What are Grids?

A discussion on grids and gridded census data.

Washington and Oregon SDCs Meeting October 3rd, 2023

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Gridded Census Datasets

- Researching a new data product.

- Initial development stage.

- Gathering data user input.
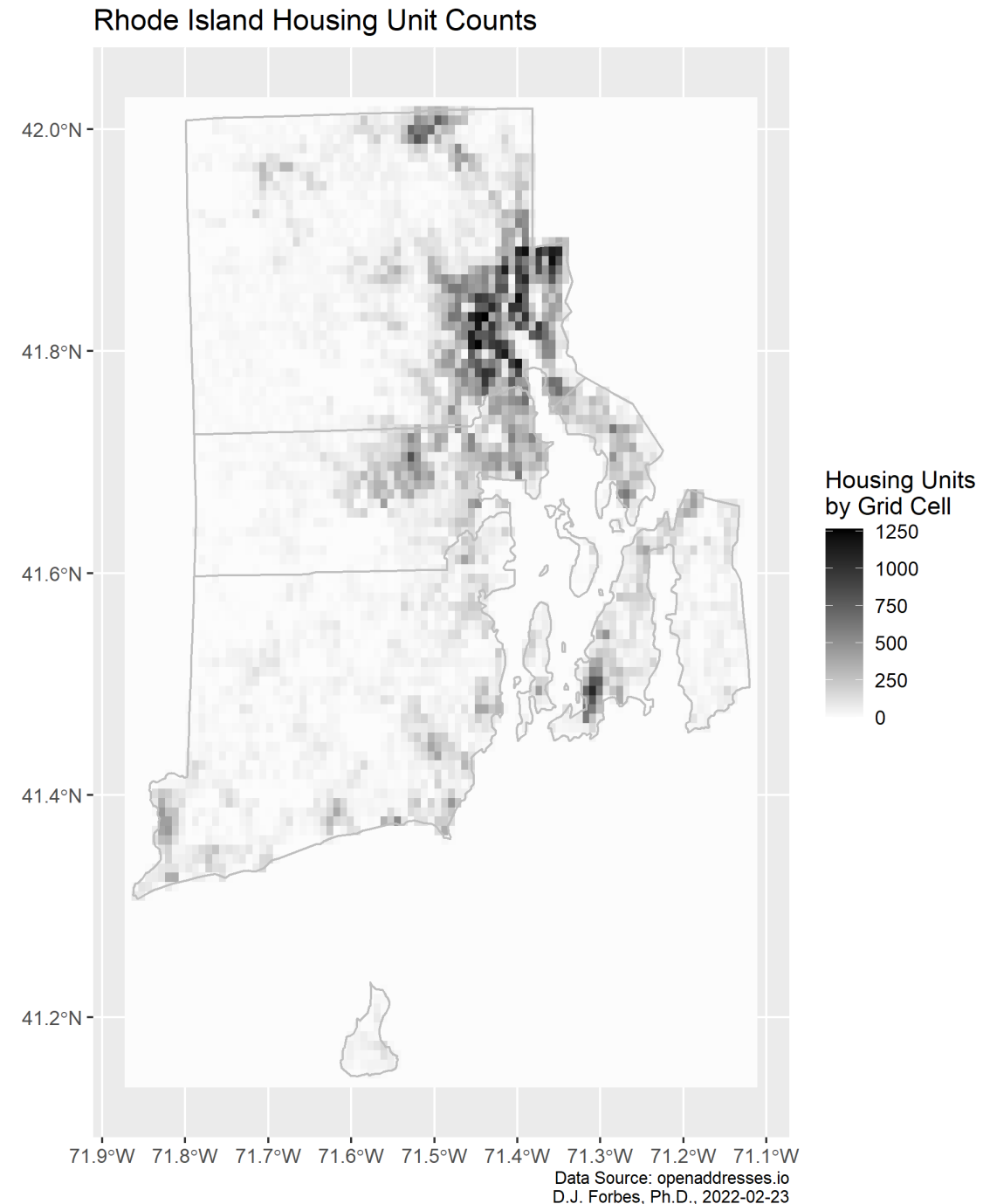
Project Overview

Purpose:

- Expand our available product portfolio to **meet changing demands**.

- More accessible, interoperable, and relevant data.

- Producing **new and innovative** Census data products.

- Fulfillment of mission needs and **meeting stakeholder requests**.

- **Creating quality products** to ensure we meet today's data demands.

- Providing tools to **support informed, timely decisions**.

Expectations:

- Gridded data products will be **in addition to** current administrative/statistical units.

