What is spatial epidemiology anyway?

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Today's Theme

What do we learn when we examine disease risk in space?

Agenda

- What is spatial epidemiology?

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- In-class exercise.

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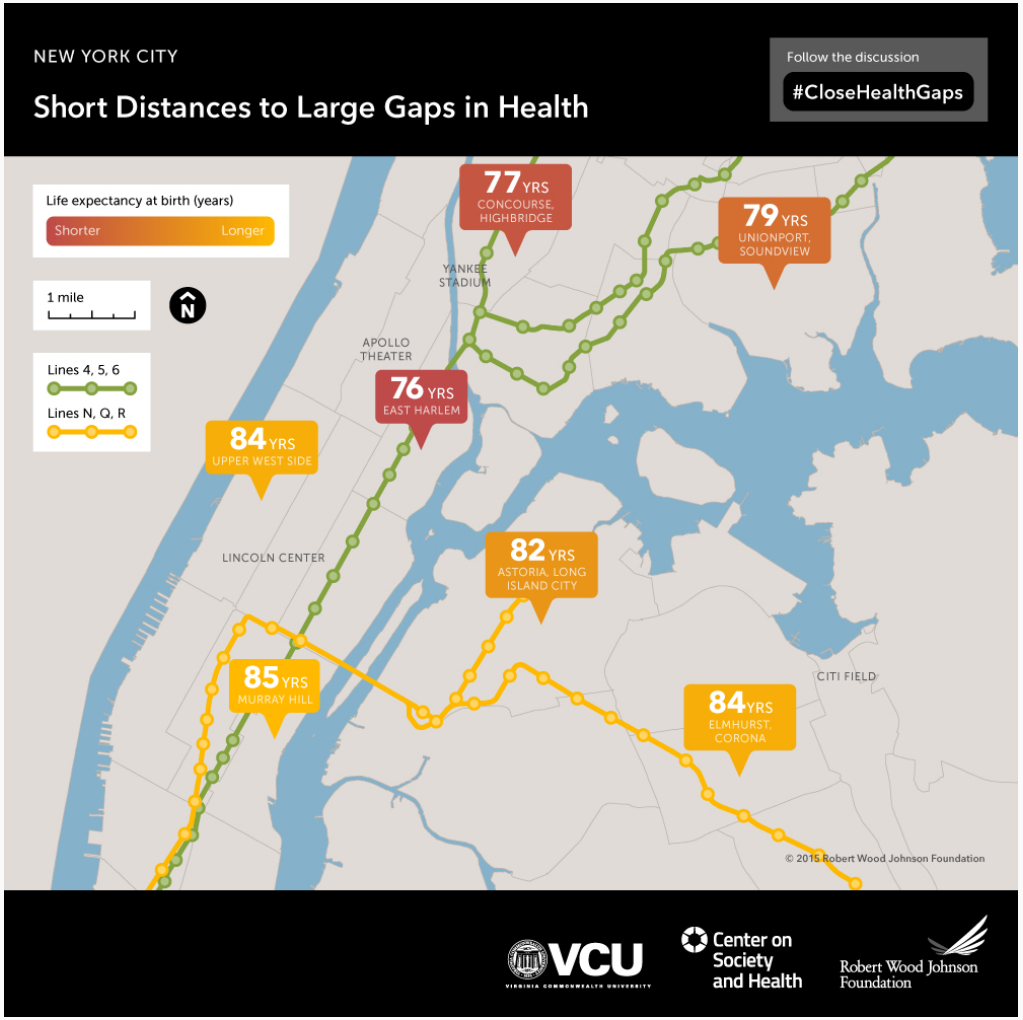
- What is spatial epidemiology?
- In-class exercise.
- Discuss and understand the relevant scales of spatial analysis.

Maps!

Maps can condense a tremendous amount of information into an image



In pairs: What does this image tell us? What doesn't it tell us?

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- Maps are critically important for understanding and interrogating spatial patterns of health and illness.

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- Maps give us clues to what might be going on or highlight problems we need to address.
- Spatial epidemiology is about understanding the ecological and individual factors contributing to the patterns we see represented on maps.

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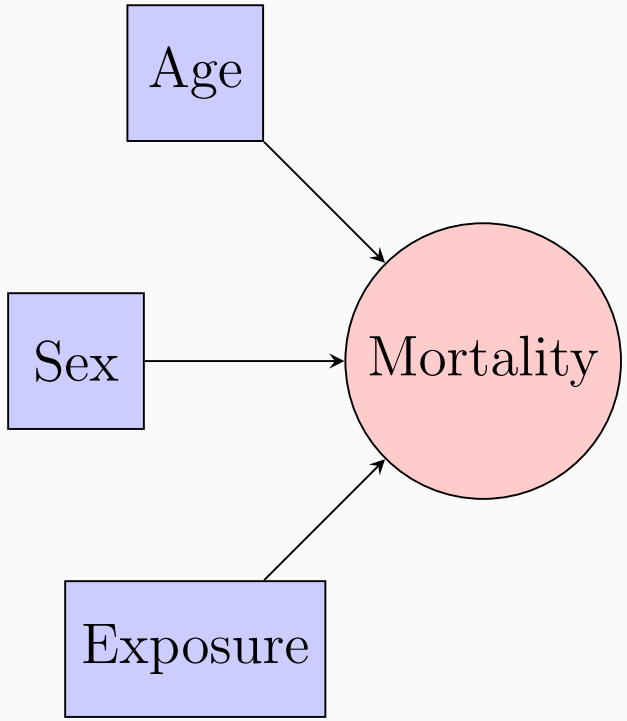
Point data:

- Individuals
- Households
- Environmental point sources, e.g. well/water source

Areal data:

- Neighborhoods/cities/states
- Legislative districts
- Health center catchment areas

