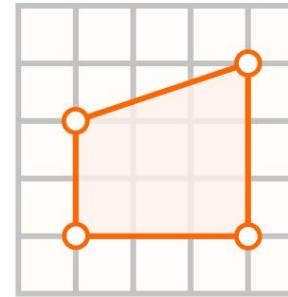
# Spatial Data



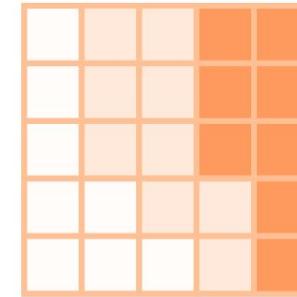
Point



Line

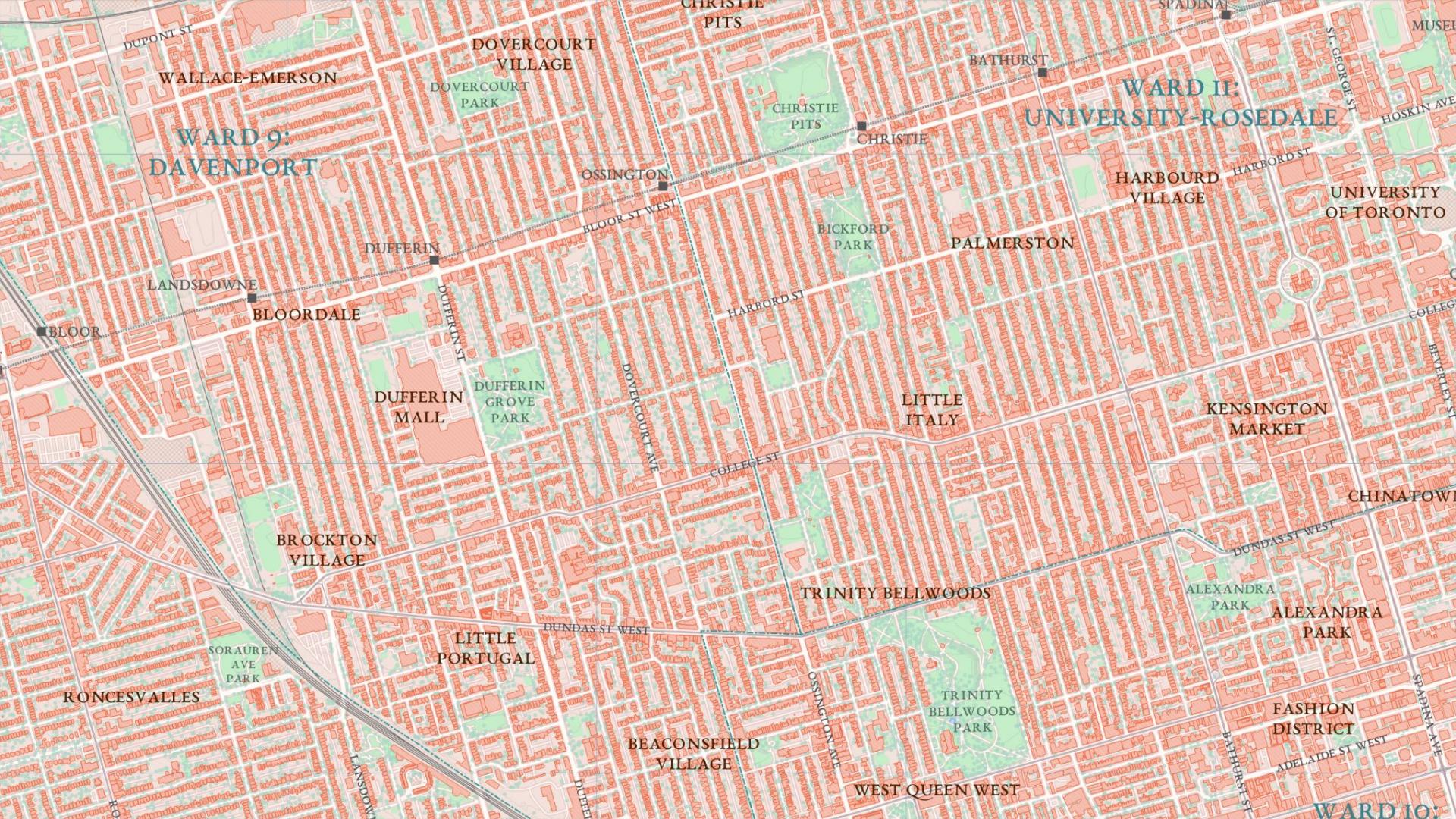


Polygon



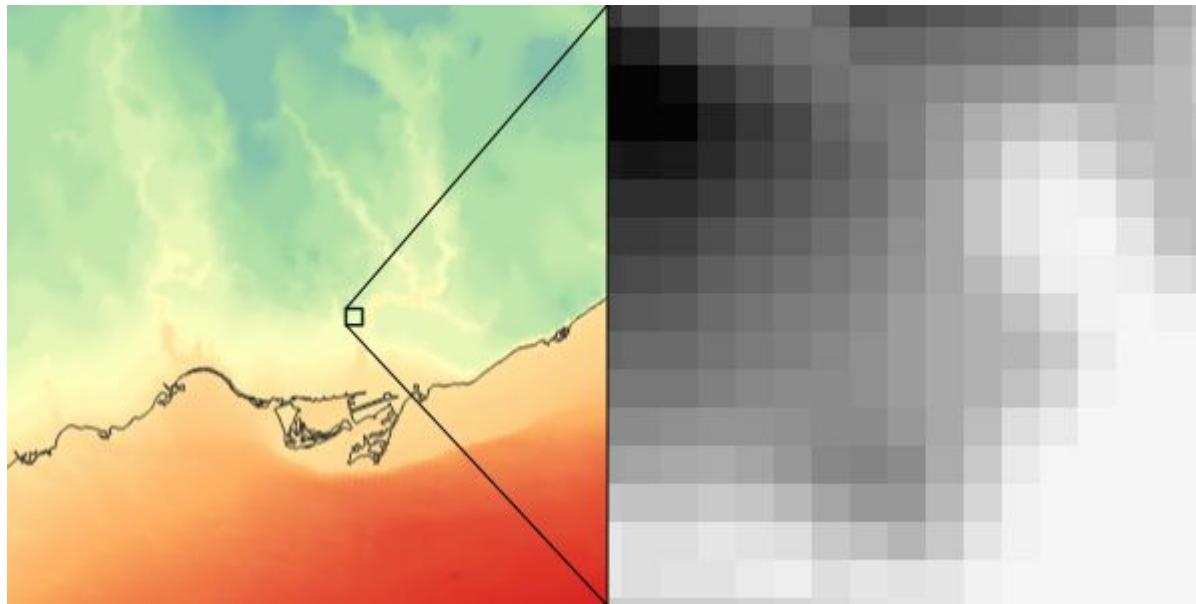
Raster

**Vector**



## Raster data example

Digital Elevation Model (DEM) of Toronto



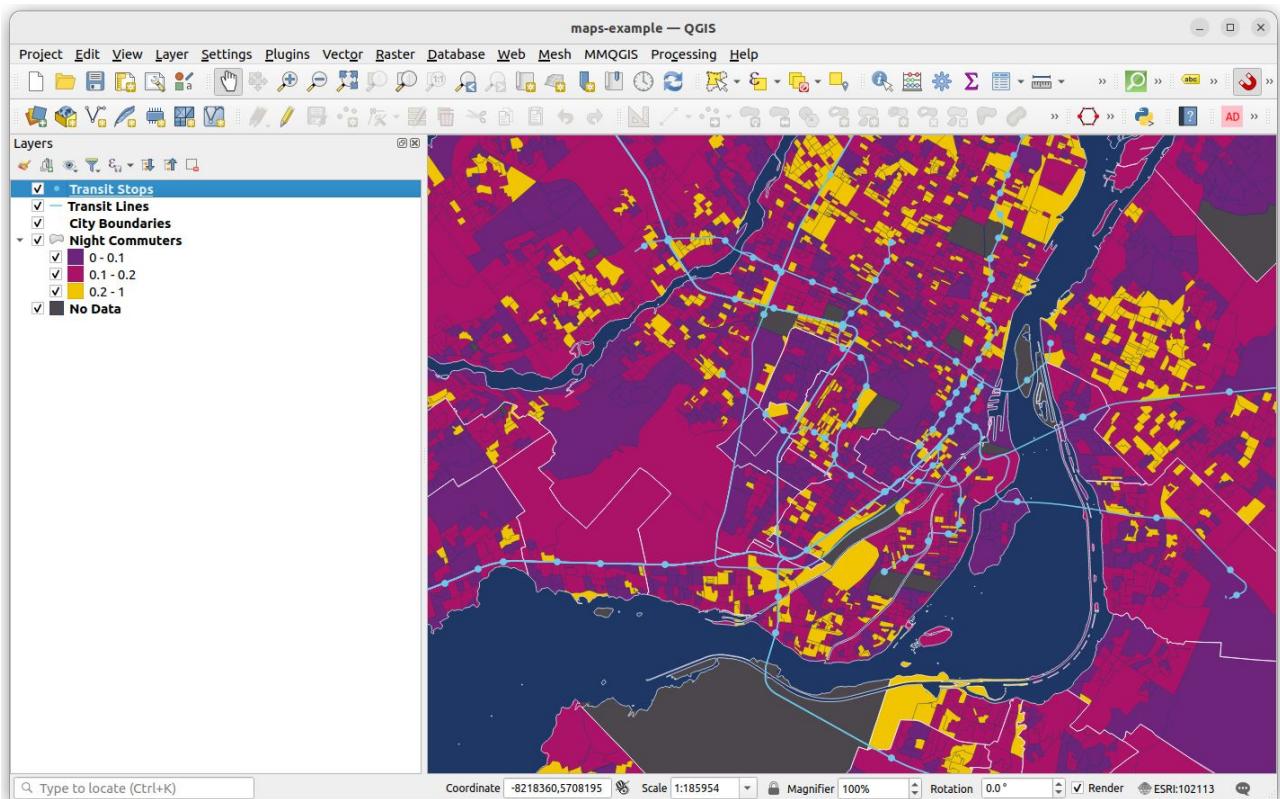
# GIS (Geographic Information Systems)