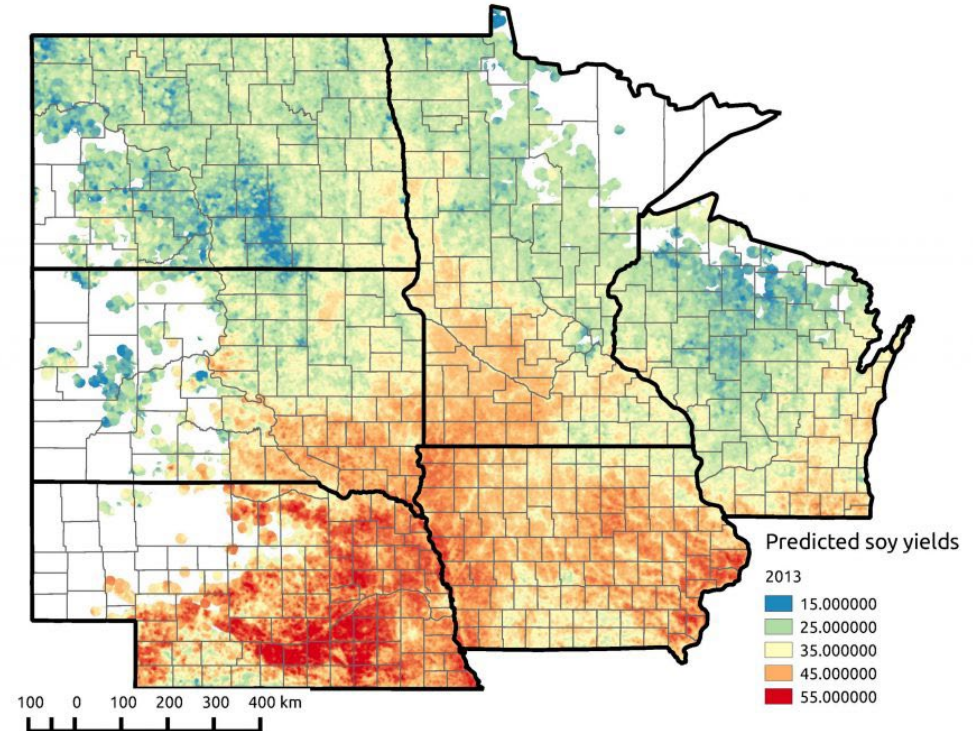- We will produce gridded data products as a **standard annual public delivery**.

What are grids?

- Grids are characterized by a **pattern of regular repeated shapes** that fit together without gaps or overlaps.

- Can be any shape that **does not create gaps or overlaps**, such as squares, rectangles, triangles, quadrilaterals, or hexagons.

- **GEO has received inquiries** from external partners for Census data provided in a gridded format.

- **Grids have several advantages** in comparison to administrative units.

Rhode Island Housing Unit Counts

Housing Units by Grid Cell

1250
1000
750
500
250
0

Data Source: openaddresses.io
D.J. Forbes, Ph.D., 2022-02-23

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What are gridded data?

- Gridding data is to assign data values to grid cells.

- Grids are always aggregates because they use single values to describe (represent) a two-dimensional area of the Earth's surface.

- Examples:
  - Counts (number of housing units)
  - Sums (economic output in dollars, expected crop yield)
  - Averages (temperature, rainfall, property value)
  - Other (Ranks, presence/absence, etc)

Predicted soy yields
2013
- 15.000000
- 25.000000
- 35.000000
- 45.000000
- 55.000000

100 0 100 200 300 400 km

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Grids Advantages

- **Uniform area** (densities).
  - Uniform area supports comparative analysis.

- **Consistent** and unchanging.
  - Supports change detection and time series analyses.

- **Easily integrated** with other gridded data.
  - Provide better support for disaster response.

- Provide an alternative to (but **do not replace**) administrative/statistical boundaries.

- May assist in **small area analysis** and estimation.
  - Regions of interest are more easily defined and remain consistent.

- Potential to serve as **consistent work units** for internal data processing or sampling.

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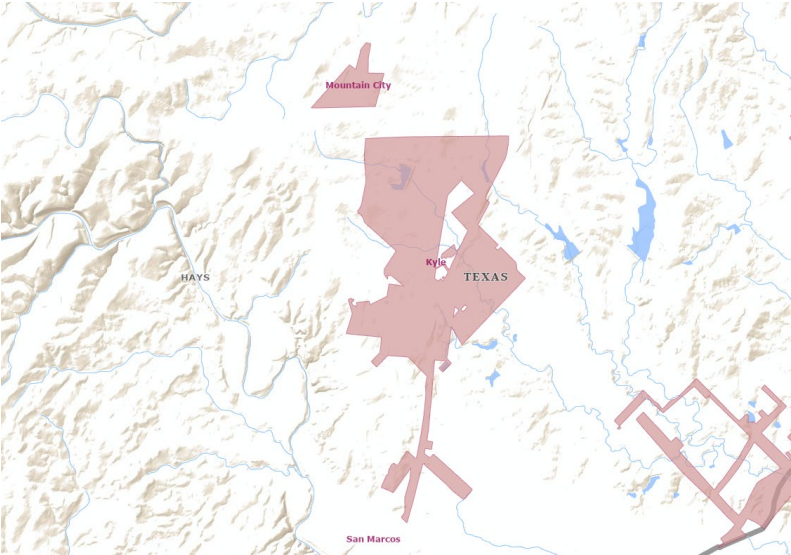
Where is "**Here**"? Part 1

- Sometimes this question can be meaningfully answered with a word linked to an administrative or statistical boundary (e.g. "here in Maryland", "here in Philadelphia", "here in Census tract 7").