An atomistic perspective

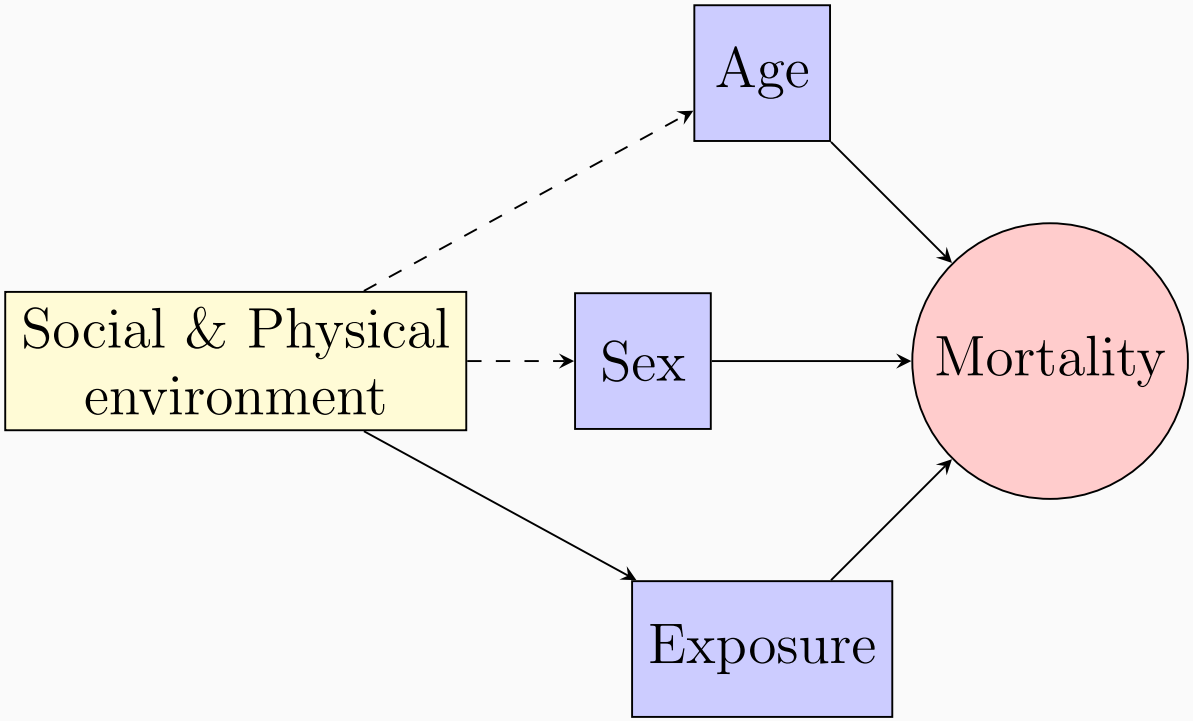


Solid lines = causal effects

Why should epidemiologists care about space?

What are some examples of diseases for which space is unimportant, i.e. where an atomistic perspective is sufficient?

Mapping immediately gives an ecological perspective



Dashed lines = effect modifiers, Solid lines = causal effects

Why *do* epidemiologists care about space?

Tobler's first law of geography:

> *"Everything is related to everything else, but near things are more related than distant things." (Tobler, 1970)*

What are some causes of spatial relatedness in epidemiological data?

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- Contagion, e.g. of infectious diseases
- Common environmental exposures
- Common social risks

The analytic tools of spatial epidemiology

- GIS/Maps

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- Theoretical simulation

A Worked Example

How good is your memory?

- I'll read a sequence of 9 numbers.
- We'll wait 15 seconds after I stop reading the numbers, and then write down as many as you can remember.

Count how many you got correct.

The numbers:

- 26, 29, 3, 25, 24, 5, 17, 15, 9

On your paper, write down how many you got correct next to “t=1”.

Let’s do it again!

Let’s do it again!

The numbers:

- 16, 24, 18, 8, 26, 29, 17, 1, 22

Count up how many you got correct this time around, and write it down next to “t=2”.

Share your responses

Use the form available here:

https://bit.ly/2G9Ng5X

Now let’s scale this up...

- Imagine you were using this to assess variation across neighborhoods in this outcome.

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- What might cause neighborhood-level variation in performance on this kind of task?

Close vs. Far

What is near and what is far?

Nearness is really a matter of scale and depends on what the frame for our question is

- Individuals living in the same neighborhood are *nearer* within cities than those who live in different neighborhoods.

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- Adjacent counties may be the relevant level of *nearness* when we're thinking at the state level.