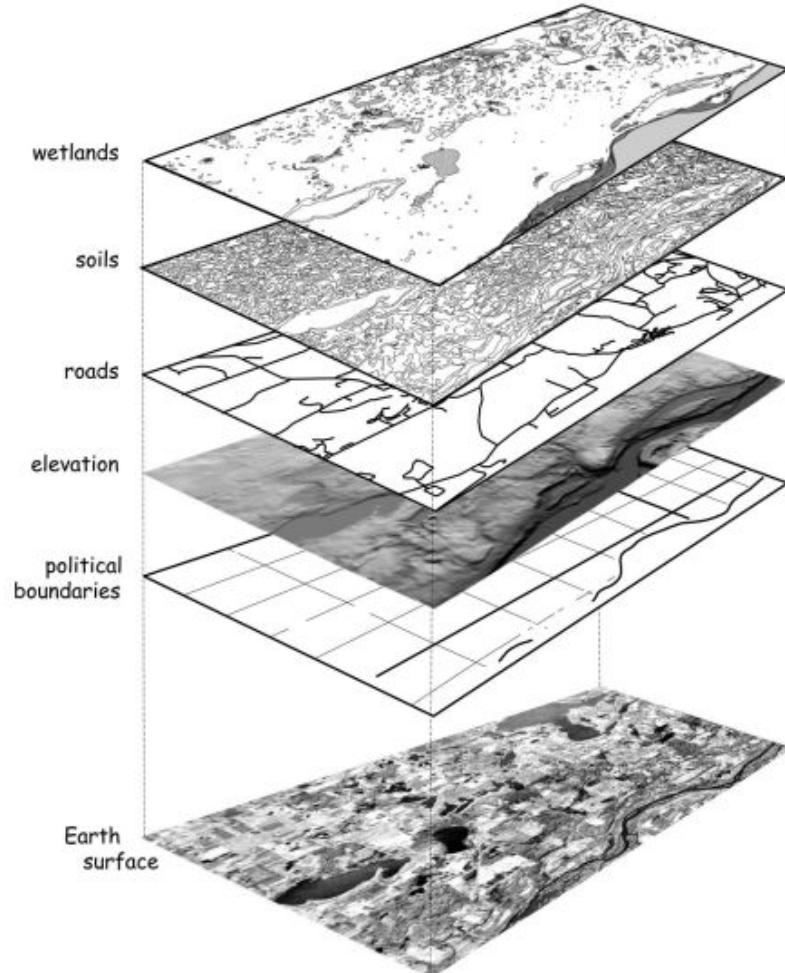
- Tools for analyzing, processing, and visualizing spatial data

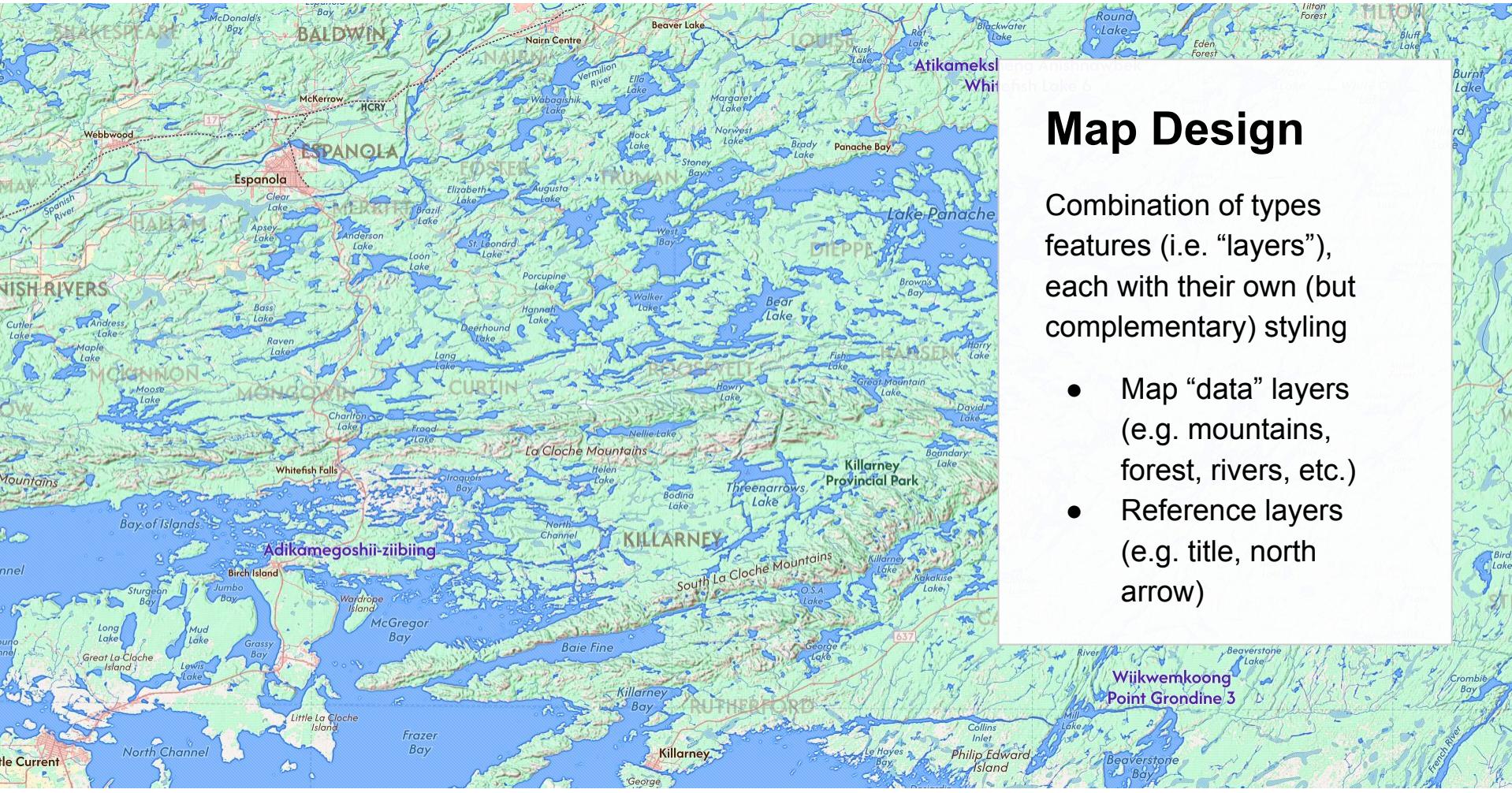
- e.g. QGIS, ArcGIS

## Other Options:

- Python, R, SQL, JavaScript, etc.