- But sometimes those units aren't appropriate because:
  - boundaries may have <u>changed</u> (illusory stability—in fact <u>change</u> is the norm for administrative units);
  - <u>comparisons</u> are difficult or hard to intuitively grasp owing to units radically different physical areas;
 - these units do not actually encapsulate the spatial extent of many important <u>events and phenomena</u>.

Boundary Changes

Historical population		
Census	**Pop.**	**%±**
1890	779	—
1910	742	—
1920	744	0.3%
1930	606	−18.5%
1940	874	44.2%
1950	888	1.6%
1960	1,023	15.2%
1970	1,629	59.2%
1980	2,093	28.5%
1990	2,225	6.3%
2000	5,314	138.8%
2010	28,016	427.2%
2020	45,697	63.1%
2022 (est.)	57,470	25.8%

U.S. Decennial Census[16][failed verification] 2020[3]

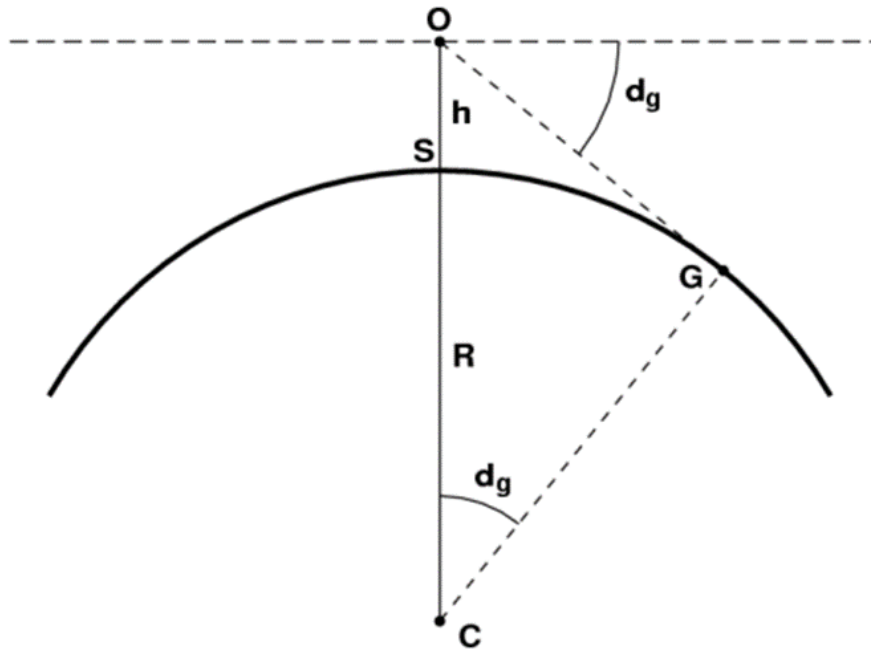
"Kyle, TX": 2010
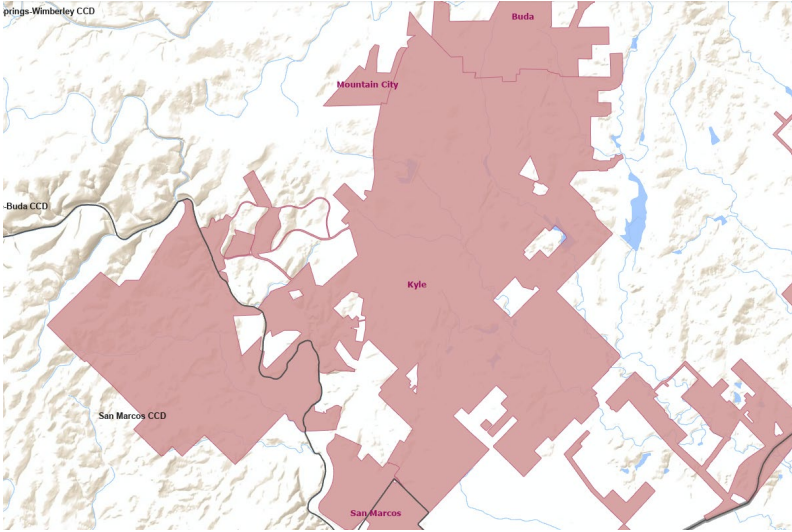
"Kyle, TX": 2020
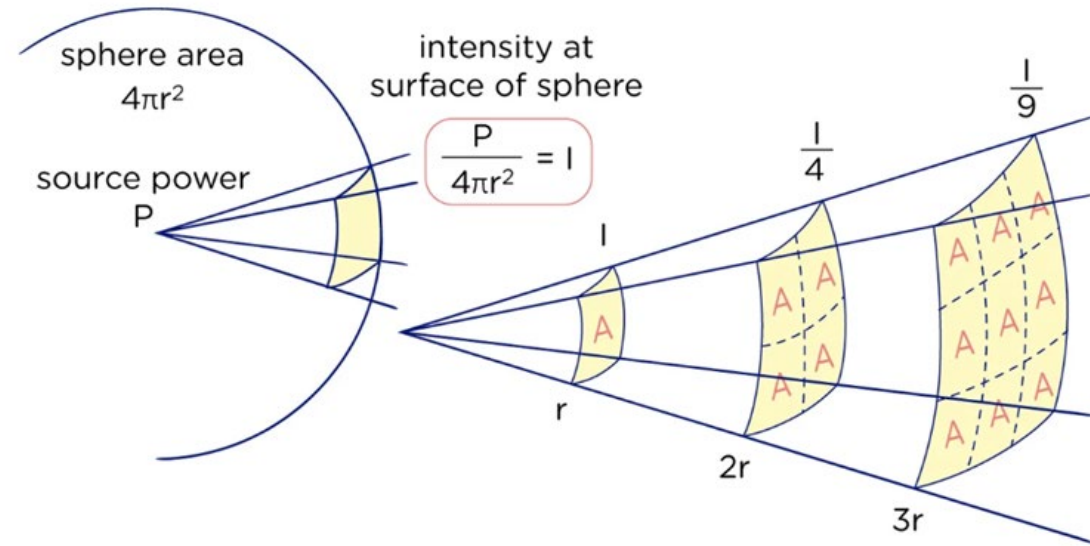
Where is "**Here**"? Part 2