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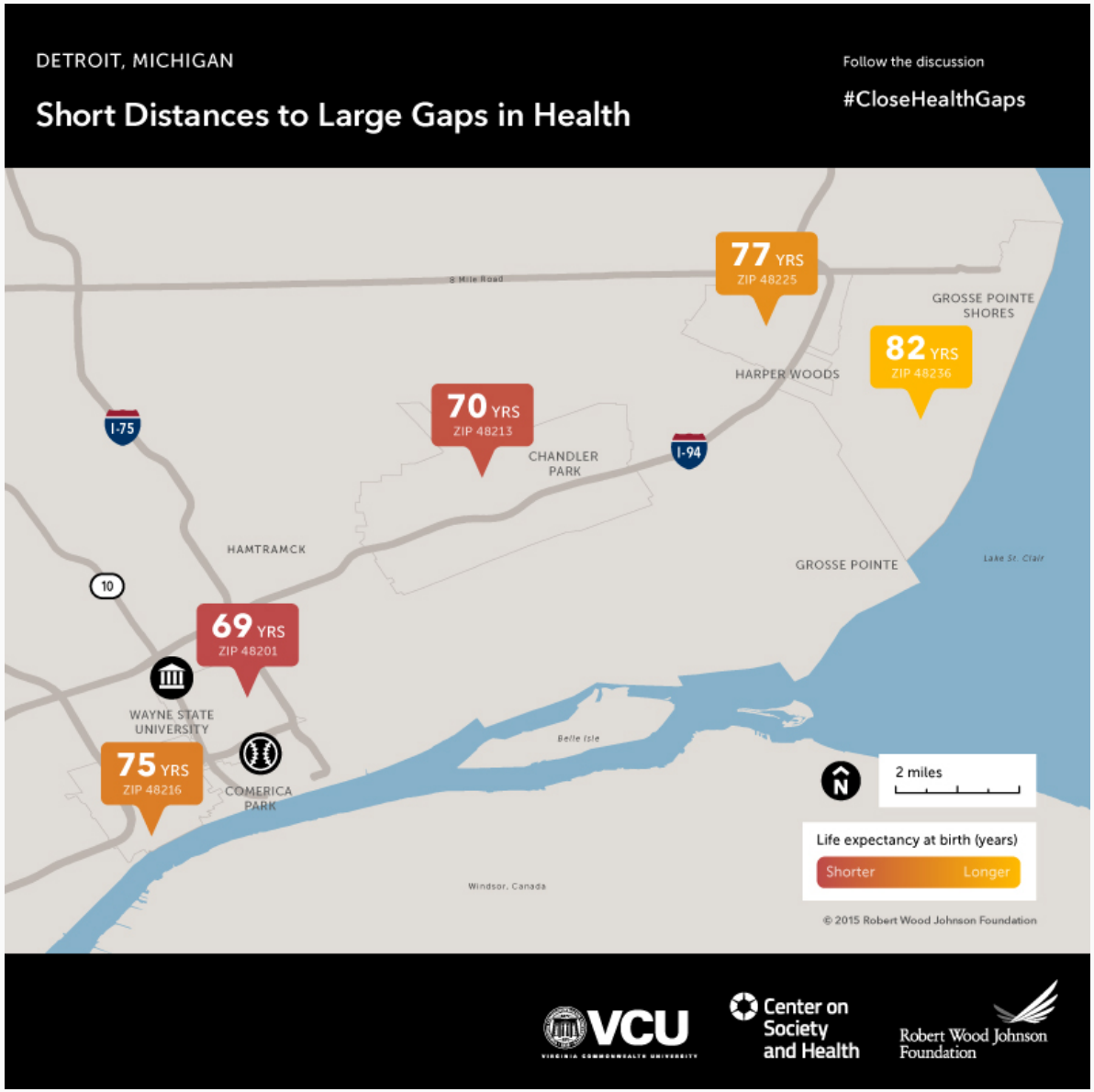
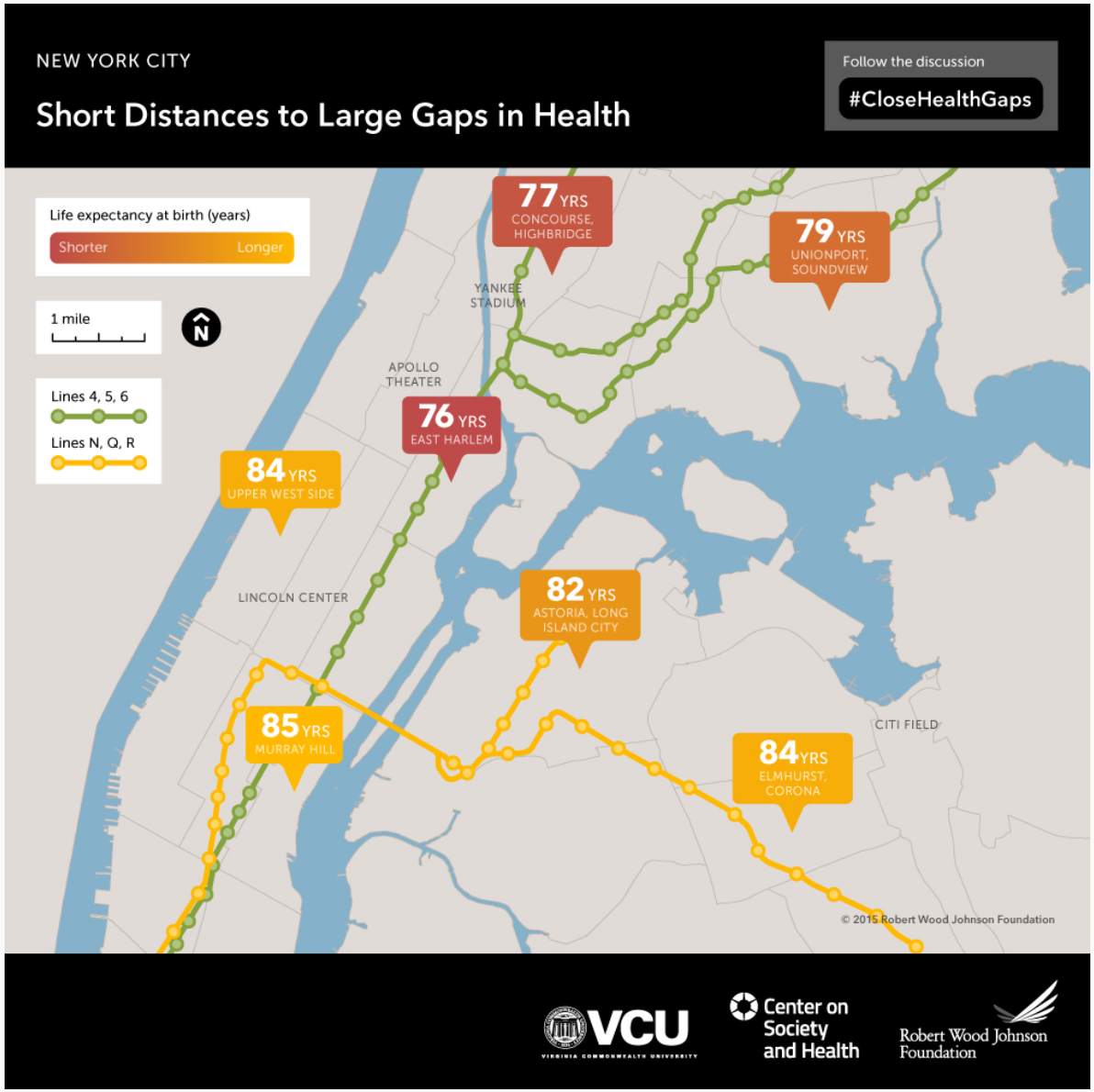
- Individuals living in the same neighborhood are *nearer* within cities than those who live in different neighborhoods.
- Adjacent counties may be the relevant level of *nearness* when we're thinking at the state level.
- Nearness may be a function of accessibility rather than just pairwise distance.

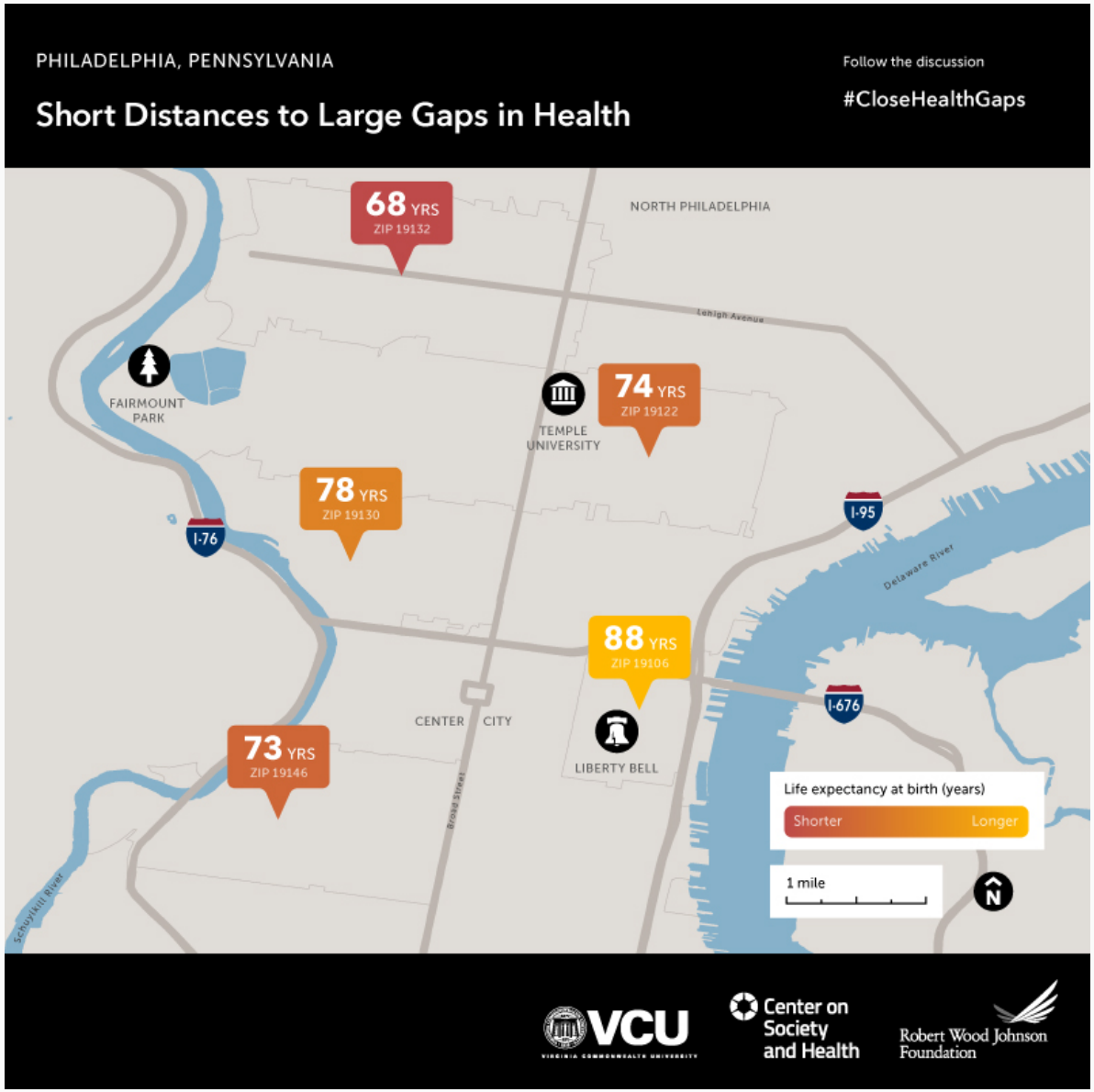
Big change can happen over short distances