## Map Design

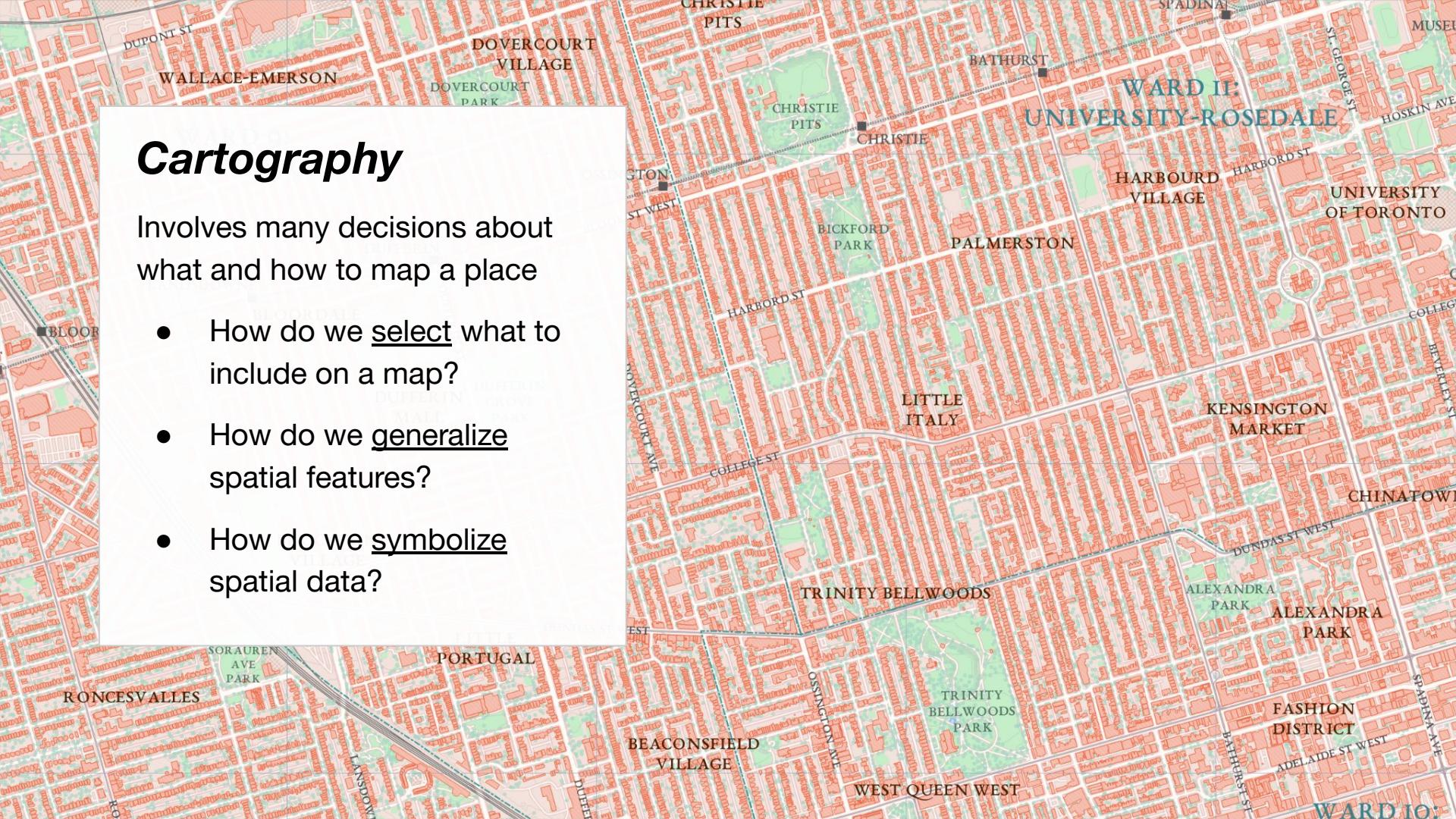
Combination of types  
features (i.e. “layers”),  
each with their own (but  
complementary) styling

- Map “data” layers  
(e.g. mountains,  
forest, rivers, etc.)
- Reference layers  
(e.g. title, north  
arrow)

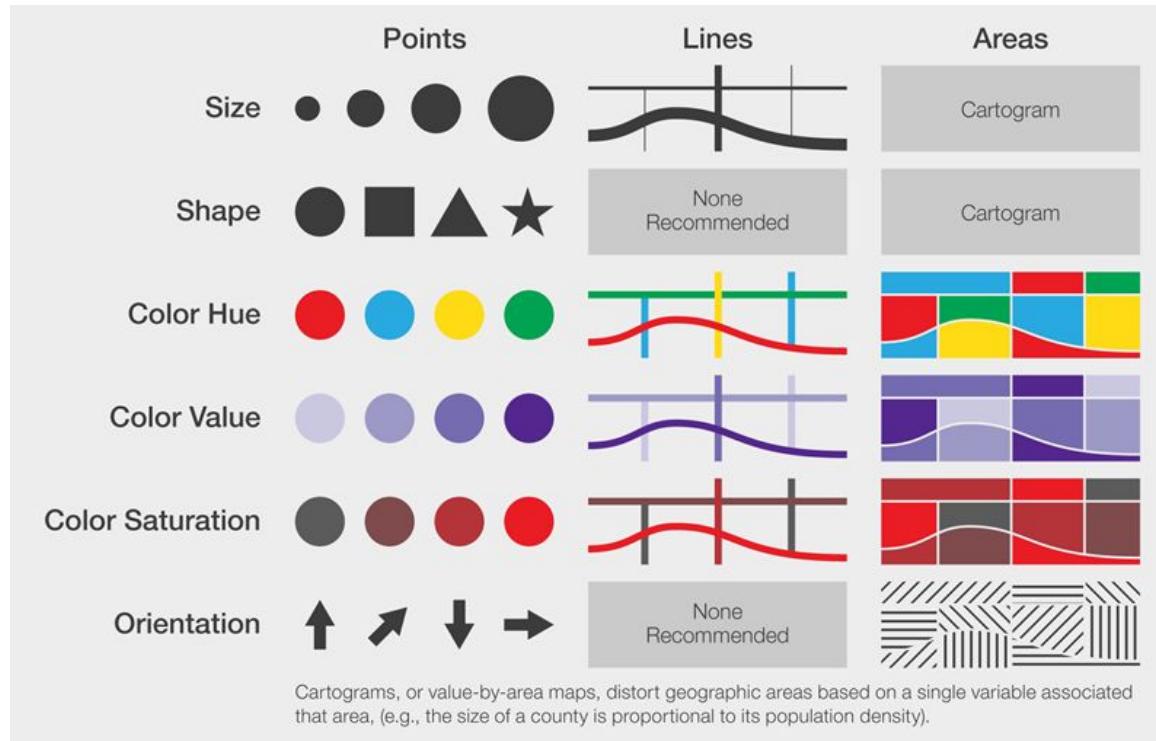
# Cartography

Involves many decisions about what and how to map a place

- How do we select what to include on a map?
- How do we generalize spatial features?
- How do we symbolize spatial data?