- Sometimes this question can meaningfully be answered by referring to a coordinate or location.

- But sometimes coordinates are not appropriate or workable because:
  - Continuous nature of coordinate data can make for expensive computation.
  - Integration of different datasets in this format can be difficult.
  - Coordinates are in essence an <u>analog</u> format.
  - It is much easier to find patterns and meaning (defining "here") at the human scale by treating events as impacting small areas such as grid cells.

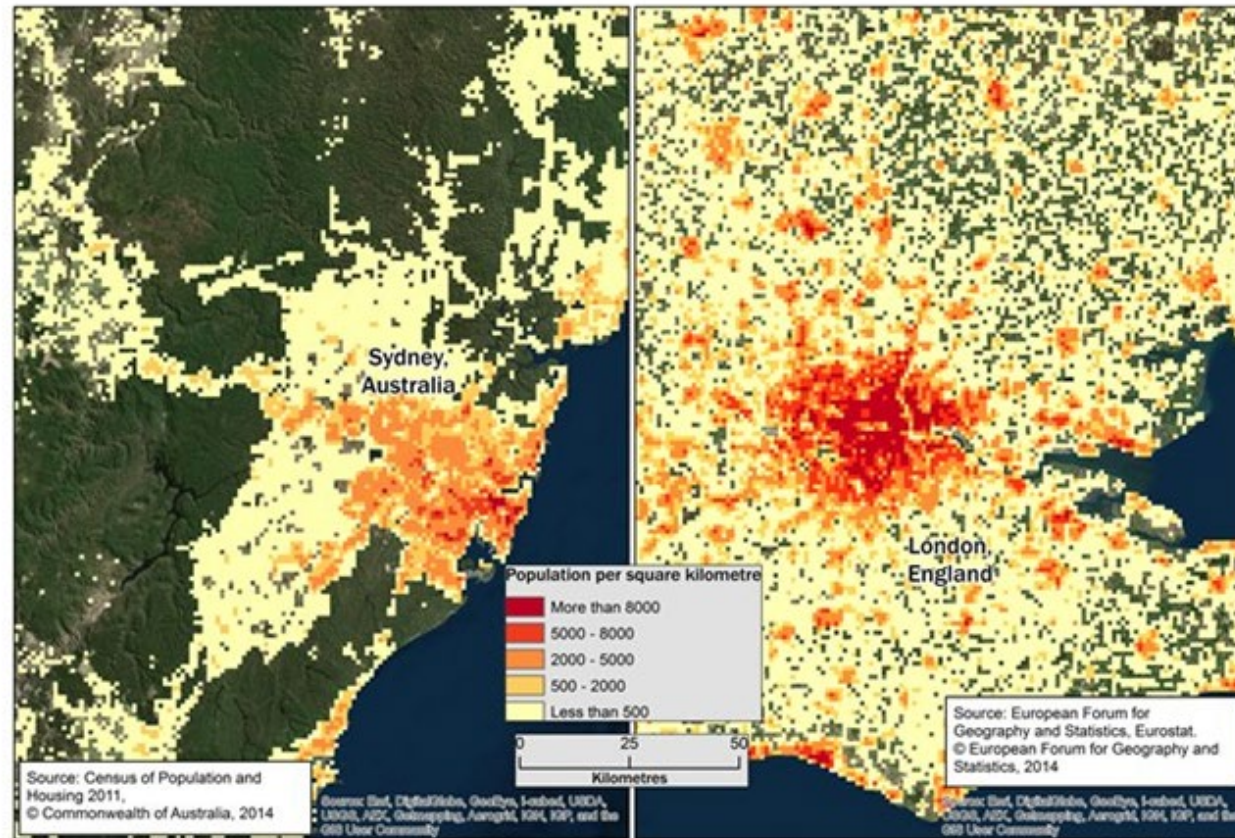# Size: 200m-5km Grids are Human Scale
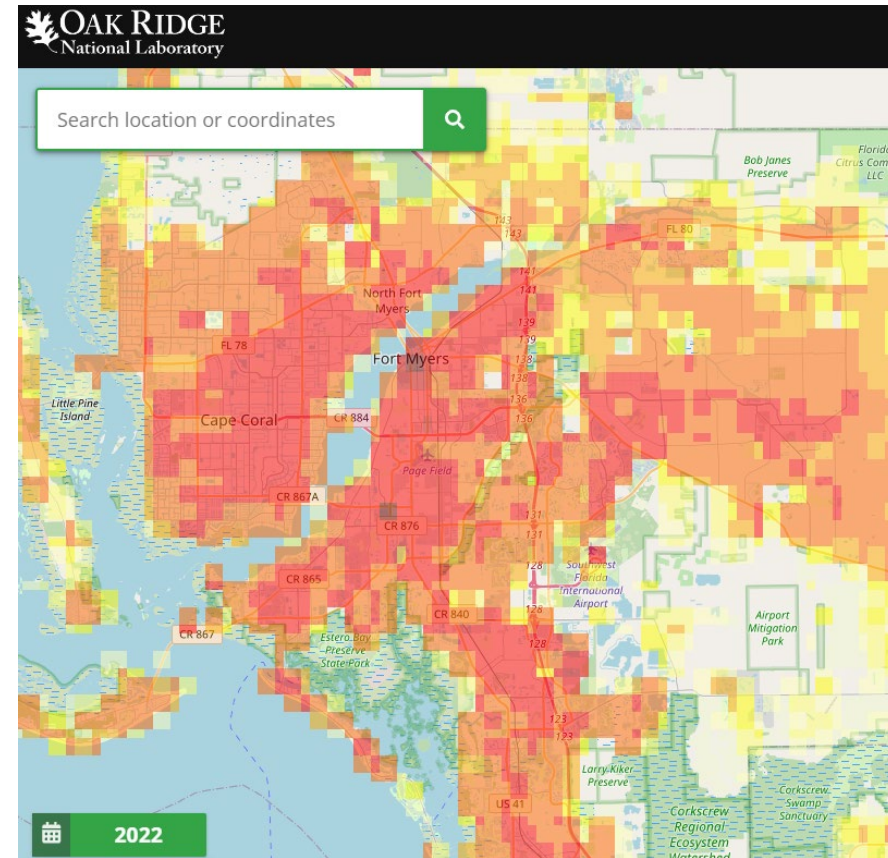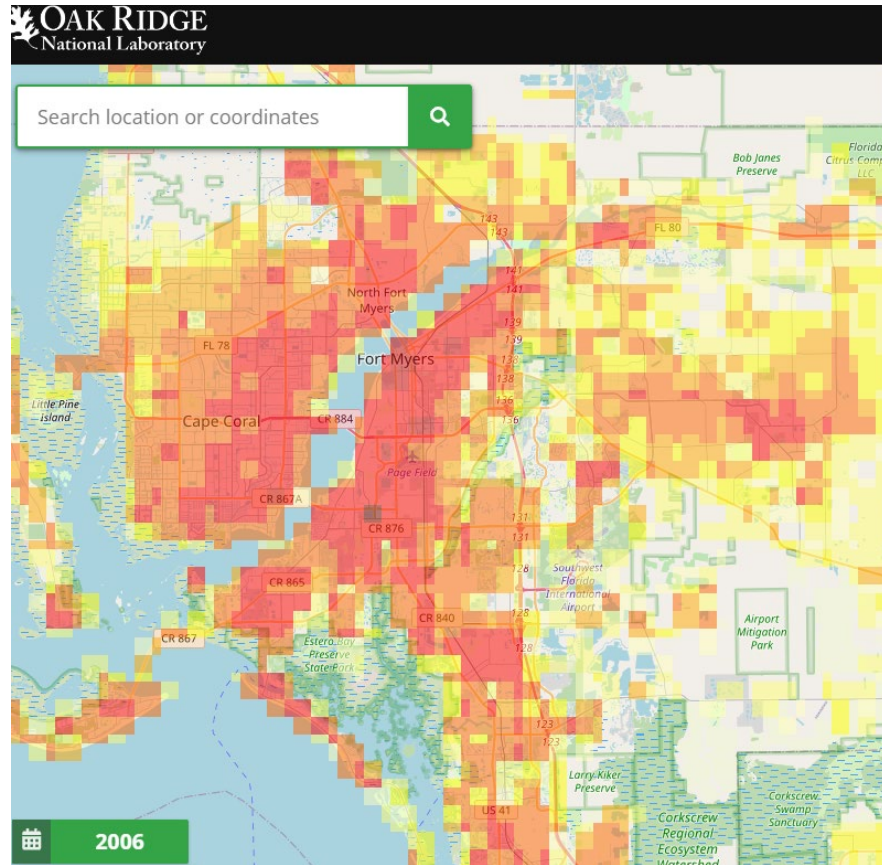