Health Gaps in New York City



Health Gaps in Philadelphia

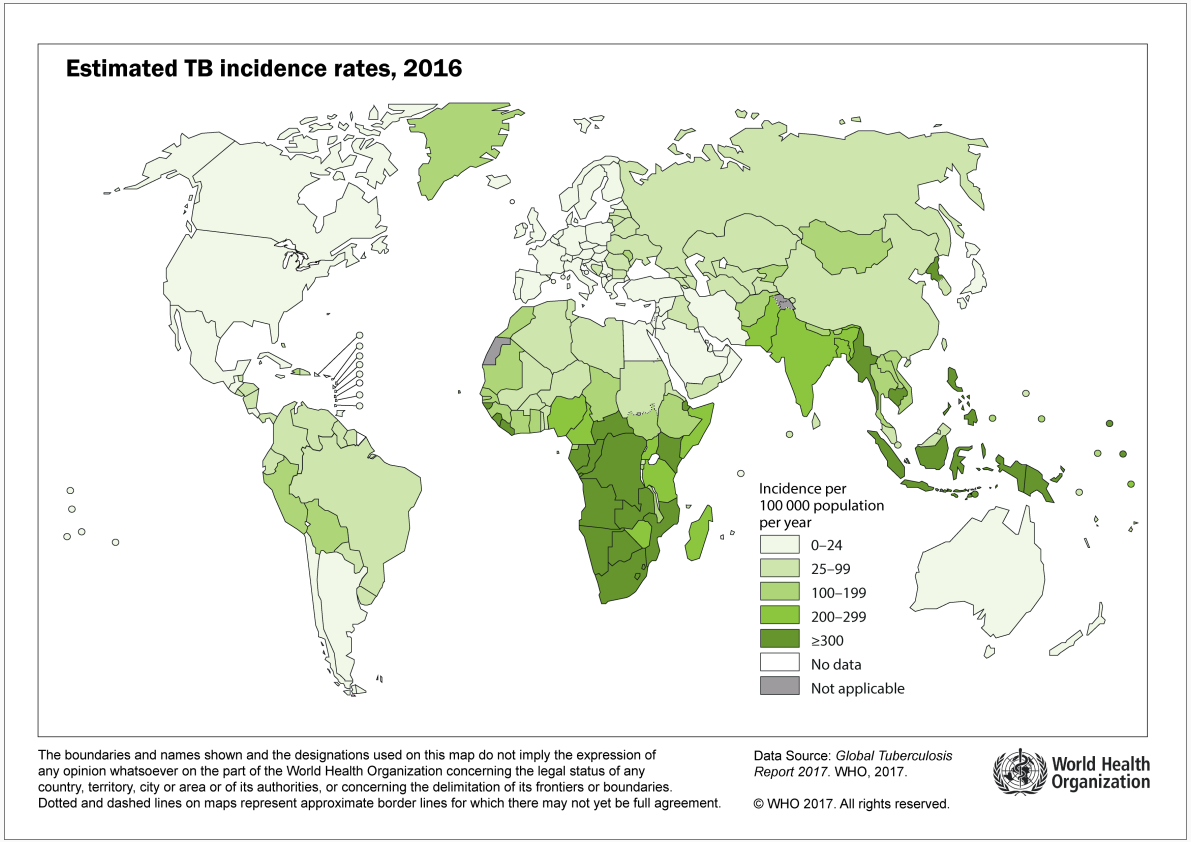


What are places and how do they impact health?

Places are subsets of space with shared attributes

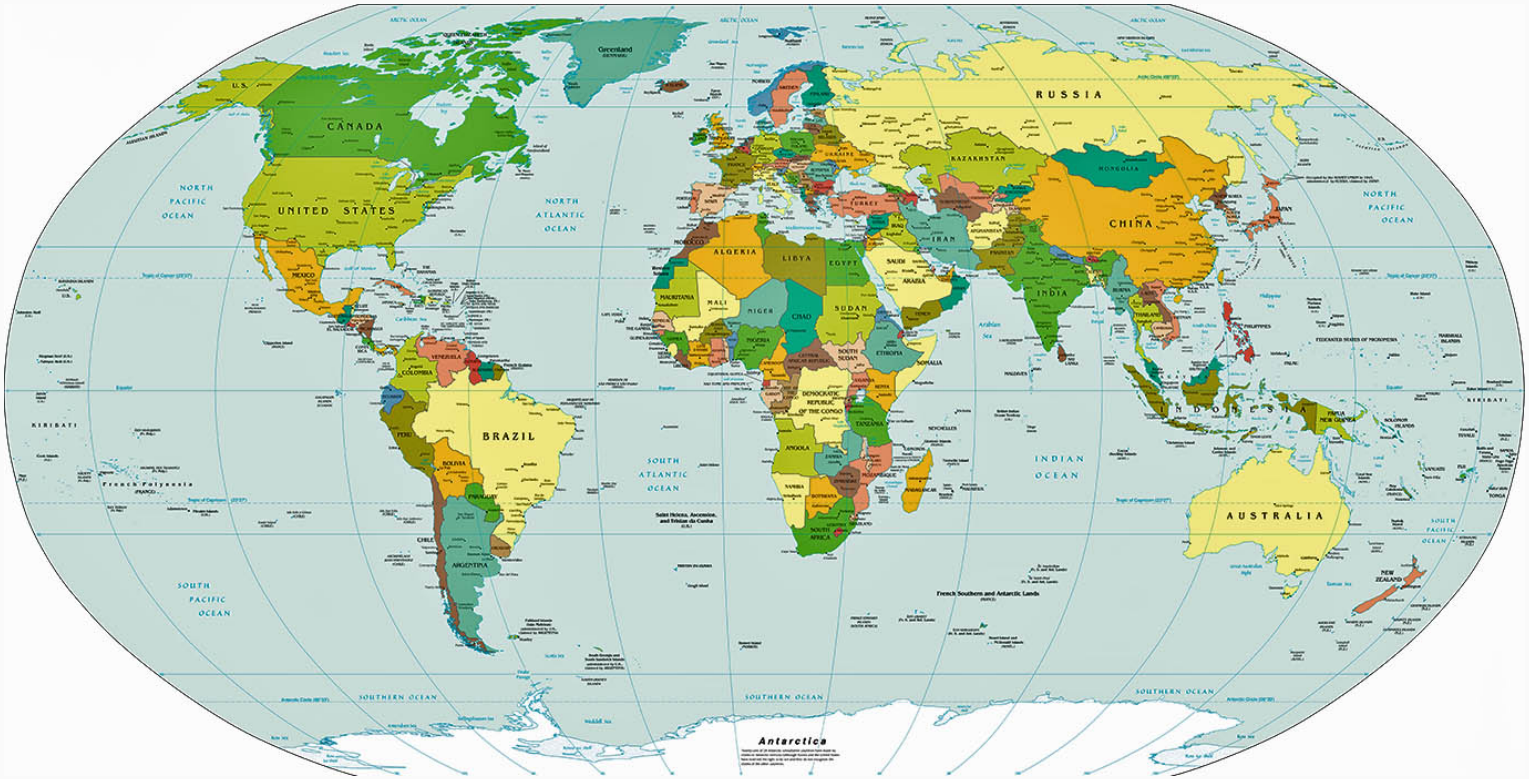
- Households
- Neighborhoods
- Cities
- States
- Countries