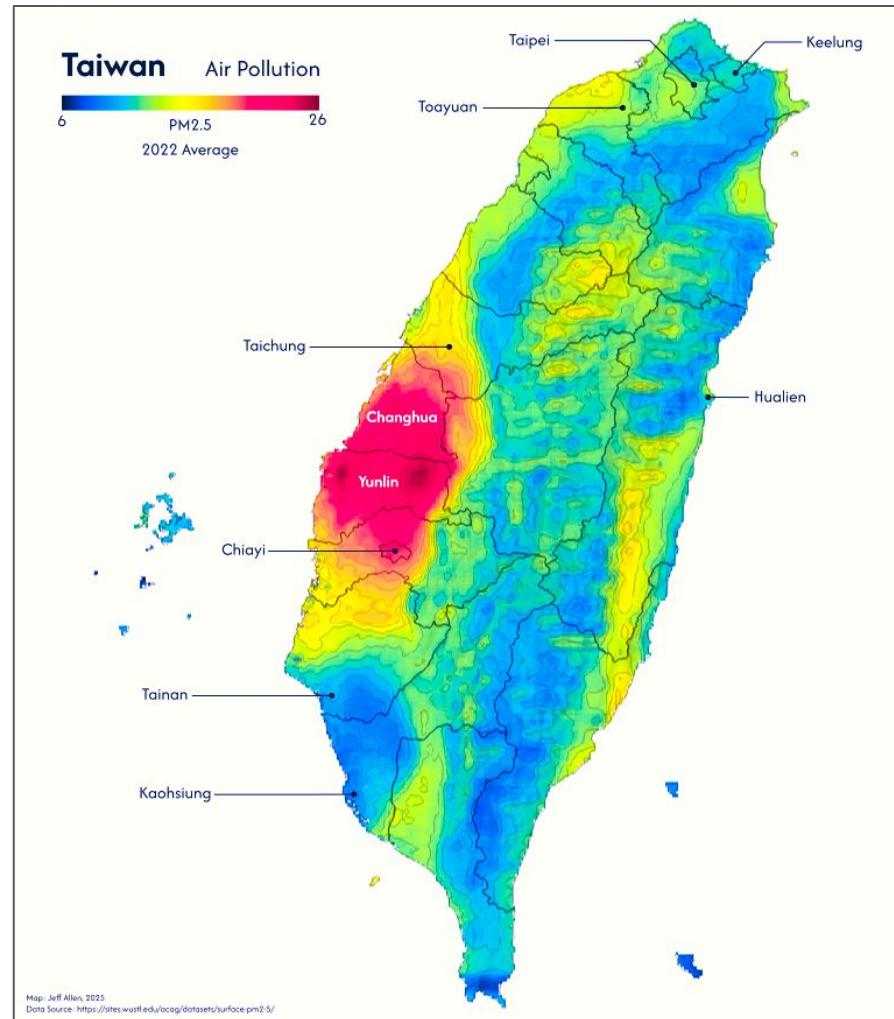


# Symbology

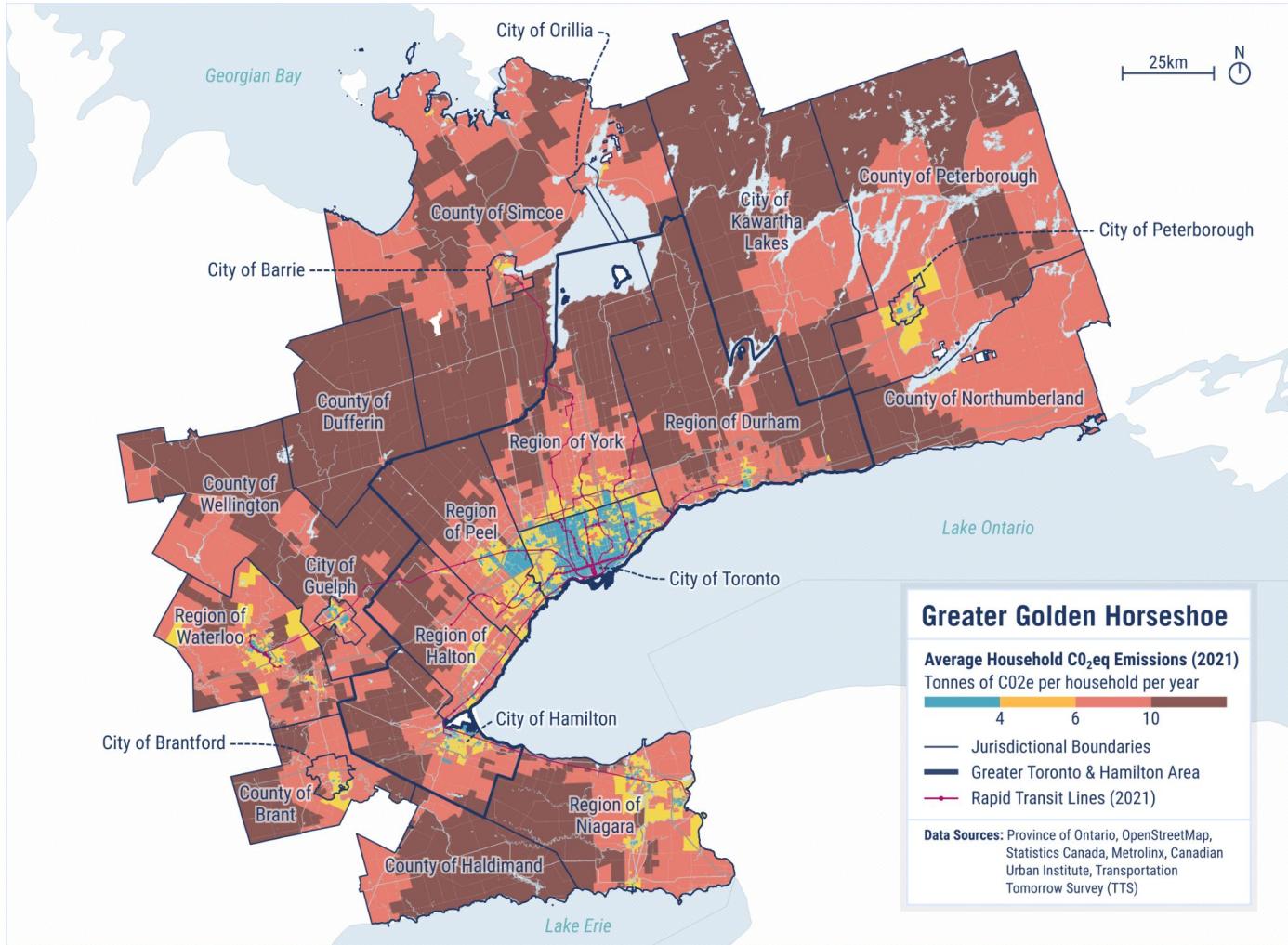


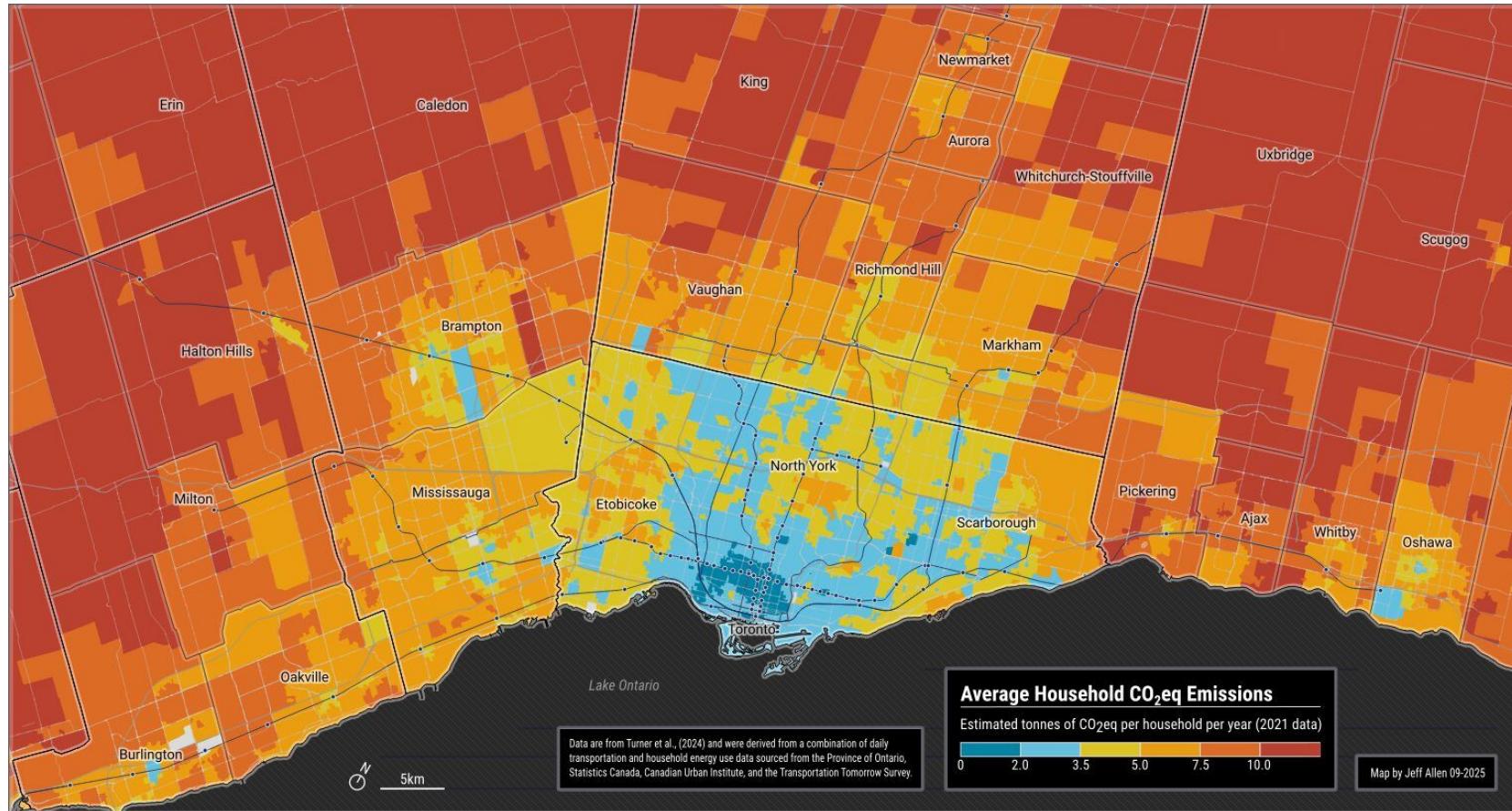
# Thematic Maps

- A type of map that portrays the geographic pattern of a particular subject matter in a geographic area