Intensity Decreases Exponentially

sphere area
$4\pi r^2$

source power
P

intensity at
surface of sphere

$$\frac{P}{4\pi r^2} = I$$

$\frac{I}{4}$

$\frac{I}{9}$

I

r

$2r$

$3r$

Jack Westin

International Comparisons

Figure 5. Population Density 1km² Grid 2011 - Sydney and London

Comparisons Over Time

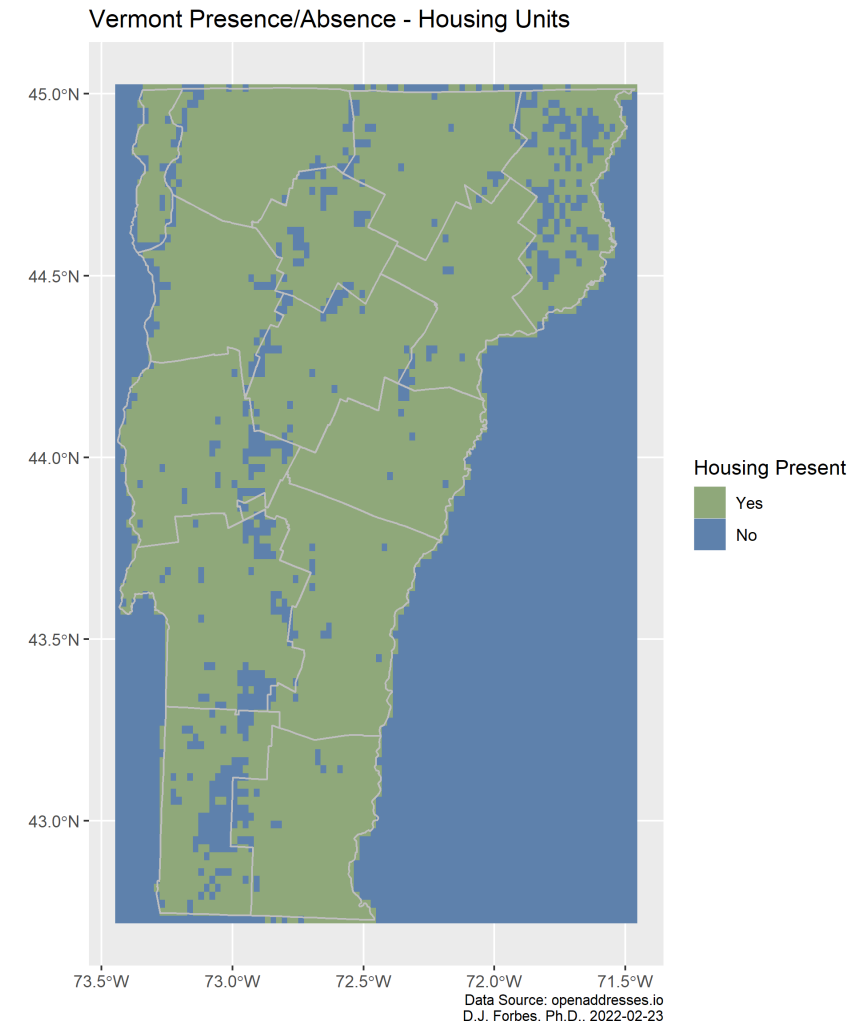# Representing Null or Zero Values

Nobody Lives Here

Kaore tetahi e noho ana i konei

Parts of New Zealand with no inhabitants living per one square kilometre

(78.21% of New Zealand's total area)

THE MAP KIWI

Map by Andrew Douglas-Clifford

andrewdc.co.nz

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Current Work

- Engaging with the statistical community.
  - Disclosure avoidance planning.
  - Statistical content discussions.
- Integrating grids into existing production processes.
- Developing testing and quality control procedures.
  - Identify best practices for process and product metrics.
- Planning for storage and serving grids to the public.
  - Formats (geopackage, shps, raster vs. vector, etc.)
    - Have yet to prototype/test raster formats in MTDB.
  - Tiling.
  - How many versions of grids do we support?
- Staffing and resource planning.
  - How many staff are required for these activities?

Vermont Presence/Absence - Housing Units

Housing Present
- Yes
- No

Data Source: openaddresses.io
D.J. Forbes, Ph.D., 2022-02-23

Key Questions for our data partners!