Place-level variation is often represented by a choropleth map



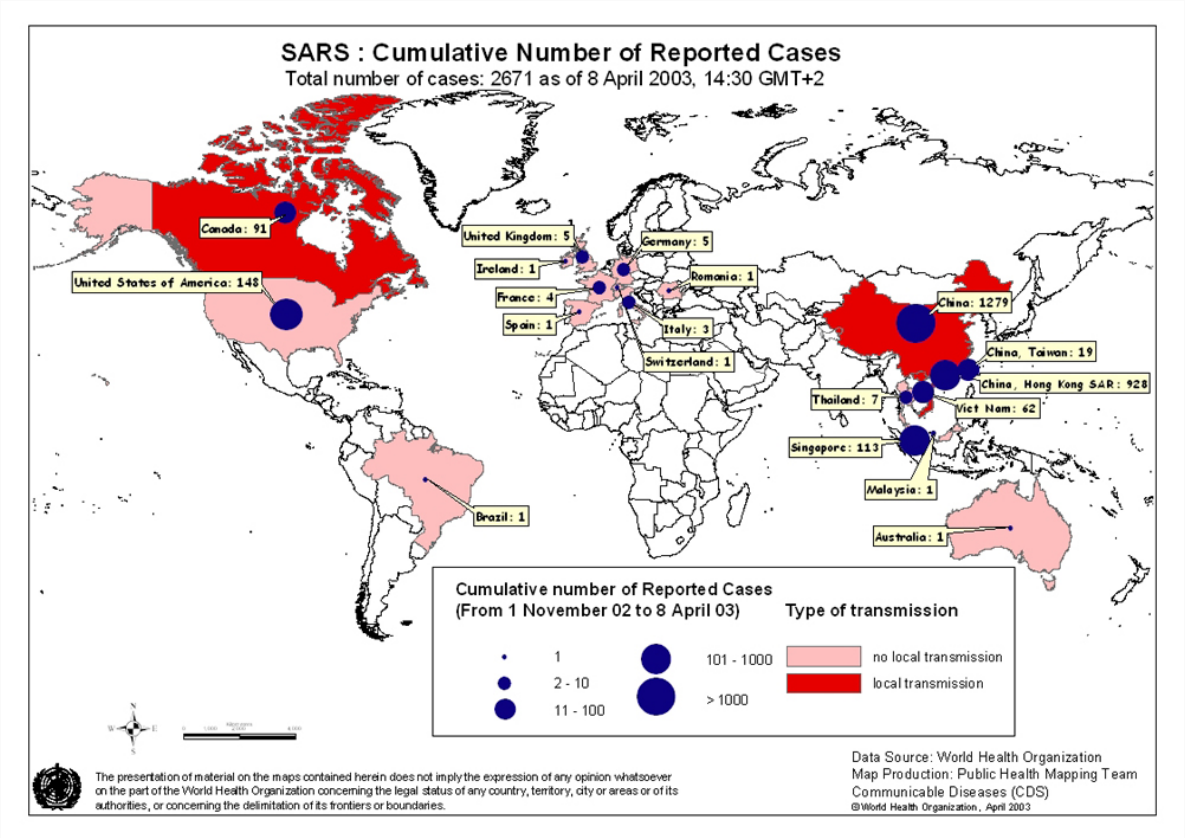
In a choropleth areas are shaded or colored based on their value on some outcome metric, in this case annual TB cases per 100K population in 2016. (From WHO 2017 Global TB Report)

Levels of analysis: Global



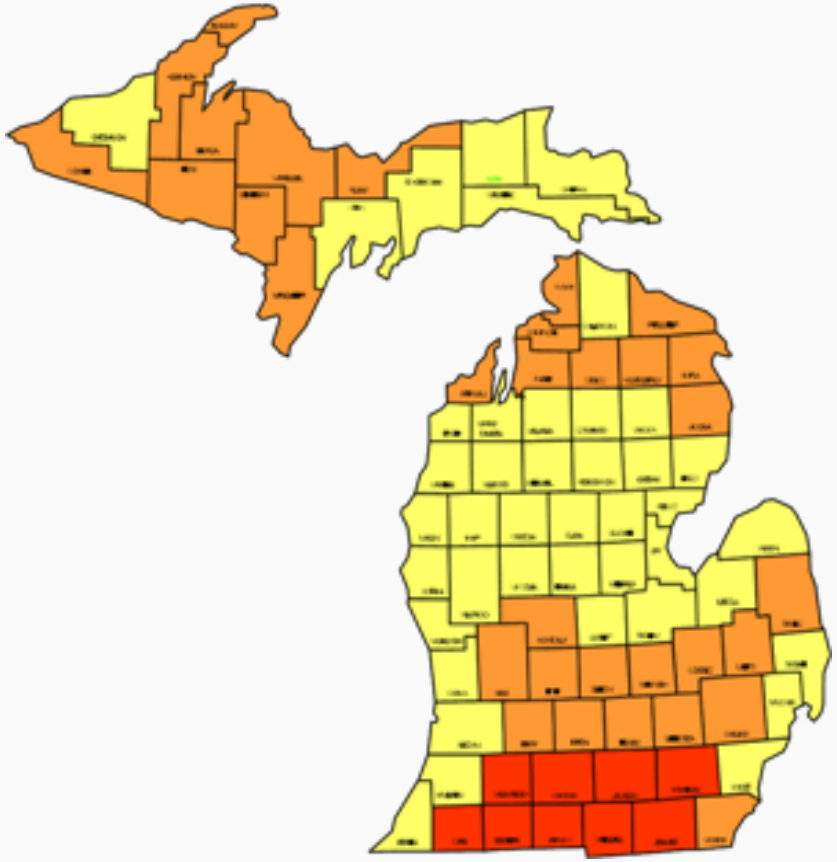
What might we want to understand at the national level?