# Choropleth Map (e.g. GHG Emissions)

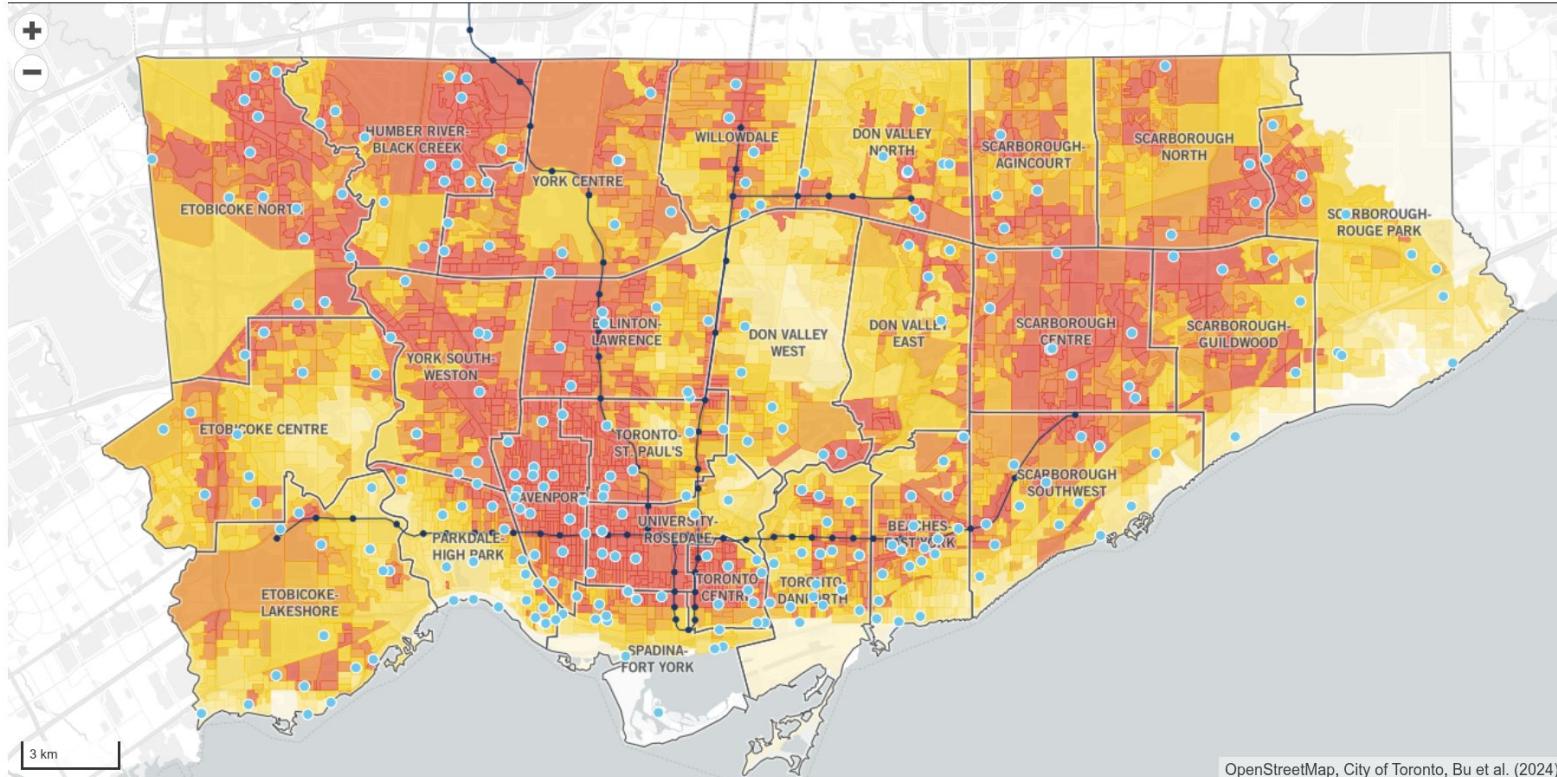




## Heat Vulnerability Index

| Low

| High



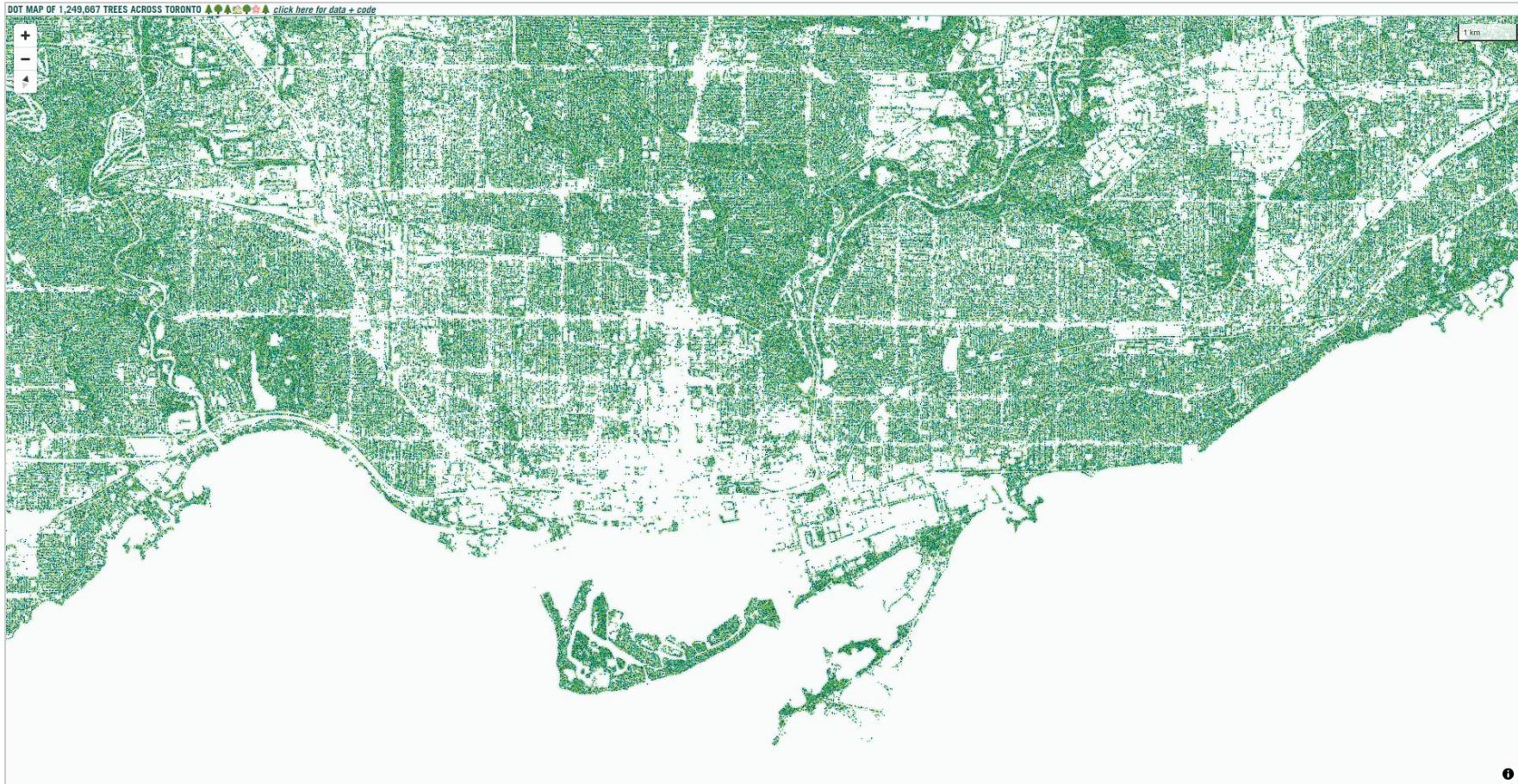
• Outdoor Swimming & Wading Pools

• Hospitals

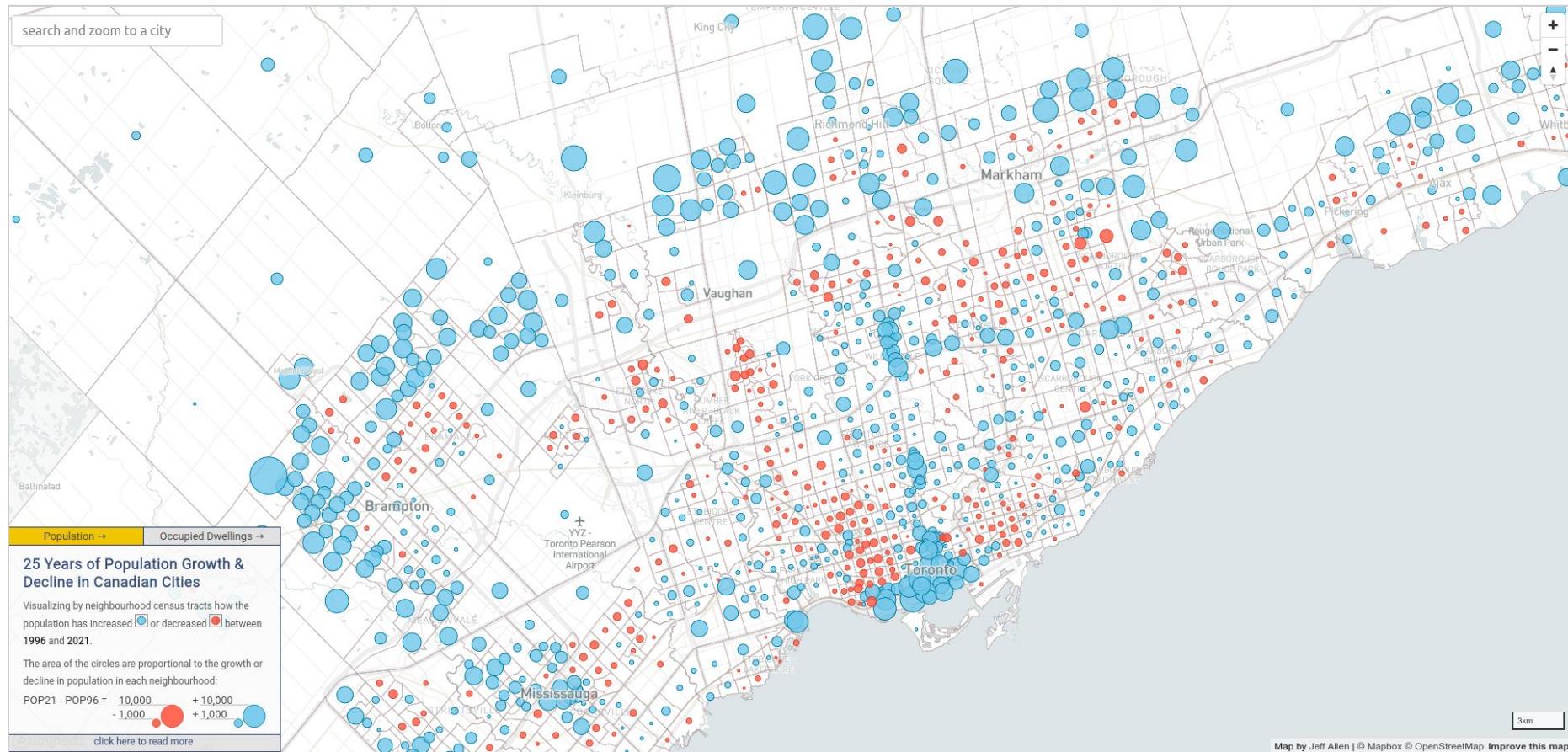