- How should we communicate with YOU, our data users to solicit input?

- We want your feedback on data use-cases and requirements:
  - Statistical data (contents) -
    - What census and survey data should be disseminated?
    - Decennial Census Data? American Community Survey data? Economic data?
    - Minimal vs. maximal datasets –
      - What's does the "minimum viable dataset" look like for your needs?
    - Integration of other datasets – what would you "mashup" with census data?
  - Geospatial formats and preferences (container) -
    - Raster vs Vector.
    - Shape and Size(s) of Grid Cells.
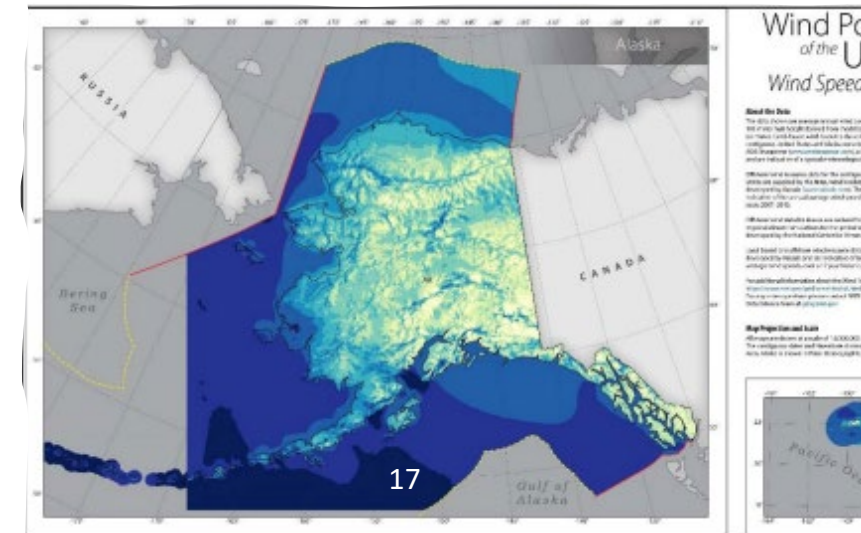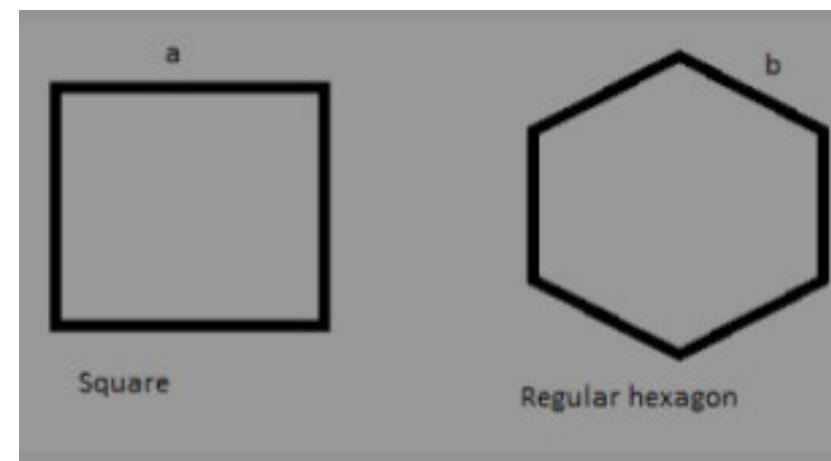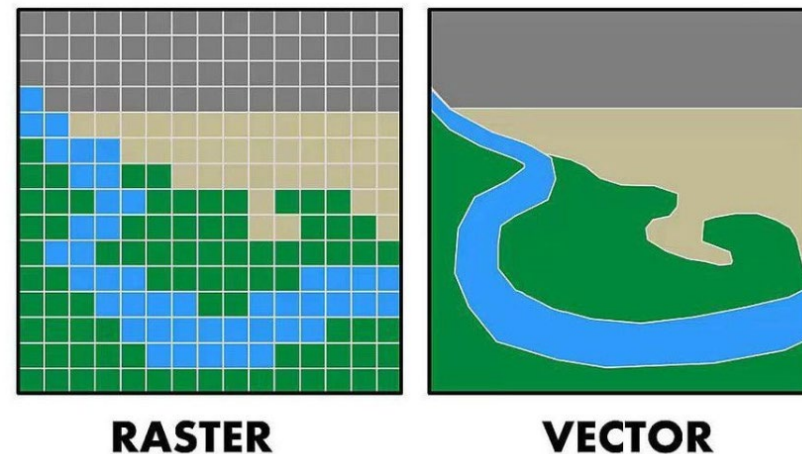   - Equal area vs equal dimensions.

Discussion

Current grids

- Do agencies in your state use gridded data?
- If yes, what kind of gridded data?
  - Earth Observation/Remotely Sensed/Satellite Imagery
  - Elevation data
  - Land Use/Land Cover data
  - Transportation/Traffic
  - Population/Housing/Demographics

Grids – geospatial


RASTER   VECTOR

- For those that use grids, what type of grid are you using?