Rapidly-spreading pandemic amenable to *global* representation



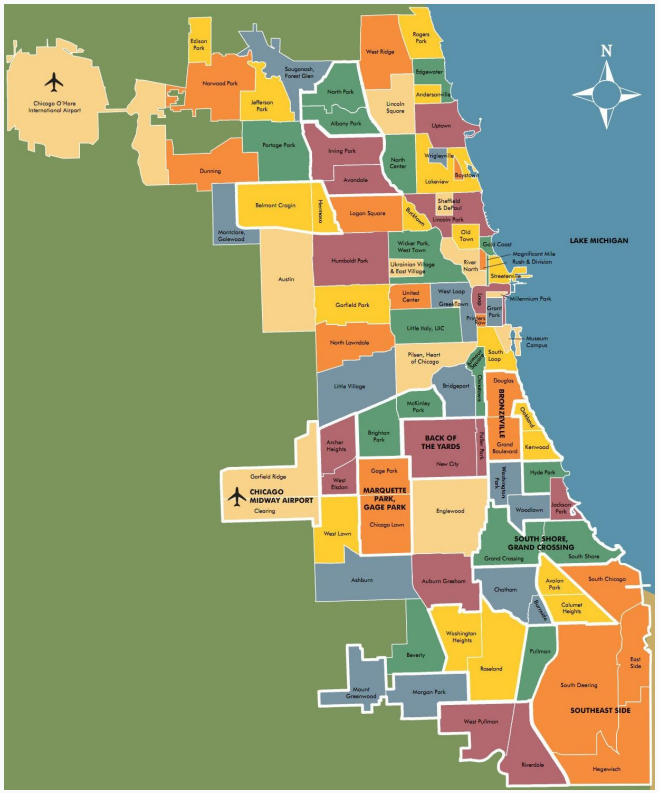
Global spread of SARS during 2003 pandemic.

Environmental risk stemming from variation in uranium deposits amenable to county-level representation



Variation in radon exposure at the county level in Michigan.

Impact of socioeconomic factors within cities may necessitate small-scale, neighborhood level perspective

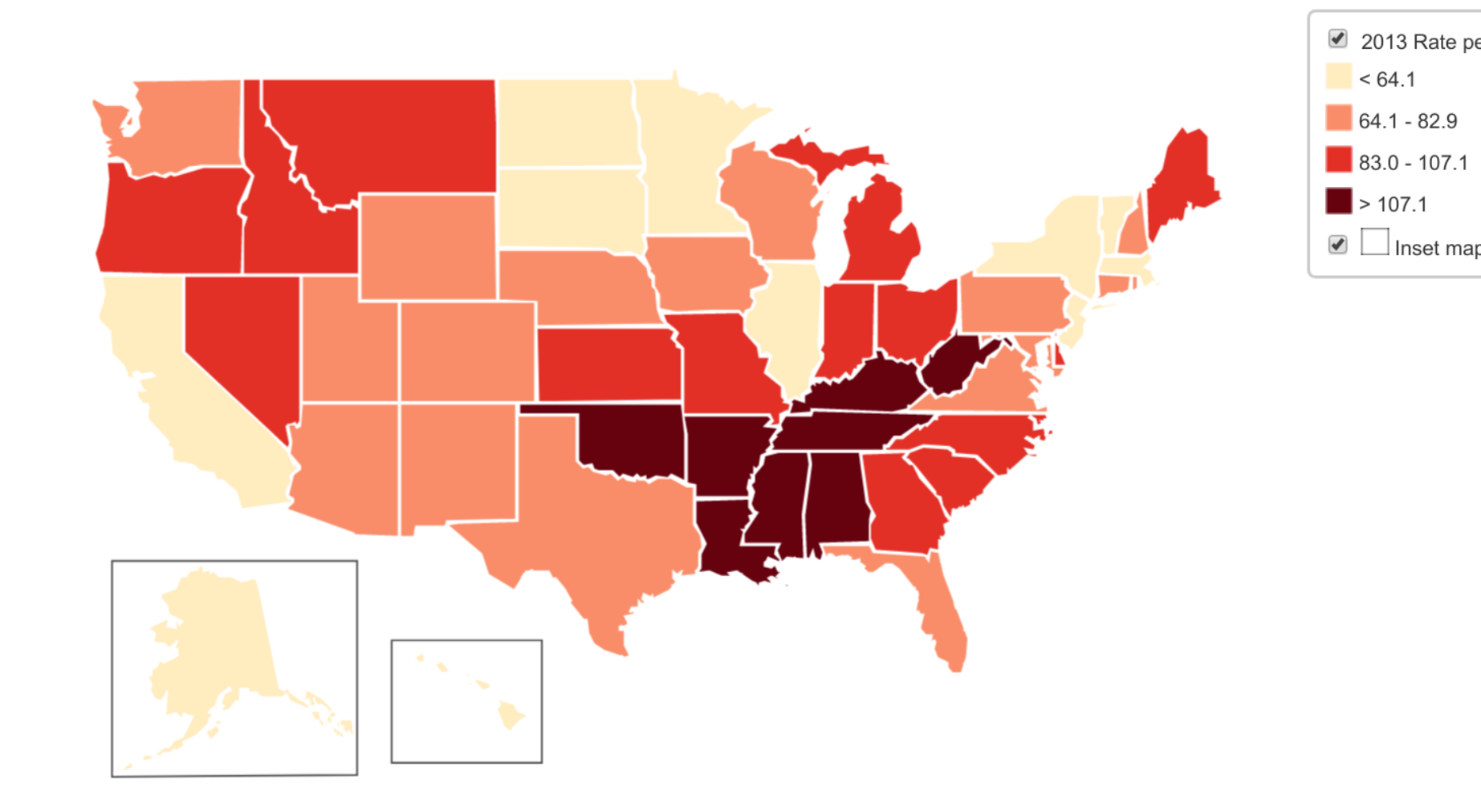


Neighborhood boundaries often reflect wide variation in SES and potentially environmental exposures.