• Cooling Centres

• Apartments Without Air Conditioning

## Dot Density Map (1 dot = 1 tree)



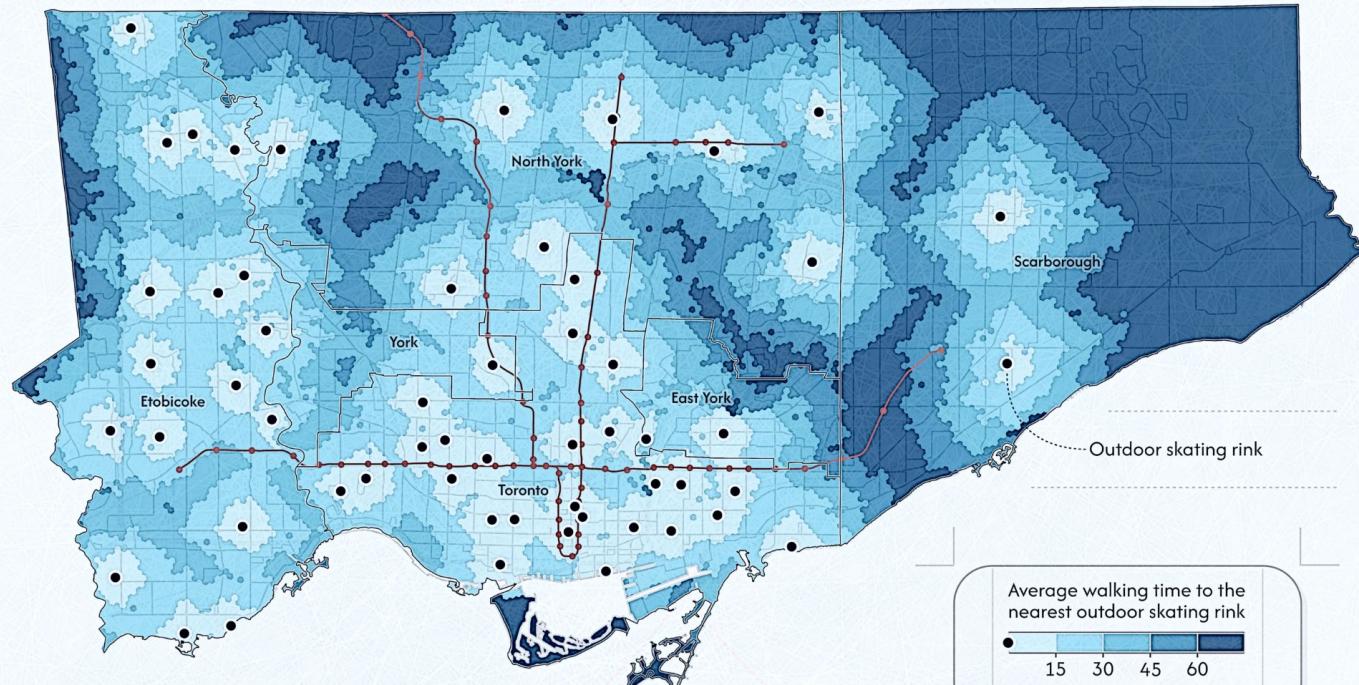
# Proportional Symbol Map (e.g. colour and size of circle represents population growth or decline)