  - Raster data?
  - Shape
    - Rectangle/quadrilateral? Hexagonal?
  - Size?
    - 1km? 5km?
  - Existing standard (e.g. DGGS or National Grid) or self-generated grid?

Square   Regular hexagon

Grids – use-cases

- If we produced grids, how would you use them?

- What use cases do you have for grids?

- What statistical data might be useful in a grid?

Grids – comparative geographies

- What is the smallest geography you frequently use?
  - Tracts? Block groups? Blocks? Other?
  - What statistical data do you use with these geographies?
    - Demographic/Housing characteristics or counts.
    - Business, Jobs, Employment characteristics or counts.
    - Socio-economic characteristics or counts.
    - Other?
  - What drawbacks or limitations do you find with these geographic units?

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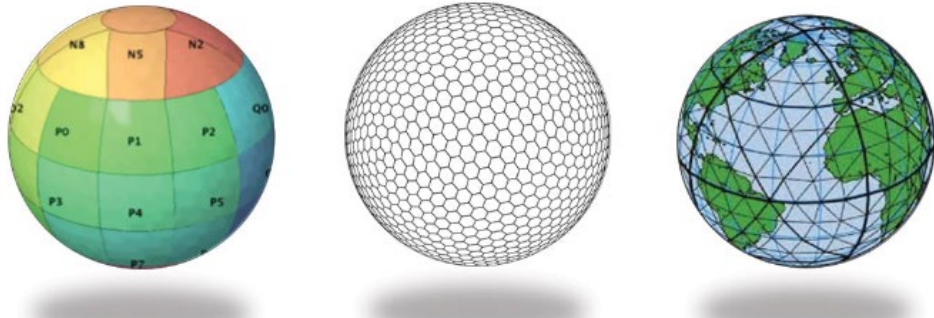U.S. Census Bureau GEOGRAPHY
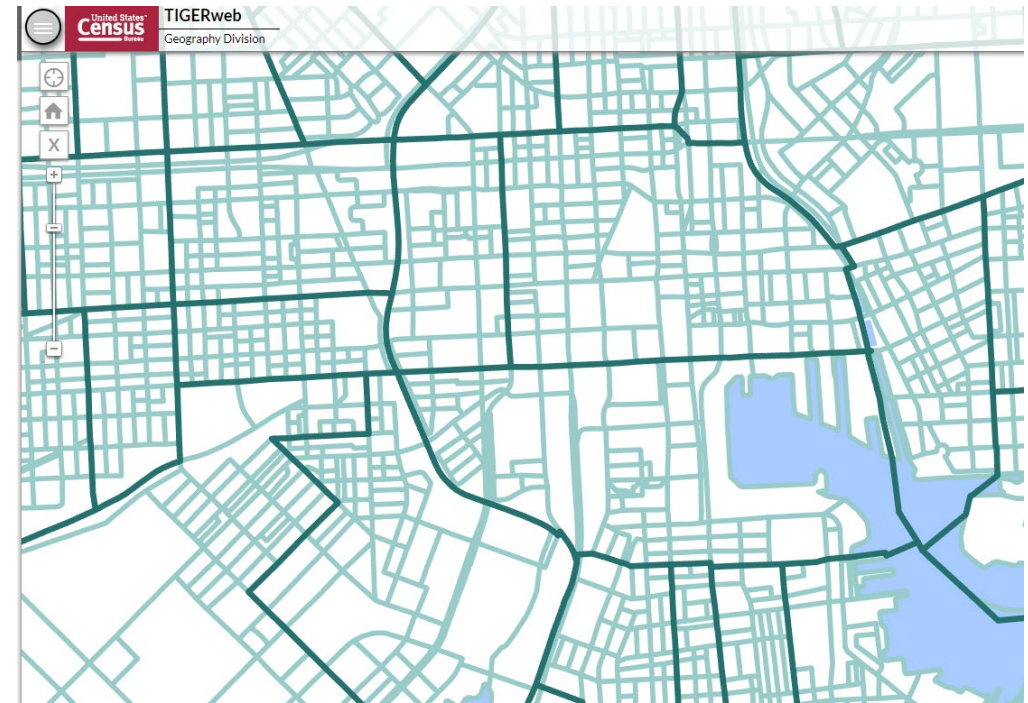
Final Discussion

- What final thoughts do you have about grids?

- What are your gridded data needs?

- What requirements would you like to communicate to us?

- Please share any final thoughts with us at **geo.grids@census.gov**

DGGS Advantages

- Each cell has unique address (vs continuous coordinate systems).

- Greatly simplifies the definition of "here" in studies.

- Data of any type can be held in these cells.

- Integration of data is on-demand and virtually free (computationally).

- Cells are hierarchically organized allowing for rapid aggregation and decomposition.

- Works at every latitude including polar regions.

- OGC DGGS suite is leading candidate for adoption as global standard.