Infectious disease outbreaks may necessitate a micro-level perspective

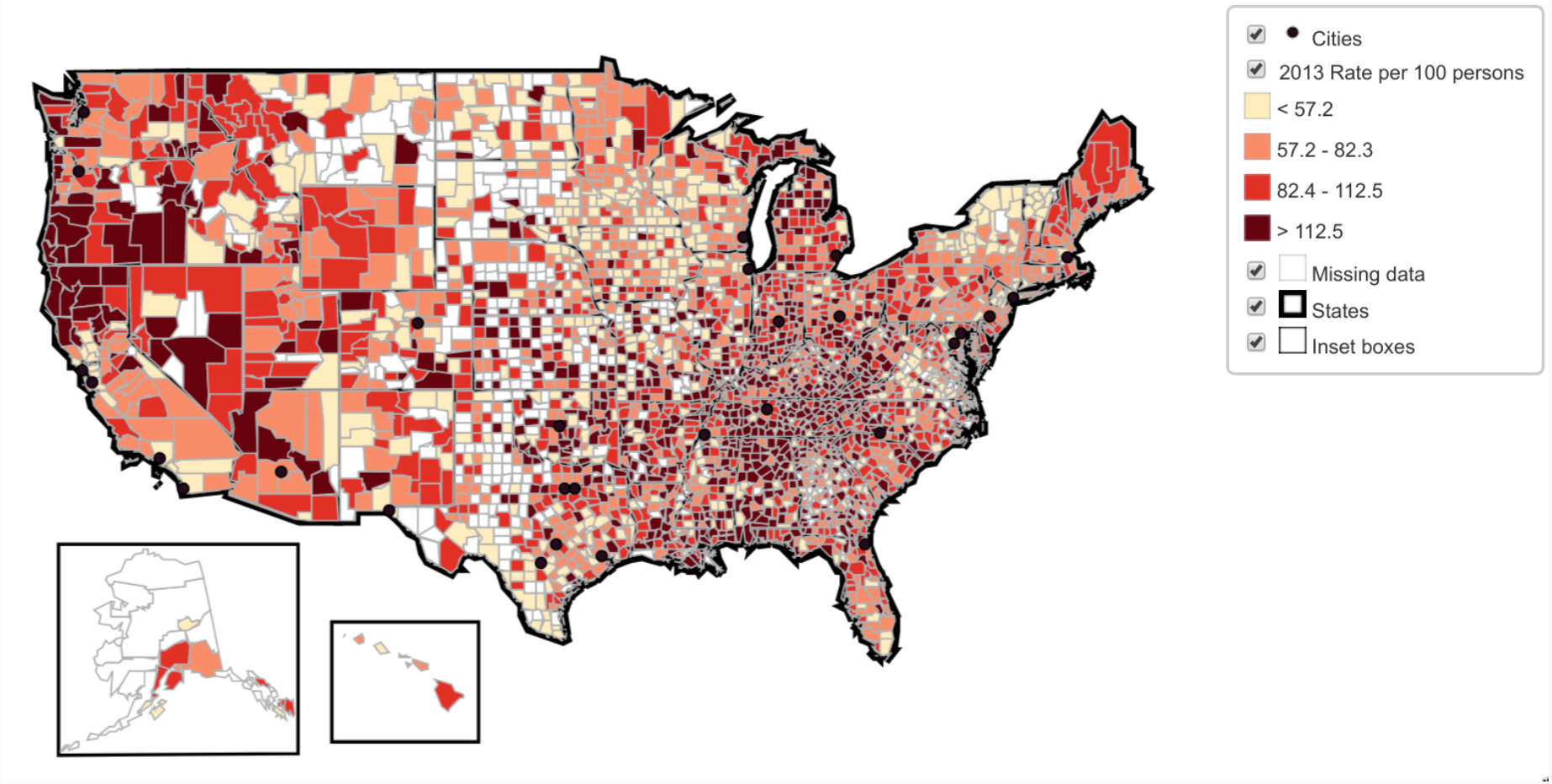
John Snow's map of mortality from the 1854 Broad Street Cholera outbreak

Picking the right scale for analysis can be tricky



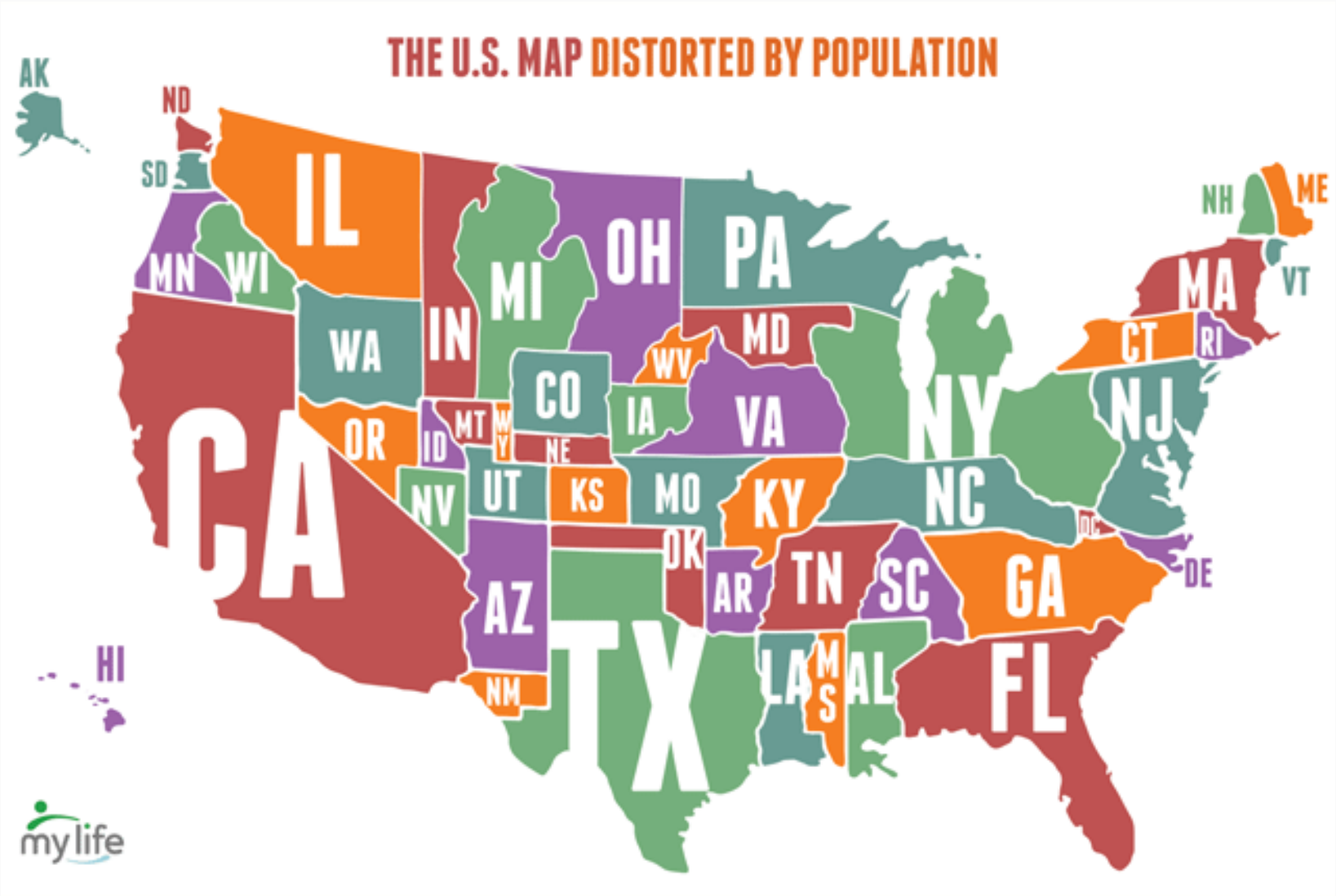
State-level opioid prescription rates, 2013 (Source: CDC)