## *Proximity to outdoor skating rinks in Toronto*

N

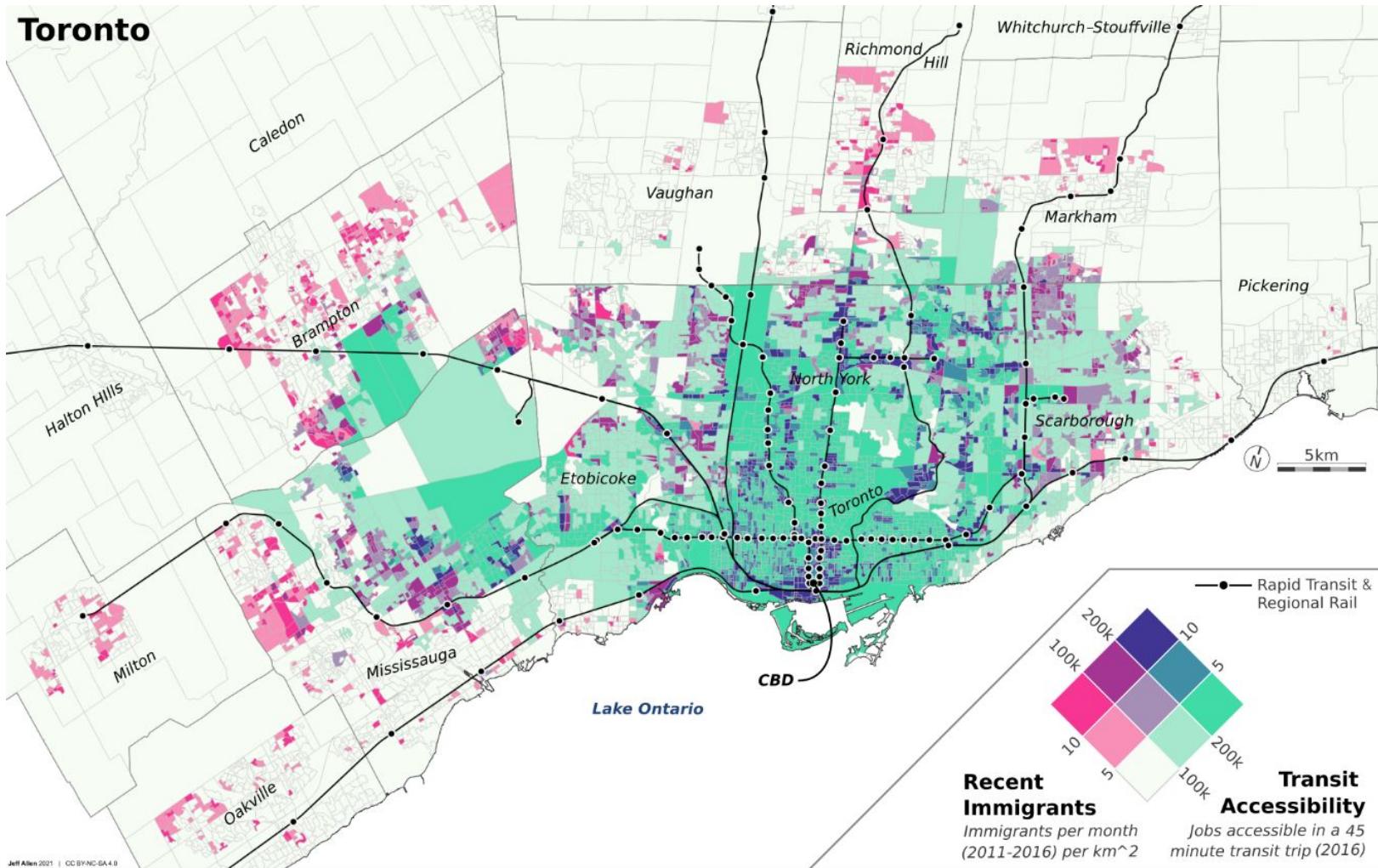
5km

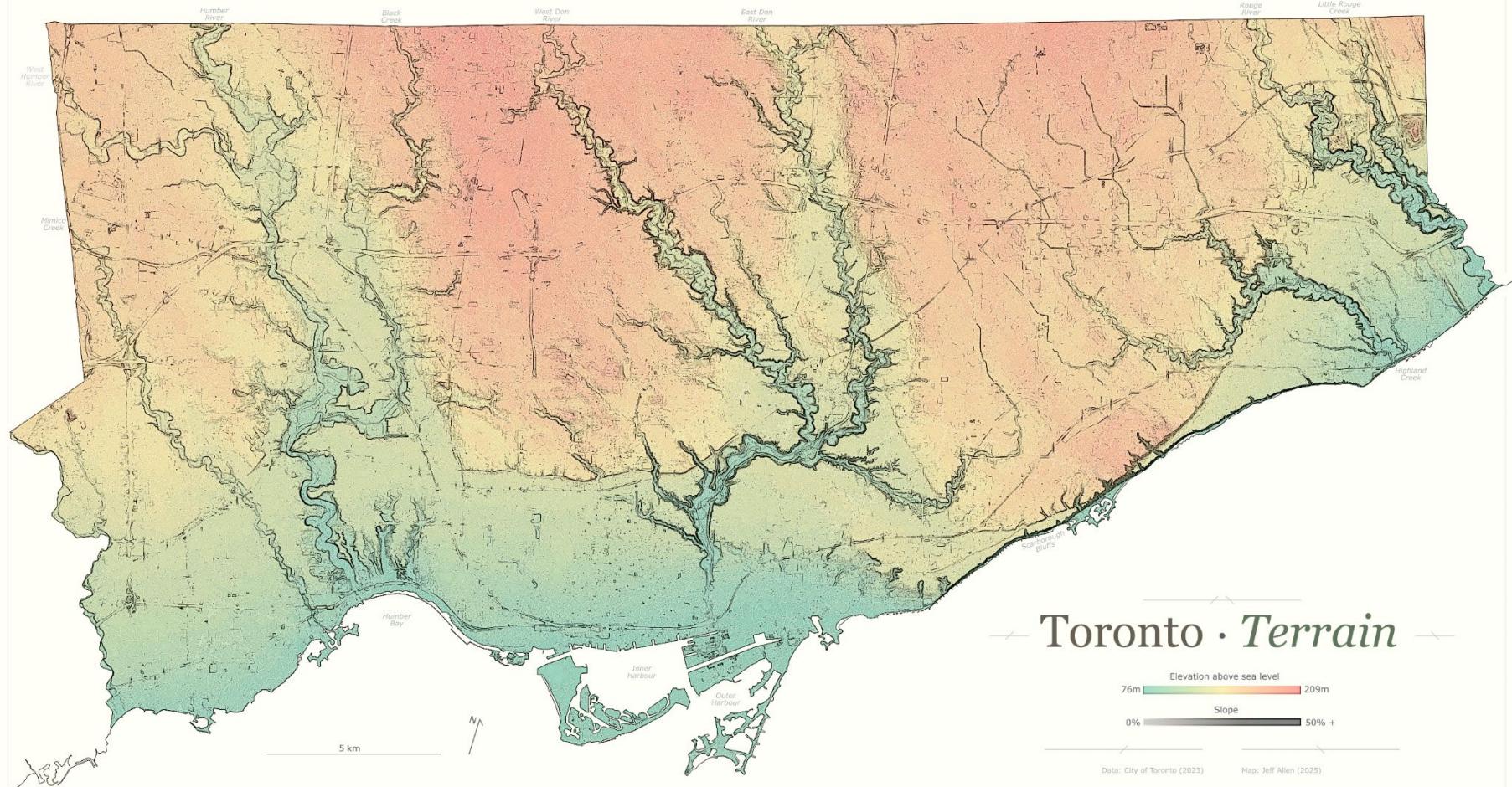


Map by Jeff Allen and Teresa Lau, School of Cities, University of Toronto

Data Sources: City of Toronto, OpenStreetMap

# Toronto







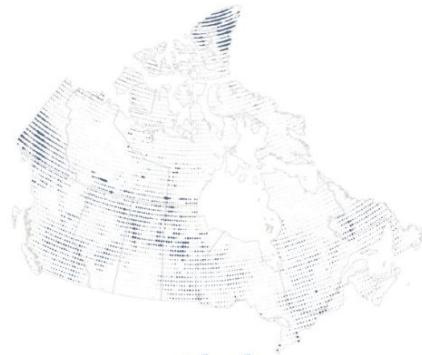
*Deforestation*



*Biodiversity Loss*



*Wildfires*



*Floods*



*Drought*



*Soil Degradation*



*Water Stress*



*Sea Level Rise*

## Accessibility

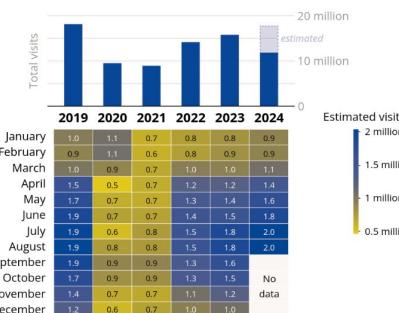
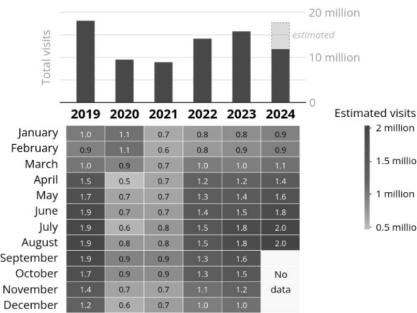
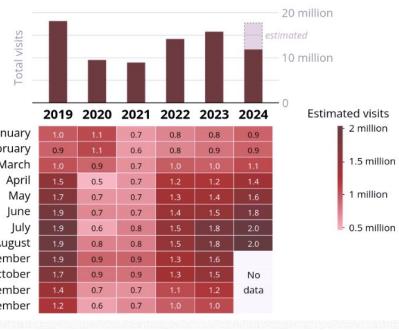
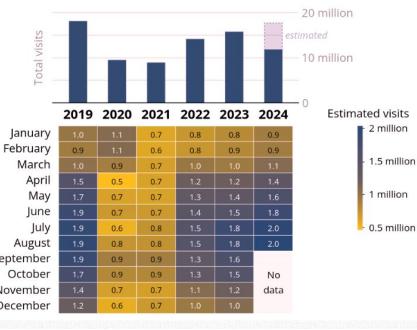
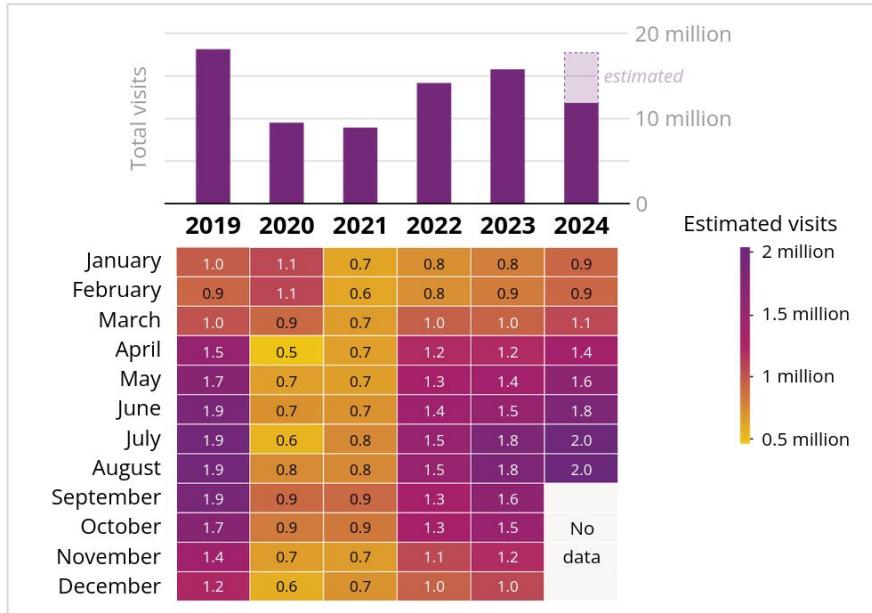
- Colours
- ***Contrast*** 
- Resolution
- Font sizes
- Language
- Screens
- Data Transfer
- Open Source

Can you read me?

Can you read me?