Higher levels of aggregation can conceal important lower-level variation



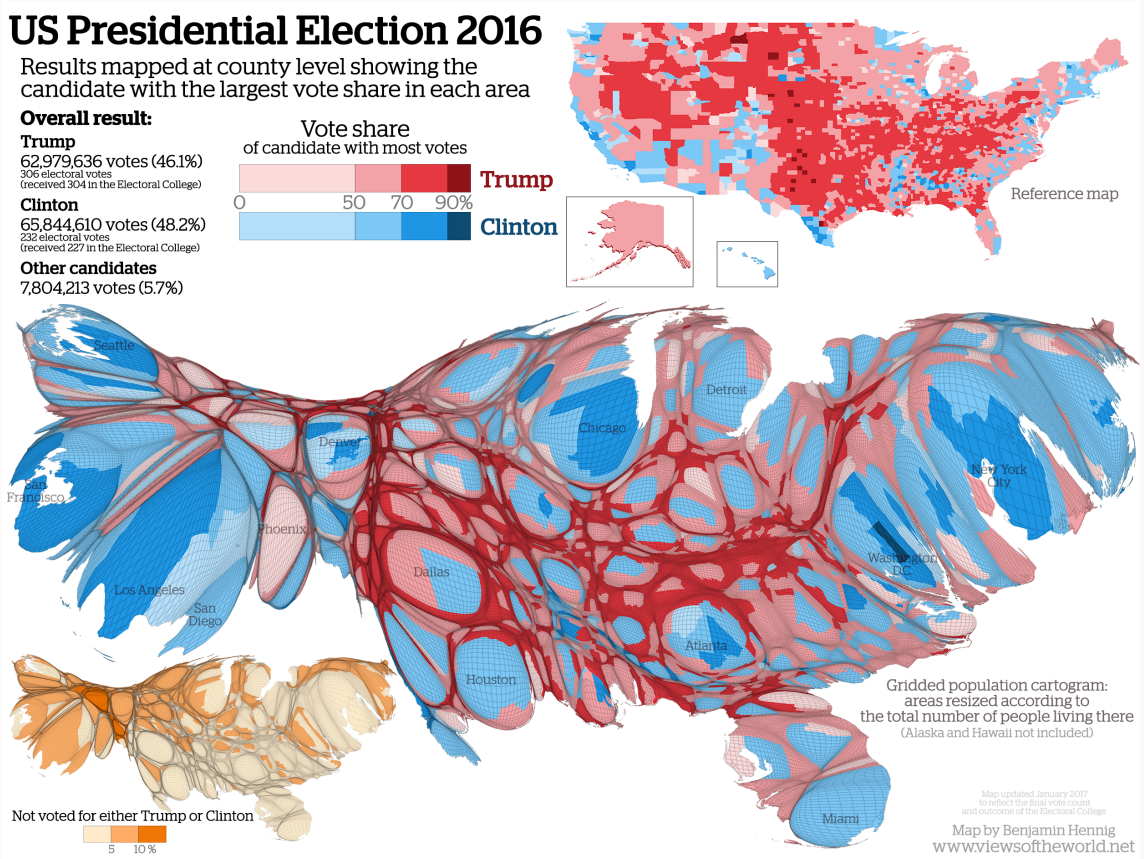
County-level opioid prescription rates, 2013 (Source: CDC)

Classic choropleths can be deceptive



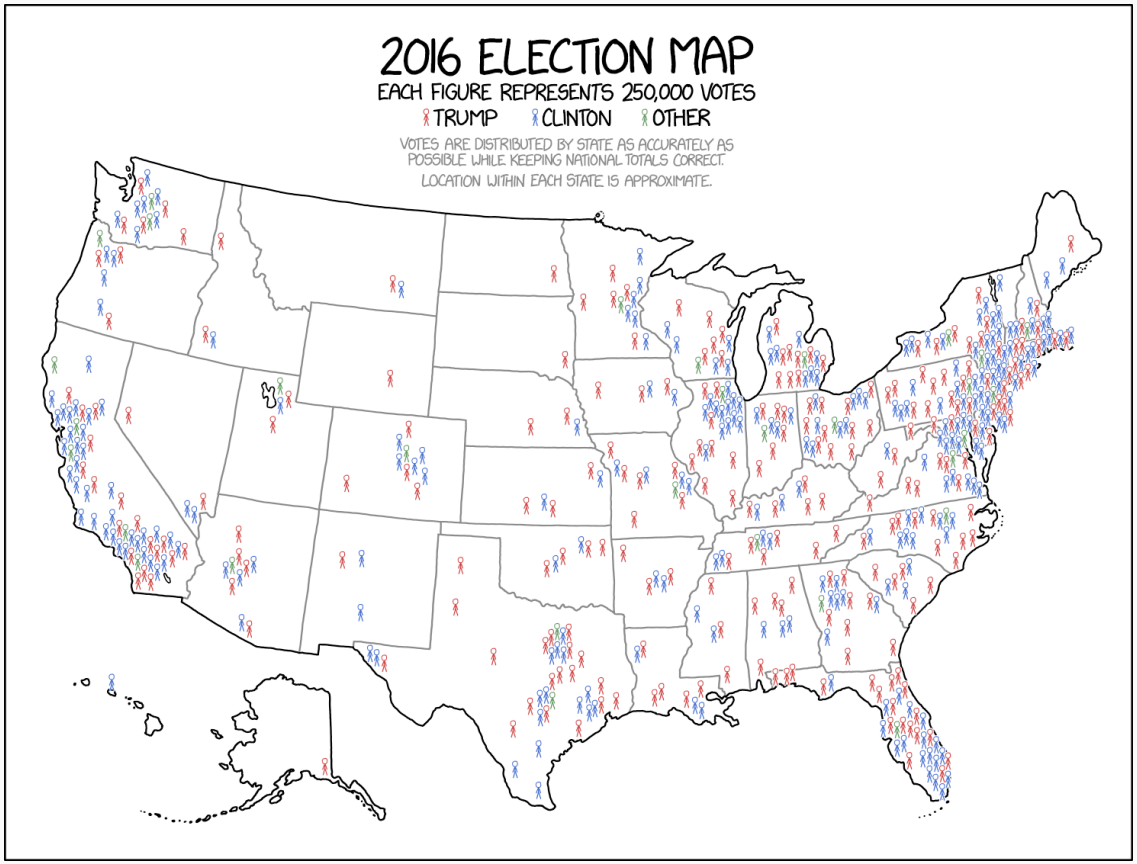
cartogram in which state size is proportional to population.

Higher resolution can be instructive, but obscures geographic features



Choropleth of 2016 election results in which county size is proportional to population.

Sometimes less is more?



XKCD 1939

References

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