Can you read me?

e.g. designing graphics for people who are colour blind

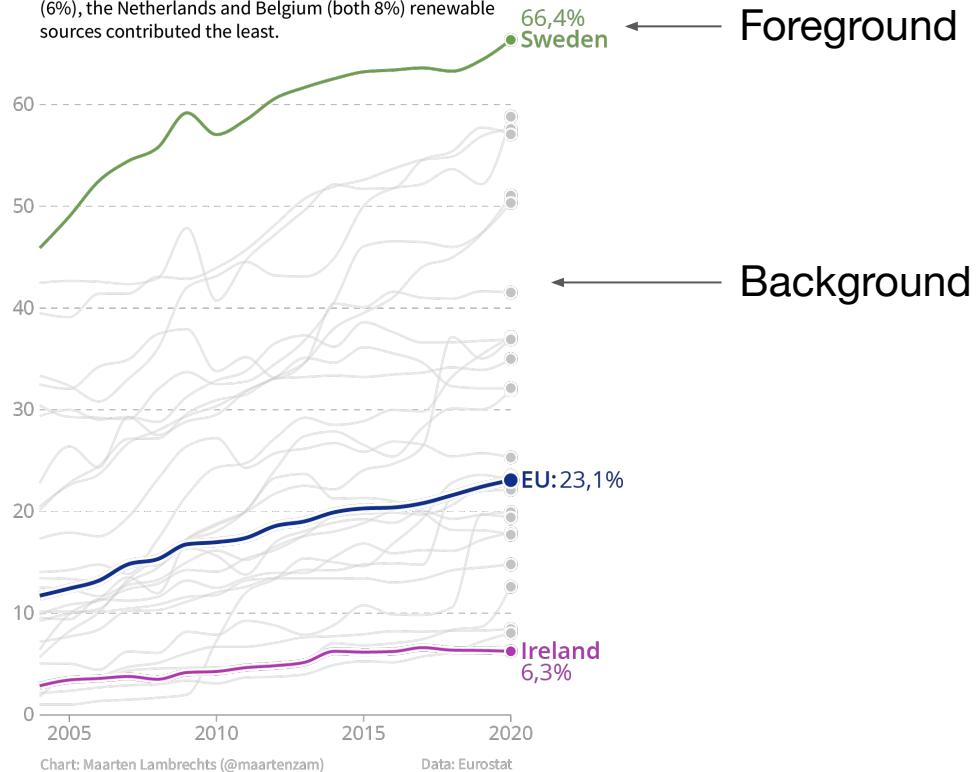


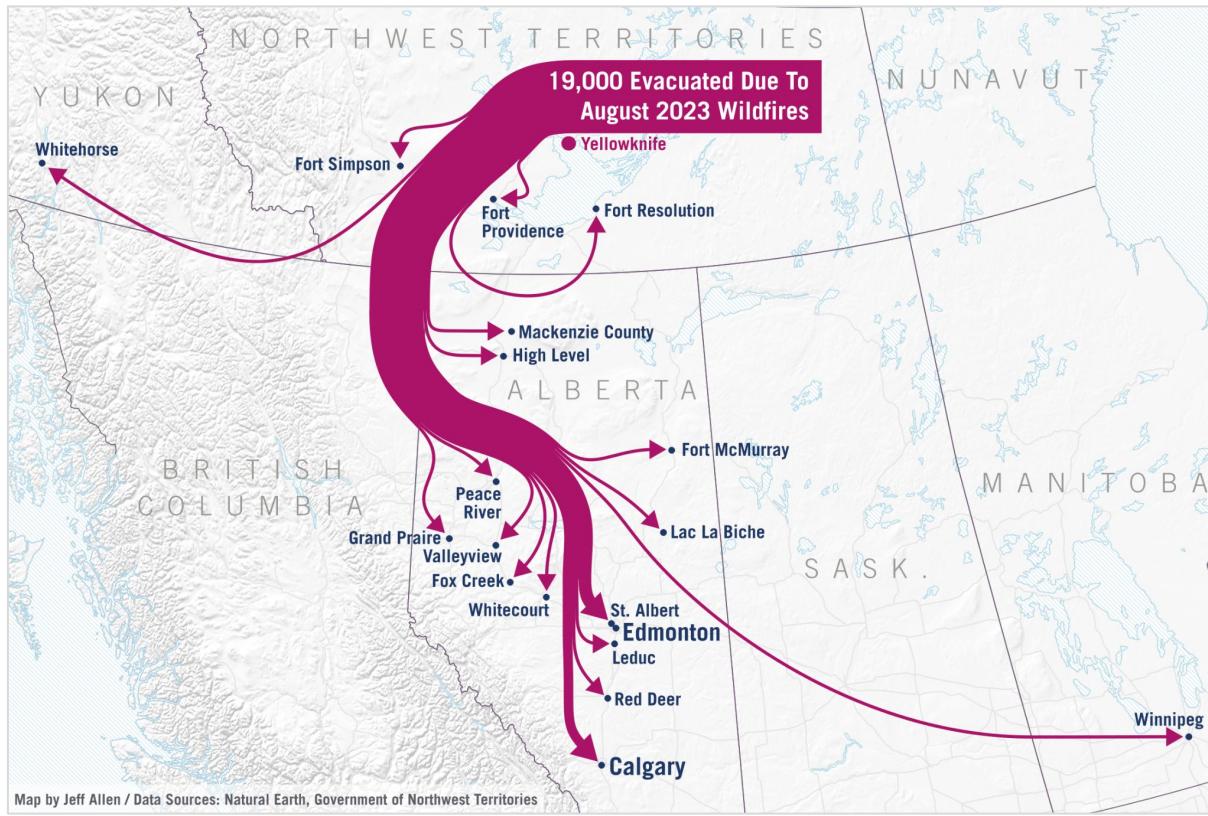
## Visual hierarchy

*Emphasis of certain layers and features, de-emphasis of others, to highlight trends or story*

### European Union slowly on its way to greener heating and cooling

Almost a quarter of the energy used for heating and cooling in the EU came from renewables in 2020, a doubling since 2004. Sweden stands out with two thirds of renewables (mostly biomass and heat pumps). In Ireland (6%), the Netherlands and Belgium (both 8%) renewable sources contributed the least.





Online textbook: <https://schoolofcities.github.io/urban-data-storytelling/>

## Recommended chapters:

- “Spatial data and GIS”
- “Maps and visualizing spatial data”
- “Ten practical tips for effective data visualization”
- “Choropleth maps”
- “Visualizing and mapping density”

UNIVERSITY OF TORONTO | SCHOOL OF CITIES

## Urban Data Analytics, Visualization, and Storytelling

Jeff Allen, Julia Greenberg, Evelyne St-Louis, Michelle Zhang, Aniket Kali, and Karen Chapple

Welcome to the *Urban Data Analytics, Visualization, and Storytelling* online textbook, written and created by the [School of Cities](#) at the University of Toronto. It is a combination of learning materials on data analytics, data visualization, and narrative techniques to make complex urban trends understandable and engaging for specific audiences, such as policymakers, funders, or community members.

There are three core modules, each composed of several chapters and hands-on tutorials.

- [Urban data storytelling](#): Craft compelling narratives about cities, in order to communicate research and key insights, inform policy-making, build public will, or advocate for change.
- [Urban data analysis](#): Find, process, and analyze data via Python, spreadsheet software, and GIS aimed at deriving key findings and answering research questions.
- [Urban data visualization](#): Learn a variety of strategies, methods, and practical tips for effective visual communication of urban data via a range of maps and charts.

The diagram consists of three overlapping circles. The top circle is teal and labeled "Narrative" with a quill pen icon. The bottom-left circle is light blue and labeled "Visuals" with a pie chart icon. The bottom-right circle is dark blue and labeled "Data" with a folder icon. The overlapping area of all three circles is yellow and contains the text "URBAN DATA STORYTELLING". Below the diagram, the text "Framework for data storytelling" is written.

# Workshop data: <https://github.com/schoolofcities/clarke-workshop-2026>

The screenshot shows a GitHub repository page for 'clarke-workshop-2026'. The repository is public and contains one branch ('main') and no tags. The repository owner is 'jamaps'. The README file provides material for a data visualization workshop, mentioning the Clarke Prize and QGIS requirements. The repository has no releases or packages published.

**Code** (highlighted with a red box) and **Download ZIP** (also highlighted with a red box) buttons are visible in the central clone area.

**About** section details:

- No description, website, or topics provided.
- Readme
- Activity
- Custom properties
- 0 stars
- 0 watching
- 0 forks
- Audit log

**Releases**: No releases published. [Create a new release](#)

**Packages**: No packages published. [Publish your first package](#)

# Open-source tools

- Inkscape, GIMP
- **QGIS**
- Python, R, SQL
- HTML, CSS, Javascript
- Svelte
- D3, MapLibre, Leaflet
- Tippecanoe, PMTiles
- GitHub

The screenshot shows the GitHub organization page for 'School of Cities, University of Toronto'. The page features a header with the organization's logo, name, and a 'Unfollow' button. Below the header, there are sections for 'Popular repositories' and 'Repositories'. The 'Popular repositories' section displays five repositories: 'historical-aerial-imagery-toronto', 'gentle-density', 'mapping-workshops-2023', 'parking-tickets-toronto', 'downtown-recovery', and 'bike-share-toronto'. The 'Repositories' section lists several more repositories, including 'gentle-density', 'air-pollution-and-premature-mortality', 'access-programs', 'yellowknife', 'bike-share-toronto', 'non-profit-real-estate', and 'venture-capital-canada'. Each repository card includes details like the language (Svelte, Jupyter Notebook, HTML, CSS), stars, forks, and last update time. On the right side of the page, there are sections for 'View as: Public', 'Discussions', 'People', and 'Top languages'.

# Thank you! :)

Email: [jeff.allen@utoronto.ca](mailto:jeff.allen@utoronto.ca)

School of Cities Website: [schoolofcities.ca](http://schoolofcities.ca)

Personal Website: [jamaps.github.io](https://jamaps.github.io)

Mastodon: [@jamaps@mapstodon.space](https://@jamaps@mapstodon.space)

Bluesky: [@jamaps.bsky.social](https://@jamaps.bsky.social)

LinkedIn: [/in/jeffallenmaps/](https://in/jeffallenmaps/)

GitHub: [@jamaps](https://github.com/jamaps